

A Framework for Evaluating Innovation Challenges

MARCH 2017

INTRODUCTION

An innovation challenge awards a prize to a problem-solver who achieves a pre-specified goal. Historically, innovation challenges have spurred vital technological breakthroughs. Prizes in the 19th and 20th centuries were awarded for innovations like the first non-stop flight from New York to Paris, calculating longitude at sea, canned food, margarine, and the first gasoline-powered automobile. Modern innovation contests have proven effective in generating solutions to difficult problems by engaging diverse participants and communities, leading to other innovation-related impacts.ⁱ Governments and philanthropists increasingly offer prizes to spur innovations to solve a range of social problems (see box). The number, variety, and value of prizes have increased significantly in the last 15 years:ⁱⁱ The U.S. Federal Government alone offered over 730 prizes between 2010 and 2016.ⁱⁱⁱ The Federal Challenges and Prizes Toolkit (challenge.gov/toolkit) presents several interesting case studies of innovation challenges spanning topics such as analytics, software, and entrepreneurship, with outcomes including analytical methods, technology solutions, and business models to take technology to market.^{iv} For example, the U.S. Environmental Protection Agency ran a challenge to develop and market reliable, affordable sensors that

measure nutrient loads in water to help address the serious environmental problem of nutrient pollution. As another example, AgResults is a \$118 million, multi-donor, multi-lateral initiative that uses results-based economic incentives to spark private sector investment in agricultural innovation globally.

“Despite hundreds of recent challenges, we have limited information about their impact, as only a fraction of innovation challenges have been systematically evaluated”

Despite hundreds of recent challenges, we have limited information about their impact, as only a fraction of innovation challenges have been systematically evaluated. Challenge managers may often conclude the award of a prize is itself proof that the challenge achieved its goal. However, we do not know if the observed solutions to problems targeted by innovation challenges resulted because of the challenges or if they would have been developed over a similar period of time without the challenges. Neither do we know if innovation challenges are a cost-effective way to produce their solutions, relative to standard government contracting and grants, which pay entities to undertake specified activities without tying compensation to results. This brief proposes an approach to learning from innovation challenges run by the government, public sector, and non-profit institutions. We present an evaluation framework for sponsors and managers to use to improve the design and implementation of future innovation challenges, by learning from existing challenges what works and what does not work.

USE OF INNOVATION CHALLENGES

- 1 Innovation prizes worth \$1-2 billion awarded
- 2 Over 200 prizes of \$100,000 or more awarded since 1970
- 3 Significant growth in number of prizes offered since 2000
- 4 Prizes historically focused on aviation and space, science and engineering, climate and environment

HOW DO INNOVATION CHALLENGES WORK?

Organizations seeking social or scientific progress—primarily foundations and government agencies—launch challenges to motivate effort and investment toward a pre-specified goal or a solution of a concrete and difficult social or scientific problem. Organizations typically use innovation challenges when a well-defined and effective solution does not already exist. Outcomes can range from developing ideas, technologies, products and services, to engaging people, organizations, and communities.

A well-governed innovation contest specifies clear requirements for winning the prize and a robust process of verifying that a solver has met the requirements. Once verification is complete, the winning solver receives the prize (or multiple solvers each receive a prize) as described in the prize mechanism for the challenge.

There are several types of innovation challenges, each with a different prize mechanism. Single prize contests and patent buyouts are winner-take-all prize mechanisms. A **single-prize contest** awards one final prize to the first or best winner; organizations often use this design to find a technological solution. Single-prize awards put potential solvers in intense competition to reach the goal. Solvers best suited for this have the capacity to solve the problem and ability to weather the financial implications if they do not win the prize. Such challenges may imply that the winner has a monopoly over the solution. Patent buyouts, in which the government can purchase the winning patent at its estimated private value, can address the monopoly price distortions caused by patents.

As an alternative to single-prize contests, prize sponsors may use prize structures that allow for multiple awards. Prize sponsors may award **milestone prizes** along the way to the final prize to reduce potential solvers' investment risk. **Proportional prizes** award money proportional to the relative success of the various solvers. Potential solvers under this approach may face less competition and reduced investment risk—as all successful solvers earn some prize—without eliminating incentives to “win” since more successful solvers earn larger prizes. This approach works best when sponsors can measure success in allocable units, such as the value of production or the value of sales for individual solvers when all increments to volume contribute to the goal. Prize sponsors can also award a **per-unit prize** or prize per unit of success achieved which significantly reduces competition among solvers and increases the chances that any potential solver wins a prize. Such a prize may eliminate competition among solvers if sponsors base

the award on solvers improving their own performance by a certain unit or percentage. An **advance market commitment** guarantees solvers a market at a given price for all units of the desired product they deliver. This approach is best suited to spur creation of products for which sponsors know the desirable characteristics, but no current market exists for sellers.

Finally, it is also possible for a challenge to run without a cash prize if prize sponsors make other non-monetary benefits available to solvers.

Innovation challenges are often considered “pull” mechanisms that create solutions to tough social problems. This approach has several advantages over more traditional “push” mechanisms that pay based on effort rather than outcomes. The pull incentive in innovation challenges removes a sponsor's risk of contracting with a sole innovator who may not succeed—yet will use up the sponsor's resources in the attempt. Also, without relinquishing resources up front the sponsor can engage more than one innovator at a time, increasing the chances of success. For this reason, innovation challenges are less useful if the pool of potential solvers is small. Another advantage is that potential solvers may exert effort for reputational, social, or political reasons above the level that maximizes their expected monetary gains from participation. This further increases the chances of a solution and could have the additional benefit of incentivizing innovations besides those directly required to receive the prize. Finally, regardless of the prize outcome, sponsors can learn from solvers' efforts and approaches—including reasons they did not succeed—to inform future efforts to address the problem.

Although these potential advantages of innovation challenges are clear, only an evaluation can determine if a particular challenge had its intended impact, the magnitude of that impact, and whether the innovation challenge was more appropriate and cost-effective than other common approaches such as activity-based contracts, research grants, and the granting of patents. An evaluation can also advance understanding of the optimal contest design and implementation for new challenges. While an independent evaluation is often desirable, particularly for large-value innovation challenges, building into challenge governance in a learning framework can also yield benefits.

The next section presents an evaluation framework for innovation challenges that delivers learning benefits, one that can be readily adopted by challenge administrators and sponsors to meet their learning needs.

A FRAMEWORK FOR EVALUATING INNOVATION CHALLENGES

An evaluation enhances the value of an innovation challenge to its sponsor and to society as a whole if carefully framed and executed. The most appropriate evaluation frameworks include key questions that the study will answer, the approach to answering those questions (including the evaluation's design and data sources), and an end-of-the-line synthesis that takes into account answers to all evaluation questions to generate lessons learned. The framework presented in this brief groups research questions into four key learning topics: performance, cost, design and implementation, and social impact (if applicable to the specific challenge). We describe these learning topics at an overview level and then present, within each topic, more detailed questions and evaluation approaches to answering them.

CHALLENGE PERFORMANCE

Challenge performance refers to the results spurred by the incentive mechanisms, which includes both the direct results as specified by the prize requirements and any unintended results (positive or negative) above and beyond those requirements. The evaluation can answer the following questions in this topic area:

- Did the innovation challenge achieve the intended outcome for which the prize was awarded?
- What unintended outcomes did the challenge achieve beyond the outcome for which the prize was awarded?

A further learning topic is the assessment of who participates in the challenge as solvers and who does not.



CHALLENGE COST

This topic comprises assessment of the innovation challenge's costs, including awarded prizes; the costs of challenge governance; and, ideally, solver expenditures not offset by the prize award (to arrive at the full social cost of the undertaking). You can assess challenge cost against the challenge's performance and its social impacts (if any) to measure the cost-effectiveness of the initiative in achieving the solutions. Specifically, you can answer the following question:

- Was the innovation challenge cost-effective?

CHALLENGE DESIGN AND IMPLEMENTATION

Under this topic, the evaluation assesses the appropriateness of the prize mechanism design and the quality of implementation. Specifically, you can answer one or all of the following questions: Was the innovation challenge implemented well?

- Was the prize mechanism well suited to its context and goals?
- Was the innovation challenge implemented well?
- What are the key conditions that led to the success or failure of the innovation challenge in achieving its outcome?
- What are the lessons learned in the design and implementation of the innovation challenge?

CHALLENGE IMPACT

Under this topic, the evaluation assesses the ultimate intended social impact of the challenge, which may go beyond developing the particular solution sought by the challenge, such as to address a particular health or environmental problem. This is only applicable for challenges that spur solutions that beneficiaries can adopt and benefit from in the short or medium term. The question that the evaluation answers is:

- What is the social impact of the innovation challenge?

Types of evaluations that might be used to address the various topic areas are discussed in the next section.

LEARNING TOPICS AND EVALUATION APPROACHES

Challenge sponsors and administrators can incorporate learning objectives and activities into any challenge—whether as part of management or a formal evaluation. Below, we discuss in more depth how you can learn about each topic using different methods. In a table at the end of the brief, we give possible detailed learning questions under each of the four topics, along with metrics, approaches, and data sources to illustrate how you can assess challenge performance, cost, design and implementation, and impact.

Depending on the purpose and scope of any particular innovation challenge, you may seek to answer only one or two key questions or pursue a more comprehensive research agenda. For each question, you need to determine the appropriate approaches, metrics, and data sources. Similarly, evaluation approaches that can answer the questions under these four topics vary depending on the nature and approaches of the innovation challenge (e.g., if achieving social impact is a primary goal), the number of solvers expected by the sponsor, and the expected outcomes. You can answer most questions on challenge performance, cost, and design and implementation by either comparing metrics before and after the challenge or through a post-challenge assessment. Questions on challenge impact can reliably be answered only by using a more rigorous impact evaluation approach.

You can use formal impact or performance evaluation approaches (see box for definitions). Rigorous impact

evaluation approaches establish a valid counterfactual for what outcomes would have been without the challenge, so you can identify the challenge’s contributory impact. In general, due to their large sample requirement, quantitative impact evaluation approaches—randomized controlled trials and quasi-experimental approaches—are appropriate only if you expect the innovation challenge will lead to a social impact that affects a large number of beneficiaries. However, an impact evaluation may not be always be feasible because of resource constraints. When conducted, impact evaluations can be supplemented with qualitative data collection, such as interviews and document review, to help understand how and why the challenge had the observed outcomes.

Performance evaluation approaches such as before-and-after designs, snapshot designs, and case studies can generally be used to assess innovation challenges. You can use before-and-after designs to compare outcomes of solvers before and after the challenge using administrative or primary data. In snapshot designs, you look at solvers at one point in time during or after the innovation to assess how solvers view the quality of challenge implementation and the effects of participation.

You can use case studies for a comprehensive portrait of the innovation challenge or participating solver groups. This is useful for close examination of the challenge or solvers as a whole to learn about contextual factors, solver perceptions and decision making, and outcomes associated with the challenge. The resource list at the end of the brief contains resources on formal evaluation approaches.

Generally, to evaluate innovation challenges, sponsors and managers need information beyond what they need to know to award the prize. To best assure such information is obtained, administrators or evaluators should identify their learning questions, approach, and data sources before announcing the challenge. Challenge managers can then collect needed information through mandatory participant surveys if these are easy to understand and respond to. You can collect additional primary data from challenge sponsors, administrators and solvers using optional online surveys and in-person or phone interviews. Valuable secondary data includes reports from solver organizations and posts from social media relating to the challenge. The table at the end of this brief suggests data sources to answer each type of evaluation question.



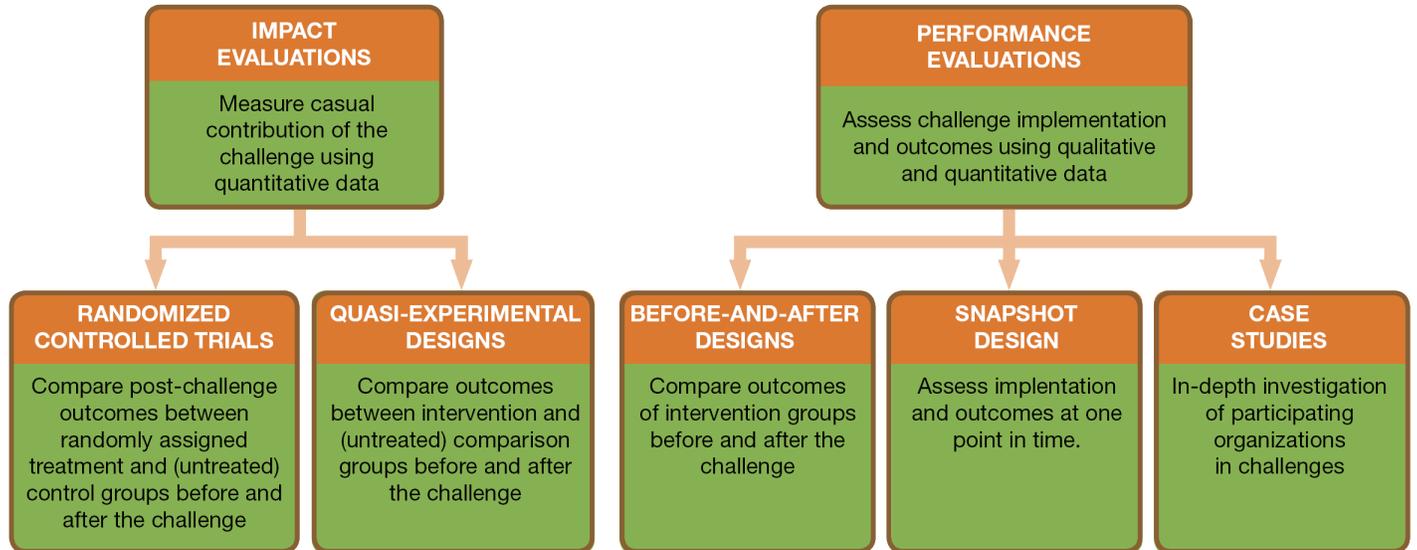
Challenge sponsors and administrators can easily incorporate learning objectives and activities into any challenge. See table at the end of the brief for examples

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The next four sections present details on the specific evaluation approaches, including ideal data sources, for answering questions on the four topics.

Example evaluation approaches for innovation challenges



Here are approaches that you can use to answer questions under each of the topics introduced above.



CHALLENGE PERFORMANCE

Challenge performance is central to the learning agenda of any innovation challenge that aims to incentivize development of a technology, product, or other solution. Challenge performance refers to the results spurred by the incentive mechanisms, which includes both the direct results as specified by the prize requirements and any unintended results (positive or negative) above and beyond those requirements. To assess performance, you can assess **participation** in the competition and its **direct outcomes**.

Participation. Learning about the types of solvers who participate in a challenge is useful when challenge performance particularly depends on the characteristics of the solvers, the solver group is very diverse, or there are questions around what influenced challenge participation (e.g., the solution requires high levels of technical expertise, the challenge targets a problem with little public awareness). However, while exploring solvers' participation in the competition can help contextualize direct outcomes of the challenge, it does not necessarily tell much about the challenge outcomes themselves.

APPROACHES



You can assess key factors that affect challenge participation, including the number and type of solvers, their motivation to participate, and the role challenge governance plays in their participation. You can collect data on these aspects and document characteristics of solvers and changes in these characteristics over time, as part of solver applications and challenge monitoring. This can also be part of a performance evaluation. For example, applications to enter the challenge contain data on the characteristics of each solver team that you can use to understand types of solvers and characteristics of teams in relation to different levels of participation and success in the competition. During or after the challenge, you can also interview solvers to learn about their motivations to participate in the competition and constraints they faced. You can use thematic analysis (an analytic technique to identify themes that emerge in text data) of interview data, for example, to understand which factors influenced solvers' decisions to pursue the challenge, such as market interest, community engagement, reputational capital, or public perception of the challenge or social problem.

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Direct outcomes. For all challenges, answers to basic questions about the features of the winning entry and the time needed to develop it are very instructive.

APPROACHES



You can assess types and novelty of solutions the challenge leads to, including those developed by organizations that did not win the prize, using reporting or monitoring data collected as part of the challenge governance or a performance evaluation. Solutions may go above and beyond what the contest required or lead to spillover effects that are a direct result of the contest such as higher awareness of an issue. If no solver wins the prize, the evaluation can still assess progress toward concrete solutions and key impediments to finding them.

You can address questions about challenge outcomes using a ***before-and-after assessment***, in which you gather data on the state of innovation among the pool of solvers that apply before the challenge begins, and the state of innovation after the challenge is completed. Not all of the change can automatically be attributed to the existence of the challenge, however. You can get close to gauging the challenge's impact using comparative case studies, if problems exist similar to the one the innovation challenge aims to solve, which are not being tackled through innovation challenges. For example, in a challenge to spur development of a vaccine for a disease, you could examine a similar disease for which a vaccine has not been developed and for which no challenge is offered. This assessment can compare progress toward vaccine development between the disease targeted by the challenge and similar diseases not targeted by a prize over the same time period. The difference can be interpreted as the impact of running the challenge in one case and not the other. Alternatively, the case studies can compare the performance of solvers that do not participate in the challenge against those that do—if the pool of potential solvers is large, and not all of them enter the challenge competition. You can collect these data directly from similar capable entities through interviews and from publically available sources. Quantitative evaluation of large numbers of solvers may also be feasible, although in practice, quantitative evaluation of innovation challenges has only been done retrospectively.

Other applications of interviews and surveys include learning about progress made and constraints faced by unsuccessful solvers, and for the winner, learning about its plans for applying and potentially commercializing the solution post-challenge. To assess the level of innovation spurred by the challenge, solvers and subject matter experts can also characterize or rate the level of novelty of the developed solutions in interviews and surveys.



CHALLENGE COST

An important question is whether a challenge is a cost-effective way to find the solution sought, given available resources, compared to other approaches such as traditional contracting that uses provider “push” strategies rather than market “pull” mechanisms. This analysis can be particularly instructive when challenge costs are high or other mechanisms to source the solution exist, and the relative cost-effectiveness of a challenge-based approach is not obvious.

APPROACHES



Cost-effectiveness analysis gives the ratio of the total cost required to achieve a given outcome. In the current application, the most central cost-effectiveness indicator is the cost of achieving the challenge’s solution. Comparing this cost with the corresponding costs of a non-challenge approach reveals the relative cost-effectiveness of the challenge.³ The adjacent green box describes the methodology used for calculating these and related measures in the cost-effectiveness realm.

To determine a challenge’s cost-effectiveness, you must measure the challenge’s total cost—including the cost of its governance, the cost of verifying whether the solver achieved the solution, and the prize money awarded.⁴ A good guide to determine cost elements to include in the total is to think of all expenses you will incur to replicate this challenge. You do not need to include any cost incurred by participants if you are not examining costs to society as a whole. However, it matters considerably what society invests toward meeting the challenge, including the spending undertaken by private actors in pursuit of the prize. These resources might have been put to other uses with a higher social return—or perhaps not. In any case, you should include these as dollar costs to society in a full cost-effectiveness analysis.

You can use readily available challenge management data, particularly accounting records, to answer simple cost-effectiveness questions

³ When comparing the cost to outcome ratios, you need to assess the methods used to estimate cost and outcomes and ensure comparability across the different approaches. See Dhaliwal et al. 2011 for general framework for conducting cost-effectiveness analysis.

⁴ These cost elements comprise only the prize sponsor’s costs and are appropriate to include in the cost effectiveness analysis assuming that the goal is to maximize cost-effectiveness for the prize sponsor funds and not for society as a whole. To maximize cost-effectiveness for society as a whole, a full accounting of the social costs is needed. This would require including costs incurred by the solvers and users of the solutions.

Next, you determine the outcome achieved by the challenge, which could be the solution sought itself, or the social impact resulting from the solution. To estimate the latter you will need an impact evaluation. It may also be useful to calculate the cost per unit of progress produced on some metric other than a simple up/down for whether a solver found the solution. Conversely, one can calculate the units of progress achieved for a given cost.

If conducting a **comparative cost-effectiveness analysis**, you need to obtain the cost per unit of the same outcome achieved using a non-challenge approach, from available secondary data. Comparing cost per unit of the outcome across the two approaches will give an estimate of the cost savings from the challenge approach, if any.



CHALLENGE COST (CONT'D)

COST RATIO = Challenge outcome^{*} / challenge cost^{**} **Comparative cost-effectiveness ratio** = (Total outcome achieved by challenge – Total outcome achieved without challenge) / (Total challenge cost – Total cost without the challenge to achieve the same outcomes) = Outcome achieved because of the challenge per unit of incremental dollars spent

^{*}**Challenge outcome:** Solution produced (e.g., vaccine with given requirements developed, or food intake software developed), or total adoption of new technology as a result of the challenge

^{**}**Challenge cost (\$)** = Challenge governance cost (staff resources, travel, expenses incurred for communication materials, events, meetings etc.) + verification cost (staff resources, expense incurred for expert consultancy to judge prizes, data collection for verification etc.)+ prize money awarded

A good guide to determine cost elements to include in total challenge costs is to think of all expenses that you will incur to replicate the challenge. You do not need to include any cost incurred by challenge participants if you are not calculating costs to society as a whole.

For multi-year challenges, costs incurred in different years should be adjusted for inflation and discounting. For a detailed guide to conducting cost-effectiveness analysis see Dhaliwal et al. 2011 and EPA analysis guidelines (US, EPA 2010).

Here is a simplified hypothetical example of calculating the cost-effectiveness ratio for an innovation challenge that incentivizes the adoption of a new cost-effective mobile technology for enhancing early grade reading test scores (reading test scores) by at least 15%. The numbers below are illustrative.

Challenge cost (over 12 months): challenge governance (\$15,000) + cost of verifying the adoption of mobile technology by schools (\$35,000) + prize money (100 schools * \$1500 prize per school that adopts, with total 25,000 children) = \$15,000 + \$35,000 + 100*\$1,500 = \$200,000; or equivalently \$200,000/25,000 = \$8 per child

Challenge outcome (at the end of 12 months): Increase in reading test scores by 20% per child based on evaluation using a sample of 1000 in-program and 1000 out-of- program school children; 25,000 children in 100 schools receive the program

Cost-effectiveness ratio (challenge): = \$200,000/25,000 = \$8 per child to produce a 20% increase in reading test scores, or equivalently 125 children helped to that extent for every \$1000 spent

Cost-effectiveness ratio (non-challenge): One can estimate this from secondary data on non-challenge approaches using total program costs with and without the program, and the total increase in test scores with and without the program. If a non-challenge approach costs \$15 per child for improving reading test scores by 20%, then the cost of increasing reading test scores for 125 children by 20% will be \$15*125 = \$1,875.

Comparative cost-effectiveness: Non-challenge approach costs \$875 more than challenge approach for increasing test scores by 20% for 125 children; or equivalently non-challenge approach costs \$15-\$8 = \$7 per child more than the challenge approach to increase test scores by 20%.



CHALLENGE COST (CONT'D)

APPROACHES (cont'd)

Cost-effectiveness analysis avoids the thorny issue of monetizing benefits resulting from the outcome, which is needed in a cost-benefit analysis. It is also appropriate in contexts where programs focus on a key outcome since the cost is compared for a specific outcome, which is typically the case for challenges.³ You can use readily available challenge management data, particularly accounting records, to answer simple cost-effectiveness questions. You may need additional secondary data if you compare the cost to a non-challenge approach.

For challenges that may increase adoption or sales of a technology or product, but for which total adoption is not known, you can conduct a **break-even analysis**, which requires only an estimate of the monetized benefit of the solution per unit of adoption. For example, you can measure the benefit of adopting a vaccine for an animal disease as the product of the probability of exposure to the disease (as measured by the prevalence of the disease in the baseline before vaccine availability), the efficacy of the vaccine (the probability of not contracting the disease if exposed, from efficacy studies), and the value of economic activities negatively impacted by the disease. You can then calculate the number of adoptions at which the total cost equals the total benefits using information on total costs and the benefit of adoption per unit of adoption. Note you may have to include additional costs if public sector assistance is needed to market or promote the vaccine to livestock owners; you do not need to add these, for example, if only the private sector invests in marketing and promotion. This analysis can help challenge sponsors assess the extent of adoption required for a positive return on investment in the challenge and gauge whether that degree of adoption is reasonable given current conditions. If only very low adoption rates are required to break even, sponsors may conclude that a prize mechanism that produced the initial solution will, over the long run, be cost-effective.

³ If a program has multiple desired outcomes, a cost-benefit analysis is more useful since all the program effects or benefits are monetized and compared against the cost. However, monetization of benefits is not always feasible without making extensive assumptions.



CHALLENGE DESIGN & IMPLEMENTATION

For all challenge types, you should determine the quality of prize mechanism design and its implementation before evaluating performance. The former is also an important step in drawing lessons for challenge design and implementation.

APPROACHES



You can assess how well the challenge design suits the targeted problem and goal—and incentivizes action by targeted solvers—as part of challenge governance or through a performance evaluation. Information from stakeholder interviews, relevant reports, and academic literature can help qualitatively assess the main features of the challenge design and whether it was well-suited to the problem. You can gather and synthesize information on challenge design and implementation throughout the competition and post-prize award through interviews with solvers and challenge administrators. These interviews can feed into your reflections on the challenge design, key drivers of success and obstacles surrounding the challenge and targeted outcomes, and the quality of the challenge implementation (see box for examples).

Example interview questions on challenge design and implementation

Questions for solvers:

- What motivated your organization/team to enter the challenge?
- What aspects of the challenge positively influenced the performance of your organization/team (e.g. challenge design, challenge governance, resources)?
- What problems did your organization/team face while participating in the challenge?
- How could the challenge have further incentivized or helped your organization/team succeed (e.g., what changes in challenge design and/or governance would have been helpful)?

Questions for challenge administrators:

- What components of the challenge design positively/negatively affected its outcomes?
- What aspects of the challenge governance were successful (e.g. challenge administration, transparency, clarity of rules, outreach)?
- What hurdles did you face implementing the challenge (e.g. outreach, participation, resources)?
- How did external factors affect the challenge implementation and outcomes?
- If you were to redo the challenge today, what would you do differently?
- What lessons did you learn from the challenge? What lessons would you apply to future challenges?

Challenge sponsors or evaluators can use these data, along with findings from other topics explored, to draw general lessons about conditions for success and sustainability. You can supplement this information through interviews with key stakeholders after the prize is awarded, as post-prize reflections on sources of success and obstacles—and any lessons learned—are often useful for challenge sponsors. The focus of a “lessons learned” analysis will depend on the answers to other research questions. Synthesized answers on challenge performance, cost, and impacts can reveal, for example, whether the prize mechanism design was or was not capable of achieving its intended goals or whether the challenge was well administered.

If the challenge resulted in the anticipated solution, it may be possible to draw lessons about which aspects of the prize mechanism were most essential to successfully engaging capable solvers and spurring solution development (particularly if challenge managers tried simultaneous alternative approaches). In addition, identification of key obstacles faced in award governance and any unexpected implementation features can help inform future challenge design. Lessons can also help determine external factors that influenced solver participation and challenge performance. Such an assessment can guide administrators in deciding when a similar innovation challenge approach is appropriate for addressing future social objectives.



CHALLENGE DESIGN & IMPLEMENTATION (CONT'D)

For all challenge types, you should determine the quality of prize mechanism design and its implementation before evaluating performance. This is also an important step in drawing lessons on challenge design and implementation.

APPROACHES

Ultimately, you can tease out the most important aspects of challenge design and governance that lead to or impede success, and further, determine the critical external conditions for success to inform scale-up of these approaches. These lessons help challenge designers choose appropriate problems to target and design more effective and efficient challenges. For sponsors who manage a portfolio of challenges, a synthesis of findings across evaluations of several challenges can enrich best practices in designing and implementing innovation challenges. By connecting findings across topic areas and multiple studies, we can further strengthen our understanding of the external factors that influence solver participation and challenge performance. This understanding can help guide decisions on when to use an innovation challenge approach for addressing other social objectives.



CHALLENGE IMPACT

The ultimate expectation of many challenge sponsors is that a solver's solution not only results in the awarding of a prize but also produces a social impact (e.g., increased sales of improved on-farm storage to the rural poor). While the challenge itself ends with the development and certification of a solution, it only has a social impact if intended beneficiaries adopt or use that solution, which is not necessarily a requirement of the challenge rules. For example, a challenge could spur development of improved on-farm storage suitable for smallholder farmers in developing country contexts. While the prize will be awarded if the technology is developed, the ultimate social impact—improved food security—follows only from the adoption of the new on-farm storage technology by rural households.

APPROACHES

 For challenges that seek a social impact, you can assess the expected or actual social impact using a variety of quantitative impact evaluation approaches, such as randomized controlled trials and quasi-experimental approaches. This is most applicable for large monetary prizes where calculations of return on social investment rise in importance.

An impact evaluation may not be feasible or practical if you expect adoption of the solution to take a few years. In that circumstance, you may have to project the adoption. A measure to assess expected social impact from a challenge is whether specifications established for qualifying for the challenge, appraised prospectively, seem likely to achieve that impact. To make this appraisal, you can compare solution specifications with current causes of the problem and assess the likely degree of adoption if the solution is developed as specified. If the challenge prize is awarded, the evaluator can determine if the challenge had the anticipated impact by measuring the extent of adoption of the solution and projecting the impact of that degree of adoption on the social goal. You can do this qualitatively by assessing beneficiaries' intent to adopt the solution through key stakeholder interviews. Certainly, evaluators can assess adoption quantitatively once it has happened, a few years after challenge completion, by conducting a rigorous impact evaluation to assess the magnitude of the social impact. For example, if the challenge depends on sale of a technology, the challenge administrator can work with the evaluator beforehand to randomly assign certain geographical locations as control sites and not include them in the sales effort, or include them only in the last phase of commercial roll-out. Alternatively, you can select counterfactual sites from a geographic area where the challenge is not administered.

CONCLUSION

This explores questions for challenge sponsors and administrators to learn about challenge design and effectiveness. You can apply this evaluation framework and proposed evaluation questions and approaches to guide learning about design and implementation across a range of challenge types and to gain information about the social impacts attributable to the challenge.

Challenge sponsors and administrators can also incorporate evaluation elements into the governance of any challenge. If measurement, assessment, and learning become standard parts of innovation challenges, the challenge community will have a growing evidence base with which to move ahead quickly in applying approaches best able to achieve funders' objectives, in terms of social impact and on other metrics. Much of the information necessary to assess challenges and learn from their implementation is readily available from challenge management data. You can gather additional information through short surveys and interviews with solvers and challenge administrators, or through larger population surveys of intended beneficiaries for impact analysis purposes.

Available resources and the key areas of uncertainty surrounding a particular challenge approach and its effectiveness define the depth and breadth of questions and metrics you explore. Yet every sponsor should

address key questions about performance, impact, and cost to generate lessons to inform development of better innovation challenges in the future.

The evaluation framework calls on a range of analytic approaches, depending on the application and the resources available for evaluation. We recommend at a minimum focusing on questions that can be addressed primarily using challenge management data because of the feasibility and importance of this type of research and conducting an impact evaluation whenever feasible to assess the social impact of prizes. Gathering information from solvers to answer additional questions is possible with more effort. Assessments of impact, requiring significant data collection, may require hiring staff with evaluation expertise or procuring it through outside contracts. This research component may be best suited to challenges with large budgets or that pilot new designs or move into new areas of application. Particularly for an impact evaluation, hiring a third party to assure the scientific rigor and independence of the evaluation results may be desirable. Approaches to advance learning in many areas need not be complex, but all require forethought and planning in conjunction with challenge governance.

For additional valuable resources on challenges and challenge evaluation, please find a reference list of academic studies and other published reports on page 23, as well as a list of resources on evaluation approaches.

Lessons from the evaluation can help challenge designers choose appropriate problems to target and design more effective and efficient challenges

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Topic	Metrics	Approaches	Data sources				
			Surveys	Interviews	Documents Review	Management Data	Observation
Challenge performance: participation							
Evaluation question: Did the challenge stimulate involvement of capable solvers?							
Solver characteristics	Organizational characteristics <ul style="list-style-type: none"> Number, nationality, and type of officially registered solver organizations Solvers' prior experience in relevant sector (e.g., they engage in similar research and development (R&D) activities; manufacture relevant product; provide similar services in sector) and work with sponsoring or administering entity (e.g., they have worked with the government before) Number and type of entities that partner with registered solver organizations Change in size and structure of solver organizations Organizational profile and results of winning solver compared to runner-up and other solvers 	<ul style="list-style-type: none"> Descriptive analysis of data on solver characteristics Benchmarking of solvers' profiles and progress towards solutions 	◆	◆	◆	◆	
	Team characteristics <ul style="list-style-type: none"> Number, job function, and expertise of participants' challenge team members 		◆	◆		◆	
Evaluation question: What factors influenced challenge participation and which were most important?							
Award governance	Challenge incentives <ul style="list-style-type: none"> Process and timing of contest entry and challenge awards Award size (e.g., in comparison to market price for solution) and prize structure (e.g., single award or milestone payments or a combination of both) Non-cash incentives and benefits built into prize mechanism Requirements to register and comply with challenge rules Media impact: number of members in the challenge's online community, media impressions (general and by entrant), social media posts (e.g., Twitter, Facebook) 	<ul style="list-style-type: none"> Descriptive analysis of challenge management data Descriptive analysis of media & social media activity 			◆	◆	◆
Solver motivations	Interest in market or sector <ul style="list-style-type: none"> Key characteristics of market or sector relevant to the challenge Solver-stated perceptions of state of technology or targeted problem Solver's current business or social interest in the market or sector (e.g., revenue from current related technology, product, or services) Solver-stated perceptions of market or social potential for challenge result Solver expected benefit from challenge result (e.g., public savings from activity or solution; revenue from, and buyers of, expected innovation, product, or services) 	<ul style="list-style-type: none"> Thematic analysis of solver perceptions, compared before-and-after 		◆			

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Topic	Metrics	Approaches	Data sources				
			Surveys	Interviews	Documents Review	Management Data	Observation
	Interest in challenge <ul style="list-style-type: none"> Solver stated primary and secondary motivations and drivers of decision making for contest entry, engagement, and exit Impact on solvers of non-cash incentives and benefits built into prize mechanism 	<ul style="list-style-type: none"> Thematic analysis of solver perceptions, compared before-and-after 		◆			
Challenge performance: direct outcomes							
Evaluation question: What types of challenge solutions were achieved (or not), and what level of innovation occurred?							
Challenge solutions	Challenge solutions and outcomes <ul style="list-style-type: none"> Specifications of winning entry compared to specifications to win the challenge Observed or documented outcomes other than the winning entry (e.g., increased public awareness, increased R&D activity) 	<ul style="list-style-type: none"> Before-and-after comparison or case study of challenge performance Comparison with similar problems, using qualitative case comparison or quasi-experimental design Comparison between solvers that participate and solvers that do not, using qualitative case comparison or quasi-experimental design 				◆	
	Solver progress <ul style="list-style-type: none"> Number of solvers that reached progress milestones or intermediate results for technology, product, or activity Time required to reach progress milestones or intermediate results by solver Solver-rated novelty of the solutions developed 	<ul style="list-style-type: none"> Thematic analysis of solver perceptions, compared before and after challenge 	◆	◆		◆	
	Solution constraints <ul style="list-style-type: none"> Solver-reported primary & secondary constraints to meeting the challenge specifications 			◆			
Solution use	Use of challenge solutions <ul style="list-style-type: none"> Solver-reported plans for use of/investment in challenge solutions (e.g., technology, product, or activity) post-challenge Type and extent of spillover effects of challenge solutions as reported by solvers, stakeholders, and experts Solver-reported incentives and constraints for applying challenge solutions to related applications, activities, or problems 	<ul style="list-style-type: none"> Descriptive analysis of solver-reported use of challenge solutions 	◆	◆			

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Topic	Metrics	Approaches	Data sources				
			Surveys	Interviews	Documents Review	Management Data	Observation
Challenge cost							
Evaluation question: How cost-effective was the challenge?							
Challenge cost	Challenge cost <ul style="list-style-type: none"> Total cost of the challenge competition, inclusive of challenge governance costs by challenge manager and funder, technology verification costs for prize, and allotment of prize money 	<ul style="list-style-type: none"> Quantitative analysis of challenge management data on costs 			◆	◆	
	Solver investment <ul style="list-style-type: none"> Total solver cost, inclusive of solver expenditures and in-kind contributions from solver partners 	<ul style="list-style-type: none"> Quantitative analysis of solver costs 	◆			◆	
Social Cost	Social cost <ul style="list-style-type: none"> Prize administrator's costs of governance, verification, and prize money Solver costs of participation and achieving outcomes Expected cost of adoption of the developed solution (e.g., marketing and communication costs) 	<ul style="list-style-type: none"> Secondary data on benefits per unit of solution adoption, if available to support quantitative impact evaluation Rigorous quantitative impact evaluations 	◆		◆		
Cost-effectiveness	Cost-effectiveness ratio <ul style="list-style-type: none"> Cost-effectiveness ratio – total cost per unit of solution produced or solution produced for a given cost Comparative cost-effectiveness analysis comparing cost-effectiveness ratios for challenge and non-challenge approaches 	<ul style="list-style-type: none"> Cost-effectiveness analysis using cost and outcomes data for challenge, secondary data for non-challenge approaches, if available 				◆	
	Break-even adoption rate (if applicable) <ul style="list-style-type: none"> Break-even adoption rate for challenge solution given the efficacy of the solution in providing social benefits, if they can be monetized 	<ul style="list-style-type: none"> Secondary data on benefits per unit of solution adoption, if available Quantitative analysis of cost data combined with estimates of expected monetized benefits per unit of solution adopted 		◆	◆		
	Return on investment <ul style="list-style-type: none"> Financial return on investment given challenge cost and value of solution produced Implied economic return on investment given net present value of the social benefit (if applicable) and social costs 	<ul style="list-style-type: none"> Financial rate of return analysis, with rate of return that equates prize administrator's challenge cost and value of solution produced Economic rate of return analysis, with return that equates estimates of social costs, and social benefits from the challenge impact analysis if benefits can be monetized 	◆		◆		

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Topic	Metrics	Approaches	Data sources				
			Surveys	Interviews	Documents Review	Management Data	Observation
Challenge design and implementation							
Evaluation question: What lessons were learned about best practices in design and implementation of innovation challenges?							
Challenge design	Challenge design <ul style="list-style-type: none"> Key elements of challenge design including challenge structure, incentives, timeline, and specifications 	<ul style="list-style-type: none"> Descriptive analysis of challenge management data 	♦	♦		♦	
	Effective challenge elements <ul style="list-style-type: none"> Critical challenge design elements that influenced overall success and sustainability 	<ul style="list-style-type: none"> Synthesis of findings 					
	Constraints not addressed by challenge design <ul style="list-style-type: none"> Key constraints and market failures addressed and not addressed by challenge Key constraints of solver involvement addressed and not addressed by challenge Key constraints to solution development addressed and not addressed by challenge Key constraints and market failures that limit adoption of the solution once developed (if applicable) 	<ul style="list-style-type: none"> Synthesis of findings 					
Challenge governance	Implementation features <ul style="list-style-type: none"> Key positive and negative features of challenge implementation reported by solvers (e.g., issues with challenge rules) Key facilitators and constraints to challenge governance and implementation reported by challenge administrators Key changes made post-challenge announcement Key aspects of challenge implementation that were unexpected, as reported by challenge administrators 	<ul style="list-style-type: none"> Thematic analysis of perceptions post-challenge 		♦			
	Constraints to challenge governance <ul style="list-style-type: none"> Most difficult aspects of challenge governance (e.g., verification, judging solutions) 	<ul style="list-style-type: none"> Thematic analysis of challenge administrators' perceptions post-challenge 	♦	♦			
	Unexpected implementation features <ul style="list-style-type: none"> Key aspects of challenge implementation that were unexpected 	<ul style="list-style-type: none"> Thematic analysis of challenge administrators' perceptions post-challenge 		♦			
Context	External factors <ul style="list-style-type: none"> Key external factors that influenced the challenge governance, performance, impacts, and cost-effectiveness 	<ul style="list-style-type: none"> Thematic analysis of challenge administrators' perceptions post-challenge, informed by secondary data 		♦	♦		

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Topic	Metrics	Approaches	Data sources				
			Surveys	Interviews	Documents Review	Management Data	Observation
Challenge impact							
Evaluation question: What evidence exists that the challenge resulted in a solution with the desired social impact?							
Problem characteristics	Causes of targeted problem (if applicable) <ul style="list-style-type: none"> Primary and secondary causes of targeted problem among intended beneficiaries Primary and secondary constraints to solution adoption addressed and not addressed by the challenge specifications 	<ul style="list-style-type: none"> Thematic analysis of solver perceptions pre-challenge 		◆	◆		
	Solution diffusion (if applicable) <ul style="list-style-type: none"> Number of solvers manufacturing or offering developed solution post-challenge Number of units manufactured and average sale price for developed solution post-challenge (if diffusion is a direct outcome of the challenge, this is included above, otherwise assess if applicable) Primary and secondary constraints to solver production or offering of developed solution 	<ul style="list-style-type: none"> Descriptive analysis of solution manufacturing Thematic analysis of solver perceptions post-challenge 	◆	◆	◆	◆	
	Solution adoption (if applicable) <ul style="list-style-type: none"> Number of intended beneficiaries (individuals or organizations) that adopt solution post-challenge Expected adoption by intended beneficiaries 	<ul style="list-style-type: none"> Descriptive analysis of solution adoption Quantitative data on outcomes achieved (if adoption is a direct outcome of the challenge) Rigorous quantitative impact evaluations 	◆	◆	◆	◆	
Social benefit	Social benefit (if applicable) <ul style="list-style-type: none"> Solution or direct outcomes from the challenge Prize money Expected adoption by intended beneficiaries (if not a direct outcome of the challenge, to assess expected social benefit) Social benefit to beneficiaries derived from solution adoption (to assess actual social benefit) 	<ul style="list-style-type: none"> Thematic analysis of beneficiary decision-making & social benefits related to solution adoption Secondary data on benefits per unit of solution adoption, if available to support quantitative impact evaluation Rigorous quantitative impact evaluations 	◆	◆	◆		

RESOURCES

For Further Reading About Innovation Challenges

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For further information about formal evaluation approaches

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ENDNOTES

- i. Kay 2011, 2012b
- ii. McKinsey 2009; Hendrix 2014; Goldhammer et al. 2014
- iii. U.S. General Services Administration 2016
- iv. U.S. General Services Administration 2016
- v. McKinsey 2009; Hendrix 2014
- vi. Goldhammer et al. 2014
- vii. Elliot and Hoffman 2010
- viii. Mansfield 1984; Williams 2010; Murray et al. 2012; Brunt, Lerner, and Nicholas 2008

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Abigail Conrad, Tulika Narayan, Judy Geyer, and Stephen Bell are evaluators at Abt Associates.

Luciano Kay is a research fellow at the University of California Santa Barbara.

We welcome questions or comments on this brief. Please send them to Tulika Narayan, the Research Director for the AgResults evaluation, at Tulika_Narayan@abtassoc.com.

AgResults is a \$118 million multi-donor, multi-lateral initiative incentivizing and rewarding high-impact agricultural innovations that promote global food security, health, and nutrition through the design and implementation of pull mechanism pilots. The AgResults initiative is a partnership between the Australian Government, the Bill & Melinda Gates Foundation, the Government of Canada, the United Kingdom's Department for International Development, the United States Agency for International Development, and the World Bank. Abt Associates is the external impact evaluator of AgResults. This brief draws from our evaluation design for the AgResults Brucellosis Vaccine Pilot. The contents of this brief do not necessarily reflect the views of the AgResults' partners.

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