

# Calculating the Functional Value of Innovation

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A Red Team Engineering Whitepaper on a *Quantitative Approach to Scoring Innovation Investments*

## Overview

There are several common obstacles that are impediments to receiving the benefits of innovation:

- 1) A focus on the short term instead of the ROI multiples that can happen in the mid to long term
- 2) Insufficient provision of time, resources or personnel
- 3) No incentives or rewards from management for innovative thinking or developments
- 4) Lack of a systematic process for innovation
- 5) Thinking that innovation is too risky

Many research reports have been written around the topic of innovation, in addition to *overcoming the barriers* to innovation. However, once an organization has decided to pursue a systemic innovation process (including fostering an innovation mindset), it is important to ensure that the innovation process is on track and that the desired value is being returned for the investments. This is important for a couple of major reasons:

- So that management can ascertain where to target innovation resources and capital, using real metrics that can show an innovation ROI
- It helps to eliminate some of the obstacles to innovation which ensures that innovation is not treated as merely an “initiative” but part of the fabric of the organization

Before continuing, it is important to understand some foundational concepts and answer some important questions, such as “What is Innovation?”

Sir Kenneth Robinson is a British author, speaker and international advisor on education. His statement on the definition of innovation is as follows:

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*“Innovation is applied creativity. By definition, innovation is always about introducing something new, or improved, or both and it is usually viewed as a positive thing.”*

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That’s definitely not enough to build an innovation program upon, but it captures the essence: innovation is a positive thing to those creating the innovation. Regardless of definition, innovations will always create value that can be expressed through one or more *aspects* of efficiency, which are limited to the following:

- Enhancement in *quality*
  - i.e., of a product, or a service
- Increase of *velocity*
  - i.e., reduction in time to deliver products or services, etc.
- Reduction in *cost*
  - i.e., reduction in overhead, cost of goods sold, etc.

With this understanding, it therefore becomes possible to orient the monitoring of innovation programs toward these aspects of efficiency – through an innovative concept designed for that purpose. To understand the difference in approaches, some background on other common ROI calculations follows.

## Obtaining the Financial Return On Investment for Innovation Programs

If analyzing investment returns from a purely financial perspective, there are several options available. ROI is commonly considered a performance measure of the *efficiency* of an investment, and there are some common calculations that can be performed to calculate ROI. The most common method (from a business perspective) is to take the return (or net profit) derived from the investment and divide by total resources invested, and express the result as a percentage:

$$\text{ROI} = (\text{NET PROFIT}) / (\text{INVESTED RESOURCES}) \times 100.0$$

When this is applied to multiple innovation programs, this type of ROI calculation provides the ability to quantify benefits of investments and associated returns with varying sizes, because it takes into account the invested resources used to obtain the return. Different innovation programs can therefore be analyzed for returns based on percentage, and managed accordingly.

However, this type of ROI calculation ignores some significant financial concerns, such as the “time value” of money – which is extremely important in the age of digital disruption, because competitors are also innovating at a faster pace. Understanding the impact of time on realization of ROI is important.

Other common calculations utilized are:

- Net Present Value (NPV)
  - taking into account the concept that today’s money is worth more than tomorrow’s money
- Internal Rate of Return (IRR)
  - computes a desirability factor with a bias toward programs that recoup investments faster

These and other purely financial methods of calculation satisfy the needs of those with fiscal responsibility that want to know the financial benefits of innovation programs on the organization’s bottom line. *That’s desirable and understandable*, but it doesn’t tell the whole story; creativity is a required aspect of being innovative, but how does one quantify that? How do you not only accept but *expect* intelligent failures to advance knowledge?

What *none* of the above financial calculations take into account is the *functional value* of what the organization is trying to accomplish through the innovation program. The Functional Value of Innovation (FVOI) completes the picture, by ensuring rapid, objective evaluations and intelligent fast-failures.

## Obtaining the Functional Value of Innovation

Considering that innovation is an attempt to enhance one or more of the three main aspects of efficiency (quality, cost or velocity), what is needed is a mechanism to compute and evaluate the functional value of innovation. In addition to ensuring intelligent, fast-failures, computing the FVOI serves a few additional purposes:

- It quantifies the impact on one or more aspects of efficiency
  - Keeping in mind that a reduction in cost can come at the expense of quality, for example, both positive and negative impacts to each aspect of efficiency are monitored
- It provides insight into whether goals are being achieved, especially if the investment is hard to compute
  - Enhancement of consumer User Experience (UX) on the organization’s ecommerce website may lead to higher customer retention (which is difficult to quantify financially as ROI)
- It shows the benefits of even incremental enhancements due to minor increases in efficiency

- Tracking an innovation's Critical Success Factors (CSFs) or Key Performance Indicators (KPIs) is already common; merely orienting those CSFs and KPIs toward one or more aspects of efficiency can provide the functional value associated with enhancements

The main premises of the Functional Value of Innovation concept are as follows:

- 1) Any *activity, service, process, project or program* can be monitored and evaluated with Key Performance Indicators (KPIs.)
- 2) To evaluate the performance over time, it is necessary to monitor the *progression of its performance* toward (or away from) established *performance goals*.
- 3) Each KPI should be oriented toward one or more aspects of efficiency (cost, quality, speed)

The KPIs for monitoring an innovation program should be S.M.A.R.T. compatible: specific, measurable, achievable, relevant and time-bound<sup>1</sup>.

In the following section, we develop a continuously updated figure of merit that comprises a weighted average of relevant innovation conditions.

As a matter of notation in the following sections, a *Negative Innovation Condition* is denoted *NIC*; a *Positive Innovation Condition* is denoted *PIC*. Any change in a KPI, increasing or decreasing, can be a good thing or a bad thing. Sometime more of a certain thing is beneficial. Sometimes it is not. Deciding when a change is good or bad depends upon the following conditions:

- 1) Whether an increase in the value of the KPI is favorable or unfavorable; likewise, whether a decrease in the value of the KPI is favorable or unfavorable
- 2) Where the current KPI value is in relation to its learned threshold window (baseline)
- 3) The computed slope of the sliding trend over the last (t) sample intervals
- 4) The predicted (forecast) value at some near time in the future
- 5) Where the forecast value resides in relation to the KPI's learned threshold window
- 6) The degree of confidence that can be assigned to the forecast

Of all the above conditions, only (1) is known *a priori*; whereas all other conditions can be either learned or computed (machine learning), knowing the preferred slope of the trend must be known in advance<sup>2</sup>.

Having taken the above conditions into account, the KPI is marked at a given point in time as either an *NIC* or a *PIC* with a particular *trend state* property (see innovation analytics trend table) and used as input to a grade function in order to provide the feedback necessary to rate the performance of an innovation concept which is evaluated from the associated KPIs.

## DEFINING THE GRADE FUNCTION

Given  $n$  KPIs, we assign the  $i$ -th KPI's **trend state**<sup>3</sup> – an integer value between -9 and 9 (corresponding to the table in Appendix A) – at time  $t$  as  $k_i(t)$ . Thus,  $k_i(t) \in \mathbb{Z}$  for all  $t \geq 0$ .

Given the  $n$  KPIs, let us define the set of all of their trend states  $TS$  at a given time  $t$ :

$$TS(t) = \{k_1(t), k_2(t), \dots, k_n(t)\}$$

Given how  $k_i(t)$  is defined  $\forall i$  ( $1 \leq i \leq n$ ), the set  $TS(t) \subset \mathbb{Z}$  for all  $t \geq 0$ .

<sup>1</sup> The typical Red Team list of KPIs for monitoring innovation programs will remain confidential.

<sup>2</sup> For example, if the indicator were "Average Mean Time to Repair", the preferred slope is decreasing; conversely, for an indicator called "Percent work completed" an increasing slope would be preferred.

<sup>3</sup> See Appendix A: Innovation Analytics Trend Table

We now create two special sets that form a partition of  $TS(t)$  (note: although  $k_i(t)$  may equal  $k_j(t)$  at some particular time  $t$ , the trend states are associated only with a particular KPI, so the properties of a partition will hold).

Let:

$$NIC(t) = \{k_i(t) | k_i(t) \text{ is odd and } k_i(t) \neq |1|\}$$

&

$$PIC(t) = \{k_i(t) | k_i(t) \text{ is even or } k_i(t) = |1|\}$$

In other words, at any given time  $t$ , these two sets comprise a partition of the set  $TS$  at time  $t$ :

$$TS(t) = NIC(t) \cup PIC(t)$$

Now we can define our *grade function*  $G$ :

$$G(t) = 100 \left( 1 - \frac{\sum_{k_i(t) \in NIC(t)} |k_i(t)|}{\sum_{k_i(t) \in NIC(t)} |k_i(t)| + \sum_{k_i(t) \in PIC(t)} |k_i(t)|} \right)$$

At a given time  $t$ , we divide the sum of the absolute values of the trend states of the negative innovation conditions by the sum of the absolute values of the trend states of both the positive and negative innovation conditions, subtract the remainder from 1, and then multiply by 100 to get a percentage at the end (we know this because the denominator is strictly greater than or equal to the numerator, given the presence of absolute values; the use of signs for the trend states is only for when plotting the trend on a graph).

Given that we know  $TS$  is partitioned by  $NIC$  and  $PIC$ , we can simplify our grade function:

$$G(t) = 100 \left( 1 - \frac{\sum_{k_i(t) \in NIC(t)} |k_i(t)|}{\sum_{k_i(t) \in TS(t)} |k_i(t)|} \right)$$

Alternatively, knowing that:

$$1 = \frac{\sum_{k_i(t) \in TS(t)} |k_i(t)|}{\sum_{k_i(t) \in TS(t)} |k_i(t)|}$$

We can substitute for 1, and then obtain an equivalent form of  $G(t)$ :

$$G(t) = 100 \left( \frac{\sum_{k_i(t) \in PIC(t)} |k_i(t)|}{\sum_{k_i(t) \in TS(t)} |k_i(t)|} \right)$$

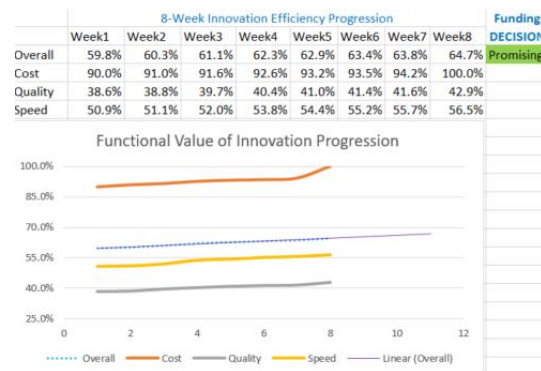
The function  $G(t)$  therefore provides the proximate performance rating, expressed as a percentage toward optimal performance, of a monitored innovation activity. Whereas the inputs are KPI's related to an overall innovation activity, graphing the result of this function in a time-series yields the requisite feedback necessary to measure progress towards the stated goal.

## Summary

Orienting the KPIs toward one or more aspects of efficiency, such as **Cost**, **Quality** or **Speed**, allows executives to determine their progress toward higher efficiency in each of these areas, in addition to the **Overall** efficiency rating.




















This methodology can be used as proof-points for ROI, to ensure quality/cost/speed standards are maintained or enhanced, and as a means to provide transparent feedback in an unbiased manner.

Additionally, it can be used as a means to detect when the enhancement in one aspect of efficiency starts to *negatively* impact another, such as when an enhanced focus on increasing quality starts to impact speed and/or cost.



For any monitored innovation program (or monitored process or service), and given a consistent set of variables, there will be some perfect balance of efficiency at varying quality, cost and speed ratings. Each will be different, but having quantifiable feedback on cost, speed and quality ratings provides the FVOI required to complete the true impact of particular innovations on an organization's bottom line.

### Appendix A: Innovation Analytics Trend Table:

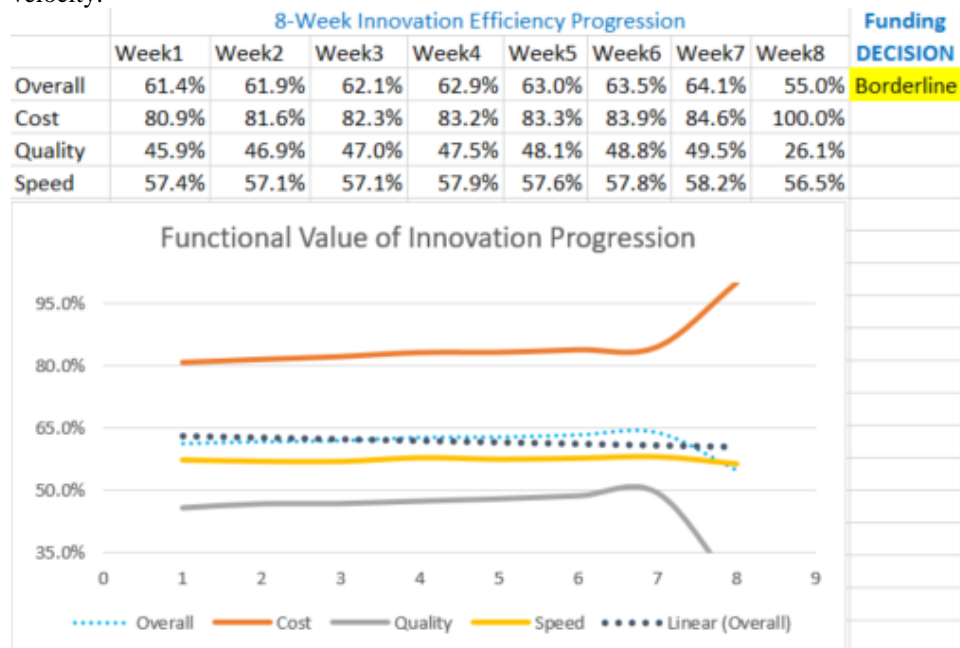
Trend States		
+9	Trend is Higher (bad), and is <i>already</i> above <u>bad</u> deviation	
+8	Trend Higher (good), and is <i>already</i> above <u>good</u> deviation	
+7	No discernible Trend, but value is <i>already</i> above <u>bad</u> deviation	
+6	No discernible Trend, but value is <i>already</i> above <u>good</u> deviation	
+5	Trend is Higher (bad), and Forecast is to go above <u>bad</u> deviation	
+4	Trend Higher (good), and Forecast is to go above <u>good</u> deviation	
+3	Trend Higher (bad), but Forecast is to <i>stay under</i> <u>bad</u> deviation	
+2	Trend Higher (good), but Forecast is to <i>stay under</i> <u>good</u> deviation	
+1	No discernible Trend, the metric is above average and behaving as expected	
0	The metric has no baseline history for this period to compare, or is inactive	
-1	No discernible Trend, the metric is below average and behaving as expected	
-2	Trend Lower (good), but Forecast is to stay above <u>good</u> deviation	
-3	Trend Lower (bad), but Forecast is to stay above <u>bad</u> deviation	
-4	Trend Lower (good), and Forecast is to go below <u>good</u> deviation	
-5	Trend Lower (bad), and Forecast is to go below <u>bad</u> deviation	
-6	No discernible Trend, but value is <i>already</i> below <u>good</u> deviation	
-7	No discernible Trend, but value is <i>already</i> below <u>bad</u> deviation	
-8	Trend Lower (good), and is <i>already</i> below <u>good</u> deviation	
-9	Trend is Lower (bad) and is <i>already</i> below <u>bad</u> deviation	

A Trend State will be determined for a given KPI whenever its value is updated with a new sample. Sign indicates slope. Odd numbers (except |1|) are NIC-related. Even numbers are always PIC-related. Higher Trend State Absolute values have a corresponding increase in emphasis in the grade function.

## Appendix B: Example FVOI worksheet and outputs

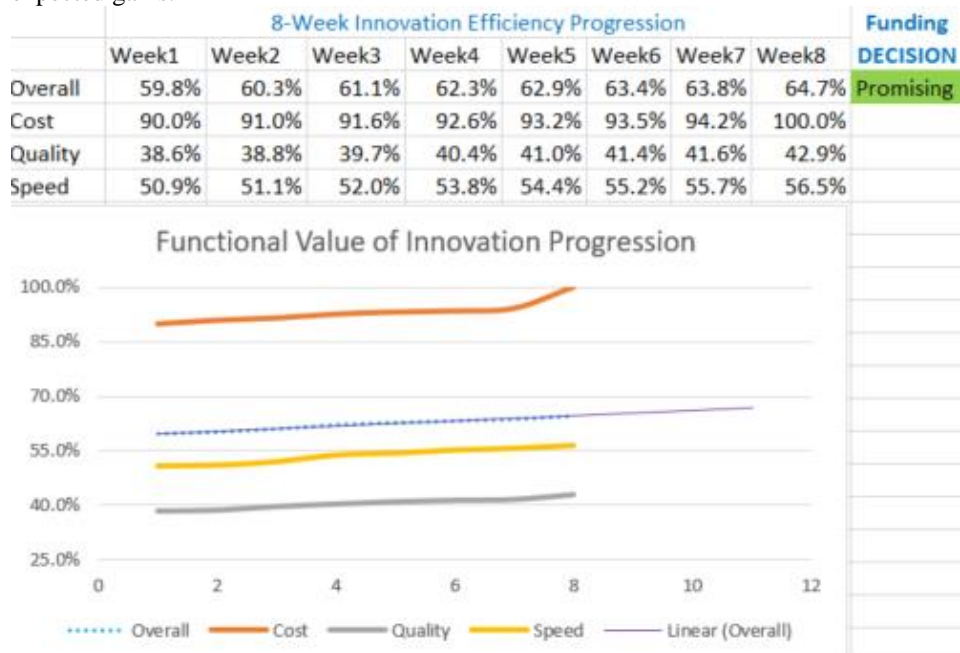
### Borderline Evaluation

In this scenario, the cost benefit is evident, but that comes at an expense of decreased quality, and slightly less velocity.



### Promising evaluation

The efficiency progress ratings are in the right direction, but impact may be minor or take longer to achieve expected gains.

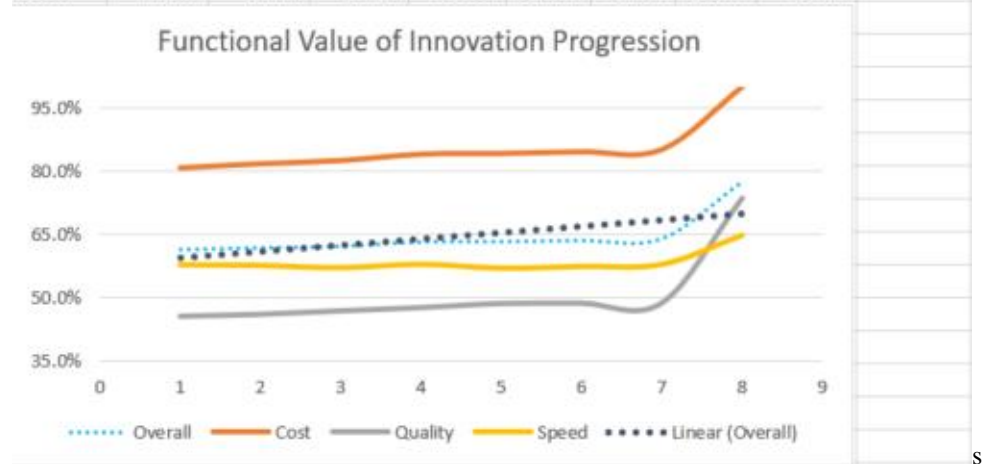




## Fund evaluation

The cost, quality and speed ratings were all high enough to bring the overall evaluation into the fund rating.

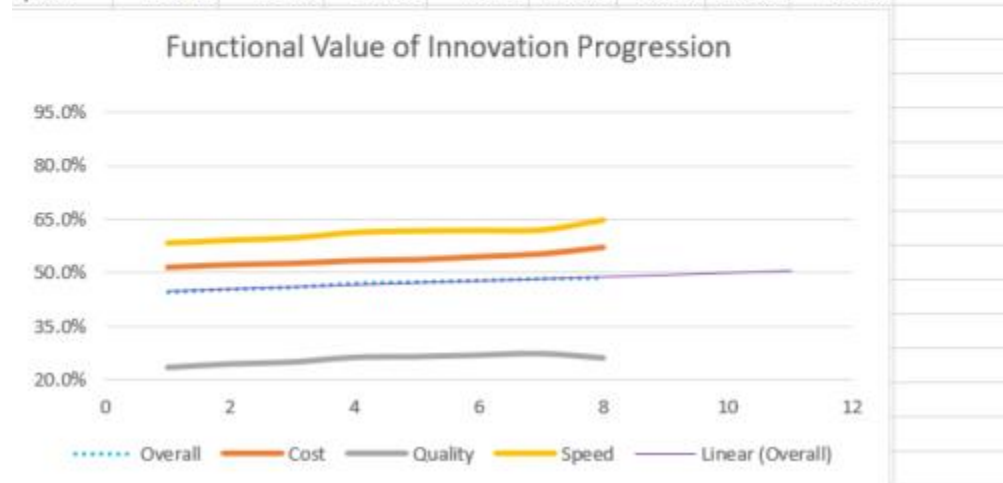
	8-Week Innovation Efficiency Progression								Funding
	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8	DECISION
Overall	61.5%	61.9%	62.2%	63.3%	63.3%	63.6%	64.0%	77.4%	Fund
Cost	81.0%	81.9%	82.7%	84.2%	84.4%	84.8%	85.3%	100.0%	
Quality	45.6%	46.0%	46.9%	47.6%	48.6%	48.6%	48.8%	73.7%	
Speed	57.8%	57.7%	57.2%	58.0%	57.0%	57.5%	58.0%	65.0%	



## Kill evaluation

There is not enough expected benefit to justify further funding and inclusion in the innovation pipeline, or the innovation caused a negative impact on tangential processes. ROI, if any, would take too long to achieve.

	8-Week Innovation Efficiency Progression								Funding
	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8	DECISION
Overall	44.5%	45.3%	45.8%	47.0%	47.3%	47.8%	48.2%	48.4%	Kill
Cost	51.4%	52.2%	52.5%	53.3%	53.6%	54.5%	55.2%	57.1%	
Quality	23.5%	24.4%	24.9%	26.3%	26.5%	26.9%	27.3%	26.1%	
Speed	58.5%	59.3%	59.9%	61.5%	61.9%	62.1%	62.2%	65.0%	



## Example FVOI Worksheet

Innovation Initiative #73: Automation scripts to manage maintenance with less human intervention

