Crowdsourcing in pharma: a strategic framework

Jörg Bentzien[1], Ragu Bharadwaj[2] and David C. Thompson[1]

Q1

[1] Boehringer Ingelheim Pharmaceuticals, 900 Ridgebury Road, Ridgefield, CT 06877, USA
[2] Appirio, 760 Market St, 11th Floor, San Francisco, CA 94102, USA

Conceptually, all organizations can be described as coordinated actors working together to deliver a product(s), or provide a service(s). For organizations to remain competitive, it is important to have processes that look outward for external 'innovations' that could improve how work is done, and what is delivered. We present a comprehensive review of a variety of processes that pharmaceutical companies have used to engage external actors ('the crowd') to provide innovation in the service of delivering novel therapeutic agents. This culminates in a framework that provides a consolidated view of crowdsourcing processes, which in turn enables a strategic application of a crowdsourcing methodology based on problem type.

Introduction

The need to innovate

Q3 The role of pharmaceutical companies within the healthcare ecosystem is in the provision of safe and efficacious treatments that positively affect patient quality-of-life. The discovery and development of these treatments is a complex, time-intensive and costly endeavor often running into billions of dollars over 10–15 year cycle times and with a very low rate of success. Given its high costs, capital markets have proven very useful in funding the majority of pharmaceutical companies. Unfortunately, such capital is neither patient nor long-term. This has further complicated the roles of pharmaceutical companies, which also have to satisfy shareholder demands for capital appreciation, certainty and quick returns. Despite significant advances in the science of R&D, along with commensurate improvements in technological and managerial factors, all things that should enable increased efficiency in commercial drug R&D, the number of new drugs approved per billion dollars spent has halved roughly every nine years since 1950 [1]. Furthermore, the rate of approvals is below that required to generate sufficient growth for the industry as a whole [2].

There are many reasons for this, and there is much discussion in the literature as to what ails the pharmaceutical sector and myriad ways suggested to potentially fix it [3]. It is important to remember however that the search for drugs is one that is occurring in an unfathomably large search space – estimates range between 10^{23} and 10^{60} potentially realistic drug-like molecules that are synthesizable [4]. Finding a novel, commercially viable product that exhibits superior efficacy and safety compared with existing treatment options ensures that pharmaceutical endeavors remain extraordinarily risky ventures unfolding in a context of incomplete knowledge.

A common strategy to manage risk is the adoption of a portfolio approach, wherein a basket of known quantities sits aside more experimental approaches. Given the lengthy timescales involved in the drug discovery process, the importance of a robust assessment of the target is crucial [5]; the more information on the target and its viability, the more of a 'sure thing' one might suppose it to be. Such known quantities are likely to experience steep competition as the market arranges itself accordingly, so differentiation at the portfolio level is vital.

Risk-focused portfolio management is an example of the underlying tension between exploitation and exploration – known quantities and novelty – and represents the most important challenge any organization has to wrestle with throughout the span of its existence. Is the balance of exploitation (using what is already institutionally known and accepted) and exploration

Corresponding author: Thompson, D.C. (david.thompson@boehringer-ingelheim.com)

1359-6446/© 2015 Published by Elsevier Ltd.
http://dx.doi.org/10.1016/j.drudis.2015.01.011

(investigating what is not institutionally known and accepted) appropriate? [6,7]. Another interesting framing of this same dichotomy is internal versus external. How much of what is done within an organization is planned, sourced and executed internally – versus similar activities with a focus more external to the organization.

Outside in

The modern global pharmaceutical industry has its 19th century origin in two sources: apothecaries that transitioned into the wholesale manufacture of drugs and chemical companies that established research-oriented laboratories focused on the medical application of their products. Cooperative relationships between academic laboratories and pharmaceutical firms were established early on, and drove a focus on dyes, antibodies and physiologically active agents [8]. These relationships are examples of the first instance of processes that internalize external innovation. If one broadly defines 'crowd' as the agents external to an organization, this is arguably the first use of crowdsourcing in the pharmaceutical space.

Crowdsourcing

Crowdsourcing as a term that was coined in a 2006 issue of *Wired* magazine [9] and described an internet-enabled business model that harnessed the creative ability of agents external to an organization. As implied above, crowdsourcing existed before the internet and one of the best-known examples of crowdsourcing, pre-internet, was the British government's establishment of the Longitude Act in the 18th century. To prevent the loss of ships at sea, the government created a prize purse of £20 000 (the equivalent of
Q4 £2.5 million in 2014) to map longitude. The winning solution, the chronometer, came from an unexpected source, John Harrison, a carpenter and clockmaker by trade, and was delivered some 50 years after the establishment of the act [10]. The unexpected nature of the winning solution is a result of using a process that enables exploration and demonstrates that, when constructed appropriately, such searches encourage but do not necessarily reward 'expert bias' [11]. The use of crowdsourcing has grown following the widespread adoption of the internet. The ready access to a distributed network has driven the widespread exposure of problems and the identification of solvers.

In this present work, we extend the definition of 'crowd' to include any actors external to an organization, working with or for the organization and in the service of solving problems of interest to the organization. In doing this we are able to connect a variety of processes that internalize external innovation (and that hark back to the origins of the pharmaceutical industry) into a comprehensive framework. Such a framing coherently connects open innovation, crowdsourcing, academic collaboration(s), consortia and pre-competitive participation activities into a single vision, amenable to strategic use.

This paper is organized accordingly. In the following section crowdsourcing is described in more detail, along with recent examples of the application of crowdsourcing to problems in informational R&D (inside and outside of the pharmaceutical industry). Some thoughts are presented on the role of community and the importance of domain abstraction, along with a brief discussion of when crowdsourcing might not work. Following this, a framework is introduced that rationalizes engagement of the crowd through crowdsourcing with other processes that have previously been employed by the pharmaceutical industry in an effort to ensure efficient internalization of externally (to the organization) innovative practices. Concluding remarks are then offered.

Crowdsourcing examples

Following the definition of crowdsourcing presented above, in Fig. 1 we outline a variety of ways through which companies are currently crowdsourcing work via internet-enabled services. We have decomposed this along a 'complexity of task' axis, ranging from micro-tasks that can be performed in seconds using a service like Amazon's Mechanical Turk (https://www.mturk.com/mturk/welcome) through to multi-hour research activities on platforms such as InnoCentive® (http://www.innocentive.com/), Kaggle (http://www.kaggle.com/) and [topcoder]™ (http://www.topcoder.com/). It is important to note that the focus below is on 'informational' crowdsourcing, wherein the crowd is solely engaged with information and the activity and their participation is solely digital. By contrast, there are a variety of recent examples of crowdsourcing with a material physical component, wherein the material is sourced through the crowd: examples include soil (mySoil) [12], fecal matter (The American Gut Project; http://humanfoodproject.com/americangut/) and genetic material (The Resilience Project; http://resilienceproject.me/).

A second dimension in Fig. 1 describes the level of subjectivity applicable to a particular crowdsourced solution. A crowdsourcing platform that enables the objective improvement and optimization of a codebase presents a different (albeit no less useful) resource than a service optimizing the inherently subjective effectiveness of a marketing campaign. In general, with objective metrics to define results, crowdsourcing becomes more amenable to contests through an association of points and a subsequent ranking. When the level of subjectivity is high, collaborative mechanisms and nonmonetary rewards such as pro-social membership seem to dominate. In addition to these dimensions, a variety of additional factors (such as problem type, task modularity, task virtualization and the ability to attain a competitive advantage) underlie the motivations and explain the logic behind when to use crowdsourcing and how.

Across industries and platforms crowdsourcing consists of several common elements: a well-defined contest statement describing the context of the problem is shared. The statement includes details regarding the size of any prize, the method of evaluation and the duration of the activity. The problem statement, the method of evaluation and all additional considerations discussed briefly in the prior paragraph determine where in Fig. 1 a crowdsourcing activity will lie. We detail below some current crowdsourcing examples and successes across fields, and then focus on the pharmaceutical industry. These examples highlight the use of crowdsourcing for finding innovative solutions to problems in R&D; many examples exist of crowdsourcing being used outside the R&D sector [13,14].

The US National Aeronautics and Space Administration (NASA) has consistently used crowdsourcing to solve hard innovation problems and to develop complex software solutions. Recent successes include algorithms to help optimally position

Please cite this article in press as: Bentzien, J. et al. Crowdsourcing in pharma: a strategic framework, Drug Discov Today (2015), http://dx.doi.org/10.1016/j.drudis.2015.01.011