Quantifying Innovation-I

Elements of Innovation

*For Measurement, Evaluation and Data-driven Decision Making*

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# Introduction

Innovation is today the buzzword of many a company across industries and geographies. The idea of innovation is not new; devising products and services that change the ways of human life has been done for centuries. What is new, however, is the interest in understanding innovation so as to quicken the pace of technological, economic and thereby societal development.

Prevalent opinion presents *‘innovation’* to be mostly serendipitous and largely nebulous. Until recently, it was widely accept it to be a complex combination of art and science, in indefinite proportions. Recent research extends the understanding of innovation, though in qualitative dimensions. This work is a foundational effort to comprehend Innovation in a quantitative manner, thereby enabling measurement, scientific evaluation and data driven decision-making in Innovation Management.

# Understanding Innovation

Also, an assessment of existing research on Innovation (Langergaard , L L & Hansen , A V; 2013) indicates apparent shortcomings in the understanding of innovation. It was observed that existing research treats innovation in a fragmented way, focusing on explaining how innovation takes place rather than what innovation fundamentally is.

So, this study begins with explaining what Innovation is and what, if any, are the fundamental elements in any innovation.

The Oslo Manual (OECD; 2005) defines innovation as: “Innovation in firms refers to planned changes in a firm’s activities with a view to improving the firm’s performance.”

## Types of Innovations

Innovations are broadly grouped into the following categories**[[1]](#footnote-1)**

1. Product Innovations- significant changes in the capabilities of goods or services- new or improved
2. Process Innovations- significant changes in production and delivery methods
3. Organizational Innovations- implementation of new organizational methods
4. Marketing Innovations- can include changes in product design and packaging, in product promotion and placement, and in methods for pricing goods and services

Innovation

…in firms refers to planned changes in a firm’s activities with a view to improving the firm’s performance.

Four broad areas of Innovation:

1. Product
2. Process
3. Organizational
4. Marketing

## Factors influencing Innovation

Several factors-both external and internal to the firm- influence the origin and success of innovative endeavors. The most important categories of these factors are-

1. Appropriation- if proper protection to the outcomes of innovation is not present, the incentive to invest in innovation activities is reduced
2. Uncertainty (Rosenberg, 1994)- in development, adoption; collection of relevant information to reduce uncertainty can be very time consuming and costly
3. Legal factors- regulations, tax rules etc.
4. Economic factors- input costs, demand factors
5. Organizational structure- degree of organizational integration, organizational learning
6. Factors specific to a firm- availability of skilled personnel, knowledge, know-how

## Objectives of Innovation in Firms

Why do firms innovate?

Considering the uncertainty (thereby the risk) associated with innovation and several external influences, why are organizations motivated to promote innovation? At the core, all innovation is driven by a need or a desire to improve firm performance*1* - reducing costs and increasing demand (revenues). This is achieved by means of one or few of the following:

* Introducing a new product (product differentiation) or organizational method (efficiency, quality of operations)
* Asset creation and market experiments (altering business strategy to create product development capabilities or improve efficiency)
* Competitive positioning- defend existing or seek new capabilities and competencies
* Improving Quality or the ability to learn
* Implement changes to current products/services, processes, business model, capabilities

## Features & Characteristics of Innovation Activities

1. *Uncertainty-* over the outcome of innovation activities
2. *Investment*- significant fixed and intangible assets
3. *Spillovers-* of innovation to external complementary and supplementary products and services[[2]](#footnote-2)
4. *Utilization -of new knowledge* or a *new use or combination of existing knowledge*
5. Gaining a *competitive advantage*-altering the firm’s demand curve or the cost curve to improve the firm’s performance

## Impact of Innovation on Firm Performance

The impact of innovation is noticed directly (or indirectly) in the following areas-

* Increasing Sales & Market share
* Improvement in Productivity & Efficiency
* International competitiveness
* Increased knowledge spillovers and flow through networks

## Innovative Firms

For the scope of this work, the following definitions of indicating innovativeness of a firm are used:

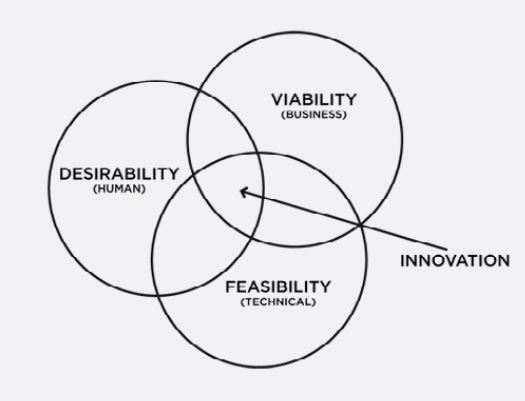
* Innovative by developing innovations in-house or in cooperation with other firms or public research organizations
* Innovative by quickly adopting innovations developed by other firms

# The Science of Innovation

According to OECD’s *Oslo Manual* (2005)-

“An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations…”

Contemporary research on identifying the elements of innovation can be succinctly summarized by the following figure:



*Fig: Themes in Design Thinking for Innovation*

IDEO, a design innovation consultancy, expresses innovation to be a confluence of human desirability, technical feasibility and business viability.

## Constituent Elements of Innovation

From an analysis of contemporary research summarized in the previous sections, the following components of innovation and a working definition have been identified and an expression has been formulated.

*Definition:* Innovation is *‘integrating existing component products or creating from scratch new products that have added/new value and which have a business impact’*

*Elements:*

1. Value indicates the activities of *Identifying Value Areas* relevant to the stakeholders

*Value = Producer’s Value (cost, differentiation) + Consumer’s Value (price, differentiation)*

1. Novelty is indicative of the set of activities/behaviors that result in *Creation of Added Value* to the stakeholders. These may be of 4 types: a. new to the firm b. new to the market c. new to the world d. disruptive innovations

*Novelty = Creativity (creating something new) + Integrating (or recombining) ability*

1. Salability indicates the activities undertaken to *Deliver Value* to the stakeholders

*Salability = Buyer/Customer willingness + Marketing ability (4Ps) + Selling environment (affordability, season, promotions, pitch)*

These three constituents of Innovation are found to be related as:

**Innovation = w1\*Value + w2\*Novelty + w3\*Salability+ Ecosystem constant**

Where

w1, w2, w3 are weights determined by firm- and industry-specific attributes[[3]](#footnote-3)

Ecosystem constant is an empirical score determined by the various relevant participant players in the innovation process in a given industry and for a given firm and the linkages among them.

# Innovation Ecosystem & Linkages

The innovating firm is connected to the ecosystem (external to the firm) by one of 3 different kinds of linkages. Several firms in an industry share a common ecosystem. However, it is the type and nature (strength) of the linkages a firm has with the agents in the ecosystem that provide it a distinct competitive advantage over the other firms in the industry.

## External Ecosystem

The typical agents in an Innovation ecosystem external to an innovating firm, in order of participation in the innovation process, are:

* Government Laboratories
* Universities & Academic Institutions
* Policy Departments/Agencies
* Regulators
* Suppliers

Researcher speak…

“…most nuance is then forgotten as the substantial majority of theoretical and empirical studies consider single-dimension outcomes like patents. We hope future research develops a richer accounting of the variations of innovation and how they related to the traits of clusters. We do not pretend that this will be easy, due in part to data constraints…”

* Competitors
* Customers

## Linkages

Three types of external linkages exist among a firm and the other players in the Innovation ecosystem-

* Open Information Sources- free/available at no cost to the Innovating firm
* Acquisition of Knowledge & Technology- available at a cost to the innovating firm
* Innovation Co-operation- collaborative effort of the firm with other players

# Indicators for measurement of Innovation

Current research uses two families of Science & Technology indicators as directly relevant to the measurement of innovation

1. Resources devoted to R&D
2. Patent Statistics

However, it is widely acknowledged that these are inadequate indicators of innovation capability. Some intended results for Innovation efforts are:

* Increased number of new ideas
* Improved quality of ideas
* More efficient implementation of ideas
* Improved resultant success from implementation of ideas

Some outcome based metrics that find relevance in quantifying innovation are:

1. Revenues from new products or services introduced in the past X year(s)
2. Revenues from products or services sold to new customer segments
3. Percentage of existing customers that trade up to next-generation products or services
4. Percentage of revenue coming from services versus products (or vice-versa)
5. Royalty or licensing revenue from intellectual property

# Conclusion

A study of existing work indicated that most research on Innovation is qualitative in nature and thereby most decision-making in areas related to innovation is based on intuition and experience. The rapidly growing popularity and need to quickly promote innovations across firms and geographies has been a motivation to quantify and standardize innovation. Despite the creative element involved in innovation, a few core elements such as value, novelty and salability have been identified to be prominent in determining the outcome of innovative activities. Also, the ecosystem in which the act and the result of innovation activities is found to be a significant element of influence.

With this foundation, future work in this direction can extend into identifying proxies for these constituent elements of innovation, gathering relevant data items for the proxies and perhaps leveraging statistical analysis tools or (Big) Data analytics to enable data-driven decision making in innovation.

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IDEO, A global design consultancy; <http://www.ideo.com/about/>

Harvard i-Lab, Venture Incubation center fostering innovation and entrepreneurship across Harvard University; <http://i-lab.harvard.edu/>

MIT Production in Innovation Economy; Massachusetts Institute of Technology; <http://web.mit.edu/pie/research/>

MIT Sloan School of Management; Programs in Innovation and Global leadership; <http://mitsloan.mit.edu/fellows/program-components/research-centers/>

Stanford Innovation & Entrepreneurship Certificate; Stanford University; <http://create.stanford.edu/>

Innovation Management Group (IMG), TCS

The IMG is the Innovation agency of the HiTech Technology Excellence Group of TATA Consultancy Services. This group is focused on capturing, creating and delivering value to customers of TCS through devising and evangelizing Innovation and allied activities.

# Post-Hypothesis notes

# Methodology

(of research, data collection and analysis)

Descriptive statistics,

Exploratory research- to identify the hypothesis

Hypothesis- the expression for innovation- identified

**To Prove:**

* These 3 are the constituent elements of an Innovation
* These are the ONLY elements of any Innovation

The elements of the expression:

**Dependent variables-** Novelty, Value, Salability

**Independent variables**- constituents of these 3 dependent variables, constituent elements of external linkages

|  |  |  |  |
| --- | --- | --- | --- |
| **Dependent Variables** | **Constituent Independent Variables** | **Proxy for the independent variable (if reqd.)** | **Data source** |
| Novelty | -in Creation | No. of new products/services/solutions developed &/or launched that are unrelated to previous/current products/services/solutions |  |
|  | -in Reconfiguration | No. of new products/services/solutions developed &/or launched that are recombination of existing products/services/solutions |  |
|  |  |  |  |
| Value | Producers’ Value | Cost reduction; product differentiation |  |
|  | Consumers’ Value | Price reduction; improved performance or features |  |
|  |  |  |  |
| Salability | Buyer willingness (Tapping existing markets/needs) | Sales Expense |  |
|  | Marketing ability (Creating new markets/needs) | New product Marketing/Market education expense |  |
|  |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
| Extraneous Variables |  |  |  |
| Purchase environment | Discounts, offers, store environment |  |  |
|  |  |  |  |

## External Ecosystem & Linkages

A new factor in the Innovation expression-(or is this the binding connect among the elements of the innovation identified in the previous sections??)

**Linkages**- variety and structure of its links to sources of information, knowledge, technologies, practices, and human and financial resources

Objective & Status check:

(To objectively score and measure value/worth of ideas)

1. Quantifying a measurable form of Innovation
2. Common patterns that emerge; our own hypothesis
3. How do we quantify Innovation?- from primary or secondary data
4. Formulate a scientific framework that is proved/validated by the data
5. Create publishable content- assets, whitepapers, patents, models etc.

## Preliminary Inferences:

Hypothesis-1: Innovation is dependent on the amount of R&D spending of the companies.

1. 7 of the top 20 R&D spenders[[4]](#footnote-4) are technology companies (Computing, Electronics, Software & Internet)
2. However, 7 of the 10 companies perceived to be most innovative are from the technology industry
3. Two of the 7 technology companies (Intel, Cisco) that spend the most on R&D do not feature in the top 10 innovative companies.
4. Apple is an outlier- spending only one third of the highest spender on R&D yet is the most innovative firm

Also, directly following the detailed analysis given here: <http://www.asymco.com/2012/01/30/you-cannot-buy-innovation/> it can be R&D expenditures are not correlated to degree of Innovation in a given firm.

Hypothesis-2: Successful Products/services of innovative companies comprise the three elements of innovation- Novelty, Value, Salability

Hypothesis-3: External ecosystem & Linkages are essential for successful innovation

Global Innovation 1000- Proven Paths to Innovation Success

Cumulative Revenues: US$ 18.4 trillion (2014)

Cumulative R&D expenditure: US$ 647 billion (2014)

3 approaches of Innovation

1. Need seekers- First movers, use superior insights about customers to generate new ideas; about 25% of Global Innovation 1000; eg: Apple, P&G, Tesla
2. Market readers- fast followers/second movers, with incremental innovations to products/services proven in the market; 40% of Global Innovation 1000; eg: Samsung, Caterpillar, Visteon
3. Technology Drivers- depend heavily on internal technological capabilities to develop new products/services; 35% of Global Innovation 1000; eg: Google, Bosch, Siemens

It’s not just the amount/proportion of R&D spends that determine whether a company will be a successful innovator. Success in innovation depends on how well companies execute their chosen strategy-

1. Align innovation strategy with business strategy
2. Prioritize the right capabilities
3. Have the right culture to enable the strategy
4. Right tools to help develop ideas and
5. Processes consistent with their innovation model

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1. The Oslo Manual, Organization for Economic Co-operation and Development, 2005 [↑](#footnote-ref-1)
2. The benefits of creative innovation are rarely fully appropriated by the inventing firm [↑](#footnote-ref-2)
3. Determining Weights w1, w2, w3 for a given industry and firm would involve case-by-case evaluation of constituent variables specific and relevant to the industry and firm. [↑](#footnote-ref-3)
4. Average R&D expenditure for two latest consecutive years (2014, 2013) [↑](#footnote-ref-4)