Online marketplaces for scientific services and goods: An overview

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ABSTRACT

Complex scientific endeavors such as drug development, genetic engineering and clinical studies undertaken by large pharmaceutical companies require many different highly specialized skills and goods. Sourcing these resources is often a lengthy and challenging process due to seller selection, offer comparison and legal delay.

New online marketplaces for scientific services and goods promise that virtually all aspect of the drug development process can be sourced out at the best price to an international community of small and large CROs, thus making pharmaceutical R&D more efficient and innovative.

This thesis aims to analyze where such platforms fit in the current market and which business models are pursued. It will be analyzed which management problems can be potentially solved from the sellers and buyers perspective. In this thesis, the current competitors will be compared systematically.

VORWORT

Komplexe wissenschaftliche Vorhaben wie Arzneimittelentwicklung, Gentechnik und klinische Studien großer Pharmaunternehmen erfordern viele verschiedene hochspezialisierte Fähigkeiten und Güter. Die Beschaffung dieser Ressourcen ist aufgrund der Verkäuferauswahl, des Angebotsvergleichs und der rechtlichen Verzögerung oft ein langwieriger und herausfordernder Prozess.

Neue Online-Marktplätze für wissenschaftliche Dienstleistungen und Waren versprechen, dass nahezu alle Aspekte des Arzneimittelentwicklungsprozesses zum besten Preis an eine internationale Gemeinschaft von kleinen und großen CROs ausgelagert werden können, was die pharmazeutische Forschung und Entwicklung effizienter und innovativer macht.

Diese Arbeit zielt darauf ab zu analysieren, wo solche Plattformen in den aktuellen Markt passen und welche Geschäftsmodelle verfolgt werden. Es wird analysiert, welche Managementprobleme aus Sicht von Verkäufern und Käufern potenziell gelöst werden können. In dieser Arbeit werden die aktuellen Wettbewerber miteinander systematisch verglichen.

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INTRODUCTION

Complex scientific endeavors such as drug development, genetic engineering and clinical studies undertaken by large pharmaceutical companies require many different highly specialized skills and goods. Sourcing these resources is often a lengthy and challenging process due to seller selection, offer comparison and legal delay. Some of the services and materials are only offered by very few - often small to medium-sized – companies. Others are standard products offered by many sellers under heavy competition. There are cases where services or products must be custom built, and potential suppliers have to be identified, supplied with a comprehensive list of requirements.

Up to now most of the sourcing is done by the purchasing departments, which often lacks clear insight what the scientist needs, and will thus follow its recommendations. Here the risk of paying too much, or acquiring less than optimal quality, is high – mostly due lacking information, missing market transparency and vendor lock-in.

The critical advantage advertised by new online marketplaces such as scientist.com, Science Exchange for scientific services and goods (e-MSSG) is that virtually all aspect of the drug development process can be sourced out at the best price to an international community of small and large CROs, thus making pharmaceutical R&D more efficient and innovative.

First, we should take a closer look at the status quo of drug development to date. The cost of developing a new drug has increased exponentially in the 21st century. While in the 70s the cost from the lab to the commercialization of a new drug was 179 million USD, now the cost is about 2,6 billion USD. Making bad purchasing decisions even to the fraction of a percent can affect the bottom line by tens of millions already. There can be even worse effects: The drug is approved a year later, this means one year less patent protection until the manufacturer of generics jumps on – and hundreds of millions of revenue are lost or redirected to competitors. Alternatively, the drug is not approved, which means a total loss of the investment.

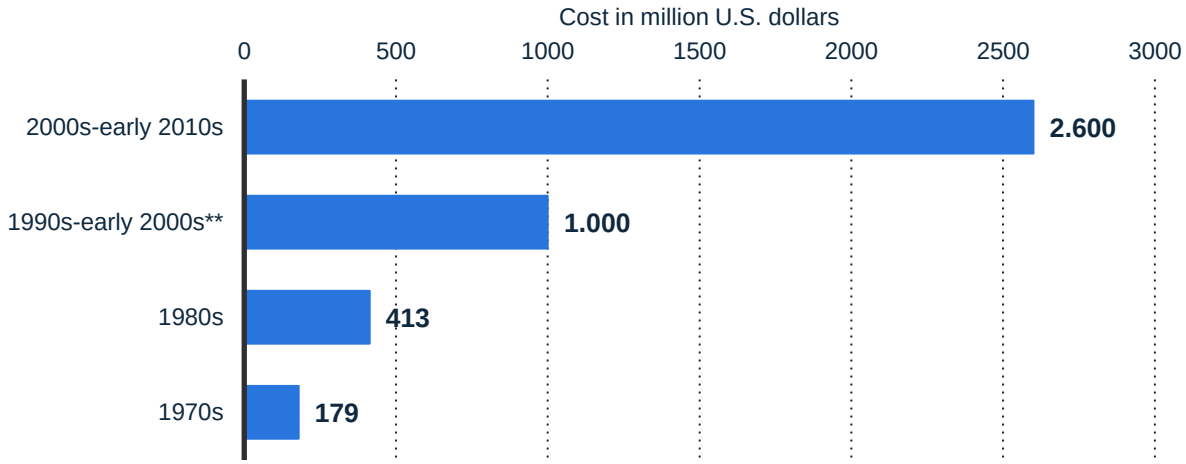

Figure 1: Cost of developing a drug in the U.S. from the 1970s until today in million U.S. dollars (Dimasi and Grabowski 2007; DiMasi, Grabowski, and Hansen 2016)

Ellery and Hansen (Ellery and Hansen 2012) identify three main problems, explaining the low returns on pharma research and development:

- No low hanging fruits, anymore: therapies for the easy-to-treat diseases were identified years ago. The remaining disease to threat: cancer, neurodegenerative diseases, and other complex diseases are far less understood, complex and as such more difficult to tackle.
- Low innovation in Big Organizations: Pharma R&D departments are large and less agile than smaller biotechs and startups. This has already led to a paradigm shift towards a culture of more open innovation, which also reflects in the willingness of the pharma companies to out- or insource services from external experts and to pre-competitive research in industry-wide cooperations.
- Delayed Peak Sales: Expensive new drugs are mostly used on small, unmet-need patient populations, where the novel compounds can provide additional value, to build up safety database on side effects and long-term use, before the drugs are made available to a broader patient population.

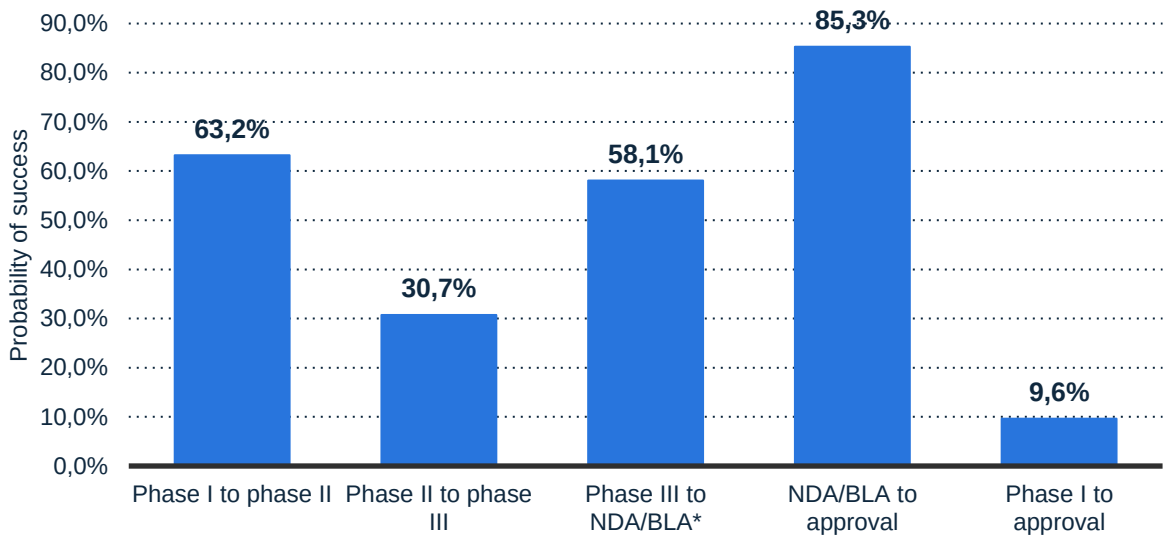

Figure 2: Probability of success for drugs in the U.S. in different development phases between 2006 and 2015 (statista.com/ Biotechnology Innovation Organization; BioMedTracker; Amplion, Clinical Development Success Rates 2006-2015, page 7)

Failure is a typical scenario in drug R&D, as the likelihood of failing at any phase in the development is quite high. Less than 10% of new substances make it from the first clinical phase to approval, due to toxicity, inefficacy or unwanted side effects. If the drug has been finally approved, it needs to be accepted for reimbursement by the health insurance. Also, this is not a given, since it has to be shown that the new substances are either safer, more effective or cheaper than existing ones. The high probability of the total loss of investment makes the development of a new drug a dangerous endeavor.

Despite these bad odds, the effort of pharmaceutical companies has been increased in recent years. The total pharma R&D spending in the US has been increased from 129 billion USD in 2010 to 172 billion USD in 2018. Also, the number of drugs in the pipeline is slightly increasing, about 500 more compounds in 2018 entered the pre-clinical more than in 2017. Because of these observations and the low efficiency of pharmaceutical R&D, the drug development strategy significantly has changed. While years ago the main focus was on internal drug discovery R&D, nowadays early research is mostly done by small startup fueled by venture capital. As soon the compound shows enough promise big pharma buy and internalize the company or just the intellectual property rights, for amazingly high sums.

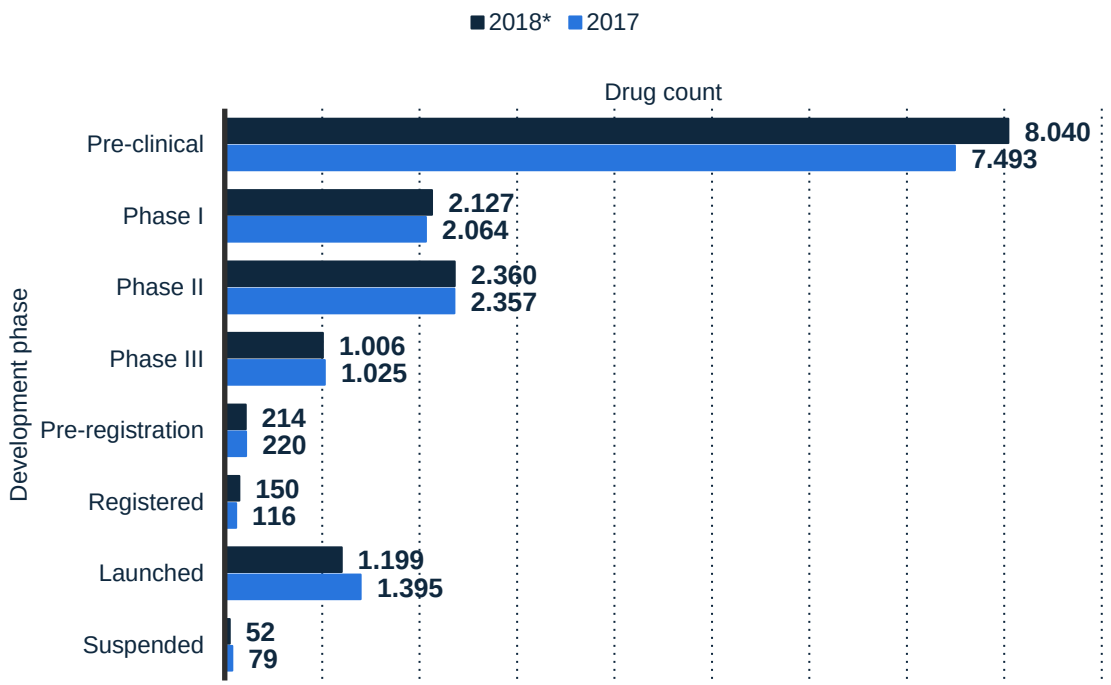

Figure 3: Number of drugs in the R&D pipeline worldwide 2017 vs. 2018, by development phase (source: Pharma intelligence (Pharmaprojects), Pharma R&D Annual Review 2018, page 5, March 2018)

This strategy change also means a culture shift in pharma by opening the internal processes and strengthening them through outsourcing. Externalizing specific task to specialized companies frees resource to focus on the big picture, and can bring in new impulses and innovative approaches. Also, the aforementioned smaller companies do not have all the necessary resources at all, making outsourcing not an option but a strict necessity.

The demand for services in pharmaceutical development is higher than ever (see figure 6). Also, due to a business paradigm shift in the early discovery phases – shifting and sourcing innovation from startups through VC and acquisitions, there are a lot of small biotech/pharma companies which cannot or won't afford owned infrastructure. These factors led to massive growth in that area. However, the market lacks transparency and thus dynamic. Many small companies offer products and service which are better, faster or more cost-effective. However these tiny to medium companies are not gaining visibility by the big pharma customers.

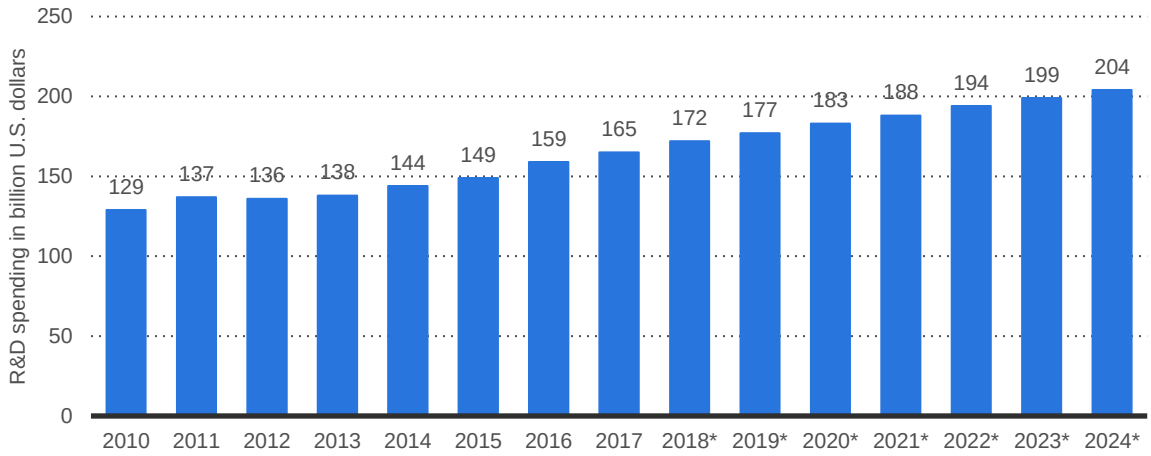

Figure 4 Evaluate, Total global pharmaceutical research and development (R&D) spending from 2008 to 2022 (in billion U.S. dollars), Statista, https://www.statista.com/statistics/309466/global-r-and-d-expenditure-for-pharmaceuticals/ (last visited Sep. 26, 2018).

In an entirely different area, the average western household, we can observe certain parallels. Needs are similarly complex. According to a much-quoted - yet unsourced - statistic the number of different goods owned by an average individual in Europe is about 10,000.

However, buying - even very complex and specialized - goods has been made much more convenient by online platforms, such as Amazon, eBay, and Alibaba., which offer a gigantic catalog of all types of goods. In January Amazon.com listed 562 million different products on its website.[1] About 53% of these products are not sold directly by Amazon but by more than 5 million third-party sellers using the platform as a distribution channel. Also, many products are offered by multiple sellers – leading to a heavy competition through full price transparency. Also, each product and seller is rated through customer feedback. In 2017 Amazon made 32 % of its revenue with its third-party seller services[2].

[1] Data from https://www.scrapehero.com/many-products-amazon-sell-january-2018/ (status 08.12.2018)
[2] Amazon.com Annual Report 2017, page 69

Compared to this the reality in B2B purchasing seems medieval: purchasing complex goods and services are complex tasks, requiring research, time and effort spent. Also, according to a study demography of B2B deciders is changing, and the use of online search tools is prevalent before 90% of all B2B purchase decisions.

In recent years, different platforms emerged pursuing to transfer these benefits to the markets for scientific services and goods. These matchmaking platforms or marketplaces bring together sellers and buyers on one easy-to-use website and a search function, basket, and payment system. Such platforms try to provide additional value to its users by creating better B2B pre-purchase research experiences and streamlining procurement transactions, often by acting as an intermediary agency. This thesis aims to analyze where such platforms fit in the current market and which business models are pursued. It will be analyzed which management problems can be potentially solved from the sellers and buyers perspective. In this thesis, the current competitors will be compared systematically.

BUYER PERSPECTIVE: OUTSOURCING & OPEN INNOVATION

Outsourcing is a growing trend in the pharmaceutical industry. According to a projection by Credit Suisse, 50% of all research in the pharmaceutical industry will be outsourced in 2020 (see Figure 6).

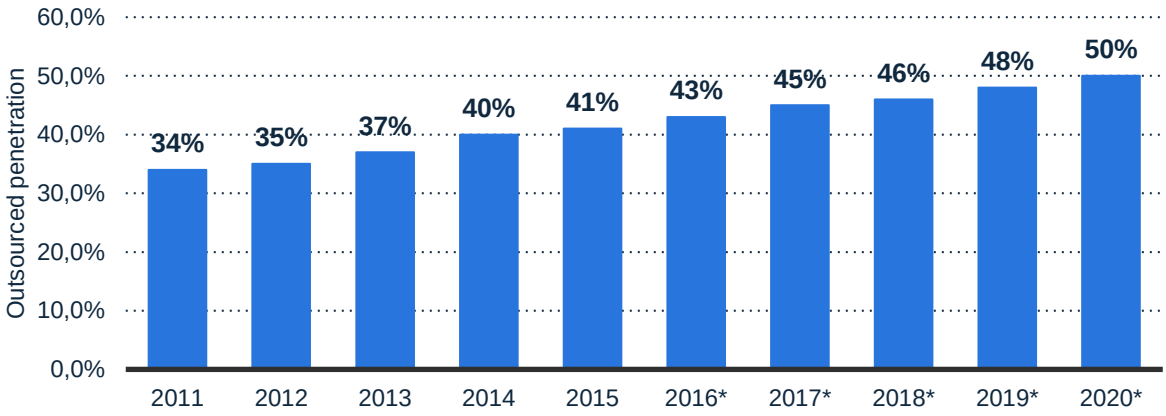

Figure 5: Credit Suisse, Outsourced research penetration in the pharmaceutical industry worldwide from 2011 to 2020, Statista, https://www.statista.com/statistics/813530/worldwide-share-of-outsources-research-penetration-in-pharma-industry/ (last visited Sep. 26, 2018).

Pharma and biotech companies rely heavily on their ability to innovate. The current yield of pharmaceutical R&D is 2 % (over 97% of compounds fail). Strategies to mitigate the "innovation crisis" (Standish 2018) is the pre-competitive sharing of data and embrace the philosophy of open innovation. Open innovation is "a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology" (Chesbrough 2003). It means that by taking an inclusive instead of a "silo" approach innovation could be harvested at a much higher rate. One example of this approach is the Innovative Medicine Initiative by the European Union (Goldman 2012). In this research funding program, all big pharmaceutical companies cooperate in research endeavors.

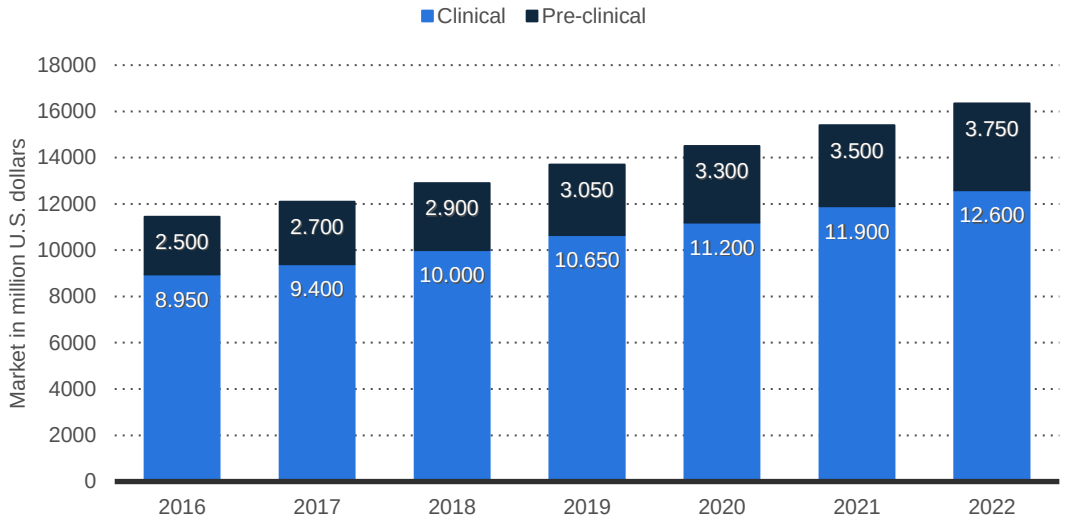

Figure 6: Statista, Size of the U.S. market for healthcare contract research outsourcing (CRO) from 2016 to 2022, by type (in million U.S. dollars), Statista, https://www.statista.com/statistics/754803/healthcare-contract-research-outsourcing-market-forecast-for

This helps to share data and efforts all players in the fields are interested in, e.g., in the fields of drug safety, orphan diseases, etc. If insights obtained in such collaborations had been individually researched and kept in the drawer by the individual companies, not only time but also money would have been lost. This is only one example where cooperation and transparency help to get drug discovery faster and more cost-effective.

Another aspect of open innovation is to include external sources for innovation such as universities, non-governmental organizations, patients, start-ups and suppliers. In research and development, many buying decisions revolve on buying items or services that haven't been purchased before - from companies yet unknown to the buyer. In contrast to production and routine processes, where the buying situations are classified as straight or modified rebuys from carefully selected vendors, in R&D many buying situations can be classified as "new tasks." These buying situations require a high level of involvement, time commitment and are steered by many influencers. From a services marketing perspective, the offered services are search or credence services.

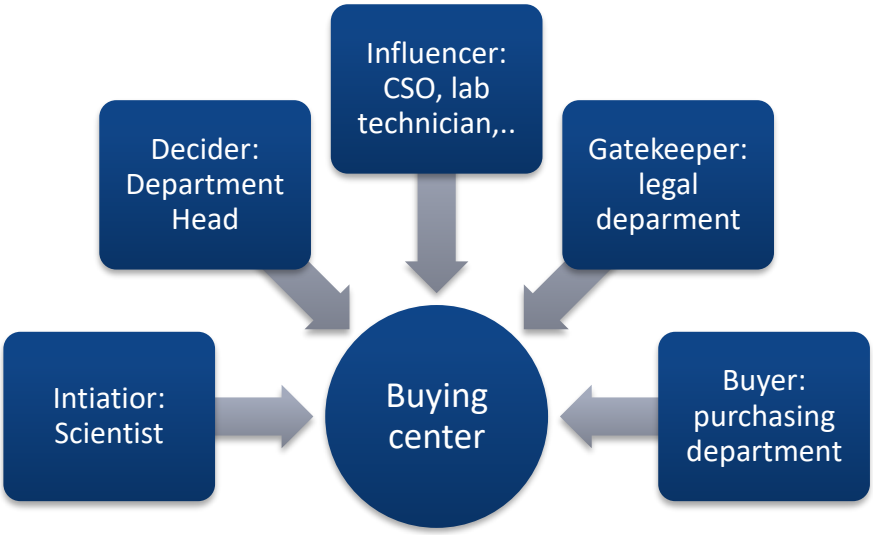

Figure 7: Different roles part-taking in the purchase decision for a scientific service or good

If we analyze the roles, involved in the decision-making process according to Kotler (Kotler et al. 2004), we can identify the scientist in charge of a specific research task as the initiator of a purchasing decision-making process. A new product/service is identified either as a replacement for existing technology, or an exploratory trial to pursue a new direction of research. Alternatively, the scientist needs to solve a specific problem at hand.

In many cases, the decision needs to be run by the department head which makes the final decision if the acquisition is the right fit and economically feasible. In large pharma companies, the purchase is organized by a purchasing department, which is also I charge of all paperwork including master service agreements, legal documentation and payment processes (see legal and financial delay). The decision can be influenced by many actors, from the lab technician to the Chief Scientific Officer (CSO) which might have a strategic interest to a particular purchase decision.

However, according to an article from Forbes due to the prevalence of e-commerce in B2C *" research buyers are expecting a similar consumer-like buying experience in their business-to-business (B2B) environment at work -- even for complex and expensive scientific products."* (Buvailo 2017).

In this chapter, we will identify the most pressing problems of the buyer of outsourcing services in the pharmaceutical research industry.

MISSING MARKET TRANSPARENCY

Market transparency means that a market participant has easy access to information on what products and services are available, in which quantity, from where at which price. A transparent market leads to increased competition, better prices, and higher quality products.

On the market for scientific services and goods, however, market transparency seems to be difficult to achieve.

The reasons are partly inherent to the field:

1.) Biological and pharmaceutical research is often aimed at very narrow and specific questions, while a biological system is almost always amazingly complex. This leads to the need for a high number of different products services, but low demands on most of them. E.g., the site antikoerper-online.de list 1,9 million different research antibodies, proteins and tests kits from 180 suppliers. This means that the site could supply a different reagent to almost every biologist on earth.
2.) Innovative research almost always starts in small research groups or Biotechs, which are not always well-represent on the market.
3.) Many research services are highly specific and require individual and confidential quotes.
4.) The level of documentation and validation requested by the buyer are significant price drivers.
5.) Products are not easily comparable due to missing standards

All of these factors make the market complicated and confusing from a procurement perspective.

SCIENTIFIC SERVICES AND OUTSOURCING

The market for scientific services can be roughly segmented in providers of standardized services and custom services.

Standard services are provided by labs proving all common routine assay services, chemical synthesis — monoclonal and polyclonal antibody generation, toxicological analysis, etc. These tasks, in general, are not driven by a creative process. They generate data, but not knowledge or savoir-faire. In general, it is possible for routine service providers to have a fixed price list for all of their offerings. Services like are also easily comparable because they usually are built on well-known and robust techniques and SOPs (standard operating procedures).

Custom services which involve significant ingenuity, creativity, managerial interaction, and decision-making are provided by contract research organizations, in short: CROs. Due to the high technological, scientific and regulatory complexity of drug development many companies do not hold own staff or every aspect of the process. Specialized companies offer services in the fields of biopharmaceutical and biologic assay development. Also, the planning and execution preclinical and clinical trials, the related data management and pharmacovigilance after commercialization is often outsourced to CROs.

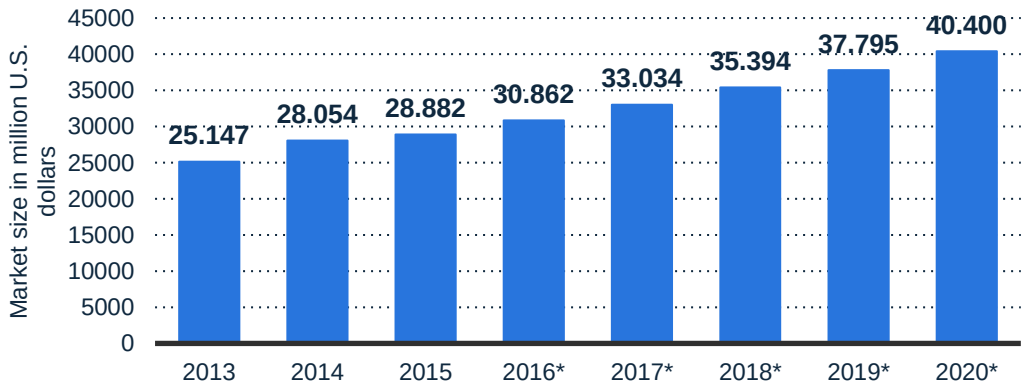

Figure 8 Credit Suisse, Total contract research organization (CRO) market worldwide from 2013 to 2020 (in million U.S. dollars), Statista, https://www.statista.com/statistics/814251/total-cro-market-size-worldwide/ (last visited Sep. 26, 2018)

According to the report "Outsourcing in Drug Discovery" from Kalorama the outsourcing market in drug discovery splits into four main service categories: High

Throughput Screening (6%), Biology Services (32%), Chemistry Services (36%) and Lead optimization (26%) of a total market of $ 20.7 billion.

THE BIOMARKER ASSAY MARKET

An 'assay' is defined as a test in order in to quantify or detect a (bio)chemical entity in a sample. For example, the standard pregnancy test is an assay. The test uses antibodies, hence *immuno*-assay, to the protein HCG, which is elevated during pregnancy, in urine. Also, many of these tests are required in scientific studies because they are used to quantify so-called biomarkers – to measure states or conditions of biological systems, e.g. if any organs are negatively affected by a drug, or vice-versa if an existing condition can be treated accordingly. The measurement of biomarkers has a proven effect on the success rate of new drug developments (see figure 9): The overall success rate from Phase 1 to approval increased from 8,4 % (no biomarkers measured) to 25,9 % (with biomarkers). The success rate almost improved 3-fold, so this is why biomarkers are currently an essential topic in pharma. It is expected that new tests lead to better – safer and more efficient – drugs.

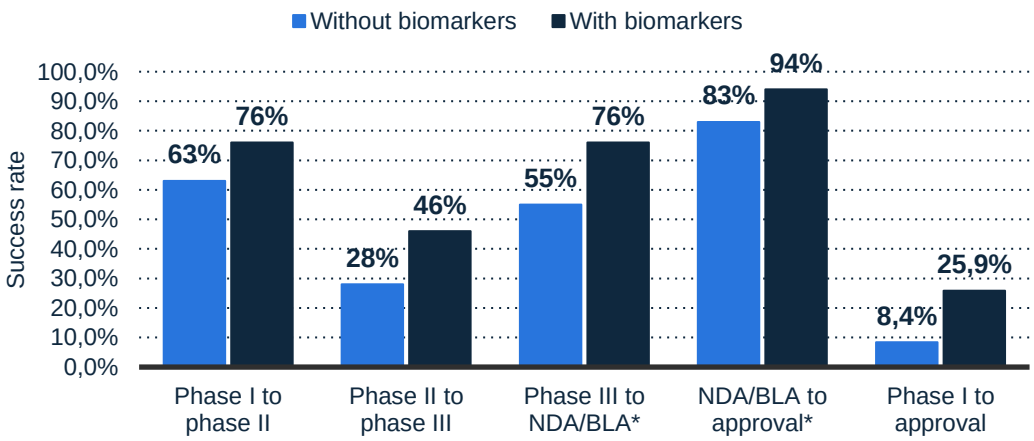

Figure 9: Probability of success for new drugs in the U.S. with and without selection biomarkers by development phase between 2006 and 2015 (statista.com/ Biotechnology Innovation Organization; BioMedTracker; Amplion, Clinical Development Success Rates 2006-2015, page 7)

Due to the complexity of a biological system, the variety of test is enormous: The human proteome alone, dismissing all genetic variance in the world population, consists of about 20.000 proteins. Each protein has a distinctive biological function and could be of interest for specific medical questions or a target for drug

development. Proteins are only one class of biomolecules. There is also the human genome with tens of thousands known SNP (single nucleotide polymorphism), which denote mutations – possibly associated with negative or occasionally positive health effects. In addition to those, a massive variety of biochemical entities such as bile acids and microRNAs.

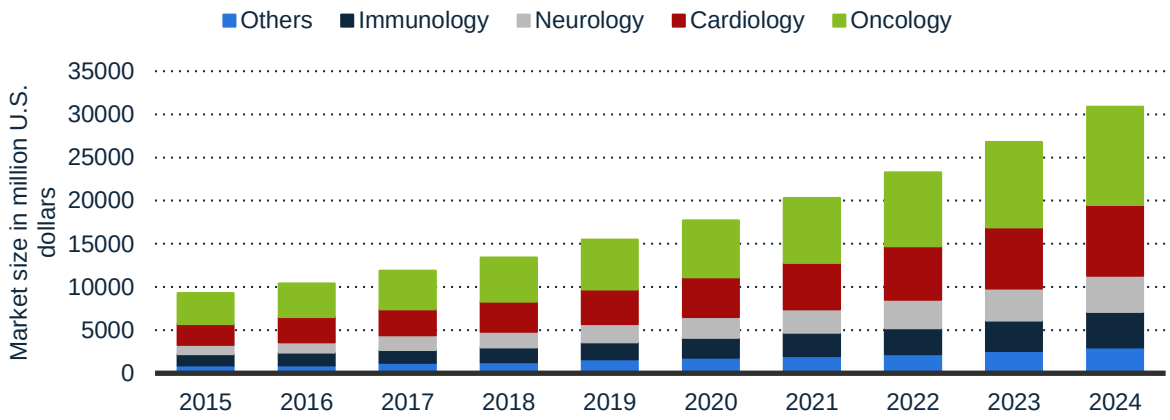

Figure 10: This statistic shows the estimated market size for biomarkers in the United States from 2015 to 2024, by condition, measured in million U.S. dollars. In 2015, the biomarker market in the U.S. was valued at around 9.3 billion U.S. dollars. (Source: Statista/Grand view research)

Even worse, many of the entities can be measured using different systems. Sometimes a system works for urine but not for blood, or vice versa. Some systems are very accurate but so slow that it is not feasible to measure a large study comprising thousands of samples. Other systems are very fast, but they are not very sensitive.

Table 1: Current (December 2018) number of assay kits available from four different major brands, retrieved from their respective online catalogs using the search term "ELISA."

R & D System	1840
Novus Biologicals:	2464
Merck Millipore	933
ThermoFisher Scientific (Invitrogen):	1206

This variety of options has led to a myriad of different products offered by different companies, all of which describe and offer their services or products in their catalog and through their salesforce. There are few big competing suppliers on the market. Usually, they have 1000s of test available in their catalog. Every supplier list datasheets and technical specifications, however, all supplier provide their own format.

SUPPLIER CERTIFICATION

If data is submitted to the regulatory authorities such as the FDA or EMA, specific quality criteria have to be met (Bhatt 2011). Each study needs to adhere to guidelines, with law-like character, or the study will and cannot be considered by the regulatory bodies. To meet these certifications suppliers of services and goods need to provide proper documentation of their quality management processes and validation standard operating procedures. Provider of scientific services needs to follow the guidelines for Good Laboratory Practice (GLP). The first implementations were an answer to cases where authorities could not reproduce findings of test laboratories after the submission of toxicology data to the FDA.

The agency published the first ruleset in 1976, which followed by similar regulations by the OECD and the European Council. GLP regulations include rules on:

- Organization and personnel
- Quality assurance
- Facilities
- Equipment, reagents, and materials
- Test systems
- Standard operating materials
- Performance of studies
- Reporting of results
- Archival of records

Establishing and keeping accredited laboratory workflow in place is very work-intensive and requires well-trained staff and expensive equipment. This very high level and strict type of regulations have two sides from the R&D procurement perspective. From the viewpoint of efficiency, it is highly questionable to keep experts and validated process on every aspect of the drug development process in-house if not strictly required for legal or intelligence reasons.

Regulatory obligations can be transferred from a sponsor to a CRO, meaning "be outsourced," according to FD regulations 21 CFR Part 312.52:

(a) A sponsor may transfer responsibility for any or all of the obligations outlined in this part to a contract research organization. […]

(b) A contract research organization that assumes any obligation of a sponsor shall comply with the specific regulations in this chapter applicable to this obligation and shall be subject to the same regulatory action as a sponsor for failure to comply with any obligation assumed under these regulations. [….]

Given this possibility, many of the intricate steps of the drug development process will be outsourced because it would not pay off to build the validated environments inside the companies. However, when the process is outsourced, it must be made sure that the selected supplier is accredited to provide the service on the required level of validation.

A supplier can provide the information whether his products or services are certified and validated, by seeking official certification such as ISO 9001, ISO 15189 or 17025. Also, he can or must agree to audits by the sponsor and the regulatory authorities.

On most marketplaces, a supplier can advertise such certifications, which are often expensive investments. Buyer can then pre-filter the supplier list, and include the level of required validation in their requests for proposals on the platform.

HOW CAN THE PROCUREMENT PROCESS BENEFIT?

Professional supplier management has many advantages such as lowering costs, improving efficiency, supply chain consolidation and improving operations. However, onboarding a new supplier in such systems can be a lengthy and expensive process (see figure 12). The total cost of one supplier acquisition can cost from USD 2k€ to 30 k€, depending on the level of administrative overhead and process automation.

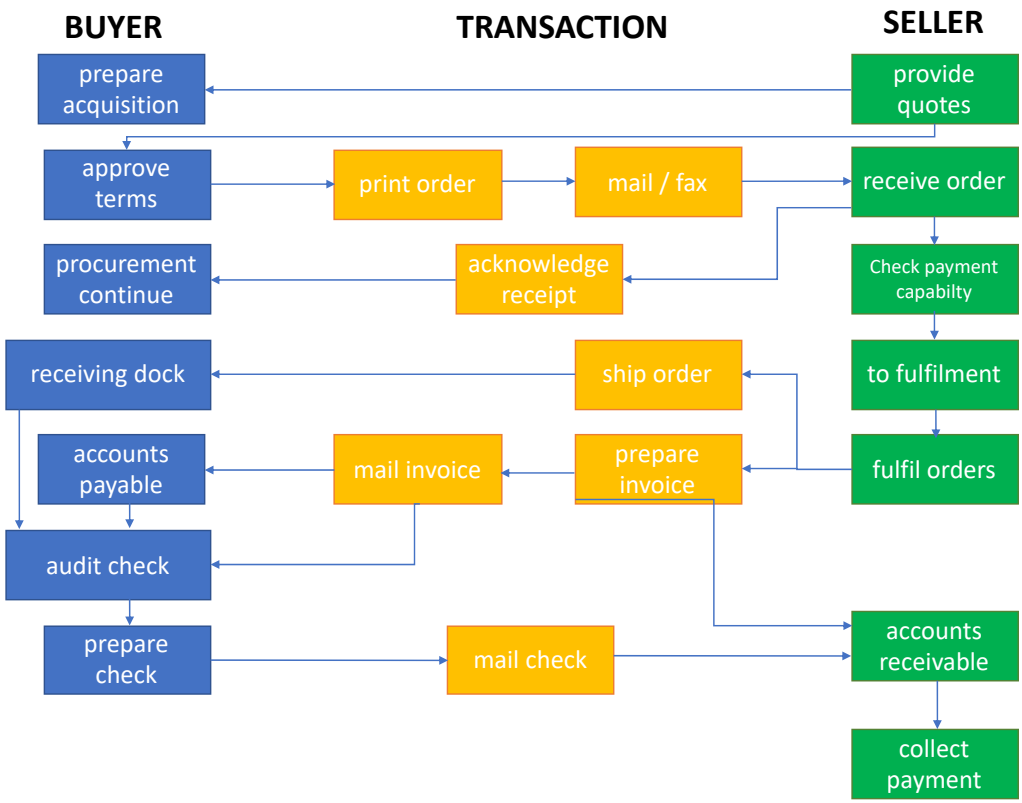

Figure 11: The traditional manual procurement process according to (Turban et al. 2018)

The procurement starts with the definition of a specification clarifying the required functions and property of the desired acquisition. The specification is usually performed by the requestor, which has in-depth technical and scientific knowledge. Online marketplace often facilitates these processes by offering pre-defined forms for this process. Requests can specify the type of service from the extensive list of categories. For some categories, e.g., genetic testing or the measurement of protein levels, fields are put in place for the species, the requested gene/protein, number of samples, etc. Also in ideal procurement environments, the buyer will have to research potential suppliers, establishing contacts and submitting the requests. In an online marketplace, suitable suppliers that have registered themselves to offer services in the requested categories are notified automatically, with all the required information to be able to submit a quote. Because all suppliers will be submitted with the same information, resulting quotes should be comparable and transparent.

When the buyer has selected a supplier contract negotiation, and exchange of legal documents such as master service agreements, and non-disclosure agreements will follow. The process of legal and financial review is, in general, a lengthy process since

it requires the involvement of the legal and financial departments which can be considered to be a bottleneck in many organizations. Also, it requires the signing of documents on both sides by legal signatories. In many online marketplaces, this step can take a shortcut because the buyer buys from the marketplace as a legal entity. Buyer and seller each have an NDA with the marketplace, relinquishing the need for bilateral legal agreements. This process has been heavily advertised as a significant advantage by the platform owners.

Next step in the procurement process is the submission of orders. Also, this step can be performed on the platforms – the order goes directly to the platform. This has the advantage that only the platform has to be added with an account to the buyer supply chain management system. The introduction of an intermediary party can affect the building of a supplier relationship negatively. Strategically building alliances with suppliers is a central goal in afore-mentioned Open Innovation paradigm.

During the Expediting phase, the platform can support the process by proving an interface to project due dates, invoices and ticket systems. However since the buyer must control the results and quality of the provided goods/services, no significant advantages arise from a marketplace model in this phase.

When it comes to the evaluation and supplier rating, platforms can significantly improve future supplier selection due to swarm intelligence. A buyer can submit ratings and share them within an organization (private marketplaces) or publicly. Also, the buyer organization can mark preferred sellers for different product categories.

THE SUPPLIER PERSPECTIVE

The providers of scientific services and goods also face unique challenges. While the big players in the market such as large CROs and distributors certainly align themselves with general problems occurring in the B2B market challenges, smaller suppliers always struggle for visibility and aim for scalability and the reduction of complexity.

BENEFITS FOR SUPPLIERS ON E-COMMERCE MARKETPLACE

The presence on any of the existing platforms constitutes a new sales channel. For a small biotech service provider / CRO selling specialty services and goods, it can be paramount, to list and expose the capabilities as many channels as the main problem is to be identified as a supplier by a potential buyer.

By offering web-shops, sellers can offer and sell their services 24/7. However, to maintain an own web-shop can be challenging for smaller companies and bigger CROs, as this requires significant expertise resources is not how business has been done in the past. This means that most businesses do not offer an e-commerce interface to its customers at all. According to a study from PWC (Pumberger and Beutin 2014) to the total volume of sales in life sciences done by E-commerce (including marketplace) will be 70-80 % by 2020

On a marketplace not only, all necessary mechanism such as the account creation, order forms, order management, billing, etc. but also the technical infrastructure hardware, hosting and backups are provided and managed by the platform. Also, most marketplaces operate globally – this gives sellers access to the global market instantly.

Ordering errors do occur in B2B transaction through communication gaps, lack of inventory visibility and product data inconsistencies. According to a 2016 survey from CloudCraze (now Salesforce B2B), 94% of B2B leaders experience order errors on a regular basis. The ordering and bidding process through a platform requires the accurate and systematic description of the offered services and goods. Furthermore

	Define specification	Select supplier	Contract agreement	Ordering	Expediting	Evaluation
P&S role	• Get specification	• Assure adquate supplier selection	• Prepare contract	• Establish order routine	• Establish expediting routine	• Assess supplier
Elements	• Functional specification • Technical changes • Bring supplier knowledge to engenieering	• Prequalification of suppliers • Requests for quotation	• Contracting expertise • Negotiating expertise	• Develop order routines • Order handling	• Expediting • ‚Troubleshooting‘	• Supplier evaluation • Supplier rating
Documents	• Functional specification • Norm/spec control	• Supplier selection proposal	• Contract	• Order	• Exception report • Due date listings • Invoices	• Preffered supplier list • Supplier ranking scheme
Possible impact of an online marketplace	• Predefined form/interface to submit specification to suitable suppliers • Help by platform agent to select suppliers • Public request can attract potential unknown suppliers • Increased competition, better price		• Platforms acts as an intermediary • Buyer/seller NDA replaced by buyer-platform and platform-seller NDA • Predefined terms an conditions by platform	• Order submitting through platfor • no need to add supplier account		• Preffered supplier list can be managed within platform • Evaluation can be shared within organization or publicly

Figure 12: Managing interfaces of the procurement process including possible impacts of an online marketplace (adapted from" Purchasing & Supply Chain Management: Analysis, Strategy, Planning, and Practice" (van Weele 2010)

, E-Marketplaces can promote the automation of previously manual processes; It is highly likely that the required accuracy in order specification can reduce ordering errors.[3]

Another positive aspect is that by joining a platform, the company will participate in the research community. By enhancing its visibility its products and innovations can gain momentum an on the market. Also, a participant can get a better awareness of the otherwise hidden competition in the field.

A distinct, related upside is that participation in a marketplace will promote the business by showcasing its capabilities. Many platforms allow buyers to share ratings of the suppliers. If the ratings are positive, they can be seen as valuable instant third-party references, which are otherwise rare in the B2B-field.

A potential advantage for the buyer, cutting down on the complexity of procurement, by using a mediator taking care of the contractual parts (legal and financial delay) will impact the turnaround time – from proposal to delivery - for the seller positively. This can make a huge difference using cash flow management.

SUPPLIER DISADVANTAGES

The one buyer advantage that is most heavily advertised is cost savings. The cost savings are realized by getting offers from more sellers, increasing competition and therefore pressure on prizes. This is, of course, the big downside for sellers. However, there is the sense, that this paradigm shift on how outsourcing and procurement work, cannot be escaped. Even larger CROs have started to get listed on the B2b platforms, although they have been very reluctant to join in the beginnings.

Another obvious downside is that seller have to pay transaction fees and revenues, which will hit the bottom line. Still, an approximate platform cost of 10% is comparable to standard marketing/acquisition costs.

[3] https://www.corevist.com/cloudcraze-reveals-94-b2b-leaders-order-errors/

Also, building a brand can be difficult on such platforms because some of the interaction is taken over by the platform. The platforms specifically advertise to group product alternatives from different sellers and offer them to the buyers when there are cheaper options. Due to this mechanism, it can be challenging to engage customers if the supplier is disconnected from the obtained service or product.

OPEN INNOVATION FROM THE SUPPLIER PERSPECTIVE

Companies developing novel products and services for the R&D market require information where the primary research efforts of their clients are going to steer their own development in the right direction. CROs and assay developers need to develop the tools year before the R&D departments or the regulatory requirement to use them are ready.

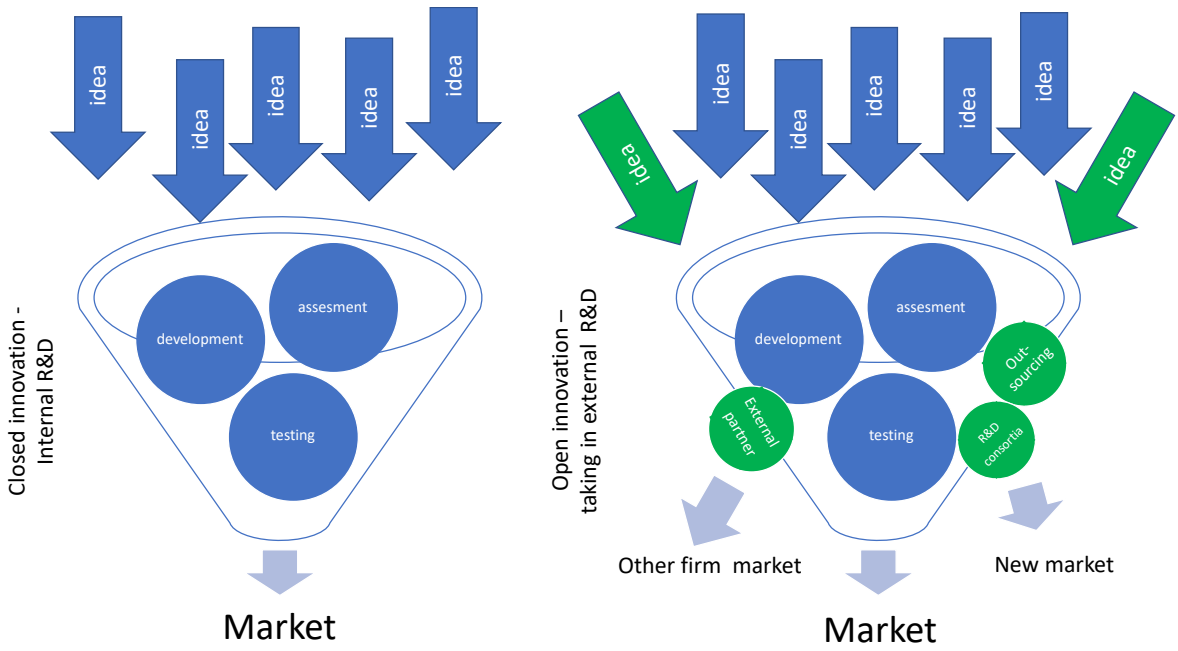

Figure 13: The closed and open innovation funnel mode. While most new ideas will be evaluated and eliminated in the classical process of research and evaluation, the open innovation model makes the organizational borders permeable to external input and output. This potentially multiplies the innovation efficiency of an R&D department significantly.

Of course, any supplier and developer of research products has a deep understanding of the state-of-the-art in its field. However, it is not always obvious and needed what is happening in secluded research labs of big pharma. By monitoring the requests for specific services and products made by companies on marketplace platforms, agile

companies can use this information to steer their research efforts in the direction of the real-world market needs.

E.g., a company could ask for some biomarker test in cats, which it was not able to find in any catalog or publication. Any biomarker assay developer can take this a hint that there is a demand for these tests. Also, the test might be in development, but have not yet been released to the market. In this case, the supplier has found a beta-tester for its novel product and a potential future client and evangelist.

WHAT IS A (SCIENTIFIC) MARKETPLACE

B2B e-commerce platforms are either vertical or horizontal. Horizontal marketplaces allow the trading is in a service or a product that is used in many different industries: Examples are office supplies, furniture, or paint. Alibaba.com is an example of a horizontal marketplace. Vertical marketplaces are specialized for a distinct industry or industry segment. Examples include marketplaces specializing in electronics, cars, hospital supplies, steel, or chemicals (Turban et al. 2018).

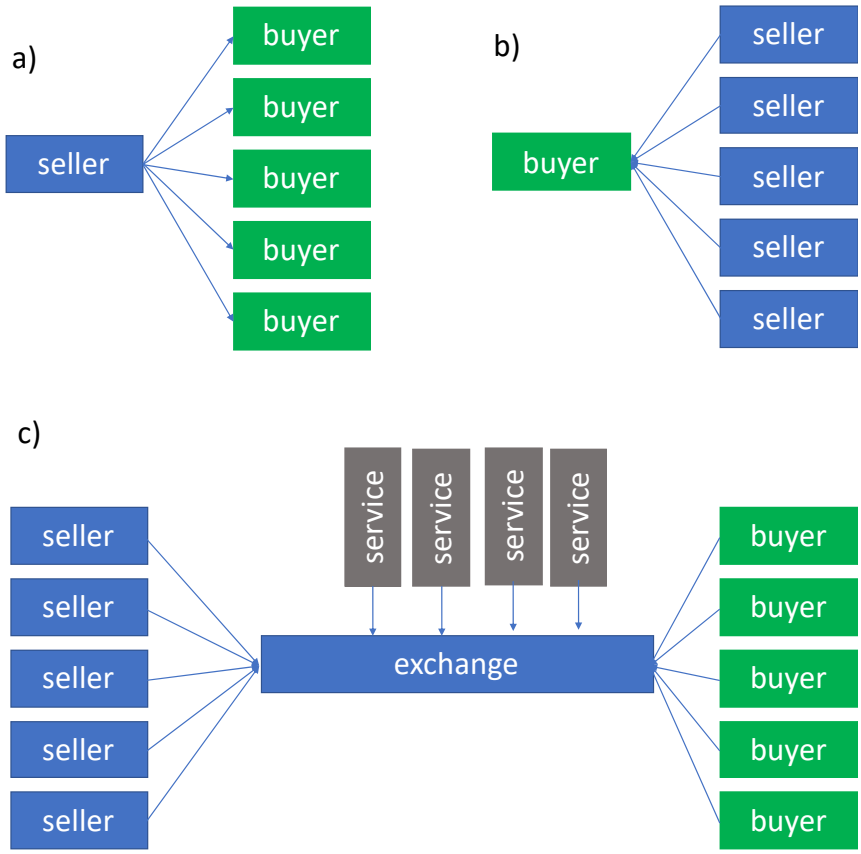

Figure 14: Three B2B transaction activity types a)sell-side one seller to many buyers) buy-side one buyer from many sellers c) marketplace or exchange (adapted from (Turban et al. 2018)*)*

Electronic marketplaces can be further divided into transaction, innovation, integrated and investment platforms. An innovation platform company, like Microsoft Windows, allows other businesses to develop complementary products. Integrated platform companies, such as Apple or Amazon, not only provide a service or product but also the means of facilitating transactions between the customer and seller, by

providing APIs and App Stores. Investment platforms stand out, as they act just as infrastructure for startups. (Evans Annabelle Gawer et al. 2016).

Transaction platforms focus on the aspect of the matchmaking process in two-sided markets, without necessarily providing a platform innovation by themselves. According to (Täuscher and Laudien 2018) a transaction platform qualifies as a marketplace if at least four criteria are met:

1.) The platform connects independent actors from demand and supply
2.) The actors enter in direct interaction to complete a transaction
3.) The platform provides a regulatory framework to perform transactions
4.) The platform does not produce or offer goods by itself

They also refer to (Teece 2010) for the definition of the term business model, which is centered on the concept of value creation for the customer. If a platform creates additional value for the customer, which he is willing to pay for, it can be considered a viable business model. A marketplace creates value by bringing the different actors of a transaction together, and facilitates the transaction for both sides financially, legally and for convenience.

The above criteria help to differentiate online marketplaces for scientific services and goods from classical B2B sales models and other existing online platforms.

PRIVATE MARKETPLACES

Pharmaceutical research requires utmost confidentiality and companies strictly protect their secrets from competitors. Industrial and economic espionage is a real threat. Furthermore, any public sharing of data could be harmful to future patent applications, because if any details about specific claims are publicized, it is considered “prior art.” Either way – anything threatening exclusivity of significant discoveries in pharmaceutical development must be avoided. Sovereignty over the intellectual property for the first 10-15 years after market entry is the cornerstone of the successful reimbursement of the research investment, and the bottom-line of the companies.

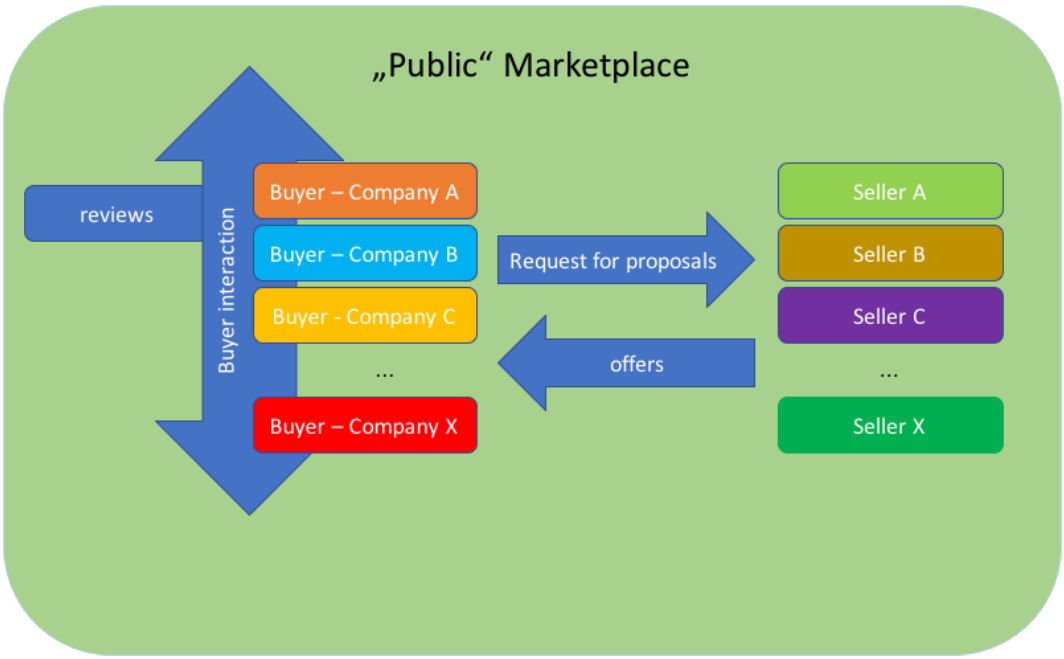

Figure 15: Schematic of a public marketplace with full buyer-to-buyer transparency

Companies are highly reluctant when it comes to data transfers which could help elucidate any findings or strategies to the competition. This very comprehensible policy, however, can be a hindrance to adopting an online marketplace. The marketplace Scientist.com, which will be described into more detail in chapter 3, offers a buyer-specific marketplace, where no communications such as projects descriptions or ratings from the buyers are shared to other buyers outside of the company. This allows better containment of critical information and protects the customer from accidentally leaking internal data. These private marketplaces are actual examples of a buy-side-B2B transaction activity type (see figure 14).

DIFFERENTIATION FROM CLASSICAL DISTRIBUTORS

Typically, laboratory materials and “fine chemicals” are purchased from larger distributors such as VWR, Thermo, Cambridge Bioscience and others. These companies follow a classical wholesale distribution model. The distributors buy large quantities and include them in their catalog. Many labs have chosen one particular distributor, where most lab materials are purchased - excluding highly specific compounds which are very specific to the research area and are not stocked by a generic wholesaler. These items are ordered either directly from the producer, or from companies specializing in such materials.

e-Commerce marketplaces take a very different approach as they do not stock any materials by themselves. They just initiate and facilitate the business transaction between the buyer and the seller, through their platform. This can be of course more cumbersome, than getting a regular invoice by a wholesaler. However, also several advantages, such as a more extensive selection of materials and better prices – through direct sales without a wholesaler, can be expected .

DIFFERENTIATION FROM VERTICAL MARKETPLACES: EBAY AND AMAZON

While eBay and Amazon indeed are also selling scientific materials and goods, they do not specialize in these items. They do not offer any guidance or user interface adapted to this market. While this might not be important for plasticware, such as tubes and cups, it is for complex materials such as chemical agents, biological materials and spare parts. MSSGs offer these features. Also, Amazon and eBay are not in the business of selling R&D services, with the only exception of the "Mechanical Turk" program from Amazon, which has been used to outsource straightforward and atomic tasks which require human intelligence for data evaluation (e.g., tagging a cat in a picture).

DIFFERENTIATION FROM SOCIAL NETWORKS

It is no uncommon that first B2B contacts are made using business networks such as LinkedIn or XING. However, these networks cannot be considered a marketplace because they just provide the technical framework to find business partners. However, they not provide a financial or legal framework to initiate or facilitate sales. Of course, through advertising and sales pitches, these platforms can also be valuable sources for fresh leads.

Differentiation from Freelance Marketplaces

Freelance marketplaces such as Freelancer, Elance, Upwork, Toptal enable freelancers to offer their services to a broad public. These platforms can be considered as conceptually similar to a marketplace for scientific services as they inevitably meet all criteria according to the previously stated definition. Nevertheless, these platforms mostly serve creative needs such as drawing, writing, and design, IT-related services.

Only in the niche of data management and curation these platforms might become a resource for clinical research. However due to the high bars for quality management and data protection legislation this only feasible in cases where such restrictions do not apply.

Are Marketplaces a Type of Procurement Outsourcing?

It could be argued that research marketplaces can be easily integrated into the waster term of procurement outsourcing or indirect procurement. In procurement outsourcing, procurement activities related to sourcing and supplier management are transferred to a third party. Travel agencies are a typical example of procurement outsourcing, used for the sourcing of business travel or recruitment agencies for the sourcing of personnel.

So why platforms should not be considered as a type of service agencies? In the case of scientific marketplaces, many of the advantages that come with procurement outsourcing, such as the extension of the supplier base, streamlining of operations and freeing up internal staff, overlap there are some differences. While the term procurement outsourcing mostly encompasses specific services required for a procurement task, such as a travel agent or head-hunter, a marketplace specifically supports the matchmaking-process through an online platform. In the strict definition in procurement outsourcing, the procurement decision is taken outside the company, with a perceived loss of control. This is possible in the market of substitute goods, where the buyer just specifies the good main characteristic. This not the case in research, where the buyer many times is not aware of the available options and the decision requires in-depth knowledge of the research problem at hand.

Figure 16: Electronic e-marketplaces for scientific services and goods have conceptual interfaces to many classical and novel fields in innovation, procurement, and relationship management fields.

There are additional, for-fee, services offered by the platform owners to facilitate to find a searched-for service ("concierge"), however this not a defining aspect of such platforms. The buyer will always require to be in control of the procurement decision when it comes to complex research products and services. Many marketplaces offer a full-service solution to facilitate transaction established through the platform including billing, contracts, customs, and taxes, where the complicated many-to-many supplier-relationship-management-tasks is significantly reduced in complexity.

In conclusion B2B marketplaces for scientific services and good have conceptual interfaces to many fields in management and procurement innovation (see figure 16). Even though there are many overlapping properties, the unique value-propositions offered by such marketplaces, they can be considered as a clearly distinguished and dedicated field.

Reference Model for Online Marketplaces

The number of different platforms for scientific services has significantly grown in recent years (insert graph/data here numbers of new platforms per year). Almost all platforms strive for a unique approach for the markets which are addressed, how matchmaking works, the business model, and other factors.

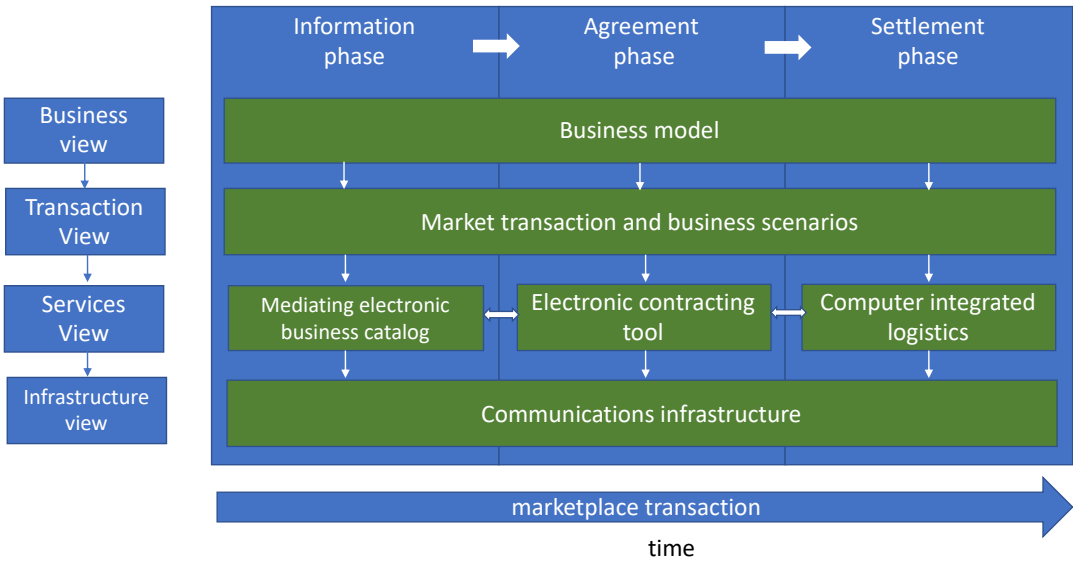

Figure 17: Proposed reference model for electronic marketplaces by Schmid and Lindemann(Schmid and Lindemann 1998)

Online marketplaces have been the subject of scholarly research for more than 20 years. Schmid and Lindemann developed a conceptual reference model to explain the central functions and properties of 'e-markets' in 1998, which is still valid and applicable to recent developments. According to this model, a marketplace can be viewed from a business, transactional, services or infrastructural view, while the horizontal dimension divides the facilitated market transaction between an information phase, an agreement phase, and a settlement phase. The model helps to find the defining components of a marketplace:

- Business model: What is the value added for the customer? What are the revenue streams?
- Market transactions: Which transactions are facilitated by the marketplace?
- Services: What are the services provided by the marketplace?
- Infrastructure: What is the communications infrastructure of the platform?

Online marketplaces for services and goods have been marvelously profitable endeavors. Their revenue generation can be classified into four different types: commission-based, membership and subscription fees, listing fees, advertising, and additional services.

e-Commerce platforms for science can also be compared to how they generate revenue. The most common revenue stream, companies rely on is a provision/transaction fee-based model, by taking 5-10 % of every transaction processed on the respective platform. This is a standard model adopted by marketplace providers such as eBay, Amazon.com, and Alibaba, and also the fee percent range resembles those. This model is well received by seller and buyers since fees only occur when transactions are performed. Since most B2B transactions in pharma are large; this model is profitable even if the number of contracts is limited.

Other platforms resemble old-school yellow-pages like directories, request a membership fee from the service providers. Some services will list suppliers for free upon request, but ask for a premium fee to upload a full profile including the company logo, and further in-depth marketing information.

Also, some platforms offer a concierge service to the buyers. Here, the seller states the problem at hand, without precisely specifying what technology or approach should be used. Agents employed by the platform owner analyze the problem, and research their supplier directory. This is basically the full outsourcing of the seller identification stage of the procurement process. In these cases, the client will pay for these consulting services on top of the transaction fees.

Another source of revenue seems to be advertising on the sites, which however seems to of minor importance – at least on the transaction-fee driven platforms. On these sites, the focus is on creating a good user experience.

MATCHMAKING PROCESS

The matchmaking process can also be a discriminatory factor. By its definition, marketplaces always strive to match demand and supply. The matchmaking process can occur unmoderated, by just providing information about products and supplier in an orderly and comparable manner. In these cases, the platforms work as mere directories and leaves the process of vendor selection to the buyer.

Some platform owners interfere, moderate or take over the process of vendor selection completely. Depending on the level of control transfer from the buyer to the platform these services can be classified anywhere from the range of consulting to procurement outsourcing.

Another match-making process on online platforms includes reverse auctions, where suppliers can bid on projects or products requests. Through the "reverse bidding" process the price decreases as the supplier compete on offering lower bids. At the end of the auction, if several independent suppliers participated in an auction, in theory, the lowest possible price has been identified. The buyer can decide to choose the offer with the lowest price or choosing an offer with higher price depending on the expected quality, time-to-delivery or other added values.

The last method of matchmaking are "challenge competitions," to be found on R&D crowdsourcing platforms such as Innocentive and Kaggle. Here multiple suppliers compete by submitting solutions to a posed problem. The winning solution is either determined by the platform or the sponsor of the challenge. The sponsor will be provided with multiple solutions to the problem.

ADDRESSED MARKETS

Another segmentation in addressed markets is of course, whether tangible goods or service are sold. This distinction has profound implications on how transparent the instantly available information can be made.

The marketplace for tangible products can be further divided into basic research materials and specialized “fine chemicals.” While the first category encompasses general traded standardized goods, which allow full market transparency, the latter ones are often custom-made, available only in small quantities and are sold one or only a few vendors.

The service market is of course even less transparent. The instantly available information often consists only of the descriptions of offered services and pricing is not available online. The main focus of these platforms is to facilitate finding a set of vendors and getting comparable offers for research tasks. Also, the markets can be segments by the customer's group. Most platforms are centered on the solvent, big pharma customer. Some platforms are more targeted at the broader small biotech or academic market.

Comparative Analysis of Available MMSG Platforms

In this chapter, we should analyze the current marketplaces for R&D Outsourcing services, research products, biospecimens, and health data. We will shortly outline essential business information and on how these companies act in the research market in the context of procurement innovation.

R&D Outsourcing Services

Marketplaces for R&D Outsourcing Services concentrate on offering custom services such from Biomarker discovery to toxicity analysis. These platforms are specifically tailored to serve the trend of outsourcing in the industry. There are two major players on the field which offer full-stack service from publishing request to supplier and buyer profiles, to transaction facilitation by acting as agencies. Also, there are several smaller sites which offer parts of what can be considered a complete transaction platform.

Science Exchange

Science Exchange was founded in 2011 in Palo Alto as a child of the Y Combinator seed accelerator, which has also acted as an incubator for Airbnb, Dropbox, and Reddit. The origin story of the company is that the founder, Elizabeth Iorns, had been struggling to find suitable cooperation's partners for scientific experiments as a post-doctoral scientist. Currently, the company has 118 employees and raised $ 72.5 M of funding in 6 rounds, the last one in 2017 with a volume of $ 28 M. Also, the company acquired the Ondeckbiotech.com in 2016.

The core business of Science Exchange is the procurement of outsourced scientific services. The catalog comprises more than 2500 service providers offering 6000 different services. The business model is to take a fee of about 5 % from each transaction run from the platform.

SCIENTIST.COM

Scientist.com - formerly Assaydepot - has been founded in 2008 in San Diego, USA. The company was founded by Kevin Lustig, a biologist, and entrepreneur. Assaydepot was Lustig' second enterprise after co-founding Kalypsis, which had the goal to develop small molecule drugs. Working in this context made him aware of the shortcomings of current procurements practices in the field. According to an interview[4], the goal with Assaydepot was to create research marketplace for scientist from pharmaceutical industry and academic groups "address the core inefficiencies of outsourcing."

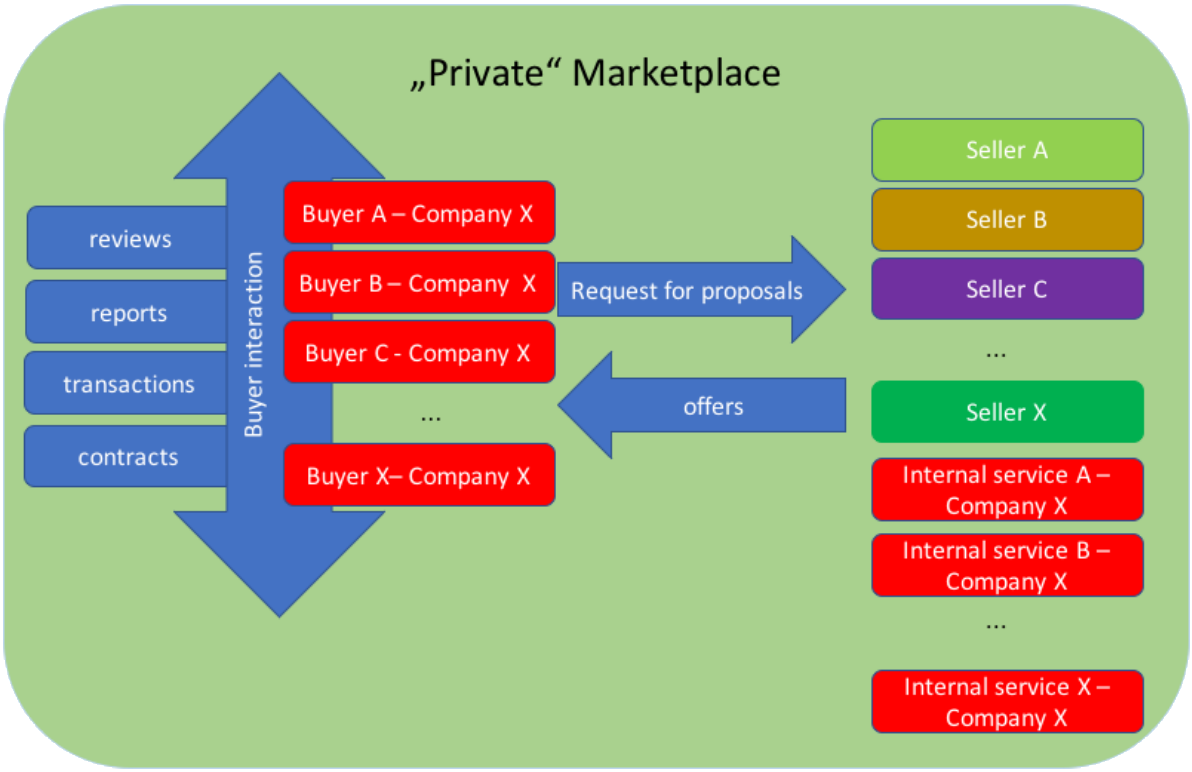

Figure 18: The private marketplace model introduced by scientist.com

Currently, the company has 102 employees and raised $ 31 M of funding in 4 rounds since 2006, the last one in 2017 with a volume of $ 24 M.

The company Assaydepot started as a directory of CROs providing assay services, including tools and mechanism to shorten the legal processes . The core business of scientist.com is the procurement of outsourced scientific services. The catalog

[4] https://vimeo.com/41187226

comprises more than 17500 service providers offering services from 3500 different categories. The most prominent platform-specific feature are the private marketplace created for 14 of to 20 big pharma companies. These platforms allow pharma customers to share sensitive information with other departments in their companies along with reviews, reports, legal documents and completed transactions. These non-public exchanges contributed to a growing revenue of the company from USD 10 M in year 1 to $ 150 M in year 3.

CONTRACT LABORATORY

Contract Laboratory LLC has been founded in 2003 and defines itself as a "the first online outsourcing and procurement network." Its website provides a comprehensive directory of laboratories, lab suppliers, lab service providers and lab consultants across 552 different industry categories.

The site seems to get business from different sources. Some companies are listed as "Premier Testing Laboratories." Also similar to other MSSG buyers can post "lab requests" on the page. These public, visible search ads describe needs in the categories test, service, product, and business. Laboratories can the place their bids on these offers. The companies claim to have facilitated 80.000 such requests since its incorporation.

LABS EXPLORER

Labs Explorer has been founded in 2016 in Paris, France. The company was founded by Stephane Tholander. Currently, the company employs less than ten employees. It raised $ 31 M of funding in 4 rounds since 2006, the last one in 2017 with a volume of $ 24 M.

The catalog comprises more than 100.000 labs. Labs explorer works an on provision-based business model retaining 10 % of the facilitated transaction. It also offers the possibility of getting premium visibility and running ads on the site.

R&D CROWDSOURCING

While we have already argued that the existence and use of online marketplaces can already be seen as a component of the open innovation paradigm change in drug R&D, some platforms embrace the concept more than others. While most marketplaces do promote the sourcing of eternal knowledge into the R&D process, other platforms take the concept a step further. On such platforms, companies post problems – or better – challenges to be solved competitively. The winner who has provided the best solution to the problems gets a prize.

INNOCENTIVE

Innocentive's company name is an amalgamation of innovation and Incentive. The site offers a well-known and respected R&D crowdsourcing platform, which has been endorsed. The Boston-based company was founded in 2001 by former employees and with a seed funding from Eli Lilly & Co., a major UK pharma company. It has received $ 72.5 M of seed funding in six rounds. A major investor besides Eli Ventures is the German software giant SAP. Also, in 2012, the company has acquired the OmniCompete, a competitor, allowing the expansion to the EMEA region.

Currently, the site lists several competitions in the field of medicine such as developing biomarkers for sudden unexpected death in epilepsy (sponsor: Epilepsy foundation), the smart prediction for cardiac pathology (sponsor: AstraZeneca), Prevention and Control of Enteropathy/Ileitis in Swine (sponsor: Elanco). Since InnoCentive was founded the platform run over 2000 competitions and claims to have over 20.000.000 $. Over 390.000 registered solvers have submitted 162.000 solutions to posed problems. According to the company, 60% of the solvers have a Masters level degree or above.

Innocentive's revenue streams include membership fee by solutions seekers, commission on solvers rewards and consulting services. Also, the platform has received support from philanthropic organizations such as the Rockefeller Foundation in the past, to promote the search for solutions of public interest.

KAGGLE

Kaggle is R&D crowdsourcing for „predictive modeling and analytics competitions and consulting.“ The headquarters are located in San Francisco. The company was founded in 2010 by Anthony Goldblum a former data scientist and economist working in the department of economic modeling at the Reserve Bank of Australia. It has received $ 16 M of seed funding in two rounds. In 2017 the company has been acquired by Google.

The platform allows clients to publish so-called “machine learning challenges” to a large community of data science specialists. These teams or individuals then compete in solving the challenge as best as possible, in order to earn a monetary price.

One example of such a task would be the correct automatic classification of tumor pictures into the categories “malignant” or “benign.” The participants get a partial dataset of pictures along the correct histological classification by an actual pathologist. They also get a test dataset without the labeling of the images. The task is to write software or train an existing algorithm to predict the labels of these images. The participants then submit their predictions to the platform. It is then compared to the correct labels, and a score is calculated. The solution obtaining the best score at a given deadline will win the competition.

According to the founder,[5] the platform has two main revenue streams: the hosting of machine learning competitions and posting jobs on the “Jobs board.”

Past challenges sponsored by pharmaceutical companies include:

- Cervical cancer screening (sponsor: Genentech)
- Flu forecasting (sponsor: Genentech, 125.000 USD)
- Prescription volume prediction (sponsor: Pfizer)
- Molecular activity prediction (sponsor: Merck, 40.000 USD)
- Diabetes classification (sponsor: practice fusion, 10.000 USD)
- Biological response prediction (sponsor: Boehringer Ingelheim, 20.000 USD)

[5] https://www.quora.com/How-does-Kaggle-make-money

- West Nile virus prediction (sponsor: Robert Wood Johnson Foundation, 40.000 USD)
- Diabetic Retinopathy Detection (sponsor: California Healthcare Foundation, 100.000 USD)

These examples show that pharma R&D departments are willing to embrace these platforms, even if the mode of contracting is unconventional.

RESEARCH PRODUCTS

Marketplaces for research products such as antibodies, reagents, and plasticware also exist in competition with classical distributors equipped with sales departments, marketing strategies, and storage capabilities. We will describe two of them in the following pages and try to elaborate on why these sites can offer added value to the customer and supplier.

ZAGENO INC.

ZAGENO is an online marketplace for life science products. The company is based in Boston and has raised $ 8 M of funding in two rounds since 2015. "ZAGENO's online marketplace for life-science research integration of ordering and purchasing processes into existing software systems."

The central way of value-creation for the customer is to make products comparable, and add additional information during the selection process. All 5.5 million listed products get a "scientific score," which takes advantage of the fact that peer-reviewed publications list the products used in an experiment in the methods section of the paper. According to the site, the scores also includes validation results from the vendor, popularity among scientists , brand performance and commercial success on the platform. The website offers a searchable catalog of the products, a shopping cart, and payment processing, facilitating the placement of orders to different suppliers.

The business model of Zageno is strongly coherent with the transaction marketplace definition: it does not own or sell the products. Also, in this case, the contract is

established directly between the seller of the products and the buyer. Zageno may receive a commission based on the sales from the seller.

QUARTZY

The marketplace Quartzy was founded in 2009 and is based in San Francisco. Like Science Exchange, the company was first incubated by Y Combinator. It received $ 22 M of funding in 3 rounds from different investors, including Jeremy Stoppelman – founder of the popular restaurant rating platform Yelp.

The key added-value provided by Quartzy is a freely available Inventory and Lab Management system on the website. The user can list the available inventory and order new items from the platform. Quartzy business seems to be more close to a classical distributor than to a marketplace since has its own storage and fulfillment centers, however providing additional services to the customer, such as comparable product information, inventory management, and communication tools. On the other hand, Quartzy offers the option to change the vendor for a product in the inventory management system. In this case, the product is not purchased from and shipped by Quartzy, but requests can be sent directly to the alternative vendor. By this mechanism, the platform positions itself as a hybrid between a distributor and a transaction marketplace.

The revenue stream of Quartzy is, of course, the margins made on the sale of products. The buying process is made attractive to customers because it interlocks with the free Inventory management system and additional services which fall in the category of procurement outsourcing.

FINE CHEMICALS

In contrast to laboratory materials the category of "fine chemicals" defines chemical building blocks, which are required for the screening or synthesis of new pharmaceutical compounds. Modern organic and inorganic chemistry knows millions of molecules, and purchasing them by browsing the catalogs of different vendors can be challenging. Different marketplaces try to aggregate the extensive stock lists and to make them accessible to the customer.

CHEMSPACE

Chemspace is a private company based in Latvia, which has been founded in 2016 by several chemical suppliers. The website features a database with over 20 million compounds by 70 suppliers listed.
Chemspace creates added value for the customer by providing a search interface, which lets the customer draw the chemical structure he is searching. The algorithm can then match the structures in the database to find an exact match or compound that is a superstructure.

MOLBASE

Molbase is a company based in Shanghai, China which has been in 2011. It got § 10 M of funding in four rounds from large investors such as Sequoia Capital China.

Like Chemspace the company offers an extensive searchable database of chemical compounds along with a listing of suppliers. Also, recommendation services and intelligent matching, and a are offered. The company's encyclopedia contains information on 40 million compounds. When looking at the country of registration in the supplier list [6] 143 suppliers are from China, and 50 suppliers from the rest of the world. The workings of the website closely resemble Alibaba.com, one the most well-known B2B marketplaces. Molbase offers access to a large number of Chinese chemical suppliers. The company can classify as a real marketplace because it concentrates on the matchmaking between buyer and seller. The buyer can post a

[6] http://www.molbase.com/supplier

buying request on the site, which will then be submitted to registered suppliers. The whole quotation, ordering and payment process can be managed on the site. The revenue streams are not explicitly disclosed a commission-based compensation however is the most likely income stream.

iSPECIMEN: BIOSPECIMENS AND HEALTH DATA

Another ingredient required in biopharmaceutical research are biological samples and health data. Biospecimens of healthy and diseased persons or animals are a rare a precious resource. Many discoveries in modern biological and medical science, such as advances in stem-cell research, would not have been made without the right in-vitro experiments. Enormous "biobanks" containing millions of samples have been established in recent years to support efforts in different areas of medical research. However, access to this samples is often strictly regulated. When it comes to datasets, issues such as privacy and data protection concerns are limiting factors, for the transfer of valuable, potentially insight-generating datasets from the owners to interested research departments.
iSpecimen has been founded in 2012 and defines itself as a "the marketplace for human biospecimens, providing researchers with the samples they need from the patients they want." The company is based in Boston and has received $ 10 M of funding in two rounds.

iSpecimen promises to solve the problem of inefficient and challenging procurement of biospecimen. The platform offers tools to manage contracting and compliance involved in the exchange of biological samples. The company claims to enable access to 24 million different human tissue, biofluid, and viable cell samples. Contributors offering their samples at the marketplace can make additional revenue from stored samples. Organizations collecting samples for charitable purposes can benefit from the system to bring their efforts to actual use by connecting the resources with researches at companies and academic research labs.

Researches can search the catalog by sample type, disease, diagnosis, and demographic data. The identified sample can be collected in a shopping cart and request a quote through the platform. In addition to the samples, accompanying de-

identified patient data and consent documentation is provided such that the sample can be used meaningfully and legally under research conditions.

iSpecimen derives its revenue [7] "through a variety of revenue-sharing agreements that we manage with the numerous healthcare providers and biobanks." The company does not have an own infrastructure for storing samples; it just runs the site collecting information from the biobanks. It, therefore, matches the criteria of a real marketplace.

[7] https://www.ispecimen.com/blog/catching-chris-ianelli-founder-ceo-ispecimen/

COMPARISON

In the last section, we have introduced ten different marketplaces for scientific services and goods, which should now be compared.

WHICH PLATFORMS CLASSIFY AS A MARKETPLACE

For the category of services and outsourcing actually, all introduced platforms Science Exchange, scientist.com, Lab Explorer and Contract Laboratory can be considered true marketplaces following the criteria of (Täuscher and Laudien 2018), except the provided regulatory framework in order to facilitate transactions. Interestingly the development level of the legal framework provided by two companies Science Exchange and scientist.com is so extended that these companies also take over significant parts of the transaction. These platforms become contract partners in each transaction. It can be discussed if this breaks the criterium that a real marketplace should not own or sell a product by itself. The original intention of this rule was to differentiate such marketplaces from classical distributors and wholesalers. This is legitimate for the trade of physical products, which would require substantial additional infrastructures such as storage and logistics. In the case of these platforms, the introduction of a third, intermediate, party is one the primary source of value creation – because the contract management, ordering, and billing processes are streamlined for the buying and selling party.

It is not surprising that the picture looks different when it comes to the sales of research products. Only Zageno fulfills the criterium of acting as an independent platform, the main competitor Quartzy present itself as a marketplace but according to the classification criteria, it is closer to a classical distributor. For the procurement of plastic-gear and reagents, which are very often easily interchangeable, it is easier to stick to the concept of normal wholesale, because buying these items does not require extensive amounts of contract management (NDA/CDA, Master Service Agreements, ..). No information, except of course the purchase and the list of items, is being transferred from the buyer to seller. There is no need to share confidential data and no knowledge is generated for the buyer on the supplier side. Zageno, however, can

still make a difference by acting as a standardized and unified and extensive catalog which is not limited by the limitations a distributor is imposed with, such as exclusivity terms. Also, the platforms for R&D crowdsourcing classify as true marketplaces although the core concept to find innovative solutions by publicizing the research problem as a competition is not just an alternative method of procurement. It requires a certain openness to community engagement and open innovation paradigms by the otherwise dimed conservative pharmaceutical industry.

WHICH BUSINESS MODELS DOMINATE

The by far most commonly observed revenue streams are transaction fees in the range of 5 to 10% on the transaction volume for orders generated through a platform. This is valid for all observed categories. A few marketplaces position themselves more as directories and will ask suppliers for a membership fee to upgrade from a standard entry to a premium entry in the catalogs.
By terms of value creation, most platforms offer a searchable catalog of products or services, which enables the customer to identify suitable solutions and suppliers. Many, but fewer add elaborated contracting services and computer integrated logistics to its services. As an example, Quartzy is a cloud-based free inventory management with the feature to order material directly from the system. Other services such as Chemspace and Molbase offer large databases of chemical structure which can be used as starting points for the planning of screening projects because they expose the wealth of chemical structure commercially available on the market. The databases also offer metadata on the compounds, so these sites can also be a valuable source of information for the researcher. All services offer some form of communications infrastructure, which enables the buyer to communicate with the suppliers. Some services also add additional channels and mechanism to facilitate company internal communication in order to agree on order volumes, approve transactions and share reviews.

Table 2: Online marketplaces for scientific services and goods overview

Platform	Alexa rank	Services	Products	Type	Business model	founded in	Funding in million USD	CB rank	country	self-description (LinkedIn)
Chemspace ´	644510	no	yes	Transaction platform*	Margin	2016	NA	NA	Lithuania	Chemspace database comprises building blocks, fragments, and screening compounds. In fact, Chemspace is the largest database of the molecules on demand!
Contract laboratory	1360584	yes	no	Transaction platform	Transaction fee	2003	NA	223686	USA	Platform for expediting Laboratory Outsourcing and Scientific Procurement
innocentive	271459	yes	no	R&D crowdsourcing	Consulting fee	2001	30	52114	USA	InnoCentive is an open innovation company that crowdsources commission research and development problems.
iSpecimen	4024453	no	yes	Transaction platform	Transaction fee	2012	10	21494	USA	iSpecimen is the marketplace for human biospecimens, providing researchers with the samples they need from the patients they want.
Kaggle	2671	yes	no	R&D crowdsourcing	Consulting fee	2010	16	2955	USA	Kaggle is a platform for predictive modeling and analytics competitions and consulting.
Labs Explorer	1478907	yes	no	Transaction platform	Transaction fee	2016	NA	146158	France	Labs Explorer is a community that allows you to search for R&D partners and find financing.
Molbase	72302	no	yes	Transaction platform	Transaction fee	2011	10	23612	China	MOLBASE is committed to establish the worlds largest integrated platform for chemical e-commerce,
Quartzy	53966	no	yes	Transaction platform*	Margin	2009	22	2333	USA	The world’s leading solution for consolidating lab communication, inventory management, and lab supply purchasing.
Science exchange	458608	yes	yes	Transaction platform	Transaction fee	2011	73	3528	USA	Science Exchange is a marketplace for scientific collaboration, where researchers can order experiments from the world's best labs.
Scientist.com	405848	yes	yes	Transaction platform	Transaction fee	2008	31	8035	USA	Scientist.com is a network of public and private e-commerce marketplaces that connect buyers and sellers of scientific research services.
Zageno Inc.	858428	no	yes	Transaction platform	Transaction fee	2015	8	11326	USA	ZAGENO is an online marketplace for life science products. With an innovative solution for procurement departments to streamline ordering

ARE MARKETPLACES FOR SCIENTIFIC SERVICES AND GOODS SUCCEEDING?

According to the CrunchBase database, (see Table 2) the marketplace presented in this study alone received a total of $ 200 M, with almost half of the funding volume transferred in the last three years. Investors seem to confident that the proposed business models make sense.

The major players Science Exchange and scientist.com report to have long-lasting business relationships with most of the big pharmaceutical companies. Eight out ten pharmaceutical companies use Science Exchange to outsource R&D work (Buvailo 2017).

Besides this, it must be noted that- according to revenue data obtaining from Crunchbase and Owler - Science Exchange the 2017 revenue of Science exchange was $ 13.6 million and scientist.com had $ 43 million. If we optimistically assume 10% commission that is a transaction volume of $ 136 M respectively $ 430 M. The revenue of LabCorp, world largest CRO, was $ 11.4 billion, and Quintiles had $ 2 billion. This sets the number generated by marketplaces in perspective and demonstrates that this new form of buying for now only play a complementary role in research procurement. However, according to a study from PWC (Pumberger and Beutin 2014) to the total volume of sales in life sciences done by E-commerce (including marketplace) will be 70-80 % by 2020.

As for most internet-based innovations the United States host the most companies running e-commerce platforms for research products. While some companies are based in Europe and China, the most significant investments and startup are happening in the US.

SUMMARY &CONCLUSION

Electronic marketplaces for scientific services have been established for all essential products and service categories required for pharmaceutical research. Several platforms offer everything from basic laboratory supplies, fine chemicals, highly specialized services for the management of clinical trials to even human biological samples.

The bigger players (Science Exchange and scientist.com) on the market were able to attract the attention of sizeable pharmaceutical corporations which strive to smoothen their business processes for procurement, especially when buying from new suppliers. Almost all big pharmaceutical companies use these and other platforms on a regular basis.

In the conservative life science and the pharmaceutical industry buying online is still not rule, but this will most likely change in the future. A survey from Google (Snyder and Hilal 2015) found that half of the B2B deciders are millennials and 71 % of all B2B researchers start their research online. Due to the adoption of e-commerce in all aspects of B2B sales to projected 17 % in 2023[8], and the inevitable adoption of online sales in all aspects of daily life and business, it can be expected that the rise of the marketplace has just begun.

The main advantages for the buyer on these platforms are cost reduction due to better market transparency and higher competition, a more efficient procurement process due to different mechanisms of contract management and computer-aided logistics, and the faster adoption and acquisition of innovative suppliers. The main advantages for suppliers are higher visibility, new distribution channels, faster lead time, and access to insights what services or products are currently of interested for the customer in R&D. This comes at the cost of elevated price pressure and the struggle to build a brand and lasting relationships to the customer.

8 https://www.forrester.com/report/Forrester+Analytics+B2B+eCommerce+Forecast+2018+To+2023+US/-/E-RES145710#

On a closer look, just a few of the presented platforms fulfill all properties expected from an electronic marketplace, e.g., by not acting as buyers or seller themselves. Many of the self-declared marketplaces are disguised distributors with additional services for the customer. However, it seems that every company strives to impact and improve some aspects of the procurement process. Most companies generate revenue by asking for a commission on the sales facilitated through their platform. Also, additional for-money consulting services are offered to buyer and sellers.

R&D crowdsourcing platforms such as Innocentive and Kaggle are used by the companies. However, it seems that this not a common practice in pharma R&D. The future will show if these efforts go further, especially when the recent developments in machine learning and AI impact innovation in pharma.

In summary online marketplaces provide can provide significant benefits to buyer and sellers of research services and goods. The platforms provide added value to the customer, even if they are in some cases glorified small-scale distributors for laboratory products because the platform owners try to technologically translate what has been successful in B2C and horizontal B2B platforms to more narrow focused markets.

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ERKLÄRUNG

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