Development of an innovative IPS2 model

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Abstract

High-tech companies invest R&D efforts into pacing technologies. R&D projects enable companies to respond to critical drivers for innovation and to R&D needs in technology domains to develop new IPS2.

This paper presents the Sustainable-Knowledge (S-K) model for innovation management in companies. This model focuses a new relation among R&D activities and the strategic driver of change towards new IPS2. This relation adds value to the technology-driven objectives within company's strategic innovation perspective, following the ManuFuture approach to speed up IPS2 time-to-market.

An industry case in the space sector is reported for the critical driver "Safety and Security".

Keywords

Knowledge economy, Innovation management, Production paradigm, CBA, Product-service system, Commercial feasibility

1 INTRODUCTION

In high-tech sectors, such as the aerospace industry, big companies invest R&D efforts into pacing technologies at different stage of development. The project-intensive approach targets the launch of new IPS2 that respond to emerging strategic needs and grand challenges. R&D projects, therefore, enable companies to respond to critical drivers for innovation - such as Energy and waste, Safety and security, etc - and to R&D needs in specific domains with the mid-long term objective to develop new product and service systems [1].

In this context, a new approach is needed to frame and integrate different findings emerging from multiple projects to identify a wide set of improvements that meet market expectations and technology development requirements. Now industry R&D projects mainly refer to technology management and report about different level of maturity of technological advancements. At present, each project follows or goes in parallel one another, according to a linear development from *pacing* technologies to *key* technologies. The projects target both new sustainable IPS2 and innovation of existing products/services in today's markets.

This paper[3] focuses this technology transition towards sustainable IPS2 in response to specific industry drivers.

A new model – life-cycle oriented – for managing multiple R&D projects can support to frame and integrate the knowledge development into a R&D value chain.

R&D results will be related to expectations arising from the critical drivers for change and to market expected impact.

A unique framework for this purpose is not yet in use in companies, but it is becoming urgency for competition, efficiency, cost savings, time to market, R&D return of investments and in the future scenarios for the sustainability evaluation of new high added value products/services.

This paper presents the Sustainable-Knowledge (S-K) model that relates the strategic objectives and R&D operational activities. This model follows the ManuFuture approach with the scope to speed up IPS2 high value added development.

The S-K model provides an innovative framework for innovation management in companies. It frames multiple R&D projects, carried on at company level or in collaborative partnership, into an industrial products-service response to socio-economic drivers of change and barriers. This framework represents a new relation among R&D activities – made of multiple projects – adding value to the technology-driven objectives within company's strategic innovation perspective. For each single driver of change, this relation enables to develop a streamline of knowledge generation considering also the multilevel perspective (MLP) of innovation.

In this paper, an industry case is also reported. It refers to R&D projects targeting the industry driver for innovation "Safety and Security" carried on by an important Italian company that operates in the space sector.

2 STATE OF THE ART

In the literature, the management of the innovation process of companies represents an important research area in enterprise studies.

The importance of management innovation raised in 80's-90's. Ray Stata in "Organisational Learning – The key to management innovation" affirmed that in many USA companies the bottleneck of the progress was recognized in and related to the management of innovation and not primary in the product and process innovation [2]. The first country that builds its growth on management innovation was Japan. Western economies, such as USA, Germany and Great Britain, based their progress on technological innovation [3].

In the last decade, management of innovation received serious academic consideration. A lot of approaches, models and methodologies emerged for managing

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projects, such as the Critical Chain Project Management (CCPM) [4].

In the context of project-based industries, Keegan and Turner pointed out the importance to manage the innovation rather than a project, revealing that innovation is considered more a cost than a value [5].

As Utterback and W.J.Abernathy teach, management innovation alone is not enough to guarantee the success and the growth of companies or countries. It depends on the circumstances in a particular industry [6]. In particular, technology transition not only involves changes in technology, but also changes in user practices, regulation, industrial networks, culture [7]. The co-evolution of technology and society should be focused in the analysis of innovation [8].

Three types of change have been defined for MLP: reproduction (incremental change along existing trajectories), transformation (change in the direction of trajectories), transition (discontinuous shift to a new trajectory and system) [9]. The importance to focus the long-term dynamics on management of innovation has been affirmed in the context of MLP for technology transition. This concept is adopted and developed by Genus and Cole [10] who argued that MLP may be rethought, enhancing understanding of processes of innovation affecting the transformation of technology and society. New approaches are developing taking into account the multi-level perspective of innovation and the interaction between the different levels of general management [11, 12].

In the engineering fields, such as technology management for innovation, the reports and contributions of CIRP proceedings – the Society for production research – and of European Technology Platforms – particularly the ManuFuture ETP – have opened a new interesting area for investigation on new approaches to IPS2 and – in mid term – to the next generation of high value added products/services [13, 14, 15, 16]. The innovation management and the technology development processes have been seen as business processes (together with the product/service system development process) for the Integrated Technology and Product-System Lifecycle Management [17].

The complexity of products-services development requires a new approach to the design phase of such systems. As R. Roy argues *"The design of PSS is a complex problem, and must meet the challenges of the changing financial and resource models that align with PSS strategy"* [18].

New methods and tools to evaluate new IPS2 since the design phase are required to assess the different elements and factors (social, economical, environmental and technological) that are included into IPS2 [19].

Paci and Chiacchio pointed out the importance to carry on an early impact assessment of new IPS2 evaluating the technology of future IPS2 compared with performances currently available. Through a new methodology, S-CBA, the technology at pacing level is analysed to investigate its potential impacts in terms of competitiveness and sustainability aspects [20].

On this area of sustainability evaluation of High Added Value Products [21] – in the area of Energy driver for sustainability - provided LCA methods for evaluation with insights to specific solutions for new High Added Value Products. They showed that technology replacement is not by definition a win according to eco-sustainability requirements, and different evaluations should be played.

The investigation of a new commercial environment for competitive IPS2 – which is particularly relevant for companies – has been recently proposed by Roy and Cheruvu [22]. It considers drivers the complex commercial environment area and the sustainable customer value and integrates all these elements into an IPS2 framework for industrial competitiveness.

3 INDUSTRY TRANSITION MANAGEMENT

The model presented in this paper aims to support transition management and evaluate impact on innovation achieved by a set of company's projects in the area of technological innovation. High-tech companies are now involved in many projects to innovate their industrial products and services systems. These projects differ for many reasons: the R&D needs, the field level of application, the technologies on which the products and services are built, the addressed market, the time horizon of innovation development, human resources whit related competences and capabilities etc. Fund rising and partnership are defined taking into account the R&D programmes at national, regional and European level.

However, they share a common specific industry driver of change that companies tries to respond to with R&D investment.

Therefore, due to the complexity in the current innovation path, a company requires a new approach to R&D projects management.

The new approach focuses the coexistence of reproduction, transformation and transition types of change.

The research approach describes three important aspects for IPS2 development:

- to integrate the efforts in implementation through R&D projects; this aspect strengths the value of innovation for business.
- to provide a streamline of knowledge generation to meet the needs of specific socio-economic factors and barriers adding value to the technology-driven project approach; this aspect strengths the R&D outputs towards the company strategic innovation objectives.
- to manage with a trajectory multiple projects as "steps forward" towards new IPS2, monitoring the transition through early impact assessment of innovation development; this aspect strengths the time-to-market of innovation.

This approach supports high-tech companies to be leader by investing in R&D in mid term horizon for the development of new industrial product-service system and to play the role of "innovator" in the market.

Therefore, this approach to transition management considers the sense of urgency of innovation to speed up IPS2 development with value innovation.

3.1 The model

The model proposed in this paper, called Sustainable-Knowledge model (S-K model), frames the combination between strategic objectives and R&D projects management.

The proposed model is not yet in use within companies that traditionally carry on several R&D projects targeting distinct features of specific potential technologies.

Therefore, the model proposes a framework for sustainability that unifies technological innovation and complex industrial / innovation strategic perspectives meeting R&D needs in specific domains, innovation drivers and market's and company's expectations (Figure 1).

Socio-economic factors for innovation, featuring each specific industry driver, could be estimated to target the preferred new IPS2 with investigations of consumers', companies' and stakeholders' needs. The socio-economic factors analysis will contribute to define and enable the competitiveness and sustainability of projects' outcomes and potential commercial feasibility of new IPS2.

Inside the S-K model, the operational environment, through R&D projects for transition innovation towards IPS2, plays a fundamental role to respond to the critical driver of change selected by the company for market development. To this end, the dynamic overall evaluation and the life-cycle technologies assessment – maturation from pacing to key technologies – resulting from multiple R&D projects is needed.

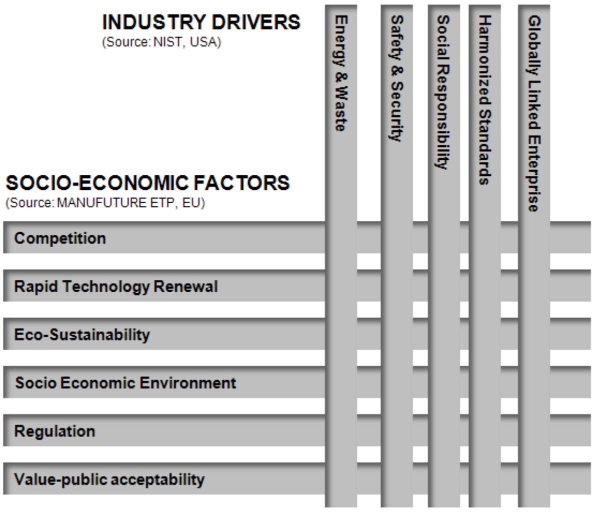

Figure 1: Sustainability framework for R&D projects for IPS2.

This maturation process is reported in a vertical representation to support the management and monitoring of R&D projects with related technological advancements. The figure below outlines the trajectory needed to achieve the company's preferred new IPS2 (Figure 2).

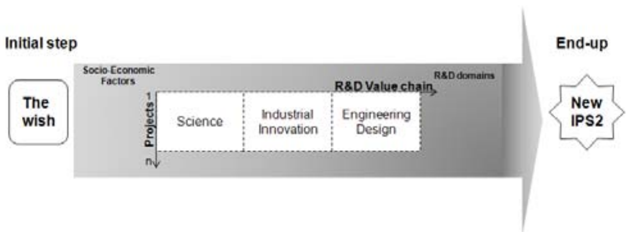

Figure 2: The R&D trajectory for new IPS2.

The base of the arrow represents the initial step and marks the company "main wish". This wish contains – in addition to market success – other values, such as improving the company image, a value expectation from society, citizens and environment.

The shaft of the arrow reports the distribution of R&D projects along the R&D value chain. The phases of the R&D value chain for new IPS2 are the following:

- Science phase refers to generic and applied technology research. The related projects, in general carried on with research institutes or universities, focus the potential of the technology in generic areas of services (mid-long time horizon).
- Industrial innovation phase refers to projects that focus on key technologies with a demonstration approach. These projects target new needs in specific area of services to get competitive advantages (short-mid time horizon).
- Engineering design phase refers to projects dedicated to the integration of key technologies in IPS2 (short time horizon).

In the shaft are also reported the socio-economic factors (for competitiveness and sustainability), interdependences and different R&D domains of R&D projects. In particular, the socio-economic factors play the role of constant at project and R&D value chain level.

At the arrowhead, the end up represents the market development of particular new preferred IPS system.

This environment (deeper represented in Figure 3) enables to manage efficiency in the R&D value chain and to relate all these achievements to the selected driver of change for time to market reduction. The interdependencies among R&D projects assume the role of indicator of efficiency in knowledge development.

Through this view it is possible:

- to assess the knowledge intensity in strong or weak areas of the R&D value chain that maybe influenced by socio-economic factors;
- to identify gaps in the innovation strategy of companies.

In fact, this environment supports high-tech companies to bond science and market, avoiding the following scenarios:

- many projects in the science phase and few projects in the engineering design phase: the risk is to loose today's markets;
- many projects in the engineering phase and few project in the science phase: the risk is to loose the leading position as "market innovator".

The S-K model proposed in this paper supports:

- flexibility due to evidence based technology;
- modularity to look at the broad spectrum of market and organizational issues;
- time to market of innovation;
- sustainability of new IPS2.

For these features, the Sustainable Cost Benefits Analysis (S-CBA) – presented in the last CIRP IPS2 Conference 2009 by the authors – contributes to this model. It allows the early impact assessment evaluating the short and mid term expectations of relevant stakeholders. The results of the S-CBA estimate the value of the R&D projects and, therefore, support the industry decision-makers for new IPS2 development responding to the main company's wish since the design phase of the IPS2 life cycle.

4 EXPERIENCES

The industry case reported in this paper refers to the activities carried on by the Technological Innovation team of Telespazio S.p.A., a Finmeccanica / Thales Company (www.telespazio.it).

This Italian company, leveraging on technological competences, facilities, participation in the main European Programmes (COSMO-SkyMed, Galileo and GMES) and on the "Space Alliance", is a world-wide player in:

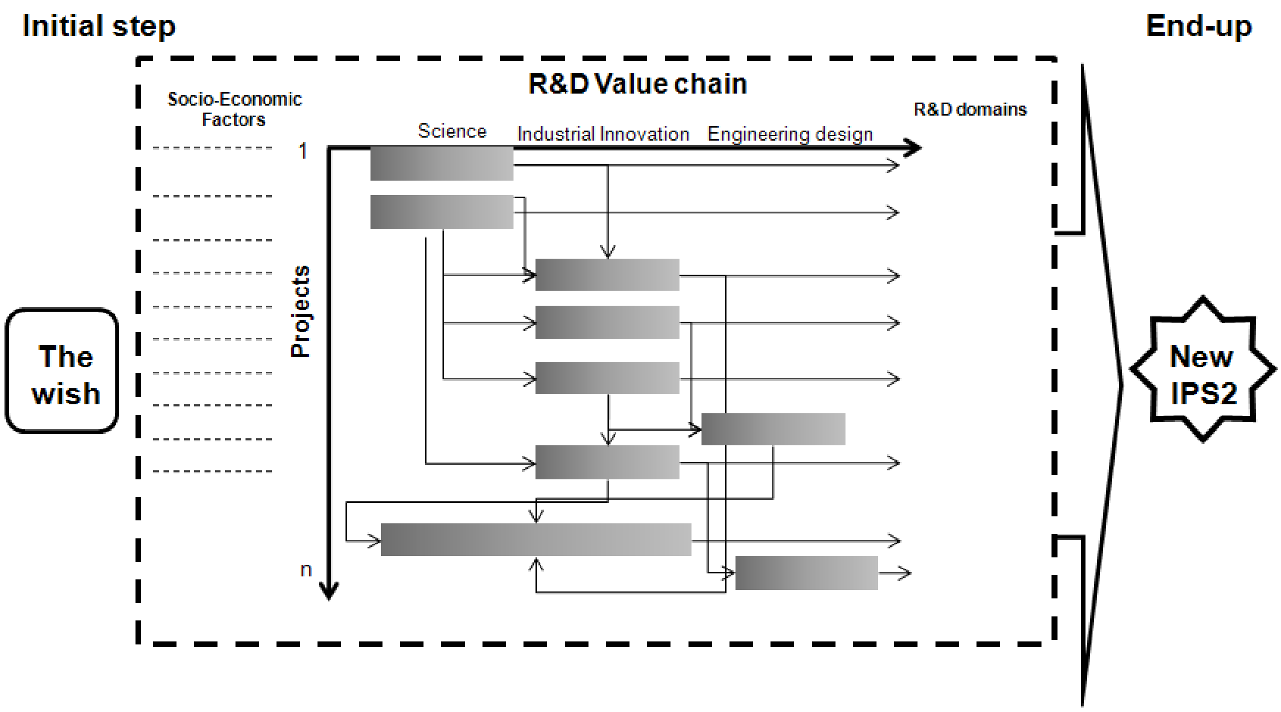

Figure 3: Operational environment for IPS2 within R&D value chain.

- Satellite Operations;
- Services for Earth Observation;
- Navigation and Infomobility;
- Integrated and Value Added Connectivity.

Company's mission is "*from space to services*" to provide Value Added Service & applications (VAS) design targeting business and institutional market segments. In particular among VAS Telespazio S.p.A. offers:

- Networks & Applications for Civil Defence;
- Solution & Services for Internet & TV on high speed Trains;
- Telemedicine;
- e-Learning.

The R&D needs of the company refer to the following domains of technological development which represent the core content in R&D projects: Navigation, ICT, Earth observation.

Recently, a big part of this core content has been focused towards the critical industry driver "Safety and Security" to provide technological solutions for new services targeting security and safety issues of operators, infrastructures, means, vehicles, etc.

The S-K model proposed in this paper is now in use in the company Technological Innovation team to manage technological innovation for dual use to respond to competition and sustainability needs.

The "Safety and Security" constitutes the selected driver of change of this company for industrial innovation becoming the objective of multiple R&D projects in the reported experience that constitute a unique big project.

This big project is the environment where multiple R&D projects concur with their interdependencies to provide answers that make feasible the design and development of new IPS2.

With reference to the company's technological plan, the big project contains several R&D projects, clustered in two main headings: Safety and Urban security clusters. Security cluster is articulated in five projects:

- Secure Space (2S) (EU) – Analysis of satellite technologies in overall economy structure and in emergency operations for different scenarios (Start December 2007 – End March 2010).
- SIT-MEW (EU) – Integrated System of Broadband telecommunications for the territory and emergency management in case of natural disasters comprehensive of early warning (Start 2008 – End 2011).
- GINS (ESA) – Study of the feasibility for a Global Integrated Network for Security (dual use for civil and military defence) (Start November 2007 – End July 2008).
- EDRS (ESA) - Study for the Definition of an Enhanced Data Relay Satellite (EDRS) (Start November 2007 – End September 2008).
- Small GEO (ESA) - To define telecommunication (TLC) missions based on small geostationary (GEO) satellites as part of a European secure TLC network (Start November 2007 – End October 2008).

Urban security cluster is articulated in four projects:

- 2SI (EU) – Earth Observation for crime prevention (Start December 20 07 – End January 2010).
- IMSK (EU) – Urban Security in case of big events (Sport's events, political summit or musical events) (Start 2009 – End 2012).
- CADMO (IT) – Daily urban security in the public transport framework (autobus) (Start April 2008 – End 2010).
- SAFER (EU) – Daily urban and extra-urban security in the railway public transport (train) (Start 2007 – End 2010).

All these projects respond to specific objectives related to the "Safety and Security" driver that consider different socio-economic factors. The technological solutions, carried out within these projects, play a great aid to solve security and safety problems.

At operational level these projects cover different phases of R&D value chain and have interdependencies that represent achievements in horizontal knowledge development.

The team needed a model and an operational environment to manage and evaluate the potential impact at short, mid and long term in order to prepare the ground for new IPS2. This supports the in-house assessment - based on the company's Technological Plan – of R&D advancements in order to enhance the efficiency of the company's R&D efforts.

The application of S-K model and its operational environment is reported in the Figure 4 that combines the critical driver of "Safety and Security" with the value chain phases of R&D projects and related socio-economic drivers and R&D domains. The R&D projects are listed according to their start date.

For the industrial innovation, the S-K model supports:

- Comprehensive view of single R&D project's positioning that forms the company's R&D value chain (in the centre of the figure).
- In-house assessment of each R&D project within the R&D value chain, establishing interdependencies for the knowledge advancements (in the centre of the figure).
- Needs-driven relation between R&D value chain and company's strategy focusing "Safety and Security" as the main industry driver for innovation (in the outer part of the figure's left side).
- Early market data capture according to the socio-economic factors, where the issues for sustainability complement the competition (in the left side of the figure).
- Leadership in the technological selected domains (in the right side of the figure).
- Next generation of IPS2 for new needs responding to socio-economic factors within "Safety and Security" driver (in the outer part of the figure's right side).

This operational environment becomes a dynamic tool to focus, through the interdependencies, the knowledge development for value creation. Interdependencies are shown among GINS, EDRS and Small Geo projects that refer all to the study and development of a Global Integrated Network for Security (dual use for civil and military defence) with the relevant satellites.

This knowledge creation concerns either the technology life cycle advancements or barriers and opportunities related to the socio-economic factors that are very relevant for IPS2 market feasibility.

For example, considering CADMO and SAFER projects, the in-house assessment shows that:

- These projects are positioned in the Engineering Design phase that means that efforts are dedicated to the integration of key technologies (intelligent sensors) for the design of new services and products for the transport market (road and rail). This positioning marks a milestone within the R&D value chain relevant for the in-house assessment.
- These projects are interlinked and have interdependencies with past and on-going projects that have dedicated many efforts on the development of strategic enabling technologies within different R&D domains.
- These projects provide deep understanding of the potential market, providing information on socio-economic factors including the competition.

This experience is on going with hopefully further results.

5 CONCLUSION

In the knowledge economy, the endless transition from science to market is exploited through R&D projects.

Companies are now project-intensive and are in turbulent markets.

The proposed S-K model supports companies to frame single R&D project into an overall view of R&D value chain from science to engineering design trajectory.

R&D projects enable companies to respond to critical drivers for innovation - such as Energy and waste, Safety and security, etc - and to R&D needs in specific domains with the mid-long term objective to develop new IPS2.

The experience reported shows how to speed up IPS2 with high added value development in real company setting. This model enables to manage the follow-on with reflections on the results back on the provided case study.

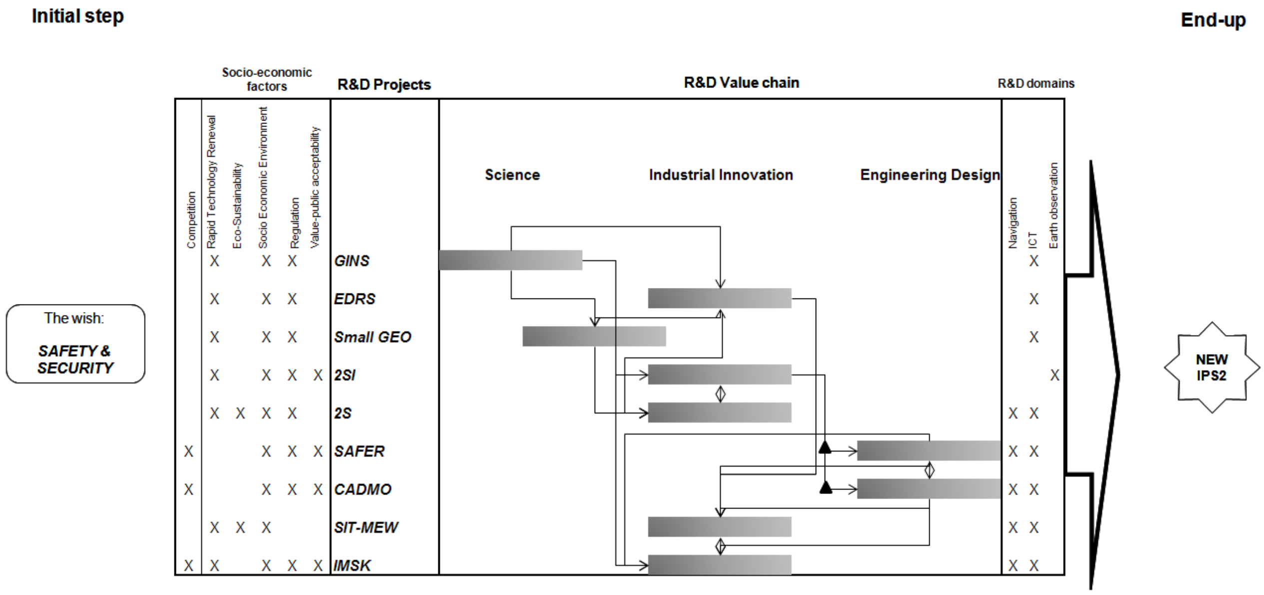

Figure 4: Operational environment for IPS2 within Telespazio S.p.A. R&D value chain.

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