WHITEPAPER

An electronic health economic allocator

by

Mehraj Parouty

e-HEAL protocol

Erecting a sustainable safety net whose strength increases with increasing medical necessity

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Contents

Abstract

e-HEAL is a collection of decentralised health technology applications, ranging from mobile diagnostic applications to statistical applications, that can execute both in parallel and in sequence in order to collectively manage a sustainable health financing fund, a safety net with an essential rule that the strength of the net increases with increasing medical necessity; thereby defining a totally decentralised and autonomous application specific health economic allocator. Governance is carried out through simple axioms of rationality by parties with a vested long term interest and is based on a transparent voting system concerning accuracy of information, importance towards e-HEAL goals, severity of a condition and others. Net income into the fund is expected mostly from life improving interventions and net outgo from the fund is expected mostly to life saving interventions. The sustainability of the fund is ensured via reserve programs.

Executive summary

Severity of the initial health state is the best documented and least controversial contextual variable [1]; with a wide body of studies indicating that people strongly prioritize treatments for patients that are seen to suffer the most [2, 3, 4, 5, 6, 7]. Some studies also found that people are willing to sacrifice quality of life gains in order to give priority to the most severely ill [7, 8, 9]. Despite the fact that this "rule of rescue" [10] is also in good moral standing among philosophers [11, 12, 13], quantification has suffered from heterogeneity in study designs [14], hampering a ranking of medical interventions according to severity. And, apart from a lack of consensus on various rankings, it has been historically infeasible to allocate health optimally based on technologies of past ages.

So, we are creating e-HEAL which eases decision making based on simple axioms of rationality. On top of the e-HEAL protocol, various smart contracts and Decentralised applications (Dapps) can be built; such as a discussion platform where participants are incentivised for posting and also for voting on posts. The platform can also significantly improve medical data accessibility and security through distributed databases, known as Oracles. Data about clinical trials, for example, often the property of their sponsors, have questionable reliability [15, 16]; resulting in a commonly known ”black box” pricing of medicines [17, 18, 19]. The platform can thus offer a considerable amount of trust in contrast to centrally stored data for client/server protocols where ”evidence based” decisions are not always reproducible.

e-HEAL initial products

For the initial setup of e-HEAL, we will first launch a decision making platform that will be compartmentalized. The platform will consist of a discussion forum, very similar to social platforms, where any individual can contribute and be remunerated for their contributions depending on both up-votes they receive and give. So, apart from medical doctors sharing their expertise and other contributors such as pharmaceutical companies advertising their products, patients, might also share their distress through a post, for example, and receive remuneration for sharing their distress, as per the content creation business model of the discussion platform. This business model is already successfully running under the name of Steemit.com [20], a combination of facebook.com, reddit.com and medium.com, where profit is not directed towards a central party but is distributed among contributors of ”posts” (or content creators). Compartments of the decision making platform might be divided so as to include contributors who have a vested interest in e-HEAL or contributors in whom e-HEAL has a vested interest. One compartment is necessary for e-HEAL governance and other compartments might include software engineering team, actuarial expert team, health economics team, research publication team, among others. Tools for the development of these compartments and other additions to the Steem protocol are largely available on steemtools.com. These tools can be implemented in the e-HEAL protocol following the mainnet release of EOS [21] decentralised operating system, expected in mid 2018.

In parallel to developing this Dapp, e-HEAL will develop a mobile app that aims to both ease diagnostics and prescriptions of medical doctors working in remote rural villages. Data, such as pictures, videos, sounds of beating hearts and others, posted to our social and content creation platform can be intelligently accessed by our mobile Dapp; free in poor rural areas. Through multi-index API for webassembly smart contracts among intelligent machines [22], the Dapp allows fast and efficient confirmations which are often scarce in remote areas. e-

HEAL's intended operating system, EOS [21], also aims to facilitate inter-blockchain communications; further adding to the possibilities of e-HEAL. For example, communication with DOC.ai [23], who are constructing artificially intelligent Omics[1] and communication with coinhealth.io [24] who can provide hashed verifications, would allow e-HEAL to acquire only relevant patient's information while totally disregarding other personal information and thus protecting a patient's privacy. Along with fast communications with remunerated medical doctors on our platform, this significantly reduces the risks of patients in rural areas where medical doctors are, often, short of confirmation resources. While the use of this mobile Dapp, based on country-codes, is free within low income areas, they will be marketed at competitive prices in high income areas; with a built-in hedging mechanism against e-HEAL token volatility. These profits in high income areas will constitute the initial inflow into the e-HEAL fund. e-HEAL will also initially allow hackers from high income countries and custom roms that can alter country codes, via forwarding services, to also download our mobile Dapp freely because such individuals are expected to have a relatively high need for medical confirmations and a relatively low income within their countries.

Although the concept and definition of competition is ambiguous for a decentralised organisation, the market for mobile health applications, growing at an estimated rate of 44.2% per year in the U.S.A alone (estimation by the Grand View Research team, U.S.A), represents a low competition market because, not only does block chaining significantly reduce e-HEAL costs by pruning unnecessary and inefficient chain of administrative processes through smart contracts, but also because costs of running Dapps on e-HEAL include no fees and such cost minimization is technologically infeasible for typical ERC-20 companies on the Ethereum blockchain. So, despite being transparent about our product development process, products with similar goals to e-HEAL should not impact significantly on our competitive edge for feeding our **automated charity fund** because our Dapps operate under significantly reduced costs; with parallel and sequential execution of fees-free programs.

[1] Omics are biotechnologies that are concerned with biological terms ending with -omics; such as proteomics, metabolomics and others.

Introduction

As human beings, we love a long and healthy life. However, in today's technological era, severely ill children in poor rural areas, rare disease patients in highly developed countries and many other groups of individuals around the world do not have access to quality treatments; despite the constitution of the World Health Organisation (WHO), despite Article 2 of the European Convention on Human Rights (ECHR), Article 10 of the United Nations Convention on the Rights of Persons with Disabilities, the EU disability legislation, the UKs Equality Act of 2010 and UK 'tort law', along with various other laws and legislations that, all, aim to protect our fundamental right to a healthy life [25, 26, 27, 28, 29, 30, 31, 32, 33, 34]. While funding of some life saving medical interventions can seldom be raised through "humanitarian aid", the international aid "business" can also not be claimed to be immuned against corruption or other central point of failures [35].

The economic allocation principle generally observed by a decision maker, mandated by a certain group of individuals, is to maximize the greatest good for the greatest number; given a resource constraint which is generally monetary [36, 37]. Needless to say that this maximization has been historically hard to implement in practice. For example, a typical health economic decision maker, in today's representative democracy, aims to maximize the total **aggregate** health benefit conferred given a health care budget [38, 39] because maximizing the greatest health benefit conferred for the greatest number of **individuals** given the said budget has been a realistic/technological impossibility. However, this historical maximization of aggregate health has been a root cause for abundent ethical and legal debates because whole groups of patients suffering from severe conditions do not have access to treatments [1, 40, 41, 42, 43]. Medicines for rare diseases or ultra rare disorders (URDs) that are severe and chronic, for example, are known for their poor performances in cost-effectiveness analyses (CEAs) which is based on the maximization of an aggregate [1, 44, 45, 46, 47, 48, 17, 49, 50, 66, 51, 52, 53, 54, 55].

However, blockchain technology today makes it feasible to unlock this difficulty in maximizing a population's health on an individual basis while protecting a patients privacy and personal information. And, because the maximum of a total is always at most the total of maxima from a mathematical identity known as the rearrangement inequality [56], apart from being ethically and legally defensible, the maximization of population health on an individual basis is also always economically optimum. More specifically, maximizing individual health constrained by perfect health and maximizing the number of individuals benefiting from an intervention constrained by a certain budget, a multi-variable maximization which is mathematically equivalent to a safety net whose strength decreases with decreasing individual necessity until a budget is reached, is now practically feasible through blockchain's peer-to-peer technology.

To construct this health decision making environment, we are creating an electronic health economic allocator (e-HEAL), a decentralised and autonomous organisation (DAO). The e-HEAL fund is essentially a safety fund whose strength increases with increasing medical necessity. The intent of the protocol is to harmonize decision rules within the health economic environment. e-HEAL does this by building a decentralised social voting platform and various other decentralised applications (Dapps) and smart contracts that are consistent with the e-HEAL maximization algorithm and that can execute both sequentially and in parallel. So, while bearing functional similarities to the Ethereum protocol that provides an abstract foundational layer allowing developers to write all sorts of Dapps and smart contracts [57], e-HEAL governance resembles the Dash protocol (previously known as Darkcoin) [58] whereby governance proposals are voted. Votes by the **vested members** of the e-HEAL community on e-HEAL daily operations and votes by **any individual** on ranking severity, collectively, ressembles the Steem protocol [20] where "content creators", including patients and the public at large, have a share in the decision making authority and, thus, contribute in the prioritization of the most severely ill. So, e-HEAL serves as a decentralised application specific health allocator, intended to be built on EOS [21] decentralised operating system; the only OS that currently seem to provide the capabilities of supporting e-HEAL.

Background

Universal Health Coverage (UHC) is an aspiration for most health care bodies [60, 61, 62, 63, 64]. Universal health coverage, according to the World Health Organisation (WHO) [63], means that all individuals and communities have access to promotive, preventive, curative, rehabilitative and palliative health services of sufficient quality to be effective; while not exposing the user to financial hardship. The WHO [63] mentions that UHC embodies three related objectives:

1. Equity in access to health services - everyone who needs services should get them, not only those who can pay for them;
2. The quality of health services should be good enough to improve the health of those receiving services; and
3. People should be protected against financial-risk, ensuring that the cost of using services does not put people at risk of financial harm.

Under this aegis, severe and life threatening conditions are not an individual's own burden to bear and health and access to it are both a common good to be provided and if need be, to be protected by the community, as a whole. In Mauritius island, for example, a family insurance system, known as ”sit”, is not uncommon; whereby two parties contribute to a fund and when events unfold, the most favourably affected forfeits the contribution to the least favourably affected. More official health insurance and national care systems also exist globally [64, 65]. The WHO, for example, built a model to demonstrate the impact of introducing a health insurance scheme on a national health care system; originally designed to assist Viet Nam in the development of a statutory health insurance system [64]. The model of the Australian Health Insurance Commission was constructed and used to carry out financial projections regarding the Turkish health care system under a technical cooperation agreement between the two countries [64]. In the early

1980s, the model of the German Ministry of Labour and Social Affairs, which at the time was still in charge of the legal supervision of the statutory health insurance systems, aimed to provide policy makers with an early warning system for financial difficulties to allow sufficient time to react by modifying revenue or expenditure provisions [64]. There are probably hundreds of distinguishable financial models for health allocation frameworks [65]. However, access to healthcare is known to be unequally distributed across the globe [12, 13, 66, 67, 68, 69].

While the three objectives of UHC are hardly questionable, and while they do seem to be observed by different decision making bodies, the order in which the objectives are prioritized have varied significantly among health ministries and social insurance programs [64, 65]. Along with different ways to include uncertainty and along with different methods through which different factors enter the health allocation models, sustainable financing remains an issue with disparities in hospital bed supplies across different geographical locations [67]. In May 2005, the World Health Assembly (WHA) Resolution 58:33 [70], on Sustainable Health Financing, Universal Health Coverage and Social Insurance urged Member States to:

1. ensure that health financing systems include a method for prepayment of financial contributions for health care, with a view to sharing risk among the population and avoiding catastrophic health care expenditure and impoverishment of individuals as a result of seeking care;

2. ensure that external funds for specific health programmes or activities are managed and organized in a way that contributes to the development of sustainable financing mechanisms for the health system as a whole;

3. plan the transition to universal coverage of their citizens so as to contribute to meeting the needs of the population for health care and improving its quality, to those contained in the United Nations Millennium Declaration, and to achieving health for all.

While all democratic environments have their pros and cons [71], the health care decision making environment is a typical representative democracy. However, decision makers, representing a group of individuals, can have different priorities in conducting a value for money

(VFM) analysis because value is subjective and dependent on perspectives [72, 73]. Maximizing the total aggregate health benefit conferred or observing the various laws that aim to ensure a fundamental right to life to all, equally are priorities that are dependent on perspectives.

Health economics

A value-for-money (VFM) analysis is the typical method that an individual uses to decide upon the purchase of a certain commodity. This VFM principle has various synonyms that are primarily dependent on various definitions and types of value; such as a cost-effectiveness analysis (CEA) for the economic evaluation of health interventions. In the market for health interventions, a decision maker, mandated by society or a group of individuals, aims to find the intervention with optimum VFM. To do so, the efficacy of the intervention is established through clinical trials which can have different goals; such as, for example, the number of people that a certain technology or medication cured from a socially dislikeable health state or the number of days spent without symptoms and so forth and so on [74]. Statistical methods in clinical study designs ensure that claims about efficacy are scientifically valid with a certain percentage of confidence [75]. So, the decision maker ensures, with a reasonable amount of confidence, "*that the value of what is being gained from an activity outweighs the value of what is being sacrificed*" [76] by maximizing a measure of the total aggregate health benefit conferred given a resource constraint which is typically monetary [38, 77, 78].

However, because 'value' and 'money' have different metrics, an agreeable measure of the net 'value' of a health intervention fails to exist. While costs are measurable in a straight forward manner, valuing health outcomes has been subject to much debate [79, 80, 81]. A "willingness to pay" measure of 'value', as discussed in Pardalod et al [82], has been unpopular among health policy makers [1, 75] because of the widespread view that basic necessities should be distributed less unequally than the ability to pay for them [83]; although "willingness to pay" and "ability to pay" are different metrics. In applied health economics, for example, health outcomes are usually considered to be the relevant benefit from an intervention [84]. While Torrance [85] mentioned a consensus in literature that a generic measure for value in a CEA is both quantity and quality of life; measured by the quality-adjusted-life-year (QALY), the limitations of the QALY have also been widely discussed in literature [86, 87, 88, 89]. Normand [87] and Sassi [88], among others, provide a discussion about the controversies and limitations while McGregor [86] cautions against the use of the QALY as a direct comparison of its unit cost. Regardless of the divergences in opinions, use of the QALY is widely gaining consensus [44, 45, 75, 88, 89, 90, 91].

The CEA of a novel technology is usually calibrated by a measure of cost-per-QALY [92] which primarily serves to select the best value for money spent on health interventions. Medical interventions can, thus, be ranked based on their incremental cost per effectiveness gained [93]. Given limited resources, a maximum allowable cost-per-QALY also seems necessary [38, 75, 77, 94, 95, 96]. In the United Kingdom (UK), for example, the National Institute for Health and Care Excellence (NICE), recommends that incremental cost should not be exceeding £ 20,000 to £ 30,000 per QALY [97, 98, 99]. This benchmark or threshold, with a specified maximum allowable cost-per QALY, arises from a maximization problem [100, 101] such that "*for every given level of resources available, society (or the decision-making jurisdiction involved), wishes to maximize the total aggregate health benefit conferred*" [38].

However, Drummond et al [44] remarked a deviation between cost-effectiveness and social value; as apparent from the low societal value of the cost-effective removal of tattoos. Schlander et al. also emphasized that, while removal of tattoos would meet the benchmark for cost-effectiveness, interventions near the end of life or for severe comorbidities would not meet the benchmark [102, 103]. This is because "*QALYs are equity-neutral*" [85]. Medicines for rare diseases or ultra rare disorders (URDs) that are severe and chronic, for example, are known for their poor performances in CEAs [1, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 17, 66]. In response to this, treatments that are often deemed cost-ineffective, while potentially treating severe conditions are considered as exceptions, within a unique institutional framework [104, 105, 68].

While the logic of a CEA appears to be in accordance with the logic of VFM, a definition of 'value' has lacked consensus [72, 73]. In contrast to the current optimization of "*total aggregate health benefit conferred*" [38] yielding an "*all-or-nothing*" [1] access to treatment, various studies [40, 42, 106] have found a consistent willingness to trade some efficiency for equity in access. Drummond et al [44] argue that there is more to assessing the social value of health technologies than incremental cost effectiveness ratios (ICERs). George et al [107] also emphasize that equity cannot be disregarded when assessing medicines for rare diseases. This indicates that decision makers can have multiple and potentially conflicting objectives in the allocation problem [1, 92, 108, 109]. However, using different approaches for evaluating health interventions would violate key consistency and generalizability arguments [45, 89, 110, 111, 112].

Problem of conflicting perspectives

Different perspectives that a decision maker, mandated by society or a group, could take have also largely been considered; especially perspectives that aim to harmonize a definition of value [1, 66, 72, 73]. Perspectives within the health care decision making environment vary significantly; ranging from individual to societal and from commercial to sharing and etcetera [1]. Different perspectives of a mandated decision maker imply that reimbursement decisions vary significantly across different decision making bodies; such as, for example, between the Netherlands and Scotland [113]. Because equal access to health is generally accepted to be a common good [63], attempts to integrate equity in health economic evaluations have largely been discussed; with the means of integrating equality in access also varying differently [114]. Drummond [45] for example discussed the integration of social value into the technology assessment process. These differences in perspectives are further convoluted with differences in definitions and nomenclature [115, 116, 117, 118, 119]. Apart from different definitions of value of health leading to different health outcomes such as quality-adjusted life year, healthy-year equivalents or capability-adjusted life year [115, 116, 117], efficacy, for example is defined differently in medicine and in pharmacology [118, 119]. So, needless to say that the representative democracy with a mandated decision maker for health economic allocations have spurred much debate within the health allocation environment.

Problem of unequal medical access

In the prevailing health allocation methodology, lack of equity in access to treatments among patients suffering from severe and chronic conditions is a major concern [1, 45]. In the United Kingdom (UK), for example, the factors that are considered in a VFM by the Department For International Development are economy, effectiveness and efficiency (see www.gov.uk/government/organisations/department-for-international-development) while the factors considered by the Independent Commission for Aid Impact (see icai.independent.gov.uk) are economy, effectiveness, efficiency and also, equity. In health technology assessments, economy, effectiveness, efficiency and also equity are argued to form part of the VFM assessment [45, 47, 48, 53, 55, 91, 120, 121, 122]. However, the cost-per-QALY for medicines for rare diseases, for example, is known for being well in excess of cost-effectiveness thresholds despite the severity of their conditions [1, 45, 66, 104] and severity is the least controversial contextual variable in health economic evaluations [14, 123]. Nord and Johansen [14], for example, reviewed evidence from 15 articles published in peer reviewed journals in the time period 1978-2010 and found that concerns for severity strongly show up across countries. Nord et al [123], in an Australian survey comprising of 551 participants, also, found that severity of illness is a key deciding factor for an intervention, regardless if fewer patients could be saved due to the high costs and limited resources. However, Barratt mentions the challenges of getting both evidences and establishing societal preferences in evidence-based medicine [124] which largely involve, but are not limited to, variations in study designs [1].

Problem of unoptimal health allocation

While there hardly seems any morally defensible reason to favour one group of patients over another group when both groups include patients with similar personal characteristics, similar prognosis without treatment and similar capacity to benefit from treatment, higher cost of treatment for one group compared to the other group under a given budget constraint implies that the real choice is between treating more patients compared to fewer patients [125]. This implies that treatments for rare diseases that cost much more than other common treatments and treatments for poor countries that have a lower budget than rich ones are not health economically good options. Rare diseases, for example, result in a higher annual cost per patient compared to a common disease [125] and, in some cases, the annual cost per patient of rare diseases exceeds €100,000 [66]. With an estimated average out-of-pocket cost of $1.395 billion (2013 dollars) per approved new compound [126], these costs are hard to be recouped both from poor countries and from patients with rare diseases due to the high fixed/low variable cost structure of the pharmaceutical industry [45, 47, 48, 53, 55, 120, 121, 122]. However, such high pricing of medicines has also been argued to be a Black Box and whether the price of a medication is justified or not is an ongoing debate between industry and payers with no transparency at all and therefore, no consensus [17, 18, 19].

Consensus algorithms

The modern treatment of intransparency through formal methodologies probably originated with the statistical methods of Al-Kindi to decypher coded messages [127]. In 1982, Lamport et al [128] described the typical problem of blackboxes with an analogy to the Byzantine army [128]. A group of army generals have to come to a consensus about launching an attack on an enemy or retreating from the enemy line. Some of the army generals would like an attack while others would rather retreat, and, among the generals are also honest and dishonest ones. Moreover, in the polar world that the generals lived in, with only yes/no possibilities, the messengers communicating to and from the generals were sometimes successful and sometimes unsuccessful in delivering their messages, and so forth and so on. The goal in this problem is not about whether to attack or to retreat; regardless of the decision, the goal is to optimize informational consensus, known as the ”Byzantine fault tolerance”.

For this optimization, a proof of work or a proof of stake generally serves to provide either incentives to propagate ”honest messages” or disincentives to propagate ”dishonest messages”, respectively. Today, solutions to the Byzantine generals problem are not only numerous but are also automated because computerised systems are highly effective at executing yes/no commands, with agreed rules encoded in a protocol. These are widely used in blockchain based interactions which are essentially a set of coded rules to which two parties agree to; allowing a network of interactions to exist. All interactions are then placed inside a block which is a potential candidate to be chained to previous blocks if it correctly expresses the execution of agreed rules or otherwise it is not chained [129]. Using one of the many different existing consensus algorithms, one block and only one block is chained to other previously chained blocks.

Proof-Of-Work

For the Bitcoin network, excluding the genesis block, two main rules prevail: one cannot spend more than one has and one cannot receive less than one require [130]. Peer-to-peer ”transactions” are placed into blocks that contain a header, a time stamp, the list of transactions, the hash[2] of the previous block, and etcetera. Importantly, an arbitrary number, called a **nonce**, is also present in candidate blocks to be chained. And, because two candidate blocks with exactly the same transactions but with different nonces will have different hashes, block chainers enter into a computational competition bruteforcing[3] the nonce of candidate blocks to first reach a specific target so as to be rightful block chainer. After proving computational energy spent, the block is then broadcasted to the network. All other block chainers then verify the incoming broadcast which is computationally easy compared to the bruteforcing computations. The broadcaster achieving consensus first gets the right to chain the block. And, block chainers under this ”proof of computational work” are often called **miners** because, as a reward for computational energy spent, newly created coins are offered as a reward to the winning miner. These can, however, only be spent after a specified number of blocks have been further chained; confirming the chainer's honesty in doing the computational work within the chain with the most difficulty.

Proof-Of-Stake

Proof of work is also used by other blockchains, such as Ethereum [57]. While Ethereum currently uses proof-of-work, it is, however, switching to a proof of stake protocol whereby it is not computational power that serves as investment, but Ether, the built-in cryptocurrency, serves as proof of stake. The built-in fuel of the Ethereum protocol are staked offering stakeholders a proportional possibility of chaining [129, 131]. This serves as disincentives to cheat the network because Ether cryotpcurrency is staked by a validator for a proportional chance to chain a

[2] A hash can be viewed as a digital signature or a fingerprint. The Bitcoin protocol uses SHA256 for hashing purposes. A word has a unique hash and a whole library of dictionaries also has a unique hash.

[3] Bruteforce is a penetration mechanism whereby a target is sought by repeatedly plugging in candidate targets. Offensive security's Kali Linux, for example (available for download at www.kali.org), offers target-specific password dictionary compilers and brute force applications that repeatedly plug in different passwords from the dictionary to unlock a certain password-protected account.

block. However, proof of stake has been argued to follow Karl Marx' Law of increasing poverty [132] with the catch phrase "the rich get richer and the poor get poorer" because the more stake one has, the more is one's expected block chaining rewards.

Proof-Of-Work variations

Other blockchain protocols also exist [58, 133, 134]. Dash [58], for example, uses both miners and stakeholders in its crytocurrency to secure its blockchain and govern its operations, respectively. Dash offers services, such as Instant-send or Private-send, that operate at the protocol level. To do so, Dash uses a **masternode** reward program [133]. Essentially, block chaining reward are allocated in the ratio 9: 9: 2 to miners, masternodes and treasury. Some of the masternodes are randomly selected through a masternode election algorithm to offer the services operating at the protocol level. Masternodes also vote on hashed proposals concerning treasury fund allocations; with decisions that receive 10% more positive votes than negative ones being executed depending on fund availability. These include funding of advertisements, of educational videos, of conferences, among others. So,it is possible to have quite some subjective consensus within a totally decentralised and autonomous organisation via votes.

Rootstock protocol, on the other hand, leverages from the security of the Bitcoin network through a 2-way peg protocol [134]. Rootstock offers programmable Bitcoins that are turing complete, offering the possibility for Dapps to exist via a chain pegged to the Bitcoin chain. Bitcoins are essentially locked on the Bitcoin network and released as Smart Bitcoins (SBTC) on the Rootstock network. Backward compatibility with Ethereum also implies that Dapps running on Ethereum network runs as well on the pegged network. Consensus, in the case of Rootstock is however very interesting. Rootstock consensus is achieved through **merged mining**. That is, two blocks, Bitcoins and Smart Bitcoins, are simultaneously mined for block chaining purposes, with incentives for Bitcoin miners to mine another cryptocurrency.

Proof-Of-Stake variations

In **Delegated-Proof-Of-Stake**, on the other hand, stakeholders do not, themselves, chain candidate blocks to the blockchain but delegate this task to other network participants [135, 20, 21]. In this case, the 51% attack is mitigated by stakeholders delegating the block chaining reward to parties that adhere to some selection rules; rather than allowing a free block chaining market (mining market) where chaining cartels undermine the blockchain's integrity. This also prevents the ”poor from getting poorer”.

In steemit.com, for example, stakeholder votes on block chainers are weighted in proportion to vested interest [20]. And block production is done in rounds and in each round 21 blobk-chainers (named as witnesses in steemit.com) are selected to create and sign blocks of transactions. The 21 active ”witnesses” are shuffled every round to prevent any one witness from constantly ignoring blocks produced by the same witness placed before and any witness who misses a block and hasn't contributed to chaining in the last 24 hours is disabled until he/she updates his/her block signing key. Other algorithms can also allow for more variables to account as ”stakes”. Depending on the variables, these give rise to **proof-of-activity** [136] where online maintenance of full nodes account as stakes or **proof-of-importance** [137] with an importance score.

Complex problem solving

Within the framework of the Byzantine generals problem, an important variable, with two mutually exclusive possibilities, that e-HEAL aims to consider is that an unknown number of the generals are abled while others are disabled from wounds so that both decisions, to attack or to retreat, are not executable; except with an agreement for an intervention, whence both are equally feasible. This is not an additional option, apart from attacking or retreating, to stay; but rather, this aims to order the priorities of the generals, by sequentially answering polar questions so as to achieve consensus about an attack or a retreat. In a VFM analysis of a health intervention, numerous factors are deemed important, with differing degrees. A VFM involves numerous variables with numerous administrative steps that aim for multiple goals that are sometimes imprecise and/or intransparent. So, the problem of achieving consensus in a VFM approach for health interventions is a complex problem characterized by (a) the complexity of the situation which is traditionally defined based on the number of variables in a given system, (b) the degree of connectivity among the involved variables, (c) the dynamics of the situation, (d) intransparency or opaqueness, and (e) polytely [138, 139, 140]; where the word polytely comes from Greek words poly telos, meaning many goals [141].

To solve complex problems with a given number of multiple goals and constraints, Bellman and Zadeh [142] proposed the determination of an essential goal which is the intersection of the given goals [. . .] and the given constraints. In contrast to this essential goal [142], Zimmerman and Zysno [143] considered an overall goal which is the union of multiple goals; i.e. the sum of the weighted contribution of the multiple goals [144]. Zadeh [145] mentioned that the choice of the operator used, intersection or union, depends on whether the goals are dependent or independent. So, with dependencies of goals being grouped and formulated, the overall goal can be unfolded into its constituent multiple goals.

However, because of intransparency within the health economic allocation environment, other issues arise. Because the goals within the healthcare decision making environment are not precisely stated, they are fuzzy. A fuzzy set is a set with no sharp boundary [146]. It is a group of objects in which there is no sharp distinction between those objects that belong to the group and those that do not [146]. So, fuzzy goals imply that the distinction between goals and constraints no longer applies [147]. Moreover, priorities are also often fuzzy within the healthcare decision making environment where fuzzy priorities are linguistic variables, such as ”very important” and ”moderately important”, so that the boundary that distinguishes where ”moderately” ends and where ”very” begins is unclear [147]. In order to achieve consensus in the health economic allocation environment, it is first necessary that all parties work with similar definitions to eliminate fuzziness, followed secondly by the elimination of contradictory goals to list all goals that can co-exist and followed lastly by the careful selection of which operators, intersection or union, to use in order to define an essential goal coexisting with an overall goal.

Solution of Rawls original position

With all peers communicating with a consensus dictionary, one perspective has been proposed by Rawls in his theory of justice whereby the principles of justice are laid behind a veil of ignorance so that one individual does not know in advance who one is [148]. When an individual is unaware, in advance, who one is, then one first desires safety against the worst possibilities such as suffering the full consequences of severe and chronic conditions without access to treatments. With a flow of information from ignorance, so that the strength of the safety net decreases with decreasing severity, the Rawlsian oriented society also offers a reward system that enables competition [148]. This is also in line with economic axioms of rational choice, such as those of Von Neumann-Morgenstern [149]. These axioms provide consistency among preferences. For example, eyes to see a tattoo, are axiomatically more preferred than, say, the removal of the tattoo because the one is needed for the other to be of any value. After being guaranteed safety from the worst conditions, and only after being guaranteed this safety, individuals could compete in increasing their monetary profits. This is also the case for pharmaceutical manufacturers who would compete with each other only after they are all ensured safety from the most severe and chronic conditions. This naturally gives rise to some rules that a manufacturer would impose onto oneself so that all manufacturers would compete only after fair policies have been established.

A practice known as disease stratification, which allows manufacturers to create artificial subsets of a common disease comprising of several sub-diseases, would for example not be observed [150]. That is, while all manufacturers aim to operate optimally, a manufacturer who, for example, is stratifying a common disease into rare diseases to increase profits would be observing inconsistent rules compared to optimal ones that arise from arguments in game theory [149, 151]. This is because, although the stratification of a common disease into rare diseases increases profit of a manufacturer, it decreases the safety of that same manufacturer from suffering the full consequences of an actual rare condition. So, a Rawlsian oriented society ensures that various laws, such as European Law in European regulation (EC) 141/2000 which states that patients suffering from rare conditions should be entitled to the same quality of treatment as other patients [26], for example, are prioritized above competition laws that theoretically allow disease stratification.

Solution of equal medical access

While QALYs are equity neutral [85], the more severe the condition, the more one would expect protection by a safety net from the perspective of a peer who is blinded by a veil of ignorance. Schlander et al. also noted that severity of the initial health state is the best documented and least controversial contextual variable [1]. Various studies indicate that people strongly prioritize treatments for patients that are seen to suffer the most [2, 3, 4, 5, 6, 7]. Some studies have also found that people are willing to sacrifice quality of life gains in order to give priority to the most severely ill [7, 8, 9].

Jonsen [10] coined the peremptory rescue of people from identifiable and avoidable death as the rule of rescue which also seems in good moral standing among philosophers [11, 12, 13]. So, the method of grouping for homogeneity by Bellman and Zadeh [142] does seem to indicate that severity is central in health economic evaluations. Morel and Cano [152], also, discuss the development of Patient-Centred Outcomes Measures (PCOMs); which are quantifiable metrics of value from the patients perspective and also discuss the centrality or intersection of this value for multi-stakeholders that are less severely affected. So, equity in health implies that health is distributed equally to all, but most where it is most needed; that is, most to the most severely affected and least to the least severely affected; at the detriment of individuals wishing for the removal of their tattoos who could, however, finance such endeavours from their own pockets.

Solution of optimal health allocation

The historical health economic allocation framework has been unable to allocate health on an individual basis of need because of lack of technological systems. The historical approach has generally been to maximize an aggregate; more specifically the decision maker generally aims to maximize the total aggregate health benefit conferred under a budgetary constraint. However, this entails several questionable assumptions such as, for example, the underlying assumption that social value is a linear function of health state and life year [153]. So, the maximum of the total aggregate health benefit conferred [38], is also a questionable optimum. From the rearrangement inequality [56], the maximum of an aggregate is always at most the aggregate of maxima. And, this inequality is also true for totals. So, it follows that the maximum of the total aggregate health benefit conferred is always less than or equal to the total of the maximum aggregate health benefit conferred and that is, in turn, less than or equal to, the total aggregate of maxima of health benefits conferred to individuals. Given that the more severely ill might be in more need of a QALY [154]and given the creation of exceptions for entire groups of patients [68, 125, 155], then historical optimization is definitely not optimal. The optimal approach, from the rearrangement inequality, is to maximize health benefit conferred to an individual tax payer or health insurance premium payer, constrained by a perfect health, and to maximize the number of individual tax payers benefiting, constrained by a given budget; observing a multi-variable maximization.

Although this maximization might be argued to be difficult to implement in practice, it is, already, successfully implemented using business models of safety funds such as insurance models [156, 157, 158].

Spence and Zeckhauzer [156] mention that the purpose of a safety fund is to protect individuals from suffering the full consequences of those actions on the part of nature which affect them unfavorably. In the Netherlands, for example, while the government is responsible for health-care, health insurers are responsible for its management [159]. Although equity is not the business of insurers, the core of their strategic business allows a practical maximization of the greatest good for the greatest number so that allocation is equitable and, also, always optimal if the strength of the safety fund increases with increasing severity. This implies that the two examples mentioned in the subsection about the problem of unoptimal health allocation, namely treatments for rare diseases that cost much more than other common treatments and treatments for patients in poor countries that have a lower budget than rich ones, are economically good options because the purpose of a safety fund is to spread the risk [157, 158]. So, increasing the spread of the risk sharers, allow taxes or premiums to remain fairly stationary. Dutch physicians, for example, called for a European-wide cost-effectiveness evaluation of high cost medicines for rare diseases; compared to a nationwide evaluation [51]. WHA reports [160, 161, 162], for example, have also promoted UHC to spread the risk of catastrophic expenditures for illness, through increasing prepayments and pooling financing systems [163].

e-HEAL as a technological facilitator

The e-HEAL safety net is a fund that intakes increasing profit margins from interventions that address decreasing medical need and outgoes free financing for health interventions that are of increasing medical need; while ensuring that the income/outgo service is a sustainably continued service.

So, through this pricing algorithm, e-HEAL observes equality in the distribution of health because healthy individuals do not need interventions, per se. And, financing of a removal of tattoo, for example, is an individual choice that is payable from the individual's own pocket. Also, in line with the recommendation of the WHA reports [70, 160, 161, 162], e-HEAL adheres to the sustainable financing criteria mentioned in chapter 7 of the International Labour Organisation 1999 publication [65]. These require that the e-HEAL programme income is continuously greater than or equal outgoes and operating expenditures; where programme income is composed mainly of premiums, contributions and profit from health goods and services, outgoing expenditures are composed of free health goods and services and operating expenses are composed of platform maintenance, rewards to medical doctors, actuarial experts, e-HEAL block chainers, among others. In short, this simply means that, as time progresses, inputs are continuously greater than or equal to outputs with transparent roll-over reserves.

In mathematical notation, defining a probability space $(\Omega, \mathcal{F}, P)$ on which, firstly, a stochastic process, A, representing the difference between an income payment function and an outgo payment function that are both non-decreasing, finite-valued, and right-continuous, specifies the total amount $A(t)$ paid in $[0, t]$ $\forall\ t \geq 0$ and, secondly, a discount function, u is defined, so that they are adapted to a right-continuous filtration $\mathbf{F} = \{\mathcal{F}_t\}_{t\geq 0}$, where each $\mathcal{F}_t$ comprise the events that govern the development of payments and interest up to and including time t, then sustainability of the e-HEAL fund simply requires that $U \geq 0$ [59]; where

$$U = \int udA \tag{1}$$

Equation 1 also serves as a premise for commonly used Hattendorff theorem [171, 167, 168, 169, 170].

e-HEAL premise

While the sustainability of e-HEAL fund is maintained using a pricing algorithm for medical products by ranking the severity of the conditions they address with quantifiable and voted measures, the latter is complex because medical need, diagnosis, prevalence and recovery lack evidential standards and because income levels follow some distributional function that tend to have discrete jumps contingent on imaginary geographical boundaries. The Organisation for Economic Co-orperation and Development also remarks that all countries have their respective poverty lines [164], with the international poverty line estimated in 2015 by the World Bank to be $1.9 based on the international equivalent of what $1.90 could buy in the US in 2011 [165]. So, fair distribution cannot consider solely products and disregard individual patients [166].

However, the following premise will serve as the e-HEAL essential decision making environment. Although this premise is employed under various simplifying assumptions, it allows all types of additional complexities to be be included under realistically occurring scenarios. The premise considers 100 individuals stranded on an un-inhabited island; with each individual having different medical needs and different income (possibly payable in terms of rare sea shells that were found when their boat capsized and that are agreed by all as a means of exchange for coconut water, fruits, herbal medicines and etcetera). So, the individuals can be ranked according to the degree of their medical need and their income level. Under this premise, realistic scenarios can be formulated. For example, the 100 individuals might be a delegation representing a country.

On the island, however, the individuals agree that health is a common good. And because individuals with the most medical need are often least able to work in order to earn sea shells, the individuals agree to build a safety fund whose strength increases with increasing medical need. This is the premise of the e-HEAL project. The figure below illustrates the basic financial functioning of the e-HEAL fund in a further simplified scenario of 10 individuals who either earn income above a poverty line or below it. Green arrows represent net inflow into the fund, red arrows represent net outflow and no arrows are shown for a net flow of approximately zero.

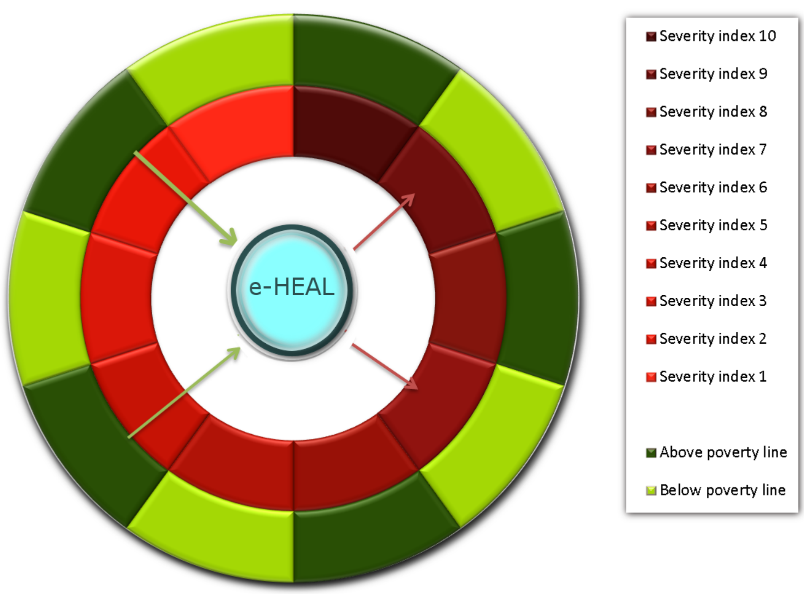

Figure 1 representing the essential e-HEAL business model

Using various simplifying assumptions, the scenario depicted concerns 10 individuals stranded on an island with medical conditions that have different severity indices (bloody red for very severe and orange for not severe) and with income that is below a poverty line or above it (dark green for above and pale green for below). Arrows in the figure show the flow of e-HEAL tokens. Minimum profit margins from life improving interventions fund the e-HEAL operations which in turns fund life saving interventions. e-HEAL operations comprise of e-HEAL platform maintainers and other experts that ensure the token flow is sustainable. For the sake of simplicity, the diagram does not depict arrows that point both to and from e-HEAL to the individual with both bloody red severity index and dark green income because inflow and outflow cancel out.

So, more income into the e-HEAL fund is expected from higher income earners and more outgo from the e-HEAL fund is expected to the most severely affected through decreased pricing of medical interventions with increasing medical need. Consequently, the **net** inflow into the e-HEAL fund is expected from life improving interventions and a **net** outflow from the e-HEAL fund is expected from life saving interventions.

e-HEAL technological architecture

Information required by a typical health economic decision maker for informed decision making are numerous. Fortunately, technologies that allow efficient informational dissemination are also numerous ranging from validated measuring instruments for measuring recovery of patients [45, 66] to statistical applications for estimating confidence intervals [172]. Further aiding the transfer of this information are internet protocols and wireless technologies. More recently, blockchain technology has allowed for disparate applications, that serve conflicting and concording purposes alike, to build onto a single blockchain [57]. This is made possible because the rules defined by the protocol will always be in agreement among all nodes since the protocol is deterministic and carefully designed. So, e-HEAL will have to be architectured in such a way that Dapps and smart contracts that serve numerous goals are in concurrence among each other so that their summative contributions to the essential e-HEAL goal to erect a sustainable safety net whose strength increases with increasing medical necessity is optimal via just-in-time compilation.

In order to allow for Dapps that have different purposes to be implemented via community vote, e-HEAL will need to adhere to the six primitives for Turing completeness [173]. While languages that allow for this compatibility are numerous, some are better designed for some purposes than others. Solidity [174] language, for example, designed by the Ethereum core development team [57] is a contract oriented programming language based on **state transitions**. However, in contrast to Ethereum offering services to developers, e-HEAL cannot charge transaction fees to developers because e-HEAL requires their services in order to, in turn, offer services to patients and the public at large. Because of the difference in business model, e-heal will therefore need to pay developers rather than earn payments from them. Moreover,

”messages”, commonly defined as ”transactions” in Bitcoin, should be controlled by messenger codes to identify:

1. the contribution of the application’s objective to the e-HEAL objective

2. the priority of the objective

e-HEAL ”messengers” should therefore be coded into identifiable and nested groups, via community votes on proposals, in order to allow each account to define a mapping between a messenger group of an account to a permission level. In a nutshell, e-HEAL should be a set of arbitrary state transition functions [57, 134, 21], with no transaction fees for program execution [21] organised via autonomous executions and/or subjective votes with remunerated participants [20].

e-HEAL blockchain setup

Challenges within blockchain based organisations generally relate to performance, scalability and security; inclusive of consensus algorithm. **Performance** generally concerns throughput and latency where throughput is the amount of data that a blockchain can deliver to a client and latency is the time it takes for one account to send a message to another account and then receive a response. **Scalability** concerns how many transactions can be processed on a blockchain in a given time. It is often measured in transactions per second (tx/s=V). Bitcoin, for example, can only process 5 to 7 tx/s in contrast to Visa that can process 2000 tx/s [175]. **Security** generally refers to rules that are breached; whether the rules are implicit or explicit. A 51% attack or a breach of privacy or a mishandling of payments or a bug is common in the ecosystem. **Consensus algorithm** generally refers to how the Byzantine general’s problem is addressed [128] because a blockchain is only as secure as its consensus protocol [129]. e-HEAL will therefore require the following blockchain characteristics:

1. Because bugs inevitably occur, e-heal platform should be robust enough to allow updates; not just through hard forks.

2. Latency should also be minimized and delays should not exceed the orders of few seconds upon initial testnet release.

3. The platform should also ensure security to its clients such as a patients privacy right and should be scalable to accommodate millions of transactions per day.

4. Fees for Dapp executions should be minimized or inexistent.

Performance

Dapps running on the e-HEAL platform would often require inputs that are outputs from other Dapps that serve different goals because some decision making processes can only be made in steps. For example, a piece of mobile diagnostic data, from another blockchain, DOC.ai [23], for example, might be automatically input in a statistical Dapp on the e-HEAL platform for confidence interval purposes. So, e-HEAL requires the ability for sequential processing. On the other hand, some of the workload is more efficiently carried out in parallel through a spread across multiple processing units. So, parallel processing should also be feasible. With both sequential and parallel computational possibilities, a separate compartmental permission management, separate from business logic of the application, becomes vital. Permission verification however adds a significant percentage of the computation required to validate transactions. In order to reduce this additional computation, permission evaluation can be made ”read-only” and a trivially parallelizable process [21]. So, changes to permissions do not execute until the end of a block, which means that all keys and permission evaluation are executed in parallel in order to enable two accounts to exchange messages back and forth within a single block without having to wait for the chaining of a block [21]. So, an **onion-structured block** will improve the e-HEAL performance. In EOS, our intended OS, blocks are effectively divided into cycles that are, in turn, divided into threads that contain a list of transactions where each transaction, in turn, contains a set of messages to be delivered.

Scalability

The different applications that e-HEAL aims to offer implies millions of transactions per day. This necessitates considerable scaling which, in turns, necessitates that components are modular. Dash [58] for example offers its services through masternodes that are elected via an algorithm so that everyone should not have to run everything, especially if they only need to use a small subset of the applications. So, an applications state in e-HEAL protocol should be entirely derived from the messages that are delivered to it, allowing any full node to pick a subset of applications to run while safely ignoring others. This implies that the totality of state communication among accounts must be passed via messages included in the blockchain because the state of all accounts is not necessarily accessible on the same machine [21].

Security

Apart from a patients safety when exposed to novel drugs, whereby stopping rules have to be drafted for patients failing to respond to a certain medication [45], time based security is also critical within a blockchain organisation [21]. Because a breach of privacy, for example, via a stolen private key, would not be known until the private key has been used, e-HEAL also requires an option that certain messages must wait a minimum period of time after being included in a block before they can be applied. So, e-HEAL account owners should have the possibility to use any owner key that was recently active along with approval from their designated account recovery partner to reset the owner key on their account.

Consensus algorithm

While e-HEAL aims to implement a fair accounting system, so that parties with more stakes can be more entrusted and parties with more work done can be more remunerated, within the software engineering profession, proof of stake or proof of work are terms that generally concern one type of particular participant, the block chainer who maintains the integrity of the blockchain. It is the block chainer who secures the immutability of the blockchain. While the theorem of Miller and LaViola [176] states that "the Bitcoin protocol achieves consensus, except for negligible probability, in a model with anonymous synchronous processes and a minority of Byzantine faults", with 51% of the computational mining power being able to centralise, for example, a mining pool has the possibility to chain its own block into an independent branch that ultimately converges to the longest chain[4]. This allows chainers to double-spend and to mine only their own transactions; and to essentially cheat the network. This security issue with proof-of-work

[4]The longest chain is the chain with the most average difficulty in chaining. Moreover, selfish nodes that do not broadcast are a much more serious security issue.

is known as a 51% attack.

During the early days of the Bitcoin network, for example, individuals could chain a block and receive Bitcoin mining rewards on an all-purpose laptop. However, resourceful parties are continually acquiring powerful ASICs, allowing mining power to become more and more concentrated [129]. Nodes that control more than 51% of the hash rate have the possibility of misbehaving. To address this issue, Ethereum, for example, proposed EthHash which uses the memory hardness property of general purpose laptops to move data in memory rather than through computations, while also, ensuring that this property is ASIC resistant. However, proof of work nonetheless takes time and energy to reach consensus, simply, because bruteforcing requires time and energy. And, proof of stake inevitably allows the ”poor to become poorer” [132]

However, because e-HEAL involves many participants and consensus algorithms concern one particular type of participant, then we can select another particular type of participant to delegate block chaining duties. And because e-HEAL operation is designed to be sustainable via reserve rules mentioned in Norberg [59], parties with vested interest in the **long term** operations of e-HEAL will vote on block chainers to maintain the integrity of the blockchain where votes are weighted according to the amount of vested interest. Conceptually, this consensus algorithm is similar to the consensus algorithm adopted by companies throughout the world; and particularly in Steemit.com [20]. So, e-HEAL will employ a Delegated Proof of Stake (**DPOS**) which seems to be the only decentralized consensus algorithm capable of meeting the performance requirements of e-HEAL applications on the blockchain.

e-HEAL decentralised operating system: EOS

EOS [21] seems to be the only decentralised operating system that will satisfy the requirements of the e-HEAL protocol, with a mainet release intended in mid 2018. For example, EOS offers the possibility for an account owner to use any owner key that was active during the past 30 days to reset the owner key on their account [21]. Hackers have disincentives to go through the recovery because they would be compromised by this process which is distinct from a simple multi-signature arrangement whereby there is another company that is party to every transaction that is executed [21]. So costs and also legal liabilities of e-HEAL would be dramatically reduced. EOS also provides a declarative permission management system that gives accounts fine grained and high level control over who can do what and when; with numerous benefits of parallel execution of permission evaluation, such as rapid validation of permission, reduction of computational load, among others [21]. Moreover, through ease of generating proof of message existence and proof of message sequence, inter-blobkchain communications are also facilitated on the EOS decentralised operating system. EOS thus seems to offer the best value, in terms of technological requirements of e-HEAL, for money, in terms of fees, with an already released live testnet.

e-HEAL initial products

e-HEAL is a technological facilitator that remunerates participants for their respective contributions in addressing different issues within the health allocation environment. One major issue is differences in perspectives. Proposed methods for achieving medical consensus has been numerous [177]. Despite health economic consensus reports drafted by international experts [66], heterogeneity in study designs, for example, implies heterogeneity in quantifying confidence intervals and this, in turn, implies heterogeneity in funding decisions [14]. The e-HEAL decision making platform aims to harmonize all aspects of health care decision making via a voting mechanism whereby participants are incentivised in the form of a cryptocurrency. So, decision making authority is shared with the patient who can allocate some of the e-HEAL tokens. This is made possible via a synthesis of different business models; inclusive of reserve models used by banks and insurance companies, business models of content creators that allow e-HEAL to not only host research articles freely, but to remunerate authors, reviewers and editors for their respective contributions. While the variety of products that can be built and that can communicate on the e-HEAL protocol are numerous, e-HEAL aims to initially start with the following applications that can be developed in parallel to the e-HEAL essential discussion platform:

1. a decision making platform
2. a mobile health app

A decision making platform

Because e-HEAL is intended to harmonise decision making within the health economic environment, the first Dapp that will be built will be a compartmentalised decision making platform. All decisions related to any aspects of the e-HEAL project will therefore be transparent and available on the public blockchain. These will involve different combinations of a ”veil of ignorance policy” and a ”transparency” policy depending on relevance. Moreover, all participants will be remunerated based on a smart contract if there is an agreement or based on the number of up-votes that their respective contributions receive from the community; with different permission levels. So, a patient might share a distress on the discussion compartment of the platform which will not only be free to share but which will also be remunerated; based on the platform's ”content creation business model”. So, a patient's subjective opinions, programming codes, mathematical algorithms, among other contributions can be uploaded in different compartments and accessible to the general public. While votes on remuneration packages for different compartments might follow the proven treasury model of Dash [58], votes on the discussion and social platform might follow the proven model of Steemit.com [20]. The number of up-votes on a certain aspect of a post would determine the remuneration of the specific contributor. Aspects of a post might be accuracy, importance, consistency with e-HEAL overall goal, among others that depend on the specific compartment in question. This platform is an extension to steemit.com [20] with regards to functionalities and is fully compatible with our intended decentralised operating system, EOS [21]. While steemit.com is the interface, steem, the database, can accommodate interfaces like facebook.com or biomedcentral.com with fairly equal ease. So, within the research compartment, not only can authors publish freely but they can be remunerated for their publications and not only can interested parties access articles freely, but they can also be remunerated for up-votes. Impact-factors and such Journal metrics are also improved in both statistical precision and accuracy.

A mobile health Dapp

Medicine is one of the oldest professions [178, 179, 180] and, today, there are not only large medical databases [181, 182, 183] but also thousands of mobile health applications [184]. Martinez-Perez et al conducted a search querry in 2013 resulting in more than 3673 documented mobile health applications [184]. And, given the exponential growth of mobile health applications, as noted by The Grand View Research Team, U.S.A, there are possibly tens of thousands of mobile health applications today. Bellina and Missoni [185] and Bellina et al [186] for example, emphasize the role that mobile health applications can play in educating locals from low income rural areas. Terry [187] also mentions the ease of mobile phones to take and send images from a microscope. While mobile diagnostic tools are becoming more accessible in poor rural areas, e-HEAL improves on most aspects of such tools; freely in poor rural areas and at competitive prices in others. e-HEAL uses a Generic Multi Index Database API [22], a new database API that gives WebAssembly a handle by which it can quickly find and iterate over database objects; significantly increasing the performance by changing the complexity of finding the next or previous item in a database from $\mathcal{O}(\log n)$ to $\mathcal{O}(1)$. So, data from the e-HEAL discussion and content creation platform are more efficiently utilized and in a more ethical way than centralised social media advertising platforms; so that platform users are synonymous to distributed beneficiaries and advertisers also do not have access to data beyond consented disclosures. Ease of interblockchain communication is also achieved on e-HEAL's intended decentralised operating system by making it easy to generate proof of message existence and proof of message sequence, combined with an application architecture designed around message passing [21]. So, e-HEAL can also communicate efficiently with, for example, both the oracles of DOC.ai [23], with artificially intelligent OMICs and coinhealth.io [24], with a patient's **hashed verification without access to information that are private and personal**, for a more precise allocation of free and priced products to patients who have total privacy while disclosing only health related information, for precision medicine purposes. So, apart from adhering to all international laws about privacy, maximizing relevance also maximizes efficiency in data processing. This also significantly increases the inflow into the e-HEAL fund with more potential outflows to poor areas.

Marketing strategy

Cryptocurrencies are bits of information, serving as disincentives or incentives, that stream through a network in order to keep it running. And depending on the utility of the network programs, they have different demands and, therefore, exchange values. However, cryptocurrencies generally have highly volatile fiat prices. Concerning the price of Bitcoin, for example, the New Liberty Standard established a value of $1 to be 1309 BTC in October 2009 based on electrical and energy costs. In June 2010, Bitcoin price ranged between $0.80 to $1 and two months later, in August 2010, Bitcoin price drops to the floor. With a high of around $20000 in December 2017, Bitcoin pulled back to about $6000 in February 2018. And, because Bitcoins are required to purchase most of the other cryptocurrencies, the majority of the cryptocurrency market also suffers from this volatility.

Cryptocurrency market volatility

Stability is an important feature in all markets. However, apart from users of a certain commodity creating demand, any market is generally composed of two distinct types of players from two, often, opposing schools of thought. They are the firm foundation analysts such as long term investors and technical analysts such as high speed traders. And, with regulatory systems generally moving at a much slower pace than technological ones, drivers of so-called ”new economy” are often subject to much speculative frenzy. One such frenzy was seen in the Netherlands during the Tulip bubble of the 1630’s [188, 189]. And another similar putative mania was seen in the 1840’s with the rail industry in Britain [190]. Thousands of investors on moderate income would buy the, then unregulated, railway shares which were speculated to give rise to a new economy. The railway market however collapsed significantly in 1845 ruining some parties but also allowing established railways to purchase strategic lines cheaply. A more recent mass phenomena was the 1990's Dotcom herd behaviours that was seen with companies' share price rising hundreds of percentage points by simply adding ".com" in their company names [191, 192].

However, the Netherlands is today indeed the world's top Tulip exporter, trains are an integral part of Britain, and interactions without internet are difficult in modern times. Although the underlying blockchain technology does seem unfailing, blockchain company prices are largely driven by news. Besides being contingent on news and hype, the Bitcoin price "puppet" is also an ardent rock-n-roller to the strings of rumours. And this seems disproportionately leveraged by some market actors, such as pump and dumpers. So, market prices cannot correctly reflect any intrinsic value of a "new economic driver" by disregarding the motivations of the different players; although intrinsic value is totally subjective because value in general is. Some shady groups, for example, might find value in the anonymity of some cryptocurrencies. An investor, on the other hand, would reason that taking profit is stopping profit while a trader would generally aim to buy low and sell high. And, regardless of price movements, the trader can always profit by longing or shorting a position; with buying followed by selling or with selling followed by buying, respectively.

In high speed trading, for example, a company, known to be a scam by all market traders, is often a good buy when the speed of the market dump slows sufficiently because the shorts will have to cover, raising the price, at least, in the short term until regulatory bodies catch up. So, market entry points and exit points are crucial. These can generally be determined by estimating when market bulls bought the dip and market bears sold the tip. Statistical tools might help to determine price support and resistance levels with a certain degree of confidence. And a common knowledge among high speed traders is the actual speed of the price movements. That is, it is not only the price increase that determines entry or exit points but it is also how fast a price is increasing or decreasing. Rapid growth in monetary value or other liquid values does usually justify profit taking. Profit taking in turns implies a market pullback with high probability of consolidation flags. However, despite the bullish overbought situation in early December 2017, and despite the January 2018 market pull back, the technology, itself, is redefining information security, democracy, economics, job markets, whereby, for example, individuals are rather handsomely remunerated for merely sharing opinions on social media (see for example steemit.com [20]), among various other disruptions; at least until the arrival of quantum computers which will likely disrupt the entire Fintech market. So, the opposite schools of asset valuation, the ”castle in the air” theory of Keynes [193] with primarily psychological posits and the ”firm foundation theory” of Bachelier [194] with utility underpinnings, do seem to unusually share striking postulates in the cryptocurrency sphere. Therefore, while we aim to leverage from the technological aspects of cryptocurrencies, the goals of different players within the cryptocurrency sphere cannot be disregarded altogether.

Mobile Dapp pricing hedge mechanism

Despite allowing for a pricing of Dapps based on demand of the Dapps, a hedging mechanism becomes necessary to mitigate the volatile effect of e-HEAL token prices on the price of e-HEAL mobile Dapps. Also, remuneration of ”content creators” in the discussion platform might best be in terms of a fairly stable token. An issue for purchasers of e-HEAL decentralised mobile applications, for example, is that one might purchase an application for €1 today and the price has risen to €2 tomorrow because of the volatility of e-HEAL tokens in the cryptocurrency market. And price stability is crucial for our mobile Dapp users, while allowing a competitive pricing of the Dapps compared to other mobile applications to exist. A hedge constructed with complex combinations of financial derivatives or with the Royal Mint Gold (https://rmg.royalmint.com/) who offer a peg to Gold that is held in reserve, however does not seem the most efficient. The most efficient hedge for e-HEAL mobile Dapps price volatility, given the purpose of e-HEAL, seems to be a peg with the global poverty line. This avoids unnecessary conversions and additional staffs who would feed the exchange databases. On the other hand, long term investors and decision makers would also like to see the value of e-HEAL tokens grow over time. So, taking into account the different players within e-HEAL community, e-HEAL tokens, the only exchangeable token in markets will include nominal pegs. The entire e-HEAL organisation is run through the following token types:

1. an electronic health economic long-term purchaser token (e-helper token)

2. an electronic health economic allocator token (e-heal token)

3. an inclusive health economic line of poverty uplifter (i-help-u token)

Holders of e-helper tokens represent the governance team of e-HEAL. The age of e-helper tokens held by a user also represents the amount of ”vested interest” and this stake allows the token holder to delegate block chaining activities and to perform other rewarded tasks in proportion to the stakes. This token can also not be sold over the counter. Should a holder wish to sell his/her e-helper tokens for e-heal tokens, an automatic annuity, payable weekly to the seller will be executed. There are also no fees payable for any transaction within the e-HEAL organisation; whether the transactions are exchanges from e-helper tokens to e-heal tokens or from i-help-u tokens to e-heal tokens. Apart from e-heal tokens which are exchangeable in markets, i-help-u tokens and e-helper tokens are both nominally priced and only exchangeable for e-heal tokens.

Dapps that require volatility hedge will be priced in i-help-u tokens. This token is nominally priced in units of the global poverty line; estimated at $1.9 in 2015 [165]. However, a fixed price disregards basic economic laws of demand and supply. Moreover, price inflation also need to be accounted for. During the 2008 economic crisis, for example, data from the Federal reserve bank of St Louis, U.S.A, indicate that from August 2008 to January 2009, US money supply grew from $871 Billion to $1737 Billion within months and continued growing at an aggregate rate of around 20 % per year for the next seven years [20, 196]. So, e-HEAL hedging is done by translating basic macroeconomic principles to the microeconomic environment of e-HEAL. While it is beyond the scope of this whitepaper to embark onto debates between the different schools of monetary policy or fiscal policy, both schools, as well as the Cambridge approach [195] and others, concur that whatever goods are sold in a given period of time must necessarily equal to whatever goods are purchased in that same period of time. That is

$$M * V = P * Q \tag{2}$$

where
M = i-help-u token supply
V = transactions per second
P = price of mobile health Dapp
Q = quantity of Dapps purchased

In equation 2, Q, the quantity of Dapps purchased equals the quantity of Dapps sold and that is known. V, the number of transactions per second, tx/s, is also known. And, M, the i-help-u token supply, can be determined on a country to country basis. Although unbounded money supply seems unsustainable, a supply of i-help-u token that is strongly correlated with a country's inflation hardly seems unreasonable. It should be emphasized again here that i-help-u tokens only have a nominal existence and only serve the purpose of pricing across different countries. e-heal tokens, the only tokens exchangeable externally, on the other hand, have a supply cap of 1 Billion. Holders of e-heal tokens can exchange these tokens for both e-helper tokens and i-help-u tokens. e-helper tokens roughly resemble a fixed deposit that can be terminated any time with an annuity payable weekly; and are therefore less liquid. So, e-helper balances are non-transferable and non-divisible and so they cannot be traded on an exchange.

i-help-u tokens also cannot be traded on an exchange; although they can be exchanged any time for e-heal tokens over the counter with no fees. i-help-u tokens are nominal specifically because their prime purpose is for pricing and they are only exchangeable within e-HEAL organisation for e-heal tokens. However, the nominal i-help-u tokens do contribute real profits; despite the fact that this real profit is expressed in nominal tokens because i-help-u tokens have an exchange value in terms of tradeable e-heal tokens. With a desirable real percentage profit from different countries, determined from the e-HEAL fund algorithm (see Figure 1 on page 23), then, P, the price of mobile health Dapps that a purchaser will pay, based on country codes can be calculated. This price is dependent on different rates of inflation and different percentage profits within different countries where e-HEAL Dapps are sold, rather than given freely. So, defining $\pi =$ as the inflation rate in a certain country and $r =$ as the real percentage profit in that country, then, from Fisher [197], the symbolic percentage profit, s, from Dapps that a purchaser will pay and that incomes the e-HEAL fund from a certain country is

$$s = r + \pi \tag{3}$$

This pricing mechanism only serves the purpose of setting prices of e-HEAL Dapps to maintain stability while adjusting for inflation and competition. Also, s, the symbolic percentage profit from sale, will determine the minimum price that a Dapp purchaser should pay. So, purchasers who wish to contribute more to free Dapps in poor rural areas can freely do so. i-help-u tokens can also be further divided among different forseeable future Dapps. So, market exchange feeds are necessary for the efficient in-house exchange of e-heal tokens. Despite interblockchain facility and automated oracles, incorrect feeds and long delays can pose potential issues. So, maximizing reliability of price feed with minimum costs and minimizing the time to acquire feeds are crucial. This can be done in similar fashion to Steemit.com [20]. That is: 1) reliability of feeds are maximized via a reward-based mandate mechanism so that feeders compete to earn the right to produce median feeds implying that outliers have little impact; 2) while interblockchain communication is eased, it would be ideal if an exchange chain utilizes lightweight merkle proofs and 3) especially when requiring feeds from outside a blockchain, automatically assigning a sequence number to every message delivered to every account also reduces costs. EOS [21] should be able to accommodate all these requirements.

Initial Coin Earning scheme

Recently, several news media reported on a scam Initial Coin Offering (ICO) that raised about $830,000 with a Hollywood actor pictured as its graphic designer [200, 201, 202]. The growing number of ICO scams have prompted several regulatory bodies to necessitate company registrations and fund raiser disclosures so that the fund raisers can be held accountable by their funders and financiers [203]. As a further example of a possibility to raise funds without any intended outcome, upon an initial e-heal token offering, for each token that a financier purchases, we might purchase 1.01 tokens and obtain majority vote to transfer all tokens to our account. So, the issue of a cartel operating to control the entire network is infinitely magnified at the singularity point of the e-HEAL network start-up because there are no nodes. And assuming that we are a Bitcoin whale, with a persistent threat of executing a 51% attack at hand, we are, therefore, not launching an ICO. While ICOs are argued to be the future of crowd funding because they offer greater opportunity for participants compared to Initial Public Offerings (IPOs), possibilities with no outcomes benefiting financiers exist. Friedman [198], for example, noted the difficulties in establishing equality of opportunity for all.

Phillips also discussed equality of opportunity in conjunction with equality of outcome [199]. So, scams and other schemes with no intended outcomes can be eliminated through contractual specification of contingencies on outcomes. Therefore, e-HEAL aims to specify the contingencies entailed in contracts between two paties so as to eliminate possibilities of misbehaviour rather than specify personal details about the parties so as to hold one party accountable towards the other in case of misbehaviour. In that sense, e-HEAL shifts the transparency from individual disclosures to transparency in agreement specifications. In line with Rawls theory of justice [148], this also allows all contents, inclusive of disclosures of medical practitioner licenses, to be marketable by a participant; with tailor-made smart contracts reflecting increasing accountability and thus, increasing revenues, for increasing disclosures. So, apart from patients and medical doctors, all participants can choose to take an active role or a passive role within the e-HEAL decentralised decision making platform; with the purchase of trust at the price of public disclosures and license verifications. And, because all participants can choose to take an active role or a passive role in all operations, as far as possible, all smart contracts will involve two options suiting the preferences of the two types of participants.

Currently, we are launching an Initial Coin Earning (ICE) scheme which is essentially a collection of smart contracts with outcome specifications so that peers can choose to take an active or passive role as a worker and/or an active or a passive role as a work financier. Until the mainnet release of EOS decentralised operating system, our ICE will run on Rootstock (RSK) network, powered by the current most secure network, the Bitcoin network, and with custodians of Bitcoins that are sufficiently decentralised. So, different participants can choose to exchange that which they have in excess for that which they aspire in return; whether concerning an exchange of intellectual contributions for Bitcoins or an exchange of Bitcoins today for more Bitcoins tomorrow, depending on individual attitudes towards risk. Therefore, our Initial Coin Earning mechanism is primarily based on proof of some work with remuneration from financiers who desire to grow their Bitcoin holdings. This is not dissimilar to the start-up of the Bitcoin network itself, except that a financier subjectively selects a work with the most difficulty to remunerate. However, the financiers are incentivised in the form of a smart contract that will earn them different returns on their investments depending on their individual attitudes towards risk. e-HEAL thus minimizes misbehaviours by simply adding more precision and specificity to agreements and contracts. So, all individuals contribute to the ICE scheme on a purely peer-to-peer basis with contracts that suit their individual degrees of risk aversion. And, because we aim to achieve a sufficient number of geographically decentralised participants who would hold e-helper tokens, our ICE scheme is necessary to attract participants prior to the crowdfunding launch. The maximum e-helper token held will however be capped depending on country codes. The total supply of e-helper tokens will be 10 million, 1% of the total e-heal token supply. Because e-helper tokens have a much smaller supply than e-heal tokens, because they are demographically capped on a country-to-country basis, and because they give their holders decision making and voting rights on core decisions, they are the most valuable tokens within e-HEAL.

Financier incentives

Financiers initially select a work that they want to remunerate or multiple works with different remunerations. So, they have more choices as to which specific work they want to remunerate and to specify an address their Bitcoins are going to. It is important that all individual intellectual contributions can be tracked via pull requests, branching, merging and etcetera; such as the tracking on github.com. Initially, financiers choose works that are already done and that they want to remunerate. Their Bitcoins, converted into SBTC, will be paid to a worker depending on the financiers selected attitude towards risk. Financier contracts will offer 2 options, one option suiting the aspirations of financiers who are risk averse and want an assurance of recouping their Bitcoins and one contract suiting the aspirations of financiers who are not risk averse and can afford paying a worker without any assurances. If, for any reason, the crowdfunding is not launched within, say, the next 9 months, the first category of financier will recoup his/her SBTC in the worst case scenario. Upon the launch of our fund raising for e-heal tokens within the next 7 months, however, in the best case scenario, apart from recouping their SBTC, the first category of financiers will also have their Bitcoin worth of investments in e-heal tokens as a reward for not having use of their Bitcoins prior to the fund raising. So, financiers can effectively double their Bitcoin worth in remunerating an e-HEAL worker for work that has already been done. Doubling a Bitcoin worth in 7 months implies an approximate return of roughly 10% per month which are paid in e-heal tokens.

The second category of financier who does not require any assurance is essentially donating bitcoins to a worker for work done in the worst case scenario. As a reward for donations, however, in the best case scenario, this category of financier will be ensured his/her Bitcoin worth of donations in e-helper tokens which give the financier voting rights. And because e-helper tokens are demographically capped and bestow increased voting powers upon their holders, they are much scarcer and more valuable than e-heal tokens. So, the e-helper tokens will be distributed first to this category of financier. If the entitlements to e-helper tokens, evaluated by Bitcoin worth, are above a certain demographic cap, the net remaining entitlements above the cap will be paid in e-heal tokens. While this whitepapers coin earning scheme does not stipulate any further rewards for donators except their exact donations worth in terms of e-helper tokens, donators who will hold e-helper tokens will be the actual governance team of e-HEAL and will be responsible for votes on treasury matters. The reason why this white paper does not stipulate any further rewards is to prevent participants from gaming the ICE scheme. A worker with Bitcoins might ”donate” to himself/herself repeatedly without any bounds and be entitled to a Ponzi-like growing number of e-heal tokens. With a one-to-one Bitcoin worth to e-helper token reward, there are no incentives to game the system. Upon crowd funding, however, all holders of e-helper tokens who undertook a higher risk during the ICE scheme can rightfully vote for a higher risk/reward ratio than financiers who were assured their SBTC custody. Most notably, the treasury system of Dash [58] with 10% treasury allocation has been proven to be a sustainable remuneration allocation. An issue with regards to distribution of e-helper tokens, however, is that in regions with extreme poverty, participants might not exist due to absence of technologies. A demographic proportion of e-helper tokens will however be allocated to potential and prospective participants from such regions. So, pre-mining of coins will also be transparent.

Worker incentives

Workers, on the other hand, have no assurances whatsoever of receiving any reward because the ICE scheme is based on work that is already done and depends solely on subjective evaluations of those works by financiers. The sole reward of a worker during the coin earning scheme is dependent on the generosity of a donor and the risk/reward aspirations of a financier. However, a worker's account will also comprise of two types of balances: A balance giving a worker who has the possibility of cashing out from a donor and a balance where the worker has custody of a financier's Bitcoins to be repaid after, say, a maximum period of 7 months in the event that the crowdfunding is not launched. A worker who considers himself/herself to have received his/her dues before his/her sweat dried out can cash out his/her SBTC in the first balance anytime and will not receive any e-heal tokens upon crowdfunding. A worker can however choose not to cash out in order to repay the financier if the crowdfunding is not materialised within the maximum period. Thus, this worker is effectively donating his/her work and is keeping his/her sweat worth of labour within e-HEAL. So, this category of worker will earn the worth of his/her Bitcoin holdings in e-heal tokens and also earn e-helper tokens upon the e-HEAL crowdfunding launch when the worker returns the SBTC that were in his/her custody to the financier. So, for relying solely on voluntary and possibly in-existent remunerations based on the generosity of financiers, upon the crowdfunding launch, this category of worker who will earn the workers Bitcoin worth of labour in terms of e-heal tokens and e-helper tokens is also motivated to work in a time efficient manner for receipt of his/her labour worth of e-heal tokens and e-helper tokens. So, time invested by a worker or SBTC invested by a Bitcoiner are equally valuable to e-HEAL. If all SBTC paid into e-HEAL remains within e-HEAL until crowdfunding launch, all participants, workers and financiers, are effectively investing their time and Bitcoins. Currently, e-HEAL can do without Bitcoin financiers but cannot do without time and work investors to perform preliminary work until a crowdfunding launch. And, because donors and workers who dont cash out their Bitcoins have no guarantee of reward, their priority are assumed to match those of e-HEAL and they will receive e-helper tokens that give them governance rights. In case all workers cash out, then only financiers will be rewarded in e-heal and e-helper tokens with voting powers. And in case, no Bitcoin financiers exist during the ICE and only workers exist, then, workers, the only stakeholders in this case, should provide the public with an additional informational work on what percentage of the raised funds is to be allocated to work already done and what percentage is to be allocated for work to be done. The treasury model of Dash [58] might again be useful. So, during crowdfunding, the SBTC raised should first ensure that a fair accounting system prevails; both towards work already done and towards work to be done and both towards stakes already held and towards stakes to be held. While majority stakeholders are rewarded with e-helper tokens until a demographic cap, a portion of e-helper tokens will also be allocated to potential participants from poor countries who are expected to join after our Dapps grow in markets; whence the input/output e-HEAL fund model, as pictured in figure 1, becomes active. It is not unimportant to note that until e-HEAL content creation platform becomes operational or until Dapps and e-HEAL products are sold to users, the entirety of our remuneration scheme and the value of e-heal tokens or e-helper tokens are not immuned against a crash. The value of the tokens depends primarily on network effect generated by users.

Steps up to and during crowdfunding

While all of the work has to be done prior to any remuneration in our ICE scheme, e-HEAL progress will significantly slow and possibly come to a halt if e-HEAL falls short of Bitcoin financiers and, more importantly, time investors or workers. e-HEAL might also necessitate experts through an open call or a procurement with predetermined remuneration so that the Initial Coin Earning scheme is not sustainable over time because it only allows remuneration for work already done and not for work that is yet to be done. For example, consider the following case of an open call for an expert with rare competencies. Warfarin drug has a narrow therapeutic range so that beyond or below certain dosages, the drug is toxic and causes bleeding in patients [207, 208]. And this drug is often prescribed in tablets that are discrete and countable. However, the risk profiles of drugs that have a narrow therapeutic range and that are prescribed using tablets, i.e. dosages that are elements of discrete numbers, might not be correctly approximated using Brownian motion models because although rational and irrational numbers complete the number line, it is difficult to prescribe dosages that are elements of irrational numbers. So, a continuous-state continuous-time (cs-ct) stochastic model which is based on differentials in probability coupled with Diracs measure, using the possibilities, therapeutic (increase, in general), toxic (decrease, in general) or neither, would be better modelling according to the principle of maximum entropy. Therefore, an open call with competitive remunerations for an expert in pharmacodynamic models, pharmacokinetic models and differential equations in stochastic processes might be warranted. Although an individual might launch an open call or a bounty for a work to be done or for a bug identification, e-HEAL requires sufficient number of geographically decentralised participants who would hold e-helper tokens and this decentralisation of stakeholders is eased via a crowdfunding. Preliminary work leading to the crowdfunding is however necessary.

Necessary preliminary work for crowdfunding

First, it is important that two specific types of options are encoded into a smart contract on RSK. A financier who wants an assurance of recouping his/her SBTC can only pay a worker who agrees not to cash out. During the crowdfunding, the financier then recoups SBTC in custody and receives e-heal tokens and the worker receives e-heal tokens and e-helper tokens. On the other hand, a financier who does not require any assurances can pay workers who have the possibility of cashing out at any time. During the crowdfunding, the financier receives e-helper tokens with voting rights on treasury. And workers who had the possibility of cashing out would only receive e-heal tokens if their work would receive further investments from crowdfunding voters and/or other voters thereafter. All work done within e-HEAL will be permanently available for votes and remuneration. While one individual might rightfully act as both a financier and a worker, it is imperative that the 4 balances, namely 2 types of financier balances and 2 types of worker balances, are distinguishable. A single SBTC address can however encompass these 4 balances.

Second, an account for users that contain several fields will be created. All fields will be separately hashed to give a Merkle hash. This prevents any bias for remuneration by providing anonymity to voters. Also, while we require a sufficient amount of geographical decentralisation for e-HEAL governance, all workers should be remunerated according to the quality and quantity of their work and any other information, such as nationality, is irrelevant. Fields might consist of:

1. a username
2. an SBTC address
3. an identifier for a piece of work, if any
4. a phone number
5. any other information

In some cases, a user might also wish to use an SBTC address only once and the Merkle hash for the other fields is sufficient for verification. A user might also be a frequent traveller and wish to change his/her phone number for access to e-HEAL mobile Dapps. Given that country codes are in the orders of hundreds starting with a known + sign, a user location can be verified within seconds by bruteforcing the entry for country codes. For as long as only one field is desired to be changed by the user at a time, verification is always possible. So, users have control over all their disclosures, except for country codes which we can bruteforce to ensure e-helper tokens are fairly evenly distributed across different geographical regions. For voting purposes, however, anonymous and transparent voting is necessary.

Third, a Dapp for scoring work done or work to be done is necessary during the crowdfunding. This scoring Dapp might be similar to Loughborough University contribution scoring system for anonymously evaluating collective work of peers [204]. Although partial honesty, as mentioned in Dutta and Sen [205], might prevail, scoring will be compared to median votes. So, apart from generating an honesty score based on median vote, this scoring mechanism can also potentially be used to determine author participation in e-HEAL publications compartment given that disputed authorships are numerous, as per the committee of publication ethics (COPE) website [206]. So, a working paper compartment for ongoing work and a published paper compartment might both be useful. The working paper compartment should be immuned against any censorship and accessible to all who wish to see or look into a mentioned issue. The published paper compartment will however be subject to votes and will then combine individual working papers, review comments which are also in the form of papers and editorial notes into high quality papers. Our built in platform dictionary which aims for homogeneity in health economic evaluation, also allows standard coding of e-HEAL program executions. Moreover, while medical doctors contributing to the expansion of the e-HEAL dictionary might be remunerated, pharmaceutical companies who wish to target the patient clientele of e-HEAL for advertising might, on the other hand, have to pay to add the names of their products on our platform. Companies with excessive and intransparent pricing might pay into the e-HEAL fund while companies or hospitals manufacturing their own products with transparant pricing might be paid by the e-HEAL fund depending on votes. For the purposes of remuneration, the following voting system and ranking of weights will be used:

1. The fit of the goal of the work(informational content creation, advertising, and other work) within the complex problem solution of e-HEAL. That is, how does the work performed or the procurement call fits within the premise of e-HEAL? And what contribution does the specific goal serves towards the overall goal to erect a sustainable safety net whose strength increases with increasing medical severity and necessity?

2. The epistemological accuracy of the work. Proven mathematical theorems or 100% consensus will weigh more than works with 99% confidence which will weigh more than works that used 95% confidence intervals.

3. Other factors that the community will deem fit. These might represent a subjective difficulty scoring, time efficiency of the work delivery and others. For example, work that is delivered sooner than an agreement might receive more remuneration than work that are delivered later.

Discussion

With the aim of paving a path towards a generalized VFM for health technologies, this whitepaper groups the goals within the healthcare decision making environment using the operators of Zadeh [146]. Because of differences in nomenclature between medicine and pharmacology, we are first creating the e-HEAL platform with a built in dictionary so that a word provides the means to clear meanings. Thus, e-HEAL peers start off with a fairly basic dictionary that is expanded by the peers, themselves; eliminating any fuzziness. Our social platform also allows peers to express how they perceive the severity of a medical condition functioning similarly to ”steemit up-vote button”. This, in turn, allows an oracle to be created where diseases are ranked according to severity. And, this, in turn, allows e-HEAL to distribute the greatest amount of the fund to the most severely ill individuals, constrained by perfect health, and our algorithm repeats this process, constrained by the e-HEAL stochastic reserve. And this allocation is economically always optimal from the rearrangement inequality [56]. This allocation model can be implemented using actuarial models pertaining to safety funds [156, 157, 158]. In the Netherlands, for example, while the government is responsible for health, health insurers are responsible for the management [159].

While e-HEAL functions on a peer-to-peer basis, typical concepts and important requirements in representative democracies are redefined. Accountability, for example, is of key importance in a health allocation scheme where lives are at stake. In the setting of Bovens [209], *the concept of accountability is used in a rather narrow sense: a relationship between an actor and a forum, in which the actor has an obligation to explain and to justify his or her conduct, the forum can pose questions and pass judgement, and the actor may face consequences*. e-HEAL, on the other hand, allows all members of the forum to share the role of the actor and thus dissolves the roles of the actor and the forum into one another, allowing all parties to take an active role in matters that are important to them; such as access to medical care. And, while peers choose to take an active role or a passive role, an essential network rule that all peers agree to is that the most severely ill are prioritized. So, the peers have only themselves to hold accountable. And blockchain technology makes this allocation optimal because it allows maximization of population health on an individual basis. Strictly speaking, health is maximized on a peer-to-peer basis where all peers agree that the most severely ill are prioritized and this priority decreases with decreasing need. And, with this network rule, all peers are, collectively, maximally accountable towards one another.

Assuming that, for example, the consequences, faced by all individuals due to the decision, are mirrored onto those with an active decision making role, then the maximization of health on an individual basis also allows for maximum accountability for expenditure of a common fund; given that the the most prioritized and least contextual variable is severity [2, 3, 4, 5, 6, 7, 1]. This assumption that the consequences that are faced by the individuals comprising the forum are mirrored onto the decision maker hardly seems unacceptable for individuals in pursuit of their well-being. This is because an important class of neurons that is argued to form the basis of empathy is the mirror neurons [210]. Although mirror neurons are not empathy neurons, they do contribute to the building blocks that govern our ethical and social concerns [211, 212]. These neurons are today known to be present in the human mind [213]. They fire both when we act and when we observe the same action performed by another [213]. Given the fuzzy issues about equity in healthcare [214], then the selected perspective is maximally accountable to, at least, visible victims. Moreover, mirror neurons are also known to play roles in motor imagery [215] so that they are activated when an *"observing self"* [216] creates an *"internal theater"* [217].

This possibly brings into accord the existing controversies regarding an individual's moral duties towards visible victims as opposed to victims that are beyond the visual landscape [3, 5, 10, 123, 218, 219, 220, 221]; as is the case with an individual blinded by a veil of ignorance, as proposed by Rawls [148]. The principles of justice of Rawls have, however, had many criticisms; such as, for example, from Gibbard [222]. Cubbon [223], for example, inferred that "*according to criteria similar to those which defined the Rawlsian Original Position, a judgement as* *to which policy will maximise QALYs will, therefore, have a measure of objectivity*" while Harris [224] criticised the 'objectivity' of Cubbon [223] and found the 'original position' and the 'veil of ignorance' behind which it hides to be misleading. However, Cubbon [223] is assuming the role of an aggregate individual; which is not similar to the role of one individual who does not know, in advance, who one is. When one individual does not know in advance who one is, then, one first desires a safety net for protection against the worst possibilities, such as treatments for the direst conditions; as postulated by various laws and legislations above-mentioned. The more dire the condition, the stronger the safety net is expected and the strength of the net decreases with decreasing direness of the condition. So, the proposed maximization of population health on an individual basis of direness is maximally just, according to Rawls theory of justice [120].

Moreover, filtering irrelevance [225, 226] is also made possible with Rawls veil of ignorance. So, preferences towards such patient attributes as gender, sexual orientation or race would have questionable relevance to e-HEALs allocation problem [106, 227, 228]. Patient attributes such as age [227, 229, 230, 231, 232, 233, 234, 235, 236, 237], social roles such as contribution to community and criminal record [123, 227], (non)smoker and others are known to influence prioritization of the public [228]. So, the preference for treatment of a young patient over an old one and the preference for treatment of a dire condition over a mild one implies that a treatment for a young patient with a mild condition and a treatment for an old patient with a dire condition are equally preferred according to Von Neumann-Morgenstern rationality axioms [149]. The objectives of the allocation problem would, then, potentially be conflicting. So, the essential priority of e-HEAL, aiming to provide a safety net whose strength decreases with decreasing necessity of intervention, serves as a technical device for holding together *the elements upon which the value of money, and changes in that value, depend"* [195].

In conclusion: Maximization of population health on an individual basis of medical necessity is in line with the "rule of rescue" principle in moral philosophy, is in line with all major laws and legislations ensuring our fundamental right to a long and healthy life and is also in accordance with economic optimality in the allocation of health. And blockchain makes this allocation technologically feasible.

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