MARKETPLACES FOR SHARING SCIENTIFIC DATA AND OUTSOURCING R&D ACTIVITIES: THE CASE STUDY OF THE PHARMACEUTICAL, LIFE SCIENCES AND BIO-MEDICAL INDUSTRIES

In the present document, we aim to review the main protagonist companies in the field of the outsourcing of biomedical R&D research and in the sharing of scientific data and contract-research consultancy services. This effort is part of a longer-term objective aimed at assessing the current state of the R&D outsourcing market via "marketplace" type of websites, in order to estimate the existing potential competition to the core areas of interest of the VIMMP project. Even though, under the current state of affairs, no direct competitors of VIMMP presently exist (within the restricted field of materials modelling coupled with marketplace and data/software sharing type of functionalities), marketplace websites active in other branches of science and technology can still provide invaluable insight in demonstrating how such R&D commercial operations can be implemented and exploited successfully and profitably.

1. General Introduction to R&D Outsourcing Services

Advances in science, technology, and engineering impact our daily lives and fuel economic growth and prosperity. Investment in innovation and R&D drives these advances, and it is the hi-tech companies and their respective industries that dominate global R&D spending. Hardware/software, electronics, automotive, aerospace and defense, telecommunications, and pharmaceutical/biotech all feature as the highest R&D spending industries.

The pharmaceutical/biotech industry has the highest levels of R&D outsourcing across hi-tech industries, with its outsourcing growth rate outstripping internal investments. Some large pharmaceutical companies suggest that 40% or more of their R&D spend will be outsourced in the near future, and that clinical operations functions will eventually be outsourced entirely. It has been the well documented challenges of R&D productivity in pharmaceuticals that have resulted in an unprecedented race to large-scale strategic clinical outsourcing deals in the last few years. This ongoing transition, moving from a traditional base of transactional and adversarial relationships, has not been without its problems. For example, a survey of 150

senior pharmaceutical R&D leaders rated 'managing outsourcing' highest on their daily challenges list[1].

Outsourcing has today matured beyond cost reduction. It has effectively become a way for organizations to better access talent and capabilities, gain more flexibility, reinvent their business model and drive innovation. Many R&D managers have described the growing importance of collaboration with suppliers and service providers as a way to mitigate complexity, reduce transaction costs, and gain competitive advantage. Outsourcing was a maturing success story according to them, and an increase in R&D outsourcing was more often than not on their corporate strategy agenda.

Nowadays, the R&D outsourcing business model is, generally-speaking, becoming very well developed and entrenched in the context of clinical outsourcing within the pharmaceutical industry. This relatively recent and innovative approach towards R&D management and execution is however also increasingly affecting other areas of science, engineering and hi-tech industry, such as for example the aerospace & defense, hardware, software, and telecommunications technological sectors.

However, the inherent complexity, uncertainty, and the risks involved in hi-tech R&D pose additional challenges for outsourcing, especially when compared to the predictable and repetitive routine processes of the finance back-office, or the HR shared service centre. Unprecedented levels and diversity of both technical and management expertise are needed to develop hi-tech leading-edge products in competitive markets. Few companies have all the expertise they need in-house, so how can hi-tech companies outsource R&D to win? The rise of collaborative partnering, via online "marketplace" type of web platforms, was hailed as a way of handling these new complexities since their onset, as outsourcing progressively expanded into areas like innovation and R&D.

By way of an example, back in 2011 Nokia made the painful decision to drop their own mobile phone operating system in favour of Microsoft's. In a similar vein, it seems likely that pharmaceutical clinical development will need to build ecosystems of integrated suppliers where they recognise that the suppliers' expertise exceeds their own, and therefore it is no longer viable to retain in-house capability. Clinical operations are one such areas where productivity pressures are driving a race in the industry to form strategic partnerships with the best contract research organisations (CROs), Business Process Outsourcers (BPOs), and their respective best-performing teams.

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[1] Heidrick & Struggles, "R&D leadership in crisis: rebuilding innovation through people," 2011

As per the market research, by using these “marketplace” type of websites, researchers can get experiments done in up to half the price charged at their home university’s core facilities, and that without waiting for lab assistant’s updates. Certainly, these research outsourcing platforms provide a much convenient, organized, quick and affordable way to carry out research work. With portals like Science Exchange & Assay Depot for example, now scientists in India, China and other developing countries can leverage the same research facilities as their counterparts in developed countries. This in turn will certainly accelerate the pace of innovation across the globe.

2. Main General Business Model Aspects of a Scientific Research Outsourcing Website

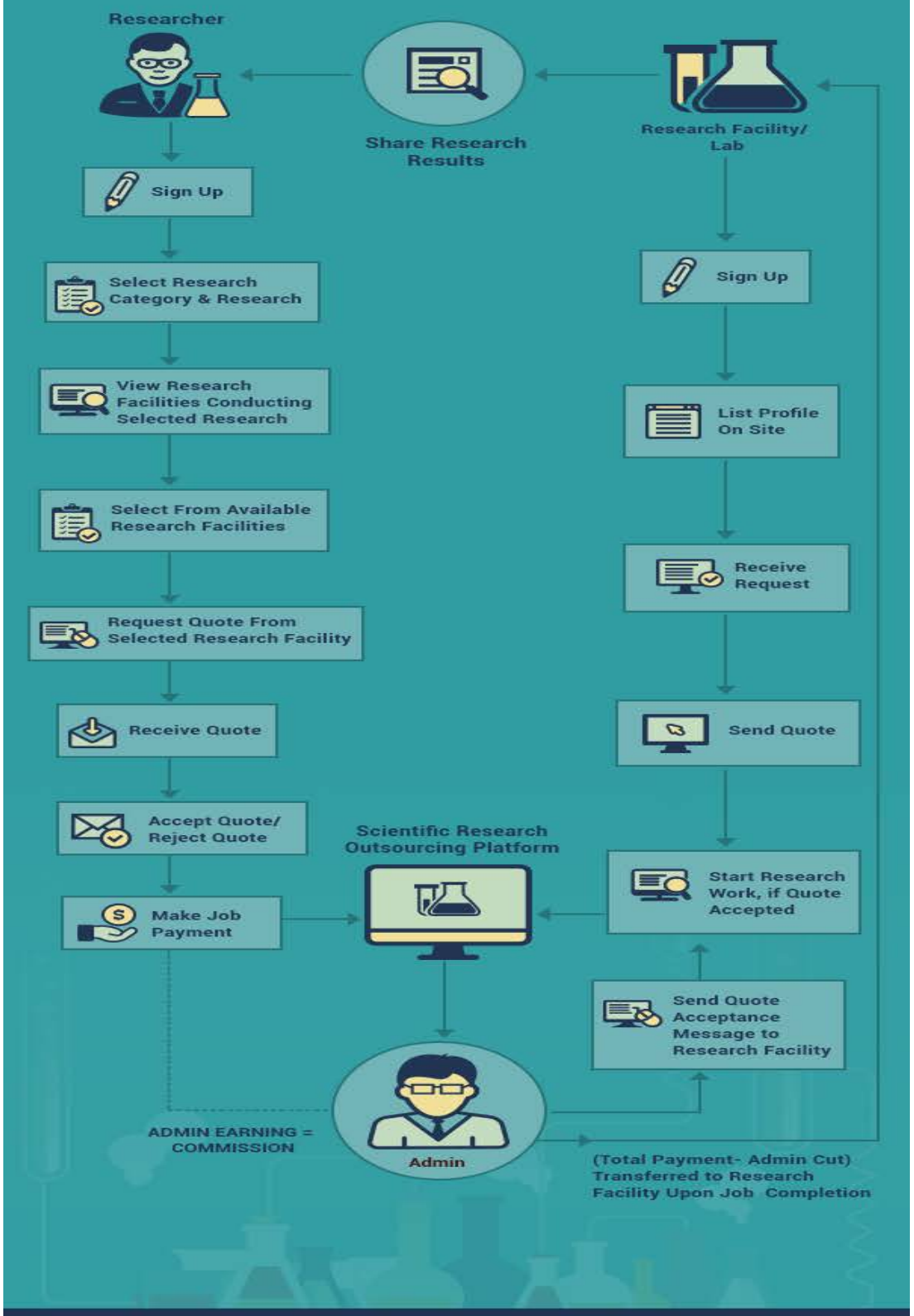
Like most emerging e-commerce marketplaces these days, scientific marketplace platforms like Science Exchange & Assay Depot also provide an online platform that connects people in need of services, to service providers in search of consumers. Here, the two groups can be generally labelled as ‘researchers looking for facilities’ and ‘facilities awaiting researchers’.

Here is a brief and general overview of how things work on these research work outsourcing websites:

• Researchers browse through lab facilities listed on the website
• After choosing the most suitable one, they request a quote from the lab
• Once the order is confirmed and the results are delivered, researchers pay the lab through the website, from which the website can consequently cut its own transaction (commission) fee share.

On the other end, the site should offer a second module for labs to list their services, including an estimate of the corresponding price offered, of their availability, and an indication of the timeframe for the execution of a potential particular type of job.

BUSINESS MODEL OF
SCIENTIFIC RESEARCH OUTSOURCING PLATFORM



FATbit TECHNOLOGIES

3. General Overview of the Pharmaceutical and Bio-medical R&D Outsourcing Industry

Pharmaceutical companies are increasingly outsourcing research activities, including early-stage research programs, to third party organizations -- academic institutions, biotech startups, and private contract research organizations (CROs) -- as a strategy to stay competitive, flexible and profitable in a world of exponentially growing knowledge, increasingly sophisticated technologies and an unstable economic environment.

From the innovation's point of view, there is a boom in the world of life sciences, stimulating the emergence of novel biological targets, therapeutic modalities, and even whole new areas of drug discovery -- adding opportunities, but also complexity and uncertainty, to research programs. In fact, according to a Deloitte's report[2], "return on late-stage R&D pipelines dropped for the top 12 pharma companies, from 10.1% in 2010 down to 3.7% in 2016".

Technologically, there is an unfolding "digital revolution", bringing even further complexity and investment cost to the table -- in the form of artificial intelligence (AI), data mining and big data technologies, data-driven diagnostics, and digital health.

Finally, the rise of the personalized medicine paradigm forces companies to rethink their traditional research pipelines, with their "one-size-fits-all" product development programs, as well as to reconsider their market strategies. The interplay of these circumstances appears to be a favorable situation for the contract research market, leading to steady growth in this R&D economic sub-sector.

The R&D tasks that firms choose to outsource include a wide spectrum of activities, ranging from basic research to late-stage development: genetic engineering, target validation, assay development, hit exploration and lead optimization (hit candidates-as-a-service), safety and efficacy tests in animal models, and finally clinical trials involving humans.

According to a report by Clearwater International[3], the global CRO market will potentially rise to a $45 billion industry by 2022, as compared to an estimated $30 billion current valuation (by

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[2] "Collaboration as a key to success in pharmaceutical R&D"; Health Care Current; Report by Greg Reh, Principal and Life Sciences Sector Leader, Deloitte Consulting LLP | January 17, 2017

[3] "Outsourced Pharma Services"; A Clearwater International Healthcare team report | Autumn 2019

Objective Capital Partners[4]), exhibiting the current rate of market growth of around 10% CAGR, with projected acceleration up to 12%. Another natural factor of growth for the contract research market is the overall increase in the number of biotech companies, and the volume of ongoing research projects within the pharma industry -- since 2007 the number of drug candidates under development almost doubled (15267 in 2018 vs 7737 in 2007).

All such observations are in line with Vantage's alliance benchmarking study[5], revealing that over 80% of bio-pharma respondents reported increased collaborative activity compared to previous periods. Getting ideas and expertise from external sources is a well-established practice in the pharmaceutical industry, with about one-third of all drugs in the pipelines of the top ten pharmaceutical companies initially developed elsewhere, according to a 2014 WSJ article[6].

The roots of such a contract research business can be traced back to the mid-1900s, when companies like Huntingdon Life Sciences and Charles River Laboratories emerged to offer basic animal experimentation services. The industry as we know it today only started to shape in 1970-80s -- with the emergence of regulatory frameworks for the pharma market, expansion of then-existing contract research companies into clinical trials and other functions, and foundation of new companies -- future CRO giants, like Quintiles (1982), Parexel (1982), and PPD (1985).

Today, the CRO industry is fairly fragmented including more than 1000 organizations, although relatively few of them are global full-service companies. However, it is those few largest CROs, like Covance, IQVIA, Syneos Health, Parexel, PPD, PRA Health Sciences, Charles River Labs, Wuxi Apptec, and Medpace, who control the lion's share of the market. According to a study by the Tufts University Center for the Study of Drug Development (CSDD)[7], the top 10 largest CROs benefited from around 57% of outsourcing spend in 2018, which is 12% more than in 2011.

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[4] "CRO Sector Fundamentals Remain Hot for M&A Consolidation"; Healthcare Insights Life Sciences - Objective Capital Partners | July 3, 2019

[5] "The Perils and Promise of Strategic Partnering with CROs"; Report by Jonathan Hughes and Stuart Price; Alliances & Partnerships - Vantage Partners | March/April 2016

[6] "Pharmaceutical Scouts Seek New Star Drugs for Cancer, Diabetes"; WSJ article by Jonathan D. Rockoff | March 9, 2014

[7] "Outsourcing outpaces internal spending but remains tactical and reactive"; Tufts CSDD Impact Reports March/April 2019, Vol. 21 No. 2

Estimations by Objective Capital Partners[8] suggest that the global contract research market in 2019 is valued at around $30B and growing. According to a 2016 report by Credit Suisse[9], the CRO industry can be roughly segmented into the following four market categories, with each having the corresponding share of the pie: central lab services -- 4%; preclinical services -- 9%; clinical stage services -- 42%; and post-approval activities -- 45%.

According to David Widley, equity analyst at Jefferies consulting firm, currently, big pharma outsources around 40-45% of their activities to CROs, and he expects this number to grow to up to 60% in the future[10]. In contrast, small and medium-sized companies outsource substantially more of their activities -- up to 65-70%, and the emerging biotech startups typically outsource up to 90%, with some of them even operating as "virtual" companies.

These growing statistics are heavily supported by a wave of recent media reports, clearly suggesting a strong focus of biopharmaceutical companies on partnering with academia, CROs, and biotech startups.

Indeed, AstraZeneca has been in the process of moving its global headquarters to Cambridge, UK, in order to harness the university's scientific might. Back in 2013-2014, the company established a number of strategic R&D outsourcing partnerships with academic organizations, including Academic Drug Discovery Consortium (ADDC), Medical Research Council Laboratory of Molecular Biology (MRC LMB), and Cancer Research UK (CRUK) Cambridge Institute.

Meanwhile, AstraZeneca's global biologics research and development arm, MedImmune, has already been collaborating with The University of Texas MD Anderson Cancer Center towards developing immunotherapies against cancer.

Pfizer has undertaken a similar strategy in the US, having positioned many of its research and development facilities close to major bioscience hubs, such as San Francisco and La Jolla in California, as well as in Cambridge, Massachusetts.

Bristol-Myers Squibb has partnered with Allied Minds, a Boston-based group focused on the commercialization of academic research, to scour American universities for innovative drug discovery ideas. The most promising research projects out of these will eventually be structured into start-up companies within a new enterprise, known as Allied-Bristol Life Sciences.

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[8] "CRO Sector Fundamentals Remain Hot for M&A Consolidation"; Healthcare Insights Life Sciences - Objective Capital Partners | July 3, 2019

[9] "CRO Industry Primer" by Credit Suisse | 20 June 2016

[10] "CRO earnings roundup: Big pharma picking up biotech slack?" Article by Melissa Fassbender on outsourcing-pharma.com | 09-Aug-2019

Following the same trend, GlaxoSmithKline has recently teamed up with the University of Leicester to develop novel drugs against blood cancer, and Actelion has recently extended an agreement with a chemical CRO named Enamine, in order to access its novel building blocks and screening libraries for use in early drug discovery.

At the same time, large pharmaceutical organizations sometimes prefer acquiring external technology vendors or innovative units involved in promising R&D projects, rather than maintaining "classical" outsourcing operations. For instance, in the oncology domain, recently AbbVie agreed to buy Pharmacyclics for $21 billion, and Pfizer acquired Medivation for $14 billion.

Whatever model to mine external expertise and resources is chosen, let's see which factors stimulate pharmaceutical companies to expand their involvement in dealing with external technology vendors, rather than performing tasks internally. The four underlying motives are summarized below.

Diminishing profits have become a major cornerstone for pharmaceutical companies over the past decade. A recent report, “Decline in Economic Returns from New Drugs Raises Questions About Sustaining Innovations”[11], reveals a somewhat alarming picture for drug makers, suggesting that the newest medicines are generating a negative rate of return across the industry.

Clearly, drug discovery and development are a costly venture, with an estimated $0.8 to $1.7 billion spent by the pharma industry in R&D to bring a new drug to market (according to PhRMA[12]). In many cases, drug candidates fail at the latest stages of drug discovery programs, and this adds up to potential risks and overall costs.

Additional tension for innovator companies comes from profit drops associated with the approaching “patent cliff” for a number of highly profitable drugs. Evaluate Pharma forecasts that around $215 billion in sales will be at risk due to patent expirations between 2015 and 2020[13].

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[11] Berndt ER, Nass D, Kleinrock M, Aitken M.: “Decline in economic returns from new drugs raises questions about sustaining innovations.” Health Aff (Millwood). 2015;34(2):245-252. doi:10.1377/hlthaff.2014.1029
[12] “Biopharmaceutical Research & Development: The Process Behind New Medicines”; Report by PhRMA | 2015
[13] “World Preview 2015, Outlook to 2020”; Report by EvaluatePharma (8th Edition) | June 2015

In order to increase the success rate of drug discovery programs and decrease R&D costs, pharmaceutical companies seek to improve and accelerate every stage of early drug discovery process, starting from target identification and validation, and all the way towards a preclinical drug candidate with an excellent ADME/Tox profile. In order to achieve these goals, drug researchers have turned to new areas in science to develop better in vitro, in vivo, and in silico methods and models. In most cases, it is cheaper and more efficient to outsource those technologies from external organizations, than it is to create in-house infrastructure and to hire all the necessary research staff.

An increasing lack of innovation in pharma seems to be among the underlying reasons why drug makers tend to outsource research to academia or CROs. According to the insight by Stewart Lyman in his article "The innovation challenge: Assessing biopharma startups" in Xconomy[14], Big Pharma is losing efficiency at discovering new drugs, and therefore "has to get its ideas from somewhere else".

Another Tufts study[15], conducted in 2012, found that biopharmaceutical companies are also increasingly forming partnerships with academic medical centers, with the goal of identifying promising pathways for potential breakthrough therapies through basic research in medicine, as well as guiding their translation into clinical development of new medical products.

According to Dr. Sy Pretorius, from an international Life Sciences consulting company named Parexel, "Academic centers are particularly well-suited for doing the early work around target discovery and target validation".

One recent example of how pharma benefits from outsourcing academic expertise is Sanofi SA, having received its first set of antibiotics drug candidates from its collaboration with Harvard University.

In the pursuit of new ideas, some of big pharma companies even try outsourcing models in a form of open innovation and resource sharing, as was summarized by Dr. Jackie Hunter in her article in Drug Discovery World[16].

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[14] "The Innovation Challenge: Assessing BioPharma Startups"; article by Stewart Lyman on Xconomy | May 4th, 2015

[15] "Making Academic-Industry Partnerships Work for Both Parties"; Tufts CSDD R&D Management Reports | August 2012; Vol. 7 No. 3

[16] "Collaboration For Innovation Is The New Mantra For The Pharmaceutical Industry"; Article by Professor Jackie Hunter on DDW | Spring 2014 Issue

For example, Lilly organized PD2 portal back in 2009, allowing researchers to have their compounds screened against phenotypic, disease-relevant assays that were already established at Lilly. The portal later grew into a network of 70 small biotechnology companies and 174 academic institutions. Later in 2011, Lilly introduced the TargetD2 program to provide external access to a panel of well-validated target-based assays across five targets of interest. In addition, there is a possibility to provide access to relevant computational methods to let researchers conduct structure-based research on the initial results.

Takeda provided incubation facilities for academics and biotech companies in its Shonan research center in Japan, where external and internal researchers can work together side-by-side.

Pfizer has launched Centers for Therapeutic Innovation in 2010, with the aim of translating leading science into clinical candidates via networked collaboration.

Advances in genomics, combinatorial chemistry, high-throughput screening (HTS), and cheminformatics have all contributed to an explosion in the number of new promising biological targets and lead molecules. However, it is rare that biopharmaceutical companies have all the required expertise and infrastructure in-house to fully embrace the new technologies' potential. Thus, companies more often choose to outsource their research programs to specialized CROs or academic centers focused on a particular area of knowledge, and capable of providing a state-of-the-art expertise in certain areas.

A vivid example when R&D outsourcing appears to be a smart approach for accessing a novel technology early in the drug discovery process is a collaboration with companies offering artificial intelligence (AI) and machine learning (ML) capabilities for big data analysis, hypothesis probing, accelerating hit exploration activities and identifying hidden dependencies in data patterns.

A partnership between pharmaceutical giant Pfizer and IBM's Watson for Drug Discovery to advance cancer research made headlines recently. Scientists at Pfizer will use the IBM's supercomputer for rapidly analysing and testing research hypotheses from "massive volumes of disparate data sources", including more than 30 million sources of laboratory and data reports, as well as medical literature.

Lundbeck has become the latest pharmaceutical company to partner with IBM Watson Health to accelerate the discovery of psychiatric and neurological treatments.

It is worth noting, though, that Watson Health has been receiving a wave of criticism lately for allegedly not being able to provide the level of innovation claimed. While it is hard to prove or disprove any such criticism, it appears illustrative of possible risks of the R&D outsourcing activities, especially when a highly sophisticated and poorly measurable technology is outsourced. Only a historical track-record of measurable success cases might be a strong indicator to choose a particular R&D outsourcing partner.

The modern world is characterized by rapidly changing technological paradigms, exponentially growing data, and the increasing role of interdisciplinary collaborations and expertise. Developing sophisticated in-house infrastructure, and substantially expanding the count of staff with specific expertise in advanced areas of research, is not only costly but also risky for a pharmaceutical company. This is especially true at the earliest stages of the drug discovery process, when the uncertainty is the highest. Maintaining only the most important core functions and competencies, while outsourcing research-intensive programs with yet uncertain results to specialized CROs or academic labs, seems to be a reasonable strategy.

The whole pharma R&D outsourcing concept revolves around the idea that it is more efficient to contract out standard and routine R&D activities, such as chemical synthesis, toxicology, drug metabolism, formulations etc, while maintaining more creative and judgmental processes ("know-how generating processes") in-house. Not only standard and routine tasks, but also well-understood science, robust and repetitive, is believed to be suitable for outsourcing models of cooperation. Another meaningful use case would be outsourcing expertise in advanced technologies, such as artificial intelligence, which cannot be quickly built up internally (however, in this latter case an option of acquiring a suitable technology vendor might be a strong alternative to outsourcing operations).

As outlined above, pharma R&D outsourcing has several decent advantages, which is driving the current industry trend up. Flexibility of the externalized R&D is probably among the key pros here, as it basically allows to transform certain R&D research tasks into a preferable variable cost, as opposed to the fixed costs of internally-maintained R&D resources.

Buying-in molecules at later stages of development, in order to mitigate risks, is another lucrative benefit of preclinical R&D outsourcing.

However, rather strong disadvantages are also existent, and it is important to realize them during strategical decision making. Those include:

- Significant increases in management overhead costs due to search and monitoring activities. A study by the Center for European Economic Research shows that the added complexity of managing an outsourcing process can easily overshadow the cost reduction of R&D work itself[17].

- A loss of cumulative knowledge base within pharma organizations due to dissolution of the teams, and the weakening of internal R&D capability, thereby weakening their "learning-by-doing" process.

In any case, one of the critical aspects to consider during any R&D outsourcing initiative is choosing the right partner with a decent track-record of success, measurable performance indicators, suitable business model, and state-of-the-art technological and innovative capacity.

When outsourcing R&D services, a straightforward “Fee-For-Service” task-based business model is typically utilized for separate well-defined services, like screening a library of compounds against a known target, or synthesizing a reference compound, which can be performed for a pre-agreed price.

Another business model option would be the Full-Time Equivalent (FTE) model, where a sponsor company basically hires a science project team at the CRO premises, and pays for all the materials and other project expenses. The FTE model is suitable for multifaceted and complex projects, where flexible continuous discovery work is anticipated, as this model allows to minimize contractual bureaucracy.

However, business models of collaboration between companies and CROs are continuing to evolve, in order to meet the growing pharma companies’ focus on external innovation and strategic alliances. In newer models, initial innovation often comes from the CROs, who establish early chemistry and biology entry points into disease, and then approach potentially interested pharma companies to collaborate as strategic drug discovery partners. Such projects can be structured in different ways, including milestone and royalty payments, FTE payments, and even potentially jointly owned intellectual property (IP) rights, commercialized as joint ventures or spin-off companies.

Some CROs or smaller service providers and biotech start-ups often have their own internal drug discovery activities and target licensing deals with big pharma. For instance, there is a wave of artificial intelligence (AI)-driven start-ups in the pharma industry, and according to BPT

[17] “Outsourced R&D: The threat to American innovation”; Article by Susan Caminiti on CNBC | Aug 7 2014

Analytics data, 9% of them have their own drug discovery pipelines[18]. The number of R&D deals (drug candidate discovery) in this sub-area has increased substantially since 2015.

Another growing trend is the insourcing of CRO researchers onto sponsor company sites, especially where the sponsor has unused laboratory space but does not plan new hires. This model can provide for high visibility into the CRO's work, efficient management, capital efficiency, and potentially lower costs. Another variation of this model is to have embedded sponsor's scientists within the CRO.

Whatever the case is, it should be noted that the general tendency is that client-sponsored and CRO-led programs are becoming more and more common across the pharma and bio-medical R&D industry.

4. The emergence of R&D marketplaces to streamline contract research offering

An important trend in pharmaceutical research outsourcing is the emergence of new types of marketplaces, which connect pharma sponsors with CROs, academic institutions, and biotech start-ups via an advanced digital infrastructure. For example, research marketplaces such as Scientist.com and Science Exchange allow clients to search for specific R&D service providers, engage in a transaction, manage projects, structure payment schedules and automate the whole process of outsourcing R&D services. Such marketplaces are, generally speaking, extremely useful in curbing management overheads.

Online marketplaces are websites with a "many-to-many" business logic. They can host multiple suppliers, trading with multiple buyers, via different e-commerce tools available as part of the website functionality.

Online marketplaces can provide a substantial added value to its users. For example, buyers can quickly compare and select better offerings, without the need to research multiple websites and surf online for price comparisons or product specifications. Additionally, marketplaces bring more transparency, trust, and standardization to the whole process of R&D outsourcing.

[18] "215 Companies Applying Artificial Intelligence in Drug Discovery and Development"; Article by Andrii Buvailo on BiopharmaTrend.com

On the other hand, suppliers also benefit in that they can get in contact directly with a more targeted audience, streamlined efficiently to their product or service pages. In fact, a well-represented company profile, with a specifications-rich catalogue, can be a powerful lead magnet for potential customers.

Both buyers and suppliers benefit a lot if a marketplace leads a role in the operational activities, such as bidding, quoting, invoicing, consulting, basic customer support etc. There are numerous marketplaces out there which do exactly this.

Normally, marketplaces include catalogue-search capabilities, options to quote and place orders online, as well as payment options to finalize a purchase. Sometimes, marketplaces support different rating or verification algorithms, in order to make sure that their website's registered users -- either suppliers or buyers -- are reliable business partners to deal with.

All evidence suggests that the life sciences R&D sector is clearly prone to embrace e-commerce as a general business paradigm. For example, in a recent PwC analysis[19], it was suggested that by 2020, e-commerce sales in the life science research market would approach 80 percent, with traditional sales methods (emails, conferences, paper journals and ads) declining down to 20 percent. Since marketplaces are a big part of e-commerce in general, they will certainly have a bright future within the area of life sciences.

[19] "Selling into Life Science Research 2020 - The eCommerce shift"; Report by PwC | 6 October 2014

In the context of the present document, we shall focus our attention on reviewing two of such marketplace platforms, namely the afore-mentioned Scientist.com and Science Exchange websites, the latter one in particular representing one of the early pioneers in the marketplace R&D outsourcing business for biomedical and pharma applications, and undoubtedly still today the market leader in the sector.

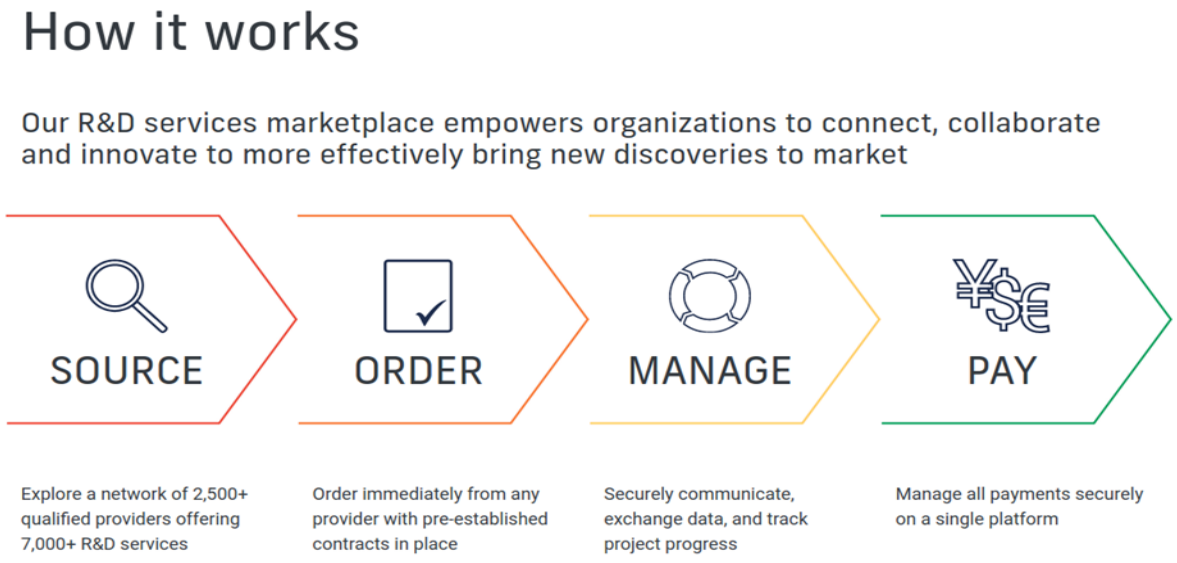
INTRODUCTION TO SCIENCE EXCHANGE

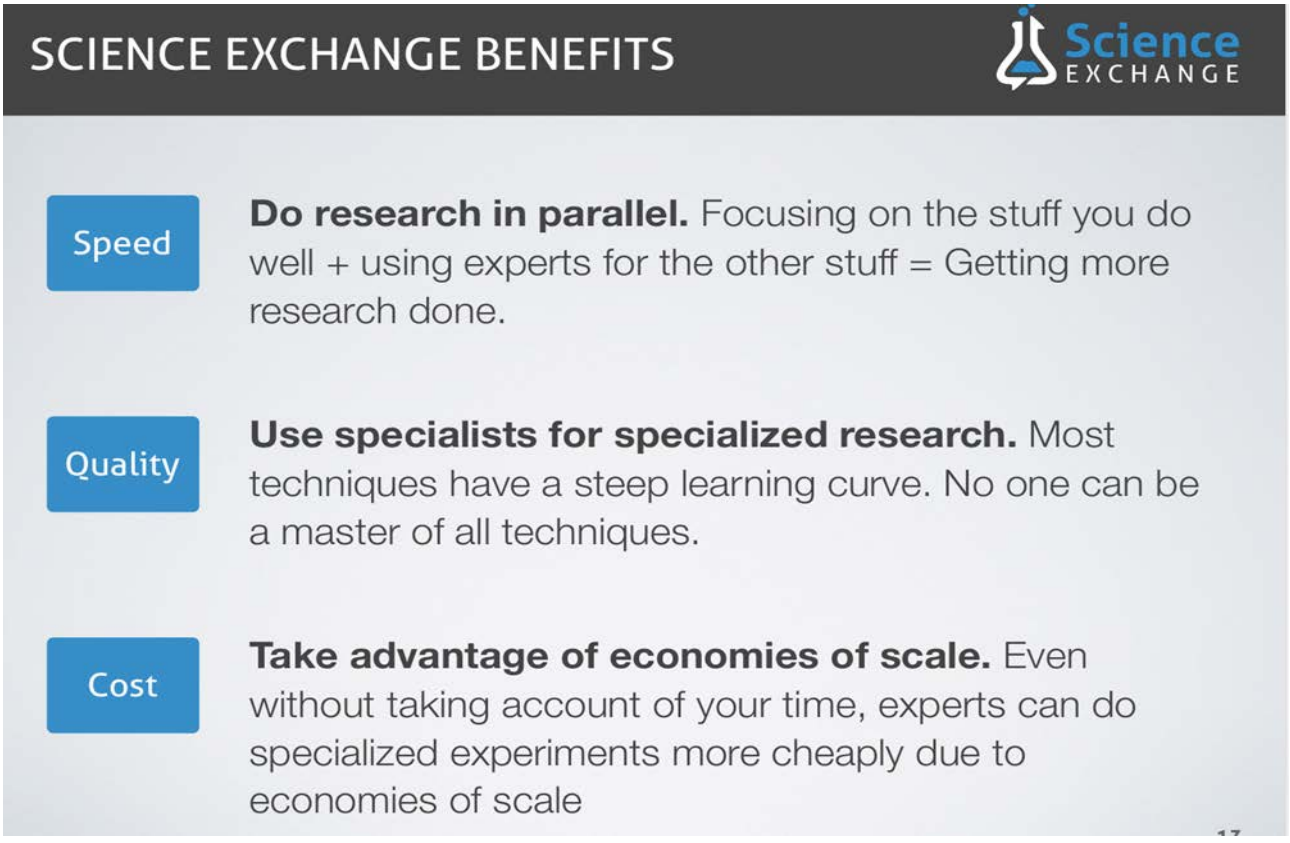
Science Exchange is a marketplace for scientists to list, discover, access and pay for scientific services from any institution in the world, thus making it easy for researchers to connect with specialist contract research providers. Science Exchange is therefore a web platform for outsourcing scientific research, where academic institutions or commercial companies (the "buyers") can order research expertise and services from a network of individual scientists, research labs or contract research organizations (the "suppliers"). While the marketplace covers a broad range of scientific areas, with brands like SpaceX and NASA[20] among the users, Science Exchange has a strong presence of major life sciences brands, like National Institute of Health (NIH), Gilead, Sanofi, and Shire, to name a few. It claims to have 2,500+ different service providers using the website, including specialized research infrastructure and expertise at top research institutions.

[20] "NASA's super-black carbon nanotubes developed through Science Exchange"; Science Exchange Customer Stories | January 1, 2019

The platform has pre-established contracts in place, protecting user's intellectual property and confidentiality, so no additional operational or legal tasks are needed on the side of buyers and suppliers to start doing business. Science Exchange has a support team of research consultants called "concierge service". They assist communication between buyers and suppliers at all stages of their mutual business negotiations, thus helping in particular with service search, quote comparison, negotiation and concluding a deal. The marketplace retains a commission fee for its services, which is a certain percentage of each contract's value.

The company was founded by Elizabeth Iorns, a New Zealand scientist, in 2011, and up to now it has raised $72.5M in 5 rounds of investment (Round C in 2017).





In summary, Science Exchange is an online marketplace of research services, enabling scientists to outsource their research and development (R&D) to scientific institutions such as university facilities or commercial contract research organizations. In addition, Science Exchange maintains enterprise-level agreements with R&D-focused organizations, such as pharmaceutical companies, medical device developers, and cosmetics companies, to provide these companies with private marketplaces of research services, in order to streamline procurement processes, investments and contracts for outsourced services. Science Exchange's enterprise clients include major drug and biotechnology companies, including Merck, Amgen, Gilead Sciences, and Genentech[21] [22].

Scientists can search, compare and request quotes from contract research organizations and other providers of contract services on Science Exchange's online marketplace. Science Exchange vets the providers on their marketplace, contracts with them through a standardized agreement, and displays performance history and client ratings on the website. The researcher selects a bid, and Science Exchange facilitates communication, project management and payment via its platform. The company receives a service fee based on the value of the project. Science Exchange also sells its own software, for use as an e-commerce platform for service providers.

INTRODUCTION TO SCIENTIST.COM (formerly Assay Depot)

Scientist.com (formerly known as Assay Depot) is a network of public and private e-commerce marketplaces that connect buyers and sellers of scientific research services. The company was founded in 2007 by Kevin Lustig, Chris Petersen and Andrew Martin, and launched its first public research marketplace in September 2008. By this time, the project had already raised $31M in 4 rounds of investment. Similarly to Science Exchange, it provides a powerful tooling for R&D outsourcing of all sorts -- with a strong operational support, 24/7 research consulting service, and all the needed administrative and legal contracts in place for the seamless business interaction between users.

Scientist.com is a procure-to-pay B2B e-commerce marketplace. Research customers use the marketplace to design, purchase and pay for custom research services and products. Research suppliers, or contract research organizations (CROs), use the marketplace to communicate with

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[21] "As Big Pharma Flocks to Science Exchange, Norwest Leads $28M Funding", Article by Bernadette Tansey on Xconomy | 30 June 2017

[22] "Science Exchange Takes On $28M To Help Companies Outsource R&D", Article by Alex Konrad on Forbes | 29 June 2017

customers, submit quotes, receive orders and submit invoices. Scientist.com receives a transaction fee on all marketplace purchases. Similarly to Science Exchange, it focuses primarily on the R&D area of life sciences, with a majority of service providers and buyers being from pharmaceutical and biotech industries. The website users include some of the world's leading biopharma brands -- AstraZeneca, Bristol-Myers-Squibb, Novartis, Pfizer and alike. The website claims to have above 17,500 research service providers.

Over the past ten years, Scientist.com has worked on sourcing projects for researchers at almost every large pharmaceutical company. To date, they have established long-term partnerships and created branded marketplaces for 13 large pharmaceutical companies. They have also partnered with many small and mid-sized biotechnology companies looking to outsource.

Scientist.com was recently selected by VWR International—an industry leader in the life science consumables and reagents space—as its exclusive provider of custom research services. This is a significant partnership, that will enable tens of thousands of VWR customers globally to have direct access to the Scientist.com platform.
In the academic space, Scientist.com was selected by the US National Institutes of Health to create an outsourcing marketplace for researchers at more than 20 major government research institutes. Other research clients include agroscience companies, consumer health companies, cosmetic companies, research universities and regional bioclusters.

The Scientist.com marketplace was designed to enable researchers to "do more with less", by for example saving time, reducing costs, improving access to innovation and ensuring compliance with internal and external regulations. The marketplace allows researchers to focus their attention on carrying out the most imaginative and game-changing experiments, while fostering a company-wide culture of innovation that can dramatically improve research success.

Because of the custom and often novel nature of the services provided on the Scientist.com marketplace, it is not uncommon to see prices vary considerably (5x-10x) across suppliers, for the same service and quality level. By making it easy to get multiple quotes, Scientist.com significantly reduces outsourcing costs. The average cost savings across the Scientist.com platform in 2016 was 12.3%, or $3,028 per order. Selecting more than one supplier in fact enabled users to achieve greater cost savings. In the top-12, top-selling categories on Scientist.com, users that selected more than one supplier saved 26.4%, or $8,123 per order.

Scientist.com streamlines the entire source to settle process, speeding up and improving

the process for researchers, as well as providing procurement oversight from start to finish. By consolidating sourcing, legal and purchasing processes, the Scientist.com marketplace allows researchers to access services and products as soon as they have finalized the study plan. The use of a single marketplace supplier agreement eliminates the need to establish a separate master services agreement. Marketplace billing consolidation eliminates the need for finance to negotiate payment terms, manage invoices and payments, and onboard new suppliers.

Across all Scientist.com marketplaces operating in 2016, the average research cycle time (request to purchase order) was 9.8 days. This significant reduction in cycle time means that users of Scientist.com can start their outsourcing project approximately 50 days earlier than before (for projects involving new suppliers).

Scientist.com enables on-demand access to novel research tools and technologies. Over 350 cutting-edge tools and technologies have been identified and made available to researchers on the marketplace Innovation Hub. Some of these tools and technologies have already been commercialized, while recent academic and other novel breakthroughs are still under commercial development. More are added every month. Marketplace users can connect globally with over 2,300 suppliers across 3,700+ research areas, making it easy to identify new technology development partners and access supplier-driven innovation.

By conducting extensive supplier due diligence, and building a proprietary compliance framework, Scientist.com ensures compliance. All suppliers on the Scientist.com network undergo a comprehensive due diligence evaluation and an ongoing monitoring process, in order to minimize reputational risks. Scientist.com uses a proprietary compliance platform called COMPLI™ for the sourcing of human samples, RWE/HEOR services, GxP studies and other regulated services. COMPLI™ establishes a rigorous compliance and governance framework, that helps researchers quickly and safely acquire these services.

OTHER INTERESTING WEBSITES

Here we review a couple of additional online resources that are not marketplaces per se, but still appear to be very useful for improving the overall R&D outsourcing experience in the area of life sciences.

Bioz (AI-driven search engine)

Bioz is the world's most comprehensive AI search engine for scientific experimentation. The patent-pending cloud platform combines the work of scientists with advanced Natural Language Processing (NLP), machine learning, and artificial intelligence technologies, to help life scientists in academia and biopharma make faster and smarter decisions to accelerate research and drug discovery. To date, Bioz had 27 million articles reviewed, and 300 million products given confidence scores.

Among other things, Bioz allows life science researchers to achieve the following objectives:

- Provides the world's most comprehensive AI search engine for scientific experimentation.
- Enables researchers to find detailed information on 300 million life science products, including reagents and lab equipment.
- Accelerates the work of researchers in academia and R&D scientists performing drug discovery.
- Reduces trial and error in product selection, so experiments can be conducted faster and at a lower cost.

While this platform is not really a marketplace, rather, a search engine for life science researchers, it is included in this review because the approach Bioz uses might well become the future of online marketplaces -- with AI-driven data-mining and automatic dynamic categorization, rating, and suggestion workflows being in the core of the operations, instead of "classic" static catalogues supplied by vendors and listed manually.

Founded in 2013 by Stanford research scientist, Karin Lachmi, Ph.D., and CEO Daniel Levitt, Bioz is a Stanford-StartX accelerator company applying Artificial Intelligence (AI) – including Natural Language Processing (NLP) and Machine Learning (ML) – to mine and structure hundreds of millions of pages of unstructured scientific papers, and to provide the life scientists insights into

what tools or products to buy, and how to use them in each particular case. It also provides information and links to vendors which supply all those products, and provides dynamic ratings for each product, tool, or supplier.

This innovative concept seems to be taking off rapidly, as Bioz has already attracted millions of users to use the platform, and it lists above 200 million products from 50,000 vendors. The company has already raised $3 M in two seed rounds, and is currently on the way to raising nearly $30 M in additional early funding rounds.

The company uses artificial intelligence, machine learning and natural language processing in order to extract experimentation data from scientific articles, such as the products that researchers used, the companies that supply the products, the protocol conditions that researchers selected, and the types of experiments and techniques. The algorithm ranks products based on how frequently they were used by researchers in their experiments, how recently a product was used, and the impact factor of the journal. The algorithm's output is a Bioz stars score for each product that was mentioned in an article. Bioz is therefore a data-driven platform for product recommendations, which is contrary to platforms such as TripAdvisor and OpenTable, that are instead based on user-generated reviews and ratings. The recommendations and scoring system that the company has developed are meant to assist researchers with the process of developing future medications and finding cures for diseases. They are guided towards products and techniques that were previously used by other researchers when planning and performing experiments. The company's revenue is based on selling SaaS subscriptions to researchers in biopharma companies. They also charge product suppliers for content syndication.

KOLABTREE

Over 6,000 freelance scientists from 131 countries have registered with Kolabtree, the global online platform for freelance scientists. These freelancers offer a broad range of advanced services, including data analytics, scientific writing and experiment design, to provide small businesses and research organizations with the specialized skills and experience required for their projects.

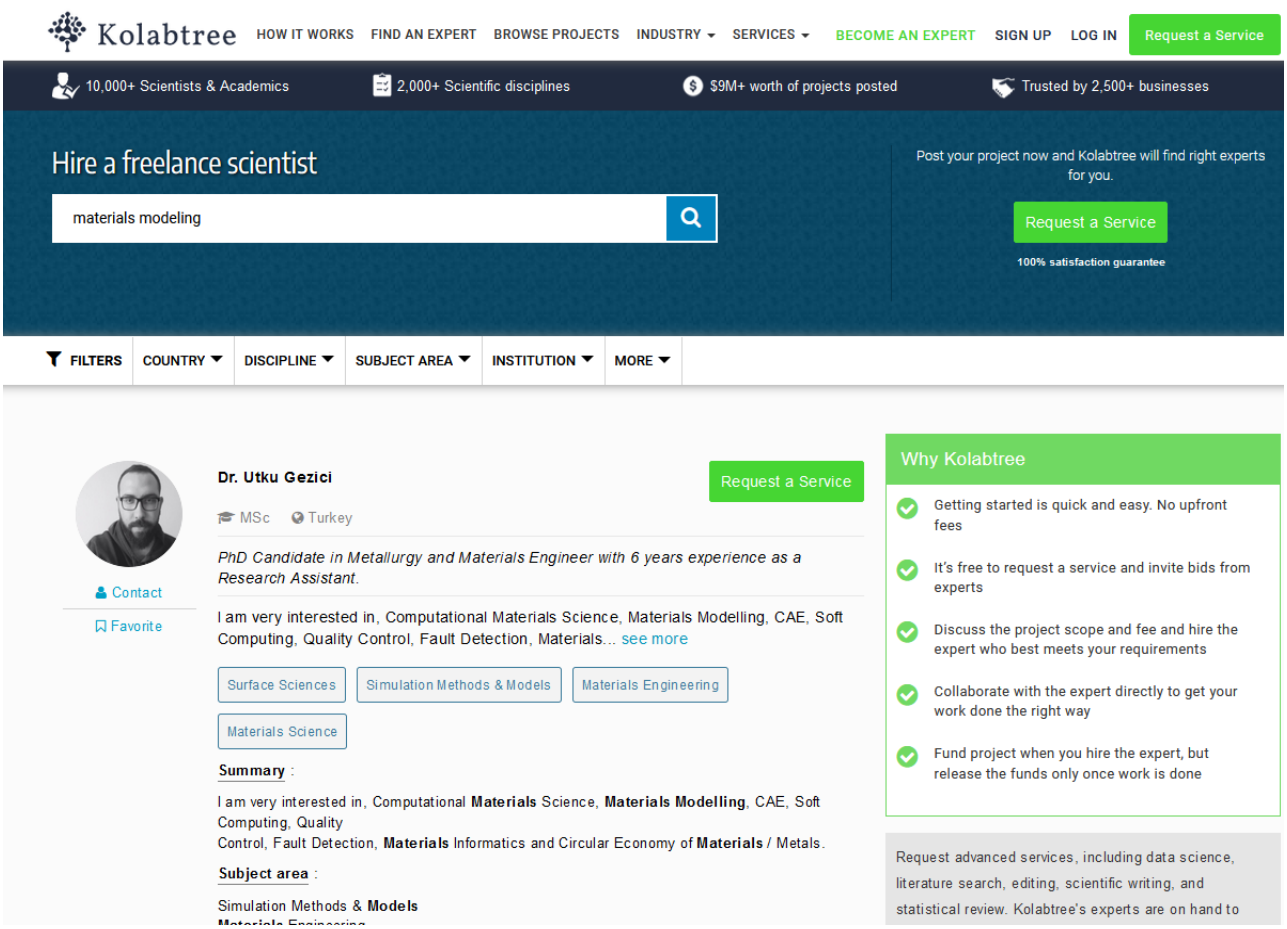
Based in London and established in 2015, Kolabtree has supported a total of 2,400 projects which, in many cases, resulted in the development of a new innovative product or arrival at reliable research conclusions. The company’s database includes freelancers, many with PhDs, specialized in over 2,000 scientific disciplines, including medical, food and

environmental science.

Small businesses and start-ups typically employ graduates, not professionals with decades of experience, because of the associated cost. Many businesses don't realise that they can gain the expertise of someone with several years' experience by using freelancers to help launch a specific product, scale up or troubleshoot a specific problem.

Kolabtree makes hiring a freelance scientist quick and easy. A client with an urgent requirement can potentially post a project, receive bids, hire a freelancer, get the job done and finally pay the freelancer, all in one day. Businesses typically can post a project on Kolabtree for free, and be confident that their data is secure and only visible to logged-in users. They then receive bids from freelancers, and have the opportunity to interact with them before choosing the freelancer that is right for their project.

While working with a freelancer, clients can keep track of documents and conversations in Kolabtree's user-friendly workspace. The freelancer is only paid if the client is satisfied with the work, and the budget can be modified if the scope of the project changes during its execution. The company bases its business model on transaction fees applied on every accomplished paid project realized via its platform.



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