Value networks identify innovation in 21st century pharmaceutical research

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To answer the clarion call for more innovation and productivity in Pharmaceutical research, the application of the ValueNet™ Work methodology to the indication switch for Viagra®, from an anti-hypertensive to the treatment for male erectile dysfunction, was undertaken to ascertain the usefulness of this approach for Pharmaceutical research in identifying both tangible and intangible value drivers, and for the identification of strong value-creating relationships within this research area. Through the identification of participants, tangible and intangible deliverables, and the analysis of their interactions in the indication switch for Viagra®, an insight into value drivers for the Pharmaceutical industry was revealed that has an impact on Pharmaceutical innovation and productivity. This methodology, in pinpointing value inflection points holds promise in analysing other aspects of research.

Introduction

In the recent times, stakeholders in the Pharmaceutical industry have an expectation of delivery of greater value to consumers (patients) and customers (those organisations purchasing medicines on behalf of consumers), as well as institutional investors, such as pension funds. In this regard, the industry itself is under pressure to decrease the cost and increase the delivery rate of new medicines [1–5]. This point has not gone unnoticed within the industry. Over the past two decades the prevailing view in several published reviews and articles is that there is a lowering of the numbers of new medicines approved for use on humans and, concomitantly, a lowering of innovation within the Pharmaceutical industry [6–8]. Thus, a clarion call has been issued for the industry to improve its productivity and to regain its innovative edge. Whilst the majority of publications support this position, the assertions on decreasing innovation are by no means universal [9]. The capture of innovative practices and increasing efficiency within Pharmaceutical research, however, is certainly a desirable goal and is not disputed. Most of the ways this has been promoted to date revolve around the importation of techniques from other industries, such as SixSigma and 5S [10], Lean Manufacturing [11–13] and Deming's principles of total quality management [14]. The recent paper from Ullman and Boutellier [13] highlights that differences exist in the methodology that should be applied in the search for and optimisation of value, with regard to innovation studios and process factories in Pharmaceutical research. Whilst there can be indisputable benefits arising from the application of these techniques to those parts of the drug discovery process that can be industrialised, they tend to focus on only minor parts of the drug discovery paradigm as a whole. Additionally, they fail to take into account that the basic (human) value creating activity of drug discovery is often recalcitrant to such approaches that focus predominantly on process. What is needed in addition, therefore, is a business technique that can consider, in a holistic fashion, more of the process of drug discovery.

Still, much of drug discovery is personal in nature and revolves around the knowledge of individuals, who can be considered the fulcrums of innovation. Much has been written on the impact and centrality great drug discoverers, such as Paul Janssen [15], Sir James Black and Simon Campbell [16], can have on drug discovery. There is a contention that for the Pharmaceutical industry to become more innovative, a change in the approach to its management is required [17]. Still others [18–21] call for the integration of knowledge management techniques within Pharmaceutical research, sometimes through the use of technology. Whilst technology is useful, it is people that make drug discovery happen successfully. We need, therefore, a better business tool to assess the value and innovation within this environment that settles on

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humans as central players in this discovery effort: one that also encompasses large swathes of the discovery and development process.

Recently, the ValueNet™ Work methodology of Allee ([22] see http://www.value-networks.com) has been used to identify and help release value in networks. This same methodology holds great promise to assist the Pharmaceutical industry to discover value based around the intangible, human dimension, and to provide guidance based upon a holistic assessment of the value network as a whole. Knowledge and other intangible assets, such as human competence, the ability to form beneficial collaboration and strong relationships, are seen as the foundations for success, particularly in a knowledge intensive industry such as the Pharmaceutical industry [24]. As with every method there are pros and cons. The benefits of this methodology are that it broadens the analysis of interactions and deepens the understanding of key relationships. It makes the intangibles visible, thereby revealing the 'softer' or human component of those interactions. The network visuals and 'logic' are intuitive for people to understand, so insights can be communicated effectively. The cons are that the qualitative data collection for the analysis leads to a more subjective and less scientifically rigorous assessment of the network dynamics than other data collection methods. This means results can be potentially biased by the mental models and frames of reference of both the participants in the research and the researcher. However, this limitation can be overcome by comparison with less subjective data sources such as E-mail records.

This article describes this methodology in brief, and how this was then applied to the discovery of Viagra® as a first-in-class treatment for male erectile dysfunction (MED). In undertaking this exercise, several objectives were foremost in our mind. Firstly, we wished to demonstrate the applicability of this methodology to the Pharmaceutical environment in a real, value-delivering situation. Secondly, we were interested in demonstrating the ability of value network analysis to identify innovation and value in the discovery of a new use for a pharmaceutically active substance. Thirdly, we wished to define some of the basic organisational value interactions within the Pharmaceutical industry in its discovery of this new use for a human pharmaceutical Viagra®. Finally, in analysing this using value network methodology, we sought to understand value delivery, and to begin to identify 'best practice' value drivers for adaptation in the Pharmaceutical industry generally. The research does not apply in this case study to the discovery of the pharmaceutically active substance itself (Sildenafil), nor to its first intended indication as an anti-hypertensive, but rather to how this New Chemical Entity, once it failed to demonstrate efficacy in clinical trials for hypertension, rather than being abandoned, was brought forward as a treatment for MED.

Overview of ValueNet™ Works methodology

The approaches of *HoloMapping*® and *ValueNet*™ *Work* analysis developed by Allee in the 1990s help to support a whole-system understanding of the value network [22,23,25,26] ([22] see http://www.value-networks.com). The *HoloMapping*® method is a business-modelling tool that describes the value dynamics for any type of organisation, and serves as an analysis tool for assessing patterns of interaction relating to core business activities and processes, examining them for their capability to deliver value to the network. The value network approach [22,23,26] ([22] see http://www.value-networks.com) helps individuals and work groups better manage their interactions and address operational issues, such as improving communication. Because the value network analysis explores the core elements of purposeful interactions and value conversions, it can address cross-boundary tasks and processes and relationships intra-company. Thus, value network analysis holds promise to analyse and indicate improvements on the process of drug discovery, allowing as it does the elucidation of how knowledge and relationships create value through its focus on

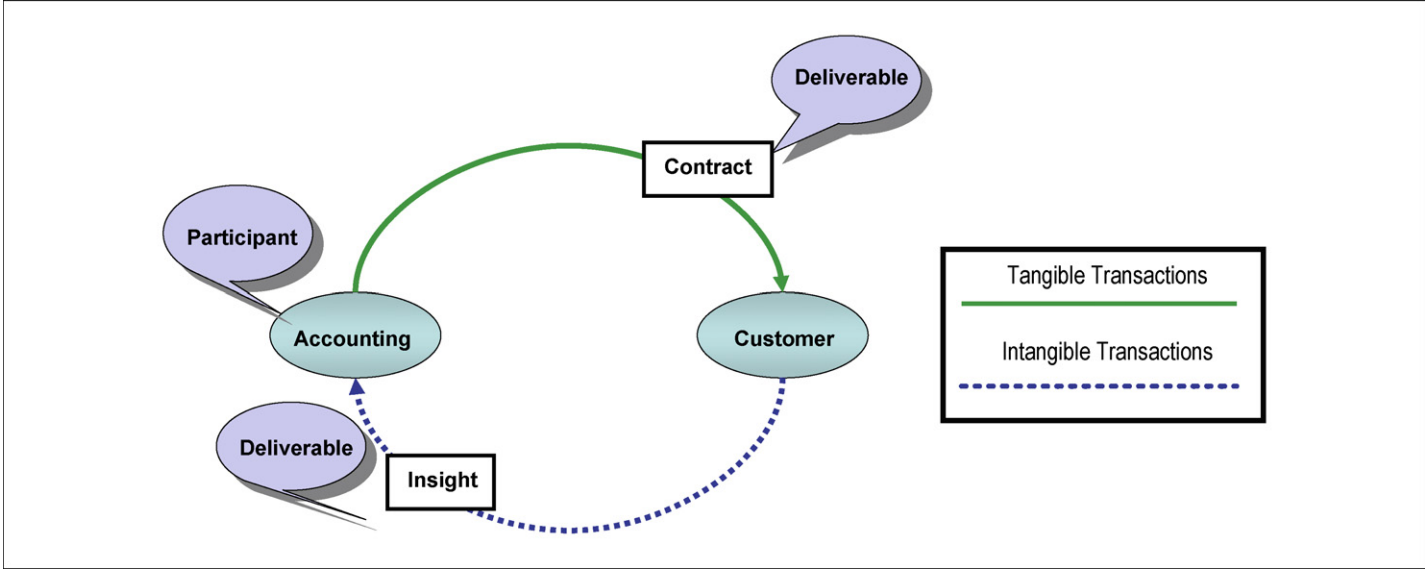

FIGURE 1

Participants, transactions and deliverables in the value network. HoloMapping® exercise showing the *tangible* and *intangible* business transactions and exchanges. The value network map identifies key Participants, Deliverables, and Transactions for an activity. The interactions between participants in a value network are depicted by an arrow (*transaction*). The transaction shows how a particular *deliverable* (depicted by a label on the arrow) moves between one participant and another. The arrow denotes the direction of a specific transaction that happens between two actors.

people as the active agents of innovation in organizations, and not on processes as is the traditional focus of analysis. Strong value-creating relationships will better enable breakthrough innovation in the Pharmaceutical industry at the operational, tactical and strategic levels.

Business relationships include activities between participants, such as exchanges of knowledge and benefits. A *ValueNet*™ *Works* analysis begins with a *HoloMapping*® diagram that shows the tangible (e.g. contractual, funding-related) business transactions and exchanges, see Fig. 1 [22,23,26] ([22] see http://www.value-networks.com). Along with this flow the crucial *intangible* or informal knowledge exchanges and benefits that build relationships and keep businesses moving forward. An intangible asset is thus a non-financial resource that a firm can draw upon to generate outputs. For example, the asset of human competence can be converted into deliverable knowledge products and services (e.g. market intelligence), and this deliverable can be conveyed from one participant to another. The asset can be thought of as the accumulating 'stock' whilst the deliverable is the 'flow' of different kinds of output that can move. These informal exchanges are the key to creating trust and opening pathways for innovation and new ideas. Traditional business practices and tools ignore these important intangible exchanges, but they are revealed with a *ValueNet*™ *Works* analysis. The purpose of the value network map, which is used as the foundation for the *ValueNet*™ *Works* analysis, is to identify key participants, deliverables and transactions for an activity, see the example in Fig. 1. The interactions between participants in a value network are depicted by an arrow (*transaction*). The transaction shows how a particular deliverable (depicted by a label on the arrow) moves between one participant and another. The arrow denotes the direction of a specific transaction that happens between two actors (in this example Accounting and the Customer). Deliverables are real things that move from one Actor to another. A deliverable can be a physical document, or it can be non-physical such as a message.

Value conversion is a process of transmuting one type of value output into another, such as an intangible asset (medicinal chemistry insight for compound design) into a tangible deliverable, such as the physical sample of a biologically active molecule. Knowledge, whether tacit or explicit [27], is an intangible asset that is one of the most interchangeable commodities. It can be traded for more knowledge, or another type of intangible such as a favour, or it can be packaged and sold for profit as a tangible. This act represents value conversion and is one of the core questions invoked from a *ValueNet*™ *Works* analysis: how do we create value from intangibles? Both tangible and intangible interactions are examined to try to better understand how intangible assets and inputs can contribute to our success and create more value.

In a value network analysis, participants are referred to as Nodes, Roles or Actors [22,23,26] (see http://www.value-networks.com). The core concept is the role a group of people plays in the value network. Most work is organised around either a process or a job function, but the concept of the role is different. Helping people understand how to work from this new perspective often triggers insights into organisational dynamics that are difficult to understand from other perspectives. Roles are based on the skills and talents brought to bear. Roles are enduring, irrespective of who might play the role at any particular moment. Just as one role can be filled by several different companies or groups, any given group might play multiple roles within a network, or play a role of some kind in several different networks.

The exchange analysis, an assessment of value dynamics throughout the whole network, focuses on finding overall patterns in the transactions, and surfacing key issues for the network such as its health, robustness and resilience. It is designed to

- indicate whether the network pattern fits its purpose;
- clarify roles and participant attributes;
- reveal value linkages and any missing links;
- identify patterns of reciprocity;
- show overall patterns of value creation or loss;
- provide insights into whole network optimisation.

We then apply an impact and value creation analysis on the process. With impact analysis, we ask how to convert inputs into value (both tangible and intangible), and how this helps to build our intangible and tangible assets. For value creation analysis we ask how tangible and intangible assets are utilised to create value for customers and other participants. The impact analysis questions help us understand value realisation from the things received in building assets. The value creation analysis question aids in considering how well those assets are used.

How can value network analysis be applied and why is this useful?

The value network that was developed for the use of Viagra® to treat MED was analysed using Allee's methodology. The results provide an insight into the types of analytical results that can be created and the questions that may be explored to expand the Value Networks in the discovery of Viagra®. More generally, this provides insight into how innovative Pharmaceutical research may run. This study evaluated a network along several dimensions to contrast the tangible and intangible transactions evident in the discovery of a new use for Viagra®.

How initial value network map and its analysis was conducted

Identification of interactions from the point where the Sildenafil indication (anti-anginal) failed to work in an initial clinical trial, to when the new indication of MED was approved by the FDA for further investigation, is depicted in Fig. 2 as a value network. These set of interactions were chosen because they represent an area where new value was created over and above what was first thought an unsuccessful putative treatment. The value network focuses on interactions, sequences of events and lessons that may be transferable to the Pharmaceutical industry in general. In completing this value network, the first stage was to draft a sequence for the flow of tangibles and intangibles from role to role, including the interplay between them.

Value networks sample sequence analysis for the discovery of a new use for Viagra®: validity and reliability of sequence analysis

The Viagra® *Value Networks* analysis was based on [28]

- A conversation with Dr Nicholas K. Terrett, co-inventor of Viagra®. His contribution centred around his recollections of events that occurred during the transition of Sildenafil from a potential anti-angina treatment to one targeting MED,

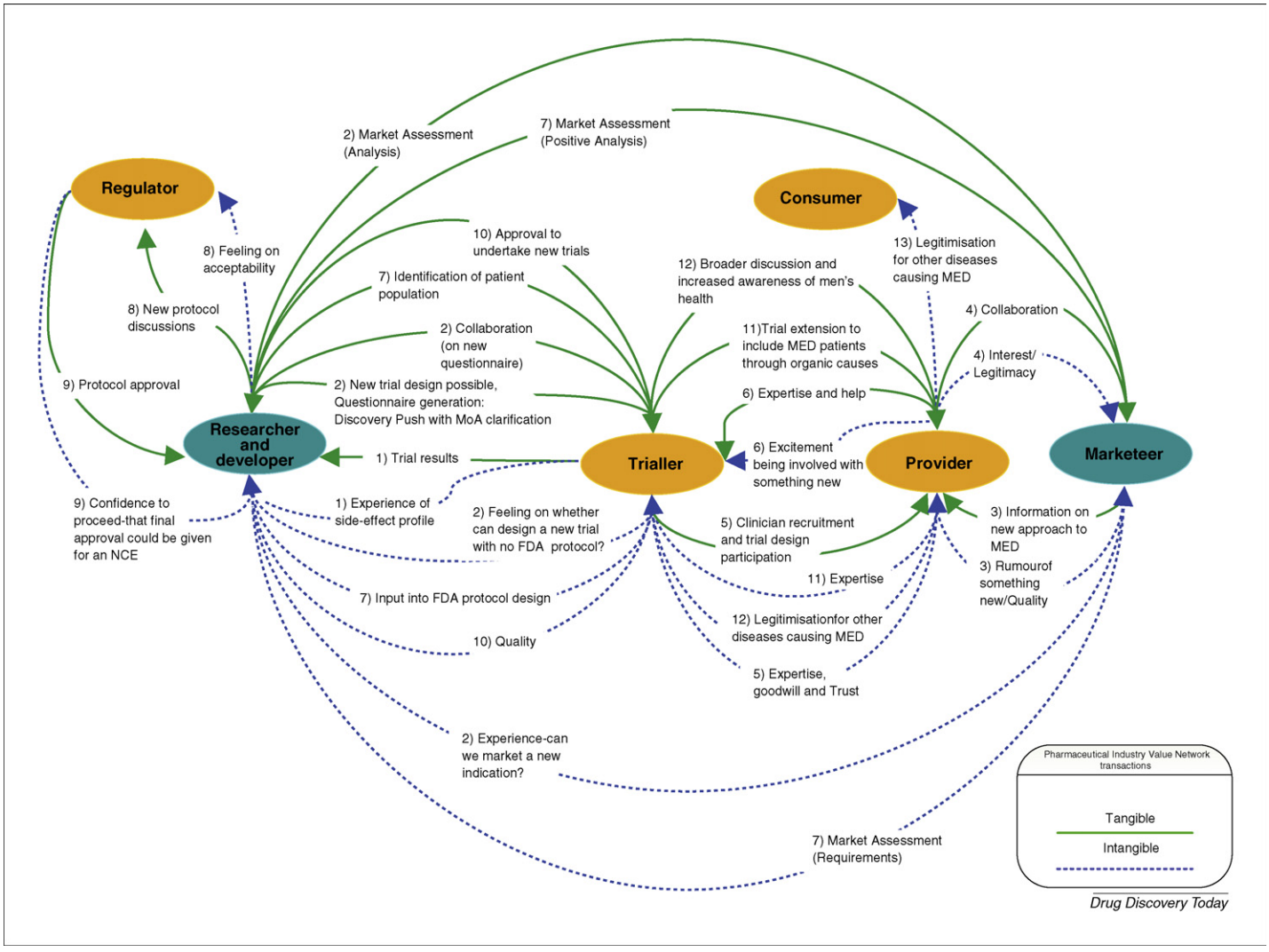

FIGURE 2

New use for Viagra® value network visualisation. Value network map indicating the deliverables, their direction and Roles involved in the value network for the discovery of a new use for Viagra®. The Roles within this value network were colour coded: Blue for internal (Pharmaceutical) roles and orange for External (Pharmaceutical) roles.

approximately ten years ago. This draft sequence first put together was discussed with Dr Terrett, where he clarified issues and sequence ordering, thus sharpening the whole process and making it more accurate.

There are limits to the accuracy and reliability of the analysis because P. Edwards was not present during the Sildenafil transition discussions, so the analysis is based upon his interpretations. Time may have eroded accurate recollections/interpretations. Thus this sequence represents our 'best attempt.' Having incorporated Dr Terrett's insights into the *Value Networks* analysis, the next action was to prepare the final value network analysis.

Definition of roles within the value network

For the purpose of this analysis, the definition of each role within the value network and their attributes of interest are given in Table 1.

Establishment of general deliverables

The next task was to craft the tangible and intangible deliverables that are involved in this network. For example, with the Role of Trialler, they have a tangible deliverable of protocol trial design. However, the intangible deliverable seen was the legitimisation of other diseases causing MED. Through discussions with Dr Terrett, the deliverables were established as in Tables 2 and 3.

The sequence for this value network is given in Table 4. This sequence put in order the chain of deliverables in this value network, so that a visual representation of this could be realised, see Fig. 2.

Value networks sample sequence analysis for the discovery of a new use for Viagra®

Next, the value network map was constructed (Fig. 2) utilising the sequence proposed in Table 4 and indicating the deliverable, its direction and the Roles involved in this value network.

Visualisation notes on the value network analysis

The relationship between roles was studied. For some Transactions, Researcher & Developer roles were equally involved. For clarity of viewing the two Roles for these specific activities have been combined into one Role. Within the wider Pharmaceutical

TABLE 1

Definition of role and interests for actors in this value network.

Role descriptions

Role	Description	Attributes of interest
Consumer	These are individuals in society at large who are subject to some disease or alteration of their normal life that requires medication for treatment or cure. They are the consumers of the medicine.	Responsiveness to treatment/ cure, buying behaviour, product/ disease area knowledge.
Marketeer	This is the Department with responsibility for gathering market data such as likely sales, market segmentation and disease and patient knowledge. This knowledge is shared with sellers and researches, for example.	Their knowledge of disease and patient populations.
Provider	These are the individuals and groups who may purchase the medicines from the Pharmaceutical company. Specifically they may be medical doctors (GPs), health trusts, hospitals or other Government agencies.	Their desire to maximise cost savings. Efficiency of providing treatment. Desire to maximize cost to benefit (safety and efficacy) for patients and financial health of their own organisation.
Regulator	These are the governmental organizations who determine whether to allow a new medicament to be sold for human/animal treatment or to cure medical ailments. Also they decide whether established medicaments can continue to be marketed.	Balancing cost of new and existing medicines to treat/cure disease and their benefit to patients as measured by the medicines efficacy and safety profile.
Researcher & Developer	These are individuals with a scientific background who choose targets to work on and design novel putative medicaments. These are scientists who take the putative drug substance made by a research route, which is often inefficient. They then optimise the preparation of up to tonne scale amounts of drug product, to the right purity. Also included here are pharmaceutical scientists who develop and optimise delivery vehicles, formulations and methods of delivery, that is, oral, inhaled and topical, etc.	Training and expertise. Their motivation and involvement in the drug discovery process.
Trialler	This is the group of individuals responsible for designing and conducting clinical trials, gathering data and writing the necessary reports to submit to regulatory agencies, for example, the Federal Drug Administration (FDA), to gain product approval for use on humans or on animals (for veterinary products).	Their ability to spot unexpected events and rationalise these. Their accuracy in monitoring and recording data, their strict adherence to plans and their concern for patient safety.

value network, where Researcher & Developer operate separately, separate nodes should be maintained. This part represents [29]:

- The endeavours of drug discovery teams who blend scientific data with experience and intuition to develop robust hypotheses for drug–receptor interactions.
- Dedicated clinicians who observed intriguing side-effects.
- Innovation, multi-disciplinary teamwork and clear decision-making.

From the initial ambiguous clinical trial results of UK-92480 (Sildenafil, Viagra®) as a potential anti-angina treatment to the submission of clinical trial data to the regulatory authorities for its new use as an oral therapy for MED, multiple value interactions occurred [28]. Most importantly

- The change of use from anti-hypertensive to anti-anginal to MED, when the mechanism of action was still unclear.
- The timing of an indication switch was perfect with the development of the 'nitric oxide' story clarifying the mechanism of action for UK-92480 [29].
- A push from Discovery at Pfizer to get the new clinical trials going.
- A rumour in the scientific community that Pfizer had something new. External and independent Key Opinion Leaders (KOLs) supported the trials. These KOLs provided powerful, persuasive marketing to engage the interest of the scientific community in general.

Insights from the value network analysis [28]

Several groups were involved in decision-making concurrently in this non-linear process (such as Trialler and Marketeer). The process itself seemed to be led by the R&D Roles. They provided a focus for pushing the Viagra® realignment forward. A further insight is that the approach for the discovery of a new use for Viagra® was contrary to the more usual way of working for the Pharmaceutical industry, namely that often Consumers have little involvement/power (at least in Europe). Here, Consumers were involved directly. There was also a good degree of help from Providers (specifically Doctors and Clinical KOLs) representing their patients unmet medical conditions more widely. Also there was a novel clinical trial design aided by scientific community volunteering their efforts to help. Finally, how, through the conclusion of this process, namely Viagra® being marketed, there was a real benefit to humankind. In this specific regard that

- There was a realisation during clinical trials that some men have been mis-diagnosed with MED thought to be through psychogenic cause(s). In fact, their MED was a side-effect of their cardiovascular problems.
- This 'legitimised' their condition (MED) and led to an opening up of a broader discussion of MED in the wider community. It made it acceptable to talk about MED and led more men to talk more about other aspects of their healthcare, such as their cardiovascular problems.
- It also promoted Viagra® to the medical community.

TABLE 2

General deliverables for value network.

Which roles are relevant for the context?	Which general tangible deliverables are present	Which general intangible deliverables are present
Consumer	Information on new approach to MED	Rumour of something new/quality
Marketeer	Market assessment (positive analysis)	Market assessment (requirements)
Provider	Collaboration	Interest and legitimacy with approach in representing to wider community/ regulator on behalf of patients
Regulator	Expertise and help	Excitement being involved with something new
Researcher & Developer	Trial extension to include MED patients through organic causes	Expertise
Trialler	Protocol approval	Legitimisation for other diseases causing MED
	New trial design possible, questionnaire generation: discovery push	Confidence to proceed – that final approval could be given for a new drug application (NDA)
	Market assessment (analysis)	Feeling on whether can design new trial with no FDA protocol? Use of project champion
	New protocol discussion	Experience – can we market a new indication?
	Approval to undertake new trials	Feeling on acceptability
	Trial results	Quality
	Collaboration (on new questionnaire)	Experience of side-effect profile
	Clinician recruitment and trial design participation	Expertise, goodwill and trust
	Identification of patient population	Input into FDA protocol design
	Broader discussion and increased awareness of men's health	Legitimisation for other diseases causing MED

Next, the deliverables were collected together based on the nature of the deliverable (tangible or intangible; Table 3) and defining the Roles (from and to).

The Pfizer Project Champion pushed for a new clinical indication, but with management of the costs and risks for the new trials [28]. Learning's here are as follows:

- The importance of timing in receiving scientific data from the external environment, such as with the development of the 'nitric oxide' story clarifying a potential mechanism of action for UK-92480 (Viagra®).
- How important the contact with the external community was for their opinion on the new indication. Also, constant contact internally from senior management allowing the search for a new indication.
- Independent scientific opinion leaders argued on behalf of their patients to unofficially promote the development of the drug and to gain acceptance from the market (and regulators).
- When a scientist in the community saw the sildenafil data and they were not recruited or in the pay of Pfizer, this was a very powerful way of getting the oral MED approach known (unofficial marketing).

Perceived value analysis arising from the value network analysis

An assessment was made of how each participant perceives the deliverables they receive, that is, how much value they receive from the transaction. Perceived responses were rated from 2 (strongly agree) to −1 (strongly disagree), see Table 5.

Value creation analysis looks at how each participant is adding value to the system. Theoretically, at every point along the value chain, Actors should be adding value to the product or service. In a value network, this means that when an Actor receives a value input they should find ways to use that input to provide greater value in the form of products and services. This analysis has been expanded to include intangibles such as knowledge. The value creation analysis is focused on the value creation and *output* of each Actor, helping identify value creation opportunities and prioritise activities. This analysis helps people better understand their roles and identifies value-creating activities. The questions we could ask are as follows:

- How well are we using our assets to create this value output?
- What value features or enhancements do we provide with this output?
- What is the level of benefit to our business in providing this output?
- Does the effort to provide this pay off in the way others perceive value?

For the senders and receivers in the value network

- There is a balance of value delivered and received amongst the roles, perhaps a reflection of the desire to produce value from the situation of a failed clinical trial for Sildenafil.

TABLE 3

Tangible and intangible transaction overview.

Deliverable	Nature	From	To	Deliverable	Nature	From	To
Information on new approach to MED	Tangible	Marketeer	Provider	Rumour of something new/quality	Intangible	Marketeer	Provider
Market assessment (positive analysis)	Tangible	Marketeer	Researcher/Developer	Market assessment (requirements)	Intangible	Marketeer	Researcher/ Developer
Collaboration	Tangible	Provider	Marketeer	Interest and legitimacy with approach in representing to wider community/regulator on behalf of patients	Intangible	Provider	Marketeer
Expertise and help	Tangible	Provider	Trialler	Excitement being involved with something new	Intangible	Provider	Trialler
Trial extension to include MED patients through organic causes	Tangible	Provider	Trialler	Expertise	Intangible	Provider	Trialler
Protocol approval	Tangible	Regulator	Researcher/Developer	Legitimisation for other diseases causing MED	Intangible	Provider	Consumer
New trial design possible, questionnaire generation: discovery push	Tangible	Researcher/ Developer	Trialler	Confidence to proceed – that final approval could be given for a new chemical entity (NCE)	Intangible	Regulator	Researcher/ Developer
Market assessment (analysis)	Tangible	Researcher/ Developer	Marketeer	Feeling on whether can design new trial with no FDA protocol? Use of project champion	Intangible	Researcher/ Developer	Trialler
New protocol discussion	Tangible	Researcher/ Developer	Regulator	Experience – can we market a new indication?	Intangible	Researcher/ Developer	Marketeer
Approval to undertake new trials	Tangible	Researcher/ Developer	Trialler	Feeling on acceptability	Intangible	Researcher/ Developer	Regulator
Trial results	Tangible	Trialler	Researcher/Developer	Quality	Intangible	Researcher/ Developer	Trialler
Collaboration (on new questionnaire)	Tangible	Trialler	Researcher/Developer	Experience of side-effect profile	Intangible	Trialler	Researcher/ Developer
Clinician recruitment and trial design	Tangible	Trialler	Provider	Expertise, goodwill and trust	Intangible	Trialler	Provider

TABLE 4

Value networks (sample) sequence analysis for the discovery of a new use for Viagra®.

Deliverable	Nature	From	To	Sequence number	Deliverable	Nature	From	To	Sequence number
Trial results	Tangible	Trialler	Researcher/ Developer	1	Market assessment (positive analysis)	Tangible	Marketeer	Researcher/ Developer	7
Experience of side-effect profile	Intangible	Trialler	Researcher/ Developer	1	Market assessment (requirements)	Intangible	Marketeer	Researcher/ Developer	7
New trial design possible, questionnaire generation: discovery push with MoA clarification	Tangible	Researcher/ Developer	Trialler	2	Identification of patient population	Tangible	Trialler	Researcher/ Developer	7
Feeling on whether can design new trial with no FDA protocol? Use of project champion	Intangible	Researcher/ Developer	Trialler	2	Input into design of novel FDA protocol	Intangible	Trialler	Researcher/ Developer	7
Collaboration (on new questionnaire)	Tangible	Trialler	Researcher/ Developer	2	New protocol discussion	Tangible	Researcher/ Developer	Regulator	8
Market assessment (analysis)	Tangible	Researcher/ Developer	Marketeer	2	Feeling on acceptability	Intangible	Researcher/ Developer	Regulator	8
Experience – can we market a new indication?	Intangible	Researcher/ Developer	Marketeer	2	Protocol approval	Tangible	Regulator	Researcher/ Developer	9
Information on new approach to MED	Tangible	Marketeer	Provider	3	Confidence to proceed – that final approval could be given for a new drug application (NDA)	Intangible	Regulator	Researcher/ Developer	9
Rumour of something new/quality	Intangible	Marketeer	Provider	3	Approval to undertake new trials	Tangible	Researcher/ Developer	Trialler	10
Collaboration	Tangible	Provider	Marketeer	4	Quality	Intangible	Researcher/ Developer	Trialler	10
Interest and legitimacy with approach in representing to wider community/regulator on behalf of patients	Intangible	Provider	Marketeer	4	Trial extended to include MED patients through organic causes	Tangible	Provider	Trialler	11
Clinician recruitment and trial design participation	Tangible	Trialler	Provider	5	Expertise	Intangible	Provider	Trialler	11
Expertise, goodwill and trust	Intangible	Trialler	Provider	5	Broader discussion and increased awareness of men's health	Tangible	Trialler	Provider	12
Expertise and help	Tangible	Provider	Trialler	6	Legitimisation for other diseases causing MED	Intangible	Trialler	Provider	12
Excitement being involved with something new	Intangible	Provider	Trialler	6	Legitimisation for other diseases causing MED	Intangible	Provider	Consumer	13

TABLE 5

Perceived value analysis for roles in the network.

Participant perceived value matrix

Sender	Receiver					
	Consumer	Marketeer	Provider	Regulator	Researcher & Developer	Trialler
Consumer		1	−2	0	2	−1
Marketeer	2		1	1	1	1
Provider	2	2		2	0	2
Regulator	0	2	2		0	2
Researcher & Developer	2	1	1	0		2
Trialler	0	2	2	2	1	

Overall this participant highly values the deliverables they receive. Strongly agree (2), agree (1), neutral/do not know (0), disagree (−1), strongly disagree (−2).

- In the exchange between Researcher & Developer and Trialler, the Researcher & Developer perceives their input into the system to be less valued by the Trialler. There appears to be some disconnect between roles perceptions of the same value network. Researcher & Developer may feel less able to influence the Trialler.
- The role perceiving least value received from the network is that of Consumer in their interactions with Trialler and Provider. Again, there appears to be some disconnect between roles perceptions of the same value network. Consumers may feel less able to influence other Roles.

Thus where value in this approach can be realised is from

- The importance of scanning the external environment for information of use (top-down, internal approach).
- Showing the value of finding new indications and treating conditions of high unmet medical need. How important the involvement of KOLs is, especially if they are not directly involved in the clinical trials (bottom-up, external approach).
- Of not giving up on an approach if there is a belief that value can be developed.
- Of the need for a leading role for research functions in this model, as opposed to, for example, a marketing-dominated approach.

This case study therefore provides for several value inflection points of how value can be realised in the Pharmaceutical industry, *vide supra*. Others have written on the subject of realising value and below are highlighted some of the themes arising from this work.

How do the lessons learnt from this case study compare with assertions in the literature?

For most of the 20th century, the Pharmaceutical industry has been characterised by [16] great individuality, thus linking here to the importance of project champions. Also, in a firm commitment to science and ways in which the science unfolds, it links to not giving up on an approach.

Thus, 'drug hunters' remain closely involved with seeing their original ideas through to conclusion [16], speaking of the need for Project Champions. Indispensable factors for Pharmaceutical research have been stated as [17]

- The use of the role of 'champions' as a strong proponent for drugs development – often against perceived wisdom of marketing colleagues.
- The 'champion' to foster understanding, encouragement, enthusiasm, patience, commitment and ensures necessary resources.
- Nearly all drugs that have become blockbusters had early histories of major disinterest and scepticism.

Thus there is a good deal of congruence between assertions made in the literature and the lessons learnt from this case study applying value networks.

Conclusions to the Viagra® case study

In conclusion to this work, we set ourselves several goals:

- We wished to demonstrate the applicability of this methodology to the Pharmaceutical environment in a real, value-delivering situation. This was accomplished through the analysis of the indication switch for Viagra®.
- To demonstrate the ability of value network analysis to identify innovation and value in the discovery of a new use for a pharmaceutically active substance. This was accomplished through highlighting the role of project champion and not giving up on an approach, for example.
- We wished to define some of the basic organisational value interactions within the Pharmaceutical industry in its discovery of this new use for a human pharmaceutical (Viagra®), such as the importance of KOLs and the importance of Research to this network for a first-in-class product.
- To analyse this using value network methodology, we sought to understand value delivery, and to begin to identify 'best practice' value drivers for adaptation in the Pharmaceutical industry generally. Here, we found some congruence with ideas stated by others [8,16,17], *vide supra*, on innovation within the Pharmaceutical industry.

This application of ValueNet™ Works methodology as part of a case study for the discovery of a new medical use for Viagra® was intended to demonstrate the utility of this methodology for Pharmaceutical research, in helping to discovery value inflection points. This has successfully been carried out with the discovery of several such value-drivers for Pharmaceutical research, giving a deeper understanding of value delivery within this network. There is obvious interest, therefore, in the further application of this methodology to other parts of the drug discovery paradigm, such as, for example, medicinal chemistry design of compounds, in order that further improvements and innovative practices can be

revealed. The ultimate goal is improvement in productivity, innovation and value delivery within the Pharmaceutical industry. Several insights brought out through value networks analysis on the indication switch for Viagra® are in agreement with more general comments found in the literature on, for example, innovation within the Pharmaceutical industry. Thus, ValueNet™ Works methodology holds great promise in further inspection of the processes of drug discovery.

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