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TECHNOLOGY COMMERCIALIZATION REVIEW: AIMING AT A FRESHER PERSPECTIVE BASED ON PARTNERSHIP SYNERGY

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ABSTRACT

Technology commercialization is a complex process wherebyscientific/technological concepts transform into a new product or service introduced in market. Partnership synergy between technology stakeholders during commercialization appears to have been overlooked in academic literature. The paper explores this aspect and offers partnership synergy as a centerpiece of a new theoretical framework. First, theoretical cornerstones/sources of the most common concepts of technology commercialization are categorized and reviewed. Second, another set of literature is studied from viewpoint of concepts related to partnership synergy. Major drivers motivating stakeholders to act in unison, dynamic capabilities to gain andimplementation mechanisms to usefor achievingbest performance are identified. Finally, a theoreticalframeworkis proposed toconceptualize the relationships among partnership drivers, partnership synergy, resources and commercialization performance. Further analysis of this framework is proposed as a future research direction.

Keywords: Partnership, synergy, technology commercialization, technology success.

INTRODUCTION

Commercialization is a complex process by which a new product or service is introduced into the market, making it available for sale to potential users. Technology commercialization is particularly interesting, as it involves transformation of scientific/technological concepts into products and services for the benefit of people. Prior literature viewscommercialization as a complete process or cycle for introducing a new product into a market (Jolly, 1997). It also explains the required actions and decisions in getting a product to a given market (Clark and Wheelwright, 1993; Isabelle, 2004). Most academic literature on commercialization focuses on challenges of different enterprises, including business ventures to commercialize new technologies in various industries. McCoy et al. (2009) studythe role of the developers/builders to further develop the domain-specific commercialization model for residential construction products. There are research studies on commercialization of medical technologies (Scanlon and Lieberman, 2007;Tilney, 2003), nanotechnology (Hobson, 2009; Tolfree and Jackson, 2007), new food industry technologies(Horton, 1995), sustainable/renewableenergy(Balachandra et al., 2010) and many others. These studies have two things in common: (1) they all focus on success factors, actions, and decisions that influence technology commercialization in a particular field; and (2) they are conceptual in nature rather than empirical. Most of these studies emphasize the important role of governments in facilitating commercialization process (Caerteling et al., 2008;Kumar and Jain, 2003). They indicate that governments provide the technology infrastructure, which leverages the ability of companies and other technology stakeholders in a national innovation system to participate efficiently in the innovation process and contribute to the technology-based economic growth (Link and Link, 2009). However, it is clear that besides government there might be some other external stakeholders interested in fast and successful commercialization of various technologies. This leads to an important issue in technology commercialization – partnership synergies and their effects. In our perspective the largest gap in academic literature is that partnership and the level of synergy between different stakeholders of innovative technologies appear to have not been studied well.Meanwhile, synergy created by collaboration can be very powerful.Collaboration with diverse players/stakeholders, whose heterogeneous traits, abilities, and attitudes bring complementary strength to the table, may have the greatest potential for generating valuable internal and external resources (such as dynamic capabilities and implementation mechanisms) for companies and contribute to success of their commercialization activities.Yet cooperation and synergy do not happen automatically and whenever they occur, it is obvious that different stakeholders are somehow driven to act in such manner.

The objectives of this paper are as follows. First we review and summarize the existing academic literature on technology development and commercialization. Second, wesuggest a new commercialization theoretical framework that provides a fresh perspective of focusing on drivers, capabilities and implementation mechanisms, rather than just the process from idea/laboratory to production/sales. This framework benefits from such theories as: diffusion of innovations, partnership, dynamic capabilities, and resource based view of firms.Third, the role of partnership synergy in commercialization is explored and included in the proposed framework. All three objectives serve as breaking ground and pointing direction to future research on technology commercialization, the results of which could be especially helpful for those directly involved in it.

MATERIALS AND METHODS

This paper synthesizes the literature found in JSTORE and EBSCO/Business Source Premier databases. We first searched the database using the phrases “technology commercialization” and “partnership synergy” andselected the relevant results to review. The selection is based not on abstracts, but on studying the entire articles. The reviewed literature isgrouped in categories facilitating the objectives of this paper. In particular, scholarly works viewing commercialization as a single sequential process of phased actions and factor-influenced decisions, as well as considering other, expanded aspects directly related to such viewwere grouped in a separate category block. This literature was the first to be thoroughly reviewed and analyzed as cornerstones/sources of the currently most common concepts of commercialization as a whole, and technology commercialization as a somewhat distinctive variety of the latter. The synthesis suggests four concepts/categories: (i) New Product Development; (ii) Stage-Gate Model; (iii) 'From Fuzzy Front-End to Commercialization'which is closely interlinked with and combines the previous two concepts; and (iv) Theory of Diffusion of Innovation. The scholarly works are provided in chronological order of their publication and grouped with relevant concepts in Table 1 below.

Table 1: Reviewed Literature Considering Commercialization as an Action/Decision Process

Literature category block I: Cornerstones of the Common Perspectives on Technology Commercialization	
Concept/Category	**Literature**
New Product Development (NPD)	• Cooper and Kleinschmidt(1995) • Smith and Reinertsen(1998) • Ulrich and Eppinger(2004) • Harmancioglu et al. (2007) • Acur et al. (2010) • Millson and Wilemon (2010) • Brettel and Cleven (2011) • Chen et al. (2012) • Haverila(2012) • Kahn et al. (2012) • Sheng et al. (2013) • Melander and Tell (2014)
Stage-Gate Model	• Cooper (1994) • Murphy and Kumar (1997) • Cooper (2001) • Koen et al.(2002) • Cooper(2008)
From Fuzzy Front-End to Commercialization (closely interlinked with and combining New Product Development and Stage-Gate Model concepts)	• Calantone and Di Benedetto (1988) • Kleinschmidt and Cooper (1991) • Gupta and Wilemon (1990) • Urban and Hauser (1993) • Ali (1994) • Parry and Song (1994) • Freeman and Soete(1997) • Khurana and Rosenthal (1998) • Radas and Shugan (1998) • Shanker et al. (1998) • Zhang and Markman (1998) • Cooper (2001) • Cooper et al. (2002) • Daum (2001) • Ziamou (2002) • Foxon et al. (2005) • Koen (2007) • Verworn et al. (2008) • Bhuiyan(2011)
Theory of Diffusion of Innovation	• Rogers(1983) • Stalk (1988) • Capon et al.(1990) • Abrahamson (1991) • Sarkar (1998) • Blundell et al. (1999) • Morgenstern and Al-Jurf(1999) • Chen(2009)

The second block of academic literature consists of categories chosen based on their relevance to the theoretical framework of commercialization with partnership synergy as centerpiece, the idea of which was conceived earlier and shaped and developed during research.In this dimension, the academic literature was studied from a viewpoint of contained concepts that focus on, lead to or stem from partnership synergy in successful technology commercialization. The literature study resulted in identification of two main groups of relevant theories/concepts: drivers (internal and external) that bring about partnership synergy and valuable ends (or resources) gained by/made available to the partners/stakeholders through synergy. Along with the partnership synergy itself and its ultimate desired effect – i.e. commercialization success – these concepts served a basis for literature categorization in a second block.

Also, definitions of the mentioned concepts were derived from the scholarly works of the second literature category block. The above-mentioned concepts and theories suggested in the existing scientific literature were used to formulate constructs for the framework proposed in this study. These constructs are summarized in Table 2, along with their respective definitions and literature references listed chronologically.

Table 2: Literature Reviewed for Identification of the Framework Constructs with Definitions

Literature category block II: Constructs for a Proposed Theoretical Framework of Technology Commercialization Success Based on Partnership Synergy		
Construct/Category	**Definition**	**Literature**
Category 1: The Ultimate Outcome – Commercialization Success		
Commercialization success including:	The successful creation of self-sustaining markets that thrive – without any favor – in a level playing field with other competing technologies	• Siegel et al. (1995) • Kollmer and Dowling (2004) • Lockett and Wright (2005) • Balachandra (2010) • Millson and Wilemon (2010)
Time Performance	Developing and launching the product to the market in timely manner	• Stalk (1988) • Gupta and Wilemon (1990) • Rosenau (1990) • Karagozoglu and Brown (1993) • Stalk and Webber (1993) • Kleinschmidt and Cooper (1995) • Siegel et al. (1995) • Cohen et al. (1996) • Shanker et al. (1998) • Smith and Reinertsen (1998) • Zhang and Markman (1998) • Pries and Guild (2007) • Chen (2009)
Financial Performance	Quantifiable measures indicating current and future financial results of the technology commercialization.	• Tobin (1969) • Montgomery and Wernerfelt (1988) • Archibugi (1992) • Chung and Pruitt (1994) • Kleinschmidt and Cooper (1995) • Jose et al. (1996) • Ahuja and Katila (2001) • Ernst (2001) • Corbett et al. (2005) • Lin et al. (2006) • Adams et al. (2009) • Xin et al. (2009)
Category 2: Resources		
Resource-Based View (RBV)	Companies possess the combination of productive resources that can be utilized to create value and competitive advantage.	• Penrose (1959) • Nelson and Winter (1982) • Wernerfelt (1984)

		• Dierickx and Cool (1989) • Barney (1991) • Grant (1991) • Teece et al. (1997) • Barney (2001) • Rugman and Verbeke (2002) • Boccardelli and Magnusson (2006) • Kleinschmidt et al. (2007)
Category 2.1: 'Resource' to gain: Dynamic Capabilities		
Dynamic Capabilities, including:	Ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environment	• Teece et al. (1997) • Eisenhardt and Martin (2000) • Lado et al. (1992) • Chang (1996) • Leonard-Barton (1995) • Henderson and Cockburn (1994) • Dyer and Singh (1998) • Ettlie and Pavlou (2006)
Absorptive Capacity	Stakeholders' commercialization capability to recognize the value of new knowledge, assimilate it and apply it to commercial ends	• Cohen and Levintal (1990) • Zahra and George (2002) • Zollo and Winter (2002) • Ettlie and Pavlou (2006)
Coordinating Capability	Stakeholders' commercialization capability to synchronize resources and tasks to improve the performance of the commercialization activity	• Crowston (1997) • Ettlie and Pavlou (2006)
Collective Mind	Stakeholders' ability to heedfully integrate their diverse and unrelated resources into a collective system through contribution, representation and subordination	• Weick and Roberts (1993) • Ettlie and Pavlou (2006)
Category 2.2: 'Resource' to gain: Implementation Mechanisms		
Effectiveness of Implementation Mechanisms including:	The degree to which all the innovative implementation mechanisms contribute to the success of commercialization of technologies.	• Wonglimpiyarat (2005) • Butler and Gibson (2011) • Jemala (2012)
Financial mechanisms	Leasing, Micro-Credit, Venture Capital, Loan Guarantee, CVC	• Boekholt (1996) • Sonntag-O'Brien and Usher (2004) • Demirguc-Kunt and Maksimovic (1999) • Beck et al. (2004) • Bis (2009) • Fulghieri and Sevilir (2009) • Balachandra et al. (2010) • Wonglimpiyarat (2013)
Incentive mechanisms and Regulatory policies	Steps taken by government to create favorable conditions for and directly or indirectly promote development and use of technologies.	• Ring and Perry (1985) • Dalpe et al. (1992) • Lerner (1999) • Edquist et al. (2000) • Norberg-Bohm (2000) • Shapiro (2001) • Salmenkaita and Salo (2002) • Dahlstrom et al. (2003) • Cobb and Gates (2004) • Le Flanchec (2004) • Edler and Georghiou (2007) • Balachandra et al. (2010) • Czarnitzki et al. (2011) • Song (2011) • Graetz and Doud (2013) • Rose (2013)
Category 3: The Centerpiece of the Proposed Framework		

Partnership	A dynamic relationship among diverse actors, based on mutually agreed on objectives, pursued through a shared understanding of the most rational division of labor based on the respective comparative advantages of each partner	• Prestby et al. (1990) • Alter and Hage (1993) • Goodman and Wandersman (1994) • Kellner and Thackray (1999) • Kreuter et al. (2000) • Mitchell and Shortel (2000) • Roussos and Fawcett (2000) • Lasker et al. (2001) • Brinkerhoff (2002a) • Pongsiri (2002) • Weiss et al. (2002)
Partnership Synergy	The power to combine the skills, resources and perspectives of a group of people and organizations, the value outcome of which is greater than the sum of its parts.	• Best (1989) • Mayo (1997) • Shannon (1998) • Lasker et al. (2001) • Weiss et al. (2002) • Krishna (2003) • Camilleri and Humphries (2005) • Jones and Barry (2011)
Category 4: Drivers to Partnership Synergy		
External and Internal Drivers	External and internal factors that are likely to stimulate technology development	• Saltman and Figueras (1998) • Lee et al. (2001) • Painuly (2001) • Ruttan (2001) • Pongsiri (2002) • Foxon et al. (2005) • Kobos et al. (2006) • Caerteling et al. (2008) • Puga and Lesser (2009) • Basaglia et al. (2009) • Chen (2009) • Brunnschweiler (2010) • Marques and Fuinhas (2011) • Alagappan et al. (2011) • Jagoda et al. (2011) • Alishahi et al. (2012) • Mouraviev (2012) • Yi et al. (2012) • Zailani et al. (2012) • Leenders and Chandra (2013)

Finally, the above constructs were organized in a theoretical framework, including the suggested directions of links between them.

Technology Commercialization Literature Review and Analysis

New Product Development

New product development (NPD) is a term used to describe the complete process of bringing a product to market (Ulrich and Eppinger, 2004). Consistent and regular introduction of new products is important for the success of many companies. There are various factors deemed important in the NPD process, among which the following are often noted: the speed with which product developers produce new products and bring them to market (Millson andWilemon, 2010; Sheng et al., 2013;Chen et al., 2012), because it provides afirst-mover advantage for obtaining and retaining a large share of the market and increasing sales(Smithand Reinertsen, 1998); the degree of integration among the various groups participating in the NPD process (Brettel and Cleven,2011;Melander and Tell, 2014); the proficiency with which the product developers perform their tasks (Acur et al., 2010;Millson and Wilemon, 2010); and the degree of success attained upon the completion of the NPD process (Millson andWilemon, 2010).Based on their motivation for rapid processing of new product development, companies determine which tools/designs to use and how vigorously to apply them (Smith and Reinertsen, 1998, Harmancioglu et al.,2007), as well as which best practices to follow (Kahn et al., 2012). Hence, companies investing heavily in NPD often follow procedures set beforehand. These procedures may vary from industry to industry and even from company to company, but most commonly the NPD process involves idea generation, product design and detail engineering, market research, and marketing analysis (Smith and Reinertsen, 1998). To make a final decision on investing in new products, managers of the companies need to evaluate the costs and benefits of any particular NPD project. They face this dilemma at different stages of product development. Since companies put a lot of resources into various NPD projects, they would like to know which projects have more potential for success. The Stage-Gate Model, developed in 1984 by Robert G. Cooper, became a popular tool for evaluating new product development projects, helping many companies to use their resources more efficiently.

Stage-Gate Model

The Stage-Gate Model is a conceptual and operational roadmap for moving innovations from idea to launch. It is designed to manage the new product development so as to improve overall effectiveness and efficiency (Cooper, 2008). The model divides the NPD process (or any other project) into stages where the project team undertakes the work, obtains the needed information, and does the subsequent data integration and analysis. Each stage is followed by gates where there are four types of decisions to be made: go, kill, hold, or recycle.

The traditional stage-gate process has five stages and five gates (Figure1): preliminary investigation (scoping), detailed investigation (building a business case), development, testing and validation, and full production and market launch (Cooper, 1994).

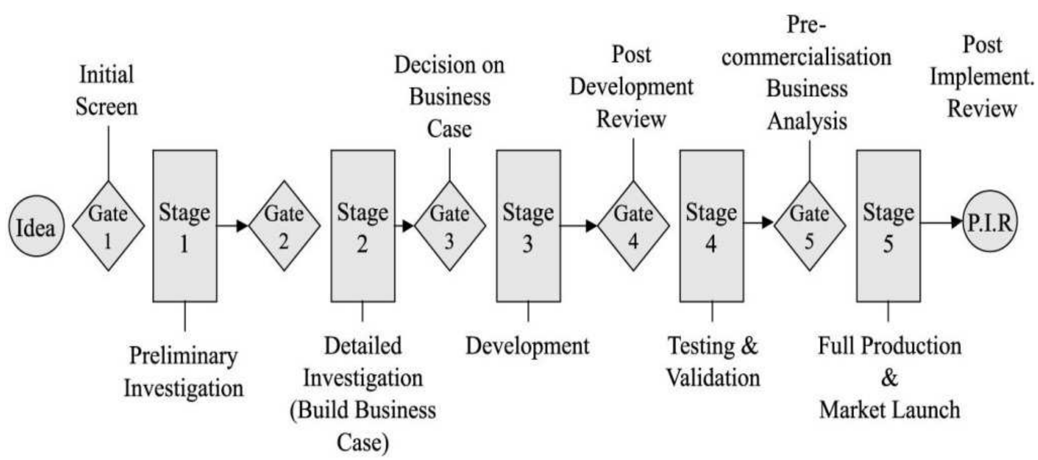

Fig. 1: Stage-Gate Model (source: Cooper, 2001)

These stages can be grouped into three major areas: fuzzy front end, structured new product development process, and commercialization (Koen et al., 2002). In the new product development processes, the 'fuzzy front end' refers to the chaotic 'getting started' stage where scoping and building a business case is involved. It roughly covers the period from generation of an idea to its approval for development or termination (Murphy and Kumar, 1997). Commercialization is the final stage of the new product development process where the actual launch of a new product into the market takes place, but it has received less attention from researchers.

From Fuzzy Front-End to Commercialization

Continuous introduction of new products plays an important role in building competitive advantage and can contribute significantly to a firm's growth and profitability (Ali, 1994;Calantoneand Di Benedetto,1988; Kleinschmidt and Cooper, 1991). For many companies, the speed of new product development is a central component in their competitive strategy (Radas and Shugan, 1998;Shanker et al., 1998; and Zhang and Markman, 1998). Time to market is strongly associated with competitive advantage (Gupta and Wilemon, 1990). As life cycles shorten and technological and competitive environments change fast, companies need to introduce new products as quickly as possible andensure customer needs are met (Verworn et al., 2008). Otherwise, these efforts are certain to fail. Since the fuzzy front-end of new product development process has a key role in deciding which project to initiate, the most attractive product idea needs to be decided in the beginning for resource allocation. This dilemma is the most difficult one for managers, who describe front end as the greatest weakness in product innovation (Khunara and Rosental, 1997). To handle this problem and to ensure they will always have new products to launch in a given time period, and pressured by customers and company's own sales force,most companies initiate too many NPD projects. Consequently, scarce resources are spread among too many projects and impactingparticular projects'work quality (Cooperand Kleinschmidt, 1995). Once a project is launched there is often no mechanism to "kill" it (Cooper et al., 2002) if it proves inefficient/ineffective. Several authors emphasize the importance of screening new product ideas in the early stages of developmentto allow innovative companies save their scarce resources and spend them on more valuable projects (Cooper,2001, Bhuiyan,2011). They have introduced several techniques, including the Stage-Gate Model, which incorporates all possible outcomes of management decisions in each event. For example, Daum (2001) proposed the net present value (NPV) of each decision starting from final year of the evaluation phase and going backward. The highest NPV alternatives automatically get a "Go." Currently, most companies use the Stage-Gate Model to manage the product development process, typically using five stages and five gates (Figure1). They consider fuzzy front end to entail the first two stages completed at Gate 3 with a business plan that includes product specifications and detailed business and financial analysis (Koen, 2007). Thus, early reduction of the number of projects reduces market/technology uncertainty and positively impactsNPD success (Verworn et al., 2008).

Although most authors did not specify what 'new product development success' means, it can be assumed that it is the successful commercialization of developed technologies, which is the last stage in Stage-Gate Model (Cooper, 2001). Before a new technology reaches the commercialization stage, it passes through different points in the innovation process. Foxon et al.(2005)define the innovation process as clearly identified stages in development of new technologies from research and development, demonstration, and commercialization to diffusion. This report describes the NPD as a procedure of matching technical possibilities to market opportunities, including multiple interactions and types of learning. It is assumed that the success of new product development depends on the knowledge accumulated from the projects “killed” in early stages, as well as external framework conditions (government, investors, etc.) (Freeman and Soete, 1997). Figure2 provides the innovation chain stages different from the traditional Stage-Gate Model. It shows the major conventional drivers of the innovation chain—from technology push (R&D) to market pull (customer demand)—which can be supported by feedback from different stages and by the influence of other players, such as government, investors, and other stakeholders in the industry where innovation occurs (Foxon et al., 2005).

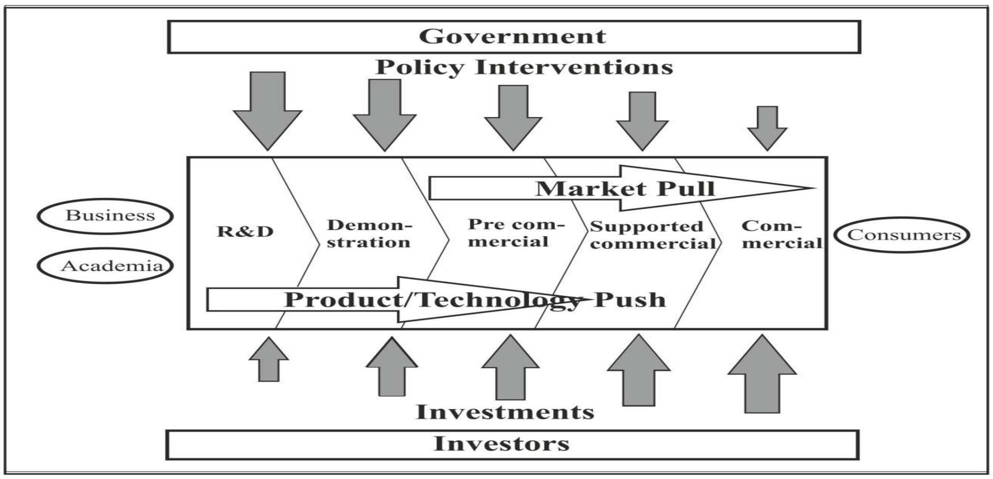

Fig. 2: Stages of the Innovation Chain (Source: Foxon et al., 2005)

According to Figure 2, regardless of where the innovation occurred, academia or private business,when a newly developed product passes the demonstration stage it falls into pre-commercial stage where two different forces—push and pull—interact. Here the overall success of a new product introduction depends on the ways the company promotes a validated technology, facilitates customer demand, utilizes the existing incentive mechanisms, and persuades investors to participate in commercialization of technologies.Successful commercialization of new technologies is the riskiest and most rewarding form of NPD activity (Ziamou,2002).

As seen, the successful commercialization of new technologies is no less important than the Fuzzy Front End; however, it has received less attention in academic literature. The general notion of these studies is that the NPD process is comprehensive and characterized by professionalism throughout.Especially in terms of selection of new ideas, development (Parry and Song, 1994) and market introduction (Schmalen and Wiedemann, 1999) have positive effects on the success of new products (Parry and Song, 1994; Griffin, 1997). There are also some studies that point to high failure rates of new products at the commercialization stage (Urban and Hauser, 1993). Therefore, it is crucial to find out whether the NPD process is aligned with the customer’s needs and the market (Cooper and Kleinschmidt, 1995), emphasizing the importance of market orientation for the NPD’s success (de Brentani, 1989). The studies on the success factors of the NPD process often ignore the fact that a technology can be developed by one entity, but commercialized and owned by a different entity (Balachandra et al., 2010). Yet this is acritical issue that needs to be considered while studying the NPD process. For example, a government-sponsored research institute or a university that is market-oriented could develop a new product and successfully demonstrate it. However, they will hardly be able to commercialize it if no interest is shown by private companies/startups or entrepreneurs. This leads to a conclusion that the stage-gate process or innovation chain might involve different organizations (stakeholders of the technology), thus making one of the gates a transition point from one business entity to another. In most cases such transitions occur at the gate leading from demonstration to pre-commercial (Figure2). The academic literature pays little attention to technology transfer from new product developers to private business entities that compete for technology in open markets (Pries and Guild, 2007). Balachandra (2010) argues that in the transition between the demonstration and commercial phases, there is a 'Valley of Death' where the cost of production is high and the market penetration is low (Figure3). The 'Valley of Death' refers to the gap between the technology development stage and its commercialization.

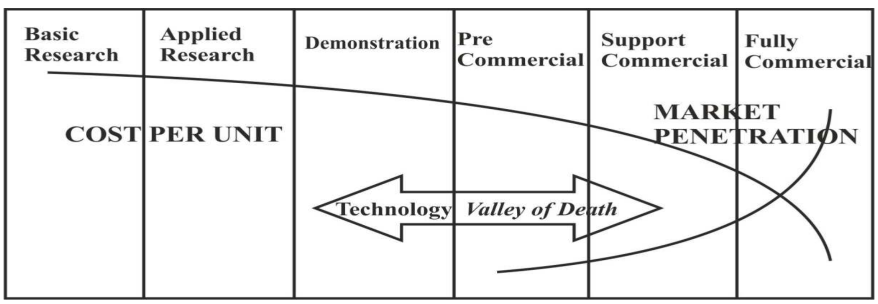

Fig. 3: Technology 'Valley of Death'

Many newly developed products never emerge from this valley and go out of business. The partnership synergy between different stakeholders is crucial for the technology to emerge from the 'Valley of Death' as it boosts the joint effort to help the technology to become commercialized.

Some studies highlight not only economic, but also social and political factors to be considered when studying technology commercialization (Das and Van de Ven,2000). It follows that, to be commercialized or adopted, a new technology needs to go through a diffusion process by which, over time it spreads through different communication channels among different political and social groups (Rogers, 1983). Understanding the factors that influence adoption of new technology would help technology developers identify the factors that facilitate the diffusion (Balachandra et al., 2010). To better understand the commercialization process and be able to develop its systematic and prescriptive model, the literature on the diffusion theory of innovations needs to be reviewed.

The Theory of Diffusion of Innovation

The diffusion theory was first introduced by Everett Rogers, a professor of rural sociology, in 1962. He synthesized research from many diffusion studies and produced a theory for the adoption of innovations among individuals and organizations. The main elements of the diffusion of innovations process were described by Rogers (1983) as: an innovation communicated through certain channels, over time, among the members of a social system. Sarkar (1998) defined technology diffusion as a mechanism that spreads "successful" varieties of new technologies through economic structures and displaces the existing "inferior" varieties. He provides a clear distinction between the process of new product development and commercialization, stating that, while the processes of invention and innovation are necessary preconditions for new technology development, it is the process of diffusion that determines the extent to which the new technology is put into productive use.

According to Rogers (1983), technology diffusion is typically modeled as an S-shaped curve over time (Figure 4).

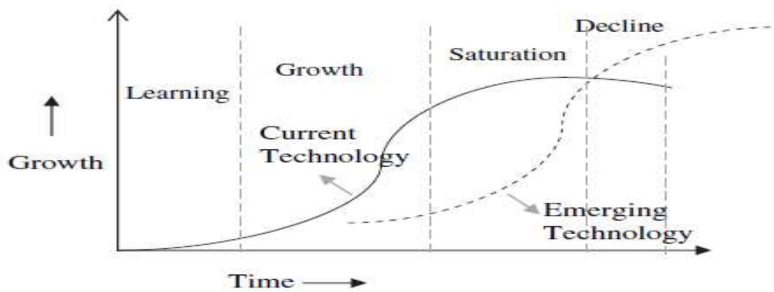

Fig. 4: S-curve of Technology Diffusions (source: Rogers, 1983)

Each new technology undergoes four phases: learning, growth, saturation, and decline (Rogers, 1983). Each technology starts declining at the saturation stage, when a newer technology that is more efficient gains wider acceptance. This process repeats with each new technology entering the market. He also outlined five different stages of technology diffusion over time:

Knowledge—potential technology adopters learn about it.

Persuasion—people are persuaded to believe in its advantages.

Decision—adopters decide whether to acquire it or not.
Implementation—consumers decide to make a purchase.
Confirmation—if satisfied, consumers continue using it.

Since individuals have different degrees of willingness to accept a technology, Rogers (1983) segregated the population of adopters into five segments: innovators, early adopters, early majority, late majority, and laggards (Figure 5).

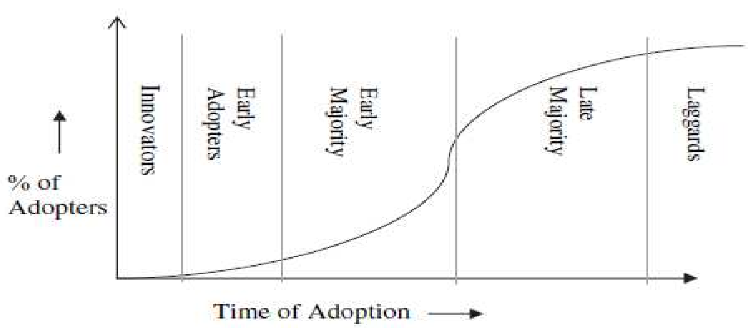

Fig. 5: Rate of Adoption of Innovation

In early stages, the adoption rate of new technologies is slow. The probability that an early majority will adopt the technology increases with its growing popularity. This is because more consumers will increase their knowledge and confidence in the newly developed technologies (Morgenstern and Al-Jurf, 1999).

Yet as it has been duly noted and analyzed by Abrahamson (1991), such process of innovation diffusion does not guarantee or even imply that in practice only the most efficient innovations will prevail or that inefficient ones will be rejected. Moreover, if viewed from a company's prospective, some other major questions remain (Chen, 2009), such as:

- What are the major factors that accelerate the adoption of new technology by early majority?

- Are there enough resources allocated to the commercialization of the company's technology assets?

- Do investments in commercialization pay off in terms of bottom-line financial performance?

Continuous development and market introduction of new technologies requiresto shortenthe technology diffusion time cycle (Blundell et al., 1999;Capon et al., 1990). In today's world, the time-based requirements for the diffusion of new technologies are becoming major determinants for competitive success (Stalk, 1988). Kleinschmidtand Cooper (1995) indicated that time performance along with financial performance are the key variables of new product development success, and hence, also commercialization success. Therefore,we review another set of literature on time performance and financial performance.

Time Performance

In the contemporary business environment, one of the key problems companies face is their inability to move new products into the market fast enough (Stalk and Webber, 1993). The speed of commercialization of new technology becomes a central component of their business strategy (Shanker et al., 1998; Zhang and Markman, 1998). The existing literature on the speed of new technology development is quite rich; however, no differentiation is made between the speed of NPD and the speed of commercialization. In general, the abundance of research on NPD speed indicates the importance of the subject to the academic and business communities. One of the most significant works in this field was done by Smith and Reinertsen (1998). The main focus of their study is on the time cycle of the new product development process. They argue that the general belief that a fast time in getting to the market is universally good is not correct. In today's competitive environment it is vital to know how much a reduced time cycle would cost a company. This means companies that buy time cycles at the right prices will win the race for customers (Smith and Reinertsen, 1998).
Cohen et al. (1996) focus on the influence of a rapid introduction of new products into the market on the product's performance. Cohen et al. (1996) build an analytical model that explicitly examines the tradeoff between product performance and the time it takes to get it to the market. On one hand, shortening the time for development may impact the quality of product performance.On the other hand, a longer product development time will shorten the

amount of time remaining for the firm to collect high margins on the new product before the opportunity window closes.

Regardless of all these concerns, in a greater part of the literature reviewed,the time to market issue is strongly associated with competitive advantages and higher profitability (Karagozoglu and Brown, 1993; Stalk, 1988). Gupta and Wlemon (1990) outlined increased competition, rapid technology changes, and changing market demands as the major drivers for the new technology's rapid introduction into the market. This helps companies improve their profitability, create an opportunity to charge premium prices, and allow utilizing the advantages of development and manufacturing (Rosenau, 1990; Smith and Reinertsen, 1998). Smith and Reinertsen (1998) recommended some tools to apply through development process to improve time performance. These tools used in organizational system are designed to compress the schedule, organize a team, facilitate communication, control the process, manage the risk, etc.

Interestingly, the majority of the studies are based on literature reviews, scattered cases, and anecdotal evidence. They all conceptualize the NPD speed as the pace of development activities that occurs between idea generation and its introduction to commercial market. Our literature review did not identify any comprehensive study which would focus on time performance of commercialization. Only Siegel et al. (1995) provide a conceptual framework for the speed of technology commercialization, where cooperation is indicated as the most essential factor for acceleration. They recognized that 'lots of new technology and know-how existed in North American and European companies, but not enough was getting out of the door and creating new revenues, profits, and jobs' (Siegel et al., 1995). Pries and Guild (2007) also pointed out that there are many other technologies "sleeping" in university and government laboratories. Lack of knowledge about business environment, insufficient commercialization experience, and scarcityof financial resources are pointed out as the major problems to commercialize these technologies (Chen, 2009). Cooperation between different technology stakeholders will help companies overcome these problems and accelerate technology commercialization (Siegel et al., 1995). According to Chen (2009), 'commercialization speed refers to the extent of the competence in developing and launching the product to the market in timely manner'. In this work,however, the speed of the commercialization is defined as the pace of bringing new technology from its pre-commercial level to a fully commercial one. Such definition shifts the focus to commercialization itself and seems more appropriate for technologies requiring no further testing or validation.

Financial Performance

Management studies on NPD and innovation have long been struggling with the performance measurement of innovative companies. Both generally available measures—e.g. R&D inputs, patent counts, patent citations, or counts of new product announcements—and more specific survey-based measurements of performance by companies have been used in trying to capture innovative performance of companies (Ernst, 2001). This broad assessment of innovative performance overarches the measurement of all stages from R&D to patenting and new product introduction. It focuses on both the technical aspects of innovation and the introduction of the new products into the market, but excludes the possible economic success of innovations (Archibugi,1992; Ahuja and Katila, 2001). There are traditional, quantifiable measures that well-established companies or industries use to gauge or compare financial performance in terms of meeting their strategic and operational goals. These measures include, for example, net income, sales, sales per share, market share, return of investments (ROI). Some studies (Corbett, 2005; Xin et al., 2009) use three profitability performance measures: return on assets (ROA), return on sales (ROS), and sales growth. Since the commercialization of new technology requires a lot of financial resources (Chen, 2009), many high-tech new ventures have negative cash flows on their way to full commercialization. This may not reflect the actual market value of the company. Therefore, these traditional financial performance indicators, except for the sales growth, are not applicable in measuring performance of such companies. A market-based measure of financial performance is better to apply to the companies in question (Adams et al., 2009).In many studies, Tobin's *Q* was used as an indicator of a company's long-term performance (Montgomery and Wernerfelt, 1988;Chung and Pruitt, 1994; Jose et al., 1996; Lin et al., 2006). Unlike the traditional short-term financial performance measures (ROI, ROA, ROS, etc.), Tobin's *Q* reflects expected future earnings and captures the lag between investments in NPD and commercialization and realized benefits (Dushnitsky and Lenox, 2006). It also represents a longer-run equilibrium measure capturing both the risk and return dimensions (Jose et al., 1996). This financial performance measure appears best applicable to companies that are on their way to commercializing technologies. However, one should exercise caution in distinguishing technology company performance and commercialization success of a technology, as in the latter case Tobin's *Q*might not be applicable.

As a result, to be able to apply traditional financial measures, most technological R&D companies look into individual product commercialization projects. Once a technology is developed and moved into commercialization stage, in order to be financed it needs to provide estimated acceptable level of ROI, ROS, ROA or other financial measures, which still have to be realized in the future. Without this the company would not be able to raise funds in each next round of financing for commercialization. Therefore, in the suggested theoretical framework the financial performance focus would be on the companies' measurable ability to attract financing for an individual commercialization project.

Resource Based View (RBV) of the Firms

The RBV argues that companies possess the combination of productive resources that can be utilized to create value and competitive advantage (Penrose, 1959). The more valuable and rare the resources are, the greater the advantages the companies obtain (Dierickx and Cool, 1989). While studying the resources of sustained competitive advantage, Barney (1991) looked into the relationship between a company's resources and its competitive advantages. He assumed that all the resources of strategic nature, which are distributed across the companies, are heterogeneous and thus make each competitor different from others. Besides being valuable and rare, the resources also need to be non-substitutable and non-replicable (Barney, 1991; Grant, 1991; Rugman and Verbeke, 2002). A proper coordination and integration of resources stimulates the development of strategic capabilities and core competences (Nelson and Winter, 1982). Persistent superior performance can be achieved to the degree to which these competencies and capabilities are unique/rare, valuable to the customers, non-substitutable with similar products and difficult to imitate (Rugman and Verbeke, 2002).

Itshould be noted that the most fundamental studies on RBV of companies were conducted in 1980-1990s. The dominant stream of resource-based research was focused on a more static perspective, where resource configuration and acquisition were the main research interest (Wernerfelt, 1984; Barney, 1991; Grant, 1991). These researchers did not consider that over time resources can deteriorate depending on the nature of the resource and innovation rate of the industry (Boccardelli and Magnusson, 2006). Hence, the stock of resources accumulated over time needs to be substituted, improved or reinforced based on the innovative changes in the industry where innovation occurs. Additionally, the competitive advantage needs to be sustained through continuously accumulating firm-specific resources (Boccardelli and Magnusson, 2006). Moreover, Dierickx and Cool (1989) pointed out that only internally developed resources can generate sustainable competitive advantages, while the assets based on resources acquired in open markets can be easily replicated by competitors (although in some emerging industries they still can be a source of competitive advantage).However, according to Teece et al. (1997) accumulation of resources (both internal and external)is not enough to support a significant competitive advantage. The companies with timely responsiveness, rapid and flexible product innovation, many useful management capabilities to effectively coordinate and redeploy internal and external competencies, are the winners in the global marketplace (Teece et al., 1997).

Dynamic Capabilities

Dynamic capabilities are defined as 'the company's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environment' (Teece et al., 1997). For example, product development routines where managers combine varied skills and functional backgrounds to create revenue-producing products and services are dynamic capabilities. Similarly, resource allocation routines are also dynamic capabilities, helping distribute scarce financial or manufacturing resources within a company. Obviously, the role of these routines is to transform existing resources into new, functional competencies that better match the environment (Eisenhardt and Martin, 2000).

Chang (1996) proposed technological and marketing capabilities as the main resources enabling firms to achieve higher performances. Moreover, he provided evidence that there is a synergy effect of technology and marketing capabilities on a company's market share. Marketing capabilities include building privileged relationships with customers and suppliers, market knowledge, control over distribution channels, and a strong "installed" customer base (Lado et al., 1992). Technological capabilities include R&D intensity, technical knowledge, and infrastructure (Leonard-Barton, 1995).

In addition to these capabilities, Teece et al. (1997) pointed out organization capabilities as another source of competitive advantage. He proposed three distinct processes as part of organization capabilities—reconfiguring, learning, and coordinating/integrating. Among these processes reconfiguring is the most essential one for the outcome of dynamic capabilities (Henderson and Cockburn, 1994) and is particularly relevant to NPD where the new products are creative adaptations of existing ones. The existing functioning competencies can be reconfigured if new knowledge is created through the learning process (Zahra and George, 2002). Then effective coordination is implemented through resource allocation, task assignment, and activity synchronization (Crowston, 1997). Finally, these new configurations need to be integrated into the organization's functions (Zollo and Winter, 2002).

While earlier studies on dynamic capabilities have emphasized that competitive advantage results from resources residing within a single company, Dyer and Singh (1998) proposed that the company's critical resources can extend beyond the boundaries of a single firm. Their study focuses on the inter-firm capabilities of the companies, which can increase the company's performance by lowering the transaction costs, enhancing flexibility of their partnerships, and reducing their dependence on the environment.

Ettlie and Pavlou (2006) studied dynamic capabilities stemming from inter-firm partnerships during the joint NPD processes. They proposed three dynamic capabilities of inter-firm partnerships: absorptive capacity, coordination capability, and collective mind.

The concept of absorptive capacity was first introduced by Cohen and Levinthal (1990) and later was re-conceptualized by Zahra and George (2002) as a dynamic capability. Absorptive capacity reflects the inter-firm NPD capability to recognize the value of new knowledge, assimilate it, and apply it to commercial ends (Cohen and Levinthal, 1990). Coordinating capability reflects the inter-firm NPD capability to synchronize resources and tasks to improve the performance of the NPD activities (Crowston, 1997). Collective mind reflects the inter-firm NPD ability to heedfully integrate their diverse and unrelated resources into a collective system through contribution, representation, and subordination (Weick and Roberts, 1993).

Implementation Mechanisms

Implementation mechanisms for technologies seem to have receivedlittle much attention in literature and this is evident by other studies as well. For example, Jemala (2012) found out that the technology identification dominates, followed by technology commercialization, while the technology implementation phase is the least developed. Yet the importance oftechnology implementation cannot be underestimated:as studies of scholars from 13 countries (Butler and Gibson, 2011) suggest, proper implementation mechanisms in place supporting technology commercialization are crucial inprompting firms to do their own R&D.

Usingpredominantlycase studies and anecdotal evidences, prior research mostlyexamines three implementation mechanisms: innovative financial mechanisms, incentives, and policy instruments. These three mechanisms need to be viewed in terms of their effectiveness and impact on commercialization success. The effectiveness of implementation mechanisms is defined as the degree to which the innovative implementation mechanisms contribute to the success of commercialization of technologies. Also, since incentives and policy instruments are introduced by government, herein they are reviewed together.

Innovative Financial Mechanisms

Private and institutional investors are not always eager to provide the necessary risk-capital for technology related endeavors (Boekholt, 1996).Usually, technology projects have very high start-up costs relative to the expected monetary returns and lengthy pay-back periods (Sonntag-O'Brien and Usher, 2004). There are two major problems associated with financing the commercialization of technologies. First, technology companies need long-term loans (Demirguc-Kunt and Maksimovic, 1999), while lacking sufficient volumes of output with attractive returns. Access to bank loans is anespecially serious problem for small- and medium-size companies (Beck et al., 2004). Second, the limited access to financing for technology companies is attributed to the competition from older technologies, which have a longer track record, relatively lower up-front costs, shorter lead times, and often favorable political treatment (Sonntag-O'Brien and Usher, 2004). Balachandra et al. (2010) summarized some of the most applicable financial mechanisms that need to be available for supporting the commercialization of technologies:

Leasing – a flexible form of financing, where a company rents out its fixed assets against contractual payments.

Venture Capital – usually these are funds, which are ready to back risky investments against higher returns and will invest in producers of new technology that have difficulty raising capital elsewhere.

Micro-credit – are prepared to lend to the firms, which are ignored by conventional financial institutions.

Loan guarantee – government backed scheme to support small scale entrepreneurs.

Another noteworthy and innovative mechanism is analyzed by Fulghieri andSevilir (2009) – asthe level of competition increases, firms provide a higher level of financing for externally organized projects in the form of corporate venture capital (CVC). In CVC, strategic alliances are formed, where large, established firms organize their projects in collaboration with external specialized firms and provide financing for externally organized projects from their own internal resources.Bis (2009) focuses on the benefits and risks of project finance method,which allows the use of leverage in funding the project and in keeping the debt in the balance sheet as well as protects small companies by gaining bankruptcy protection through special project vehicles (SPV). However, he notes that difference in business model, riskiness of research, as well as time and money required for generating patents are among the risks of the method.

Interestingly, even in the financial mechanisms where private financers should seemingly dominate, the government role is increasing, especially in Asia. For example, Singapore and Thailand have adopted the government intervention approach in venture capital financing (Wonglimpiyarat, 2013).It is thus logical to examine the government role in providing incentives and setting up regulatory policy frameworks to support technology commercialization.

Innovative Incentive Mechanisms and Regulatory Policies

Incentive mechanisms and regulatory policies, in essence, represent a government intervention in markets. In many countries such interventions in technology commercialization are often justified by the following four rationales (Salmenkaita and Salo, 2002): (i) *market failure*: in the absence of effective markets for information, profit-seeking firms are likely to invest in R&D less than what would be socially optimal; (ii) *systemic* *failure*: lack of coordination and information/knowledge exchange between the private and public stakeholders, as well as their priority differences diminish the long-term performance of the innovation system; (iii) *structural rigidities/inertia*, inherent to institutions and technological enterprises; and (iv) *anticipatory myopia*, when actors in the innovation system do not attempt to foresee beneficial interventionopportunities, or do not act on the insights they possess.

There are many ways how government can intervene to improve the conditions for successful technology commercialization, among which, to name a few, are:

- Government may influencetechnology commercialization by regulating the allocation of resources and defining the nature and scope of property (Ring and Perry,1985; Rose, 2013).

- Various forms of tax incentives for technology companies, advanced technology manufacturing or purchase of technology products may significantly boost the companies' motivation (Cobb and Gates,2004; Graetz and Doud, 2013; Czarnitzki et al.,2011).

- A number of policy mechanisms exist through which the risks associated with new technologies can be made more manageable and uncertainties can be reduced (Dahlstrom et al., 2003;Le Flanchec, 2004).

- Setting standardscan affect market completion, such as the strict environmental standards in California (Shapiro, 2001).

- "Technology-forcing instruments"such as the introduction of minimum efficiency standards and labeling programscan greatly increase the diffusion of certain technologies, for instance, renewable energy(Balachandra et al., 2010).

- Government can sometimesbe the first adopter of newly developed innovations (Dalpe et al., 1992).

- Government is a large sponsor of technology commercialization through its financial support of R&D and new business development (Lerner, 1999).

- Government as a customer often has significant buying power, which affects market price. Similarly, public and collective procurement mechanisms along with systematic approach in demand side management may play a significant role in kick-starting commercialization or not letting it die at times of economic downturn (Edquist et al.,2000; Edler andGeorghiou, 2007).

- As new technologies often suffer from lack of awareness among potential customers, governments may help diffuse information through large scale campaigns, provided that such technology is considered to bring public benefits (Balachandra et al., 2010).

Apparently, during commercialization government can simultaneously support technology development and create new markets (Norberg-Bohm, 2000).

It is not guaranteed that incentive mechanisms and regulatory policies will definitely have a significant positive effect on successful commercialization of technologies, yet it does not mean they are useless (Balachandra et al., 2010; Song, 2011). The existence of these mechanisms and policies create ground for technologies to be commercialized. Thengovernments,along with all other stockholders, should actively play a greater role in increasing the effectiveness of these instruments to accelerate the commercialization process of technologies.

Partnership Theory

Brinkerhoff (2002a) defines a partnership as a dynamic relationship among diverse actors, based on mutually agreedobjectives, pursued through a shared understanding of the most rational division of labor based on the respective comparative advantages of each partner. Partnership with other players is pursued precisely because they have something unique to offer, whether it is resources, skills, relationships, or approvals. He measured partnerships in terms of mutuality and organizational identity. Mutuality includes the spirit of partnership principles and refers to mutual dependence that requires respective rights and responsibilities on each player's part (Kellner and Thackray, 1999). One of the factors that influence the partners' decisions to participate actively in a partnership is their perception of the relative benefits and drawbacks involved (Alter and Hage, 1993; Goodman and Wandersman, 1994). Partners who are more active in partnerships perceive that they gain significantly more benefits than those who are less active, and these benefits relate as much to their own mission and economic validity as to the partners' joint goals (Prestby et al., 1990).

Weiss et al. (2002) used the term partnership to encompass all types of collaboration (e.g. coalition, alliance, consortia) that brings people and organizations together to achieve mutually accepted goals. However, there is a general belief that building an effective partnership is time-consuming, resource-intensive, and very difficult, because collaboration requires relationships, procedures, and structures that can be quite different from the ways people and organizations worked in the past (Mitchell and Shortel, 2000). In order to find out if collaboration achieves its goals, researchers and evaluators have increasingly focused their attention on how a partnership is functioning (Lasker et al., 2001). Theyoutlined various aspects of how the partnership was functioning, such as partner participation, partner relationships, staff support, sufficiency and flows of resources, leadership, management, communication, governance, partnership structure, and external environment. The outcomes of this collaboration arrangement could be the effectiveness of partnerships, satisfaction of stakeholders, the sustainability of partnerships, and many other measures, which however, have been difficult to document due to a lack of valid indicators (Kreuter et al., 2000; Roussos and Fawcett, 2000). It is very important for the partnership in its early stage to determine if the partners are making the most of these collaborative efforts (Weiss et al., 2002). As of today, most studies have focused more on why partnerships form, while relatively little is known about how this collaboration works, and through which pathways partnership functioning influences partnership effectiveness (Lasker et al., 2001).To get these answers, the level of partnership synergy must be measured, since it is the primary characteristic of a successful collaboration process (Weiss et al.,2002).

Partnership Synergy

The power to combine the skills, resources, and perspectives of a group of people and organizations has been called synergy (Mayo, 1997). The synergy that a partnership can achieve is more than simply an exchange of resources and skills. When partners effectively merge all their resources, skills, and perspectives, a valuable outcome is achieved as a whole, which is greater than the sum of its parts (Shannon, 1998; Lasker et al., 2001).

A major study on partnership synergy has been carried out in the health care industry by Weiss et al. (2002). They, as well as some other authors(Lasker et al., 2002; Jones and Barry, 2011; Brinkerhoff,2002b)suggest that partnership synergy is an outcome of the partnership functioning, which makes collaboration especially effective. The results of these studies indicate that partnership synergy may be an important proximal outcome of certain dimensions of partnership functioning, for example leadership effectiveness and partnership efficiency.

Prior research explores some cases of partnerships between various organizations such as the partnerships between government and industry on R&D synergy (Best, 1989), university and industry (Camilleri and Humphries, 2005), local government, and community based organizations (Krishna, 2003). However, prior research does not provide much evidence on the partnership between different technology stakeholders. While trying to uncover how this partnership functions, it is essentialto understand what major drivers are behind each stakeholder to participate in this partnership arrangement.

External and Internal Drivers

The traditional concept of an autonomous private sector acting in pursuit of its own immediate goals, notably profit maximization, and a public sector, with discretionary powers and multiple objectives that relate to the pursuit of long-term goals in the public interest, has changed (Pongsiri, 2002).When reviewing governments' motivations in promoting a technology, the general benefits that technology brings to the economy and society need to be considered. Hence, the external factors in this work are represented by the benefits the technologies provide. Internal factors are individual company attributes, which negatively influence performance and drive the company to seek support from other stakeholders. Currently, public and private sectors have common interests and the balance between these interests can be reached only through partnering arrangements (Saltman and Figueras, 1998), such as Public-Private Partnerships. What are the major drivers, which bring together different stakeholders (public and private) of technology industries to achieve a partnership synergy to develop more effective mechanisms and skills required for successful commercialization of technologies? Depending on the industry, these drivers could differ. For example, Basagliaet al. (2009) underscore importance of coercive and fashion setters' pressure (i.e. external factors), and the pivotal role of perceived internal benefits (i.e.internal factors) in shaping intention to adopt VoIP technologies. In renewable energy (RE) and environmental technologies, domestic concern of energy security and international environmental concerns are mentioned as key drivers for the governments around the world to get involved in developing incentive mechanisms and regulatory policies to support RE and environmentaltechnologies (Georgiou, 1993; Kobos et al., 2006;Alagappan et al., 2011;Jagoda et al., 2011;Zahedi, 2011;Alishahi et al., 2012; Leenders and Chandra, 2013).Nevertheless, without active involvement of other public and private players in assisting the government to develop these mechanisms, the latter will not be effective (Balachandra et al., 2010). It is crucial to understand what each stakeholder is looking for in this collaboration with other stakeholders. On one side, there are companies directly engaged in technology commercialization. On the other side, there is the government which can act as a champion, thoughthere are also other stakeholders who can contribute to the success of a technology.

Caerteling et al. (2008) define government championship as supply-oriented policy to provide technical assistance, political support, and human resources for companies engaged in commercialization. The championship can create demand conditions for technology products among consumers. It is known that governments must be involved with dissemination of some technologies, because markets alone are ineffective in mainstreaming, while the motivation of the government is that some of the technologies represent strategic sectors that ought to require political and policy guidance (Marques and Fuinhas, 2011).

It is also interesting to consider the international perspectives regarding the external and internal drivers and their linkage in the context of technological companies abroad. For instance, in a study for emerging economies, Mouraviev(2012) concludes that in Russia and Kazakhstanpublic policy is the major driving force for public-private partnership development, while the value of money concept and transaction cost economics appear to be neglected.Using data from a sample of 132 EMS ISO 14001 – certified manufacturing firms in Malaysia,Zailaniet al. (2012) showed that externalinstitutional drivers influence a firm's environmental performance both directly and indirectly through its internal proactive environmental strategy. Lee et al. (2001) examined the influence of internal capabilities and external networks on firm performance through the study of data from 137 Korean technological start-up companies and distinguishedpartnership- and sponsorship-based linkages for performance. Based on data from a sample of 585 firms in China,Yi et al. (2012) concluded that the effect of external institutional environment uncertainty on radical innovation is significant, but formal corporate governance is not.All these studies point to drivers that make governments around the world support development of technologies and sometimes even mandate it, as has been the case withrenewable energy technologies (Puga and Lesser, 2009).Additionally, the deployment of technologies contributes to the creation of jobs and fuels local economies (Painuly, 2001), becoming key sources of economic growth, new employment opportunities and skills (Ruttan, 2001).From the company's perspective, the drivers to seek collaboration with government and other stakeholders are the high cost of technology and lack of necessary skills to commercialize these technologies (Margolis and Zuboy, 2006). Demirguc-Kunt and Maksimovic (1999) and Chen (2009) pointed out lack of financial resources to commercialize technologies as a major problem as well.

The motivation behind all other public and private stakeholders to contribute to the development of new technologies is somewhat scattered and not always empirically validated in academic literature. However, it is generally recognized that environmental, socio-economic and security benefits derived from various technologies are drivers for government involvement. As for privatestakeholders other than technology developers themselves (for example, financial institutions(Brunnschweiler, 2010), investment funds, etc.) commercialization of technologies creates more business opportunities.

RESULTS: THE PROPOSED THEORETICAL FRAMEWORK

Based on the aboveliterature review, it was concluded that there is notheoretical framework that directly links partnership synergy and commercialization success, and that in the existing theories/models their relationship can only be indirectly inferred (e.g. the technology 'valley of death').We also find thatmost of the relationships between internal/external drivers, partnership synergy dynamic capabilities, implementation mechanisms, and commercializationhave not been explored. This makes one believe that in the coming decade, upon gradual introduction of many new technologies into the markets (e.g. nano- and bio-technologies, new renewable/alternative energy technologies, advanced information and communication technologies, etc.), there is a huge opportunity for academicians in management science to fill this gap.The theoretical framework suggested in this paper is an attempt to fill the gaps.Figure 6 below presents the proposed theoretical framework with constructs derived from the review and analysis of the existing literature.

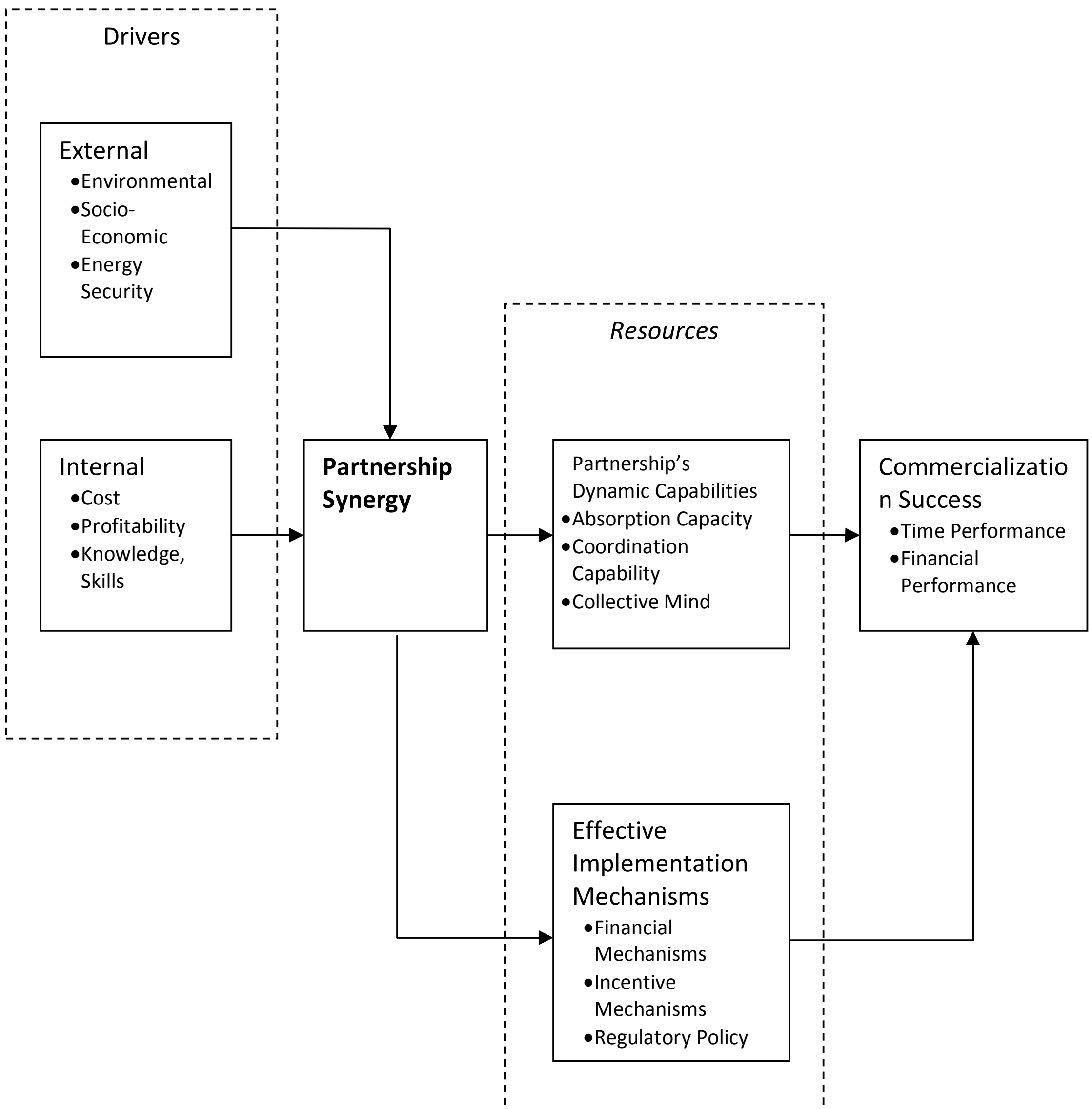

Fig. 6: The Proposed Theoretical Framework

Overall the proposed frameworkcan be conceptually formulated as follows:

(i) It is contended that success of commercialization for technologies, determined by time and financial performance, depends onthe use of what we call 'resources'. In the proposed framework resources include dynamic capabilities acquired through partnership arrangements between stakeholders and effective implementation mechanisms. Dynamic capabilities are the absorption capacity, coordination capability and collective mind, as they are defined in literature. The proposed implementation mechanisms involve financial and other incentive mechanisms, as well as regulatory policies.

(ii) Itappears logical (though yet to be confirmed by further research) that the above mentioned resources become available and/or work most effectively when partnership synergy is achieved between various stakeholders of a technology. This implies that higher levels of such synergy will lead toimproved dynamic capabilities and more enabling implementation mechanisms, which in turn contribute to commercialization success. Consequently, partnership synergy is considered a centerpiece for the proposed theoretical framework.

(iii) It is further argued that partnership between potential stakeholders and synergies stemming from it usually do not come by automatically, but rather are driven by certain external and internal factors. The suggested external drivers are environmental, socioeconomic and security concerns, while the internal drivers involve an entity's pursuit for lower costs, higher profitability and more knowledge/skills.

In summary, the proposed theoretical framework suggests that success in technology commercialization is a result of chain process drivers/partnership/synergy/resources/ commercialization success, and that once this process is initiated, partnership synergy is its most critical component. Further research appears necessary to explore and construe the links between the constructs in the proposed theoretical framework.

Besides the lack of integrative definition for partnership synergy phenomenon and a collective economic synergy theory, there appear to be no studies that integrate partnership synergy in a comprehensive commercialization theory. The introduction of such a theoretical framework related to stakeholders' partnerships is the end-result of this work. Other theories that the proposed framework brings together are the theory of diffusion of innovations, partnership theory, dynamic capabilities theory, and the resource based view of firms. The theory of diffusion of innovations provides a clear distinction between the process of new product development (invention and innovation) and commercialization. It is a process of diffusion that determines the extent to which the new technology is commercialized. Partnership theory describes collaboration as a process that brings stakeholders (people and organizations) together to achieve commercialization goals. Dynamic capabilities theory describes dynamic capability as a critical resource, which is the result of stakeholders' partnership. In a broader view, from RBV perspective, dynamic capabilities along with implementation mechanisms are the critical resources that the partnership possesses and that can be utilized to create value and competitive advantage to successfully commercialize technologies.

As a summary, this work combines the existing studies, which closely relate to the NPD process and introduces a new theoretical framework to research and validate, which addresses one of the least explored components on the five stages of the NPD model—

commercialization.Here, partnership synergy is seen as one of the key variables, which influences the rate of technology adoption and potentially addresses the questions Chen (2009) raised in his study that focus on major factors influencing technology adoption, resource allocation and potential investment payoff in terms of bottom-line financial performance.

CONCLUSION AND FUTURE RESEARCH PROSPECTS

Even though commercialization success in different industries is important for respective companies to be competitive and, at the same time, improve prosperity and quality of people's lives, there are priority areas for innovation and research where governments and societies anticipate major breakthroughs. These areas include, though are not limited to life sciences, information and communication technologies, renewable energy, nanotechnologies. Technologies are not commodities (despite their application may lead to production of commodities), and require involvement of different stakeholders, who directly or indirectly are impacted by the introduction of these technologies. Thus, besides companies involved in these industries, there are many other stakeholders concerned about getting new products into the market as soon as possible. In most cases for commercialization to be a success, it is critical to involve these stakeholders early in the process, as it may lead to partnership synergy.

Partnership synergy among technology stakeholders can have substantial effects on technology commercialization. Our literature review did not identify any major empirical research on technology commercializationfrom this perspective. Future research can build on this work to construct measurements that link partnership drivers with the level of stakeholders' partnership synergy, resources and outcomes and the first step to examine these links has been taken by creating the theoretical framework shown in this paper. Obviously, additional empirical data are needed to generalize the findings.

It has to be noted that theframework proposed herein has been tested by research for renewable energy technologies in a recently defended dissertation of one of the authors. For each of the proposed links in the framework several research propositions were developed, that were later confirmed or rejected through outcomes of four thorough case studies and 16 validity/reference interviews.The results provided a richer understanding of stakeholders' motivations to get involved in the project partnership in renewable technology commercialization projects. It was clarified how the achieved partnership synergy influences partnership's resource base and how this resource base affects time and financial performance of renewable energy technology commercialization.Given the similarities between renewable energy projects and other technology-based large projects, it is likely that the application of the framework extends to the technology development in large-scale infrastructural projects.Therefore, it is suggested that similar studies can be conducted for other technologies or the same industry, but with different methods.Particularly, the framework can be tested on individual stakeholders by conducting survey research with financers, project contractors, technology owners, policy makers, advocacy groups or the general public impacted by a technology project implementation. Thetheoretical framework formulated hereincould be a promising direction for future research that would help a broad array of people and organizations involved in funding and implementingtechnology projects to maximize the return on their investments, by realizing the full advantage of collaboration with other stakeholders.

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