

A FRAMEWORK FOR SYSTEMATIC APPLICATION AND MEASUREMENT OF THE INNOVATION MANAGEMENT PROCESSES

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Abstract: Managing innovation as a process is vital for entrepreneurs and businesses. Through our literature review we realized that the innovation measurement in many organizations does not appear to take place routinely within management practice and that, where it does, it tends to focus on output measures. Further, from the relatively small number of empirical studies of measurement in practice, measurement of innovation management appears to be under-taken infrequently as an ad hoc approach, and relies on outdated innovation frameworks due to the accelerated progress of technology and R&D management. The consequence of this is the absence of an updated rigorous and generic framework covering the range of all activities required to generate and manage ideas and turn these ideas into useful added values and new marketable products, services, or business model. In this paper we introducing generic but comprehensive framework that addresses the innovation management at both levels of the firms and projects. We first developed a synthesized framework of the innovation management and activities consisting of nine dimensions. Second, introduced the Innovation Balanced Score Card (IBSC) to measure four categories of innovation Key Performance Indicators (KPI). The paper makes two important contributions. First, it takes the difficult step of incorporating a vastly diverse innovation frameworks into a single framework. Second, it provides a innovation KPI against which managers can evaluate their own innovation activity, explore the extent to which their organization is nominally innovative or whether or not innovation is embedded throughout their organization, and identify areas for improvement. Through the application of this framework to a particular context, practitioners will be able to conduct an evaluation of their own innovation management activity, identify gaps, weaknesses and also improvement potential.

Keywords: Innovation, Framework, Measurement, Innovation Balanced Scorecard

Introduction

Innovation is the process of making changes to something established by introducing something new; these changes can be either radical or incremental. Innovation is an important force in creating and sustaining organizational growth. Effective innovation can mean the difference between leading with a particular product, process, service, or business model. Innovation framework is about describing how to systematically deliver innovations that add value to customers. (O'Sullivan 2009).

There have been several studies that have investigated the limitations of various innovation approaches and innovation frameworks (Werner and Souder 1997), and of specific measurement framework (Trajtenberg 1990) as they relate to the practice of innovation.

Our initial study and literature review on innovation frameworks showed that there exist a diversity of perceptions, approaches and practices that can be confusing and ambiguous. The consequence of this is the lack of an updated meticulous, comprehensive, and integrated framework covering the range of all activities necessary to generate and manage ideas to turn these ideas into useful added values to customer and new marketable products, services, or business model.

The purpose of this paper is to introduce integrated and comprehensive framework to manage and measure innovation at any type of organization. The next sections of this paper represent our proposed Integrated Innovation Framework (IIF). The framework is based on literature review (e.g. Meitzner 2010, O'Sullivan, 2009, and Adams 2006) and some of our empirical

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studies at the Arab Academy for Science and Technology. The following sections include eight-key-dimensions model for the IIF and covers the important roles that culture, organizational leadership and structure, strategic alliance, and shared knowledge can have on the organization competitive edge and innovative business model.

The Integrated Innovation Framework

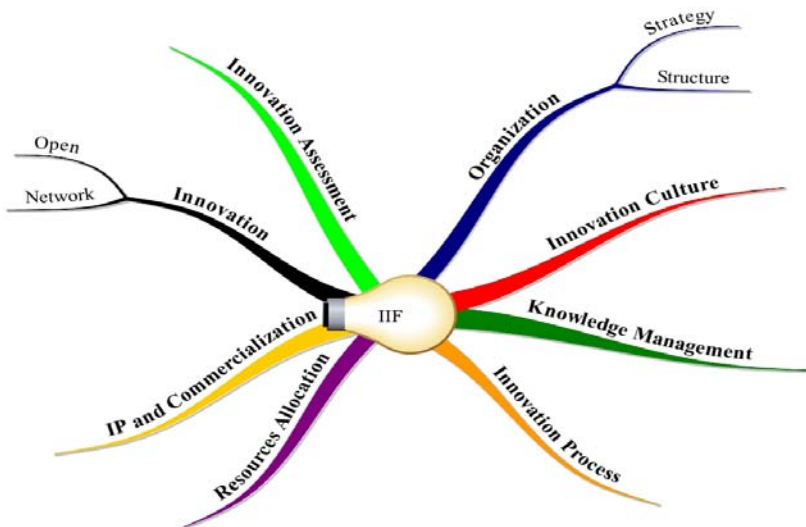
The IIF is based on literature review (e.g. Meitzner, 2010, O’Sullivan, 2009, and Adams, 2006) and some of our empirical studies at the Arab Academy for Science and Technology (Nada et al. 2010). Table 1 represents the reviewed Innovation management frameworks.

The framework is composed of eight-key-dimensions: Organization Strategy and Structure and Innovation Culture, Knowledge Management, Innovation Process, Resources for Innovation, Intellectual Property Management and Commercialization (IPMC), Open Innovation and Innovation Network (OIIN), and Innovation Assessment, Figure 1 depicts the Integrated Innovation Framework.

Table 1: Innovation management models and organizing framework

Authors Dimension	Cooper and Kleinschmidt (1995)	Chiesa et al. (1996)	Goffin & Pfeiffer (1999)	Verhaeghe & Kfir (2002)	Burgelm et al. (2004)	Adams et al. (2006)	O’Sullivan & Dooley (2009)	Nada et al. (2010)
Strategy/ Structure	✓	✓	✓	--	✓	✓	✓	✓
Culture	✓	--	--	--	✓	✓	✓	✓
Best Practices /Learning	--	--	--	--	--	--	--	✓
Process	✓	--	✓	✓	--	--	✓	✓
Resources	--	✓	✓	✓	✓	✓	✓	✓
IPM	--	--	--	--	--	--	--	✓
OIIN	--	--	--	✓	--	--	--	✓
Assessment	--	--	--	--	--	✓	✓	✓
Tool	--	--	--	--	--	--	--	✓

Fig 1. Integrated Innovation Framework



The following sections will cover four of the IIF dimensions which describe the important roles of: Creativity, Innovation Process, Knowledge Management and Innovation Assessment, in particularly innovation risk assessment, and their impact on the organization competitive edge and the innovation business model.

Organization Strategy and Structure

The organization innovation strategy is very vital element of managing innovation success at any organization. It extends not only to creating an organization where innovation can bloom, but also to providing clear direction about the goals, scale and degree of innovation that is required to deliver the strategic and financial goals of the business. This direction needs must be embedded in the corporate plan to ensure that it is resourced and managed with clear accountability for its success.

In creating the master plan for innovation, organization leadership usually works with senior management teams to develop innovation strategy to guide the innovation efforts of their organization. We view innovation strategy as the master plan which sets the goals and direction for innovation, allocates the resources and investment, specifies the measures for success and helps to coordinate all innovation initiatives.

Linked to the corporate plan and growth strategy, the innovation strategy should be designed to: (1) define the strategic arena for innovation, (2) specify the goals and expectations of the innovation effort, (3) reflect the degree of innovativeness desired (3) manage risk and reward (6) allocate people and financial resources

The Organizational innovation as new ways work can be organized, and accomplished within an organization to encourage and promote competitive advantage. It encompasses how organizations, and individuals specifically, manage work processes in such areas as customer relationships, employee performance and retention, and knowledge management. (Fagerberg et al. 2006)

The organizational structure should be built to encourages individuals to think independently and creatively in applying personal knowledge to organizational challenges.

The organizational innovation creation is fundamental to the process of innovation. Innovation constitutes part of the system that produces it. The existing literature on organizational innovation is diverse and not well integrated into a consistent framework. So, organization leadership should come up with a flexible comprehensive innovation organizational framework that can help them to achieve the following preferred organizational innovation strategies: (1) Cross functional team building, (2) Independent and creative thinking, (3) Matrix organizational approach, and (4) Open innovation (Lam 2006)

The value and importance of knowledge and learning within organizational innovation is crucial. If innovation is about change, new ideas, and looking outside of the organization to understand inside and outside environment, then continuous learning is a requirement of any organizational innovation success.

Innovation Culture

McNemara (2000) considered the organizational culture as the personality of the organization that is comprised of the assumptions, values, norms and tangible signs (artifacts) of organization members and their behaviors.

At the heart of any organizational culture is the need to be innovative at all levels and improve or change a product, process or service. All innovation focused around change - but of course not all change is innovative. ACISSR organizational culture helps individuals to think independently and creatively in applying personal knowledge to organizational challenges. Therefore, organizational culture depends mainly on innovation that supports new ideas, processes and generally new ways of "doing business".

Teece (1998) in his framework suggests that both the formal (governance modes) and informal (cultures and values) structures, as well as firms' external networks, powerfully influence the rate and direction of their innovative activities. Teece also identified four classes of variables which include (1) firm boundaries, (2) internal formal structure, (3) internal informal structure (culture), and (4) external linkages, the researcher also identifies four type corporate governance modes: (1) multi-product integrated hierarchy, (2) high-flex silicon valley type, (3) virtual corporation and (4) conglomerate. He suggests that different organizational arrangements are suited to different types of competitive environments and differing types of innovation.

In order to build an organizational culture that encourages innovation, we need first to create a climate of innovation that is encouraged and supported by senior management. Second, managers should be routinely identifying and bringing together a team that is very interested in innovation and willing to think new ideas and act on them. Third, a culture should be attached to a specific process that will take care of evaluating the innovation teams and identifying what has and hasn't worked as a result of the innovation team activities. Fourth, organization should be very focused on its goals and their core values of such an innovative culture.

The most important mindset of the creative and sustainable innovation culture rely on the management expectation about how to improve organizational structure, processes, products, services, and customer relationships as a core part of the business model.

Knowledge Management

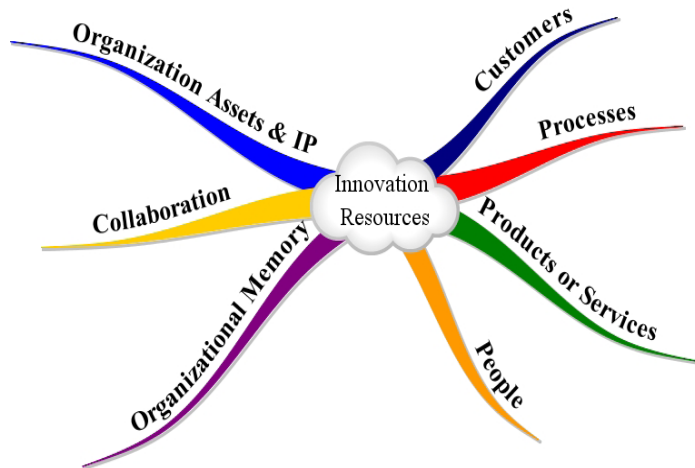
The road map to organizational innovation depends on the organization ability to impart new knowledge to their employees and in the application of that knowledge. Knowledge should be used for bringing new ways of thinking, and as a corner stone to creativity and a solid route to change and innovation.

The value of learning and knowledge can only be realized once put into practice. If new organizational knowledge doesn't result in change or improvement, either in processes, business outcomes, or increased customers satisfaction or revenues, then its value hasn't been interpreted into success. (Kustoff 2008)

Leadership will make sure of identifying, evaluating, capturing, and sharing the knowledge at all the knowledge layers. In order to satisfy the objectives of each knowledge layer, management will make sure of putting a formal knowledge management schema in place as part of its culture.

The implementation and integration of knowledge management will involve several domains such as leadership, strategy, structure, processes, and technology.

Fig 2. Innovation Resources



Many organizations usually start by focusing on the push of better sharing of existing knowledge e.g. sharing best practices. However, best practices indicate that the creation and conversion of new knowledge through the processes of innovation gives the best long-term pay-off.

Organizations can leverage value through knowledge by concentrating on some of the following seven knowledge resources: customer, processes, products and services, people, organizational memory, collaboration, or organization assets and intellectual capital. (skymre 2009) Figure 2 depicts the innovation resources.

Innovation Process

The primary challenges associated with innovation process management include identifying and investing in the best ideas that are in line with the organization innovation strategy in order to assign the right resources, and make the necessary coordination to succeed in achieving the organization objectives. The organization should have structured innovation processes in place to drive transparency, metrics development, or cross-functional collaboration.

Organization team members should be given the opportunities to contribute and to socialize ideas and within the organization. As speed and coordination are critical to organization success, an effective collaboration process is essential to turn insights into ideas and action.

Organization should adopt a well defined and validated systematic process such as Stage-Gate innovation process model which has been developed by Cooper (Cooper 2008) or the Design Thinking process.

The Design Thinking Process is a human-centered set of methods and tools that combines approaches found in design and ethnography with technology and business skills. Based on our early experience we recommend using this iterative process to find out about people's hidden needs and match those with what is technologically feasible and what is viable in terms of business strategy. The results at the end enrich the life of all stakeholders by creating experiences which could be in any form, such as products, services, processes, events and even policies.

Design thinking is a creative process based around the "building up" of ideas. There are no judgments early on in design thinking. This eliminates the fear of failure and encourages

maximum input and participation in the ideation and prototype phases. Outside the box thinking is encouraged in these earlier processes since this can often lead to creative solutions.

This paradigm also focuses on a collaborative and iterative style of work and an abductive mode of thinking, compared to practices associated with the more traditional Mathematics/Economics/Psychology (M/E/P) management paradigm (Jones 2008).

The design thinking process has seven stages: define, research, ideate, prototype, choose, implement, and learn (Simon 1969). Within these seven steps, problems can be framed, the right questions can be asked, more ideas can be created, and the best answers can be chosen. The steps aren't linear; they can occur simultaneously and can be repeated. Although design is always subject to personal taste, design thinkers share a common set of values that drive innovation: these values are mainly creativity, ambidextrous thinking, teamwork, end-user focus, curiosity.

Resources Allocation

From the perspective of its management, it is no longer sufficient to treat innovation as a linear process where resources are channeled at one end, from which emerges a new product or process. The key to organization survival is the acquisition of resources from the external environment

Organization management should develop the necessary capital, infrastructure and human resources to support the application of both preservation and evolution activities. Expectations must be identified for the output of the innovative process and funding needs to be earmarked for the support of spontaneous innovation. The application of innovation must become a requirement for advancement in the organization.

Innovation metrics must be adopted and reported with the fervor and frequency of the typical financial metrics. Intellectual property (density and quality) must be significantly enhanced by the innovation efforts. Innovative activities and outcomes must be integrated into the vision, mission, strategies and objectives of the organization. The innovative work must be rewarded and communicated – strongly – throughout the organization.

The process of selecting innovation projects requires evaluation and resource allocation under uncertain conditions. It is argued that a systematic process guided by clear selection criteria can help optimize the use of limited resources and enhance an organization's competitive position (Hall and Nauda 1990).

Intellectual Property (IP) Management and Commercialization

As the invention development work nears completion, an intellectual property management plan needs to be developed. In fact, it is advisable to anticipate this need during the technology development phase and to initiate the development of an IP management program at this time. Some strategic activities, such as the decision to patent or not, should normally be considered during the development phase.

Patented inventions are the most straightforward, since a patent provides the holder exclusive right to exploit the technology covered by the patent for a set period in a given jurisdiction. Patents are generally obtained for inventions that are key to an important process or product and without which it would be difficult or impossible to duplicate the invention in question. Companies may also patent inventions for defensive purposes, to bar entry to a market by a

competitor. The decision to keep or abandon a patent is typically based on the strategic value of the patent to the operation of the business.

Once the scope and usefulness of the intellectual assets are fully understood, they can often be commercialized in a variety of ways. There are several different commercialization or exploitation options, each with its own set of implications. These include: use in the existing business, creating a subsidiary or spin-off business, use in joint ventures, or licensing-out.

Open Innovation and Innovation Network

At the regional level, the idea of sharing ideas and innovation between companies, universities and other research centers would seem to be very uncommon practice for many institutions. In this context, the idea of opening the closed doors of research for others to learn from would seem foolhardy, and yet, the concept of 'open innovation' has become increasingly prominent, necessitating new thinking in both the intellectual property industry and the enterprise boardroom.

The institutions may move to open innovation as a result of major advances in technology and society, which in turn have facilitated the dissemination of information through different mechanisms such as the Internet. Thus, the open innovation model states that since firms cannot stop this phenomenon, they must learn to take advantage of it. Organizations may work on signing open innovation agreements with all interested institutions at the local and international levels. .

The capacity for sustained innovation is rooted in a complex set of relationships between the ACISSR dynamics and the broader setting within which we operate. The organization capabilities are sustained through regional and International communities of universities, research centers and firms and supporting the innovation networks of institutions that share a common knowledge base and benefit from their shared access to a unique set of skills and resources.

Because of the growing complexity of innovation in the knowledge-based economy, there is an increasing degree of specialization and interdependence among firms and institutions. This interdependence forces greater cooperation among firms and research centers located within geographically based clusters. (Holbrook, 2000).

A proper understanding of the role of organization in a cluster of innovation requires a more understanding of the nature of the linkages among firms and research institutions within this clusters and how the emerging needs of the region influences (and constrains) the community innovation and growth potential.

Innovation Assessment Balanced Scorecard

One of the ultimate goals the IIF presented in this paper is the construction of inclusive measures of innovation management. The choice of an appropriate R&D measurement metric depends on the user's needs in terms of breadth of innovation measurement, type of R&D being measured, available data and amount of effort the user can afford to allocate and to put into effect (Adams et al., 2006).

Quantifying, evaluating and benchmarking innovation competence and practice is a significant and complex issue for many contemporary organizations (Frenkel et al., 2000). An

important challenge is to measure the complex processes that influence the organization's innovation capability, in order that they can be optimally managed (Cordero, 1990).

Our proposed innovation assessment approach is to use a balanced scorecard that integrates indicators with strategic objectives and projects in organizations. It is distinctive and inclusive in using four strategic perspectives: finance, customer, processes, and learning.

The successful implementation of the scorecard approach should translate an organization's mission or vision and objectives into a comprehensive set of performance indicators (Kaplan & Norton, 1996).

Table 1: Innovation Management Assessment Areas

Scorecard Category	Assessment Area
Financial	People Physical and financial resources
Process	Idea generation Communications Tools Information flows Project efficiency Structure
Learning & Growth	People Culture Knowledge Management Risk Management Collaboration Strategic leadership Strategic orientation
Customer	Market research Market testing Marketing and sales CRM

Table 1 can be viewed as the basis for a balanced scorecard for innovation management, that is, as a balanced set of areas that need to be assessed in order to gain insight into an organization's capability to manage innovation.

Learning, Growth and Risk Assessment and Minimization

The process of selecting innovation projects requires evaluation under uncertain conditions. It is argued that a systematic process guided by clear selection criteria can help optimize the use of limited resources and enhance an organization's competitive position (Hall and Nauda, 1990).

Risk management practice and understanding must be continually improved, both from the perspective of software industry, as well as from the perspective of each organization. Each software development organization should also establish a risk management improvement framework that supports and forces them to learn from their past experiences through

knowledge management to improve their understanding of risk and improve their risk management practice.

After establishing the potential projects, the next step in the process of managing risk is to identify potential risks. Once risks have been identified, they must then be assessed as to their potential severity of loss and to the probability of occurrence (where severity = probability * impact). The fundamental difficulty in risk assessment is determining the rate of occurrence since statistical information is not available on all kinds of past incidents. Furthermore, evaluating the severity of the consequences (impact) is often quite difficult for immaterial assets.

In our empirical studies and prototype systems we are using the following risk categories: Technology, Project Management, Product, and Stakeholders.

Innovation Projects Assortment

In order to build a successful organization that encourages innovation, we need first to create a climate of innovation that is encouraged and supported by senior management. Second, managers should be routinely identifying and bringing together a team that is very interested in innovation and willing to think new ideas and act on them. Third, organization should a specific process that will take care of evaluating the innovation team ideas and identifying opportunities. In our empirical studies, and innovation prototype systems we are using the Pugh matrix analysis method (Pugh, 1981) to rank ideas. Fourth, organization should be very focused on its goals and their core values by seizing these opportunities and put them into project portfolio that will bring added values to their customers.

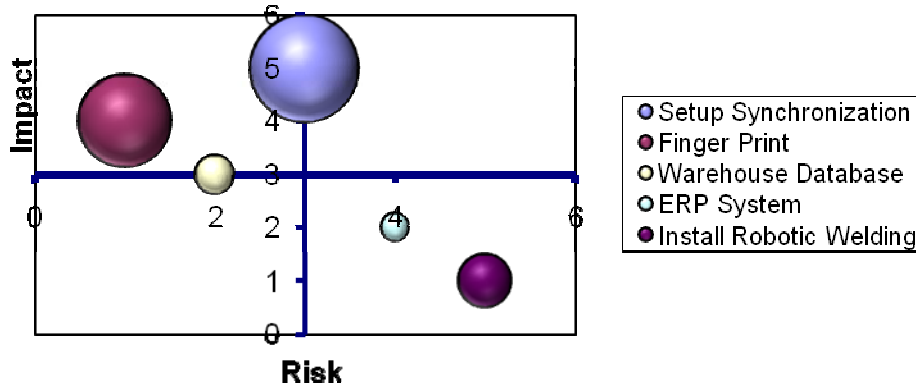
The most important mindset of the creative and sustainable innovation culture rely on the management expectation about how to improve organizational structure, processes, products, services, and customer relationships as a core part of their project portfolio. A portfolio of projects is sometimes called a program or plan. One of the key issues in managing a portfolio is achieving an appropriate balance or mix of projects, where the focus is optimizing the achievement of organizational goals rather than the achievement of specific project goals. A complementary approach is to develop a mix of risky and rewarding projects.

The bubble chart a simple means for visualizing a group of projects and providing decision support for managing a project portfolio by constructing a bubble diagram for the entire portfolio of projects where the x axis can represent the level of Risk, the y axis may represent the Impact or Reward and the bubble size, may represent the Cost. Table 2 represents the innovation projects assortment. Figure 2. depicts the innovation projects portfolio bubble diagram.

Table 1: Innovation Projects Assortment

Project Name	Cost	Benefit	Impact	Risk	Priority
Setup Synchronization	40000	10000	5	3	5
Finger print	30000	60000	4	1	4
Warehouse Database	5550	5000	3	2	3
ERP System	3000	12000	2	4	2
Install Robotic Welding	10000	2000	1	5	3

Fig 3. Innovation Projects Portfolio Bubble Chart



The IIF Systematic Implementation

The IIF must be carefully designed so that it leads an ongoing series of management decisions, actions, and reviews. According to the results of our literature review, none of the investigated frameworks has been empirically validated through a computerized system. So, we decided at the Arab Academy for Science and Technology to take further step ahead by partially developing the IIF toolkit system to provide any organization with a tool that can help practitioners to systematically implement, validate, and manage the IIF.

We started with two important modules, (1) idea generation, evaluation, and management subsystem and (2) project portfolio management subsystem. Currently, the two subsystems are under investigation and validation in collaboration with Data Management System, one of the leading software development companies in Egypt.

Figure 3. and Figure 4. depicts the IIF tool interfaces of the projects portfolio module.

Fig 3. The IIF project portfolio module main menu

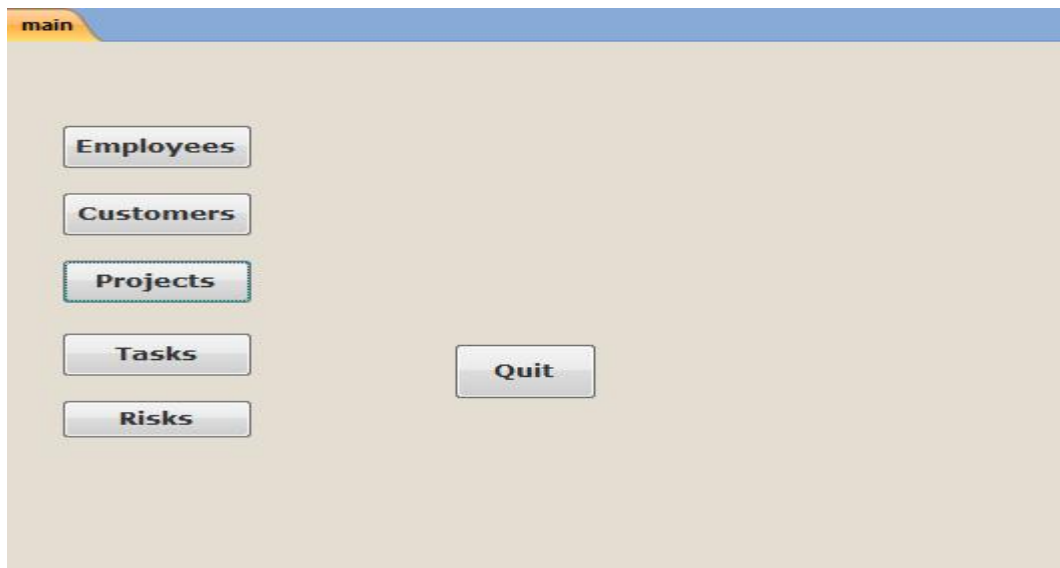


Fig 4. The IIF Project risks entry table

The screenshot shows a web interface for entering project risks. At the top, there is a blue header with the word 'risks' in a small orange box. Below this is a dark grey bar with the word 'Risks' in white. The main content area is a light beige background with a form containing the following fields:

ID:	DMSR1
Name:	Completion of website
description:	Released software has low quality
date raised:	23/11/2009
impact:	low
likelihood:	low
type:	Specific
propability:	2

At the bottom of the form, there are three buttons: 'New', 'Search', and 'Close'.

Conclusion

Our literature review on innovation frameworks showed that there exists a diversity of perceptions, approaches and practices that can be confusing and ambiguous. The consequence of this is the lack of an updated meticulous, comprehensive, and integrated framework covering the range of all necessary activities to generate and manage ideas and turn these ideas into useful added values to customer in forms of new marketable products, services, or business model.

In this paper we introduced an integrated and comprehensive framework to manage and measure innovation at any type of organization. The framework is composed of eight-key-dimensions: Organization Strategy and Structure and Innovation Culture, Knowledge Management, Innovation Process, Resources for Innovation, Intellectual Property Management and Commercialization (IPMC), Open Innovation and Innovation Network (OIIN), and Innovation Assessment.

The IIF is a synthesized framework which put emphasis on three newly introduced dimensions: Intellectual Property and Commercialization, Open Innovation-Innovation Networks, and the Innovation Balanced Scorecard to measure four categories of innovation KPI. Additionally, we partially developed the IIF toolkit system to help any organization to systematically implement, validate, and manage the IIF.

The IIF helps practitioners to conduct an assessment of their own innovation management activity, identify gaps, weaknesses or inadequacies, and also improvement potential. The IIF implementation will support the organization effort to discover and maximize the benefits and impacts that creativity, innovation and knowledge management on the organization competitive edge and their innovative business model

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