National College of Ireland

Liquid Democracy in Ireland: Innovating democracy by directly empowering citizens.

MSc Research Project
FinTech

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Liquid Democracy in Ireland: Innovating democracy by directly empowering citizens.

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MSc Research Project in FinTech

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Abstract

With the current rise in political dissatisfaction and populist political parties, the current liberal democratic system does not appear to be suitable anymore. A new concept of democracy is proposed to tackle these issues: Liquid Democracy, which is a mix between direct and representative democracy. This is being made possible thanks to new technologies, primarily the blockchain. This paper discusses the upgrade in the voting system by enabling a new dimension of sentiment, more regular referendum-like online issue-based voting bypassing the need for political parties. The Wisdom of Crowds is central to this project as it is believed that the average decisions of the many citizens are better than those of the few politicians. This project allows a voter to make a proposal on how to solve an issue as well as vote on all issues available from fellow citizens. This is done by adding their sentiment and comments of improvement to the proposals or if they prefer by delegating their vote to a trusted fellow citizen, all of which is recorded on the Blockchain. This is expected to improve the democratic process and restore citizens trust in politics.

Keywords: Blockchain, Liquid, Direct Democracy, Government, Ethereum, Political Party, Proposal, Issue-based Voting, Citizens, Decentralised Autonomous Organisation, Wisdom of Crowds.

1 Introduction

Democracy is at risk. There is currently a rising trend of political extremism and populist movements gaining momentum all around the globe, whether it is in the USA, Brazil, Philippines, Hungary, Italy, Austria, Russia, Austria, UK, China just to name a few. There are countless of different theories trying to explain this general trend and each country has its own specificities, but one pattern that tends to present itself is a general dissatisfaction of the electorate by their current political system.
This is understandable when considering that the political system has yet to experience the technological revolution, such as the FinTech one. Voting once every few years for a political party or a politician to represent its citizens was once a necessity, when information and transports was slow moving. At an age where the internet is ubiquitous, being supported by the advent of the Blockchain, the time is ripe for an upgrade of our

political system, starting with the overhaul of democracy itself, by enabling Delegative Democracy. This concept, also known as Liquid Democracy, dates as far back as 1884 when Lewis Carroll himself wrote about its basic principles in his paper "The Principles of Parliamentary Representation".
This new type of democracy could, for the first time in history, help harnessing the wisdom of crowds (i.e.: "the many, who are not as individuals excellent men, nevertheless can, when they have come together, be better than the few best people, not individually but collectively, just as feasts to which many contribute are better than feasts provided at one persons expense" (Aristotle; 1997) on the political stage by enabling citizens having a direct say on everyday issues or delegating their vote to trusted fellow citizens. Electronic voting has been in existence for a few decades all around the world, but is increasingly perceived as being unsecure. The Blockchain technology (more specifically Decentralised Autonomous Organisations), has the potential to reverse that trend and enable secure electronic voting over the internet. A solution enabling this improved governance system on the Blockchain will be proposed and should enhance the way citizens interact with politics.

2 Related Work

In order to understand how Blockchain can be used to implement the concept of Liquid Democracy, hence disintermediating political parties and revolutionising the way citizens interact with politics, it is important to get a broad understanding of the different aspects that encompass Liquid Democracy primarily. With this knowledge acquired, it will be possible to better evaluate the existing solutions surrounding this domain.

2.1 Voting

According to the Oxford dictionary, a vote is "A formal indication of a choice between two or more candidates or courses of action, expressed typically through a ballot or a show of hands". (Dictionaries; 2018)
The practice of voting to elect a representative government has emerged in the beginning of the 17th century (Britannica; 2018c), and although universal suffrage is relatively more recent, very little has changed in the way citizens express their political opinions. In some countries, the technology used for casting votes has evolved by using e-voting systems whereas the paper is merely replaced by, or used in combination of, an Electronic Voting Machine (EVM). The main advantage of e-voting is speed, as the results of the vote could be known in near real-time. The cost of a vote could also be greatly decreased thanks to the reduction of labour cost for example. These advantages are often outweighed by its disadvantages, primarily due to the security concerns. E-voting machines could easily be targeted by groups of hackers or foreign governments who wish to sway an election for instance. E-voting machines are also manufactured by private companies which could potentially be bribed to interfere with the results. Lastly, these machines can be expensive to maintain. For example, back in 2002, the Irish government had decided to purchase e-voting machines to be used for the 2004 European and local elections at a cost of 51m Euros. However, these machines were never used due to security concerns and plans to (security) patch them were scrapped in 2007, costing an extra 800,000 Euros per year for storage until then.(Britannica; 2018d) (Of; 2016)

Voting is currently very much of a "zero-sum game" with a binary yes/no outcome, meaning that one has to lose in order for one to win. This is an acceptable solution in the case of single simple issues, but there is no "middle-ground" outcome possible. In the current system, the winning majority "takes-all" even if a specific issue matters more to the losing population as "all votes are equal" (i.e. have the same weight).
Recent technologies have the potential of revolutionising the democratic process of voting by providing the voter more nuanced choices than a binary one as well as more regular and granular polling.

2.2 Referendums

Referendums are a "vote in which all the people in a country or an area are asked to give their opinion about or decide an important political or social question" (Dictionary; 2018).
Back in 1975, Margaret Thatcher described referendums as "a device of dictators and demagogues". She referred to the way dictators such as Hitler and Mussolini used in their advantage this tool as a way to legitimised their actions and decisions (Economist; 2015). When an amendment to the constitution is proposed by the parliament, the Irish population is automatically being polled in order to decide whether to pass the amendment or not. This is a great first step towards Direct Democracy, but this practice of polling the population could be further extended towards more pressing every-day issues. Furthermore, in its current form, referendums can be cumbersome (only once or twice a year) and costly. For example, as of end 2016, the costliest referendum (1st Lisbon Treaty in 2018) cost 22.2m Euros, while the cheapest (Protection of Human Life in Pregnancy in 2002) cost 10.8m Euros. (Times; 2016)

In October 2016, a referendum was held in Colombia in order to agree on a peace treaty between the FARC guerrilla and the Colombian government. The population rejected the agreement by 50.2% voting against it with a total of only about 38% of the eligible voting population casting their votes. This came to a surprise locally and internationally as the Colombian president had worked nearly four years negotiating this peace treaty with the FARC leader. (News; 2016b)
The question used for the referendum was relatively ambiguous: "Do you support the final agreement to end the conflict and build a stable and lasting peace?" (News; 2016a). An organisation called "DemocracyEarth" decided to propose their own version of the referendum using their open-source software "Sovereign" by breaking-down each of the issues that the referendum was really about. What they found out was that one specific point of the treaty was causing the most disagreement ("Do you agree with the political participation of the FARC and opening up democracy"). Due to the binarity of the question being asked on a broad topic, the negative answer to this referendum could have been avoided by clearly listing the plurality of issues being voted for.

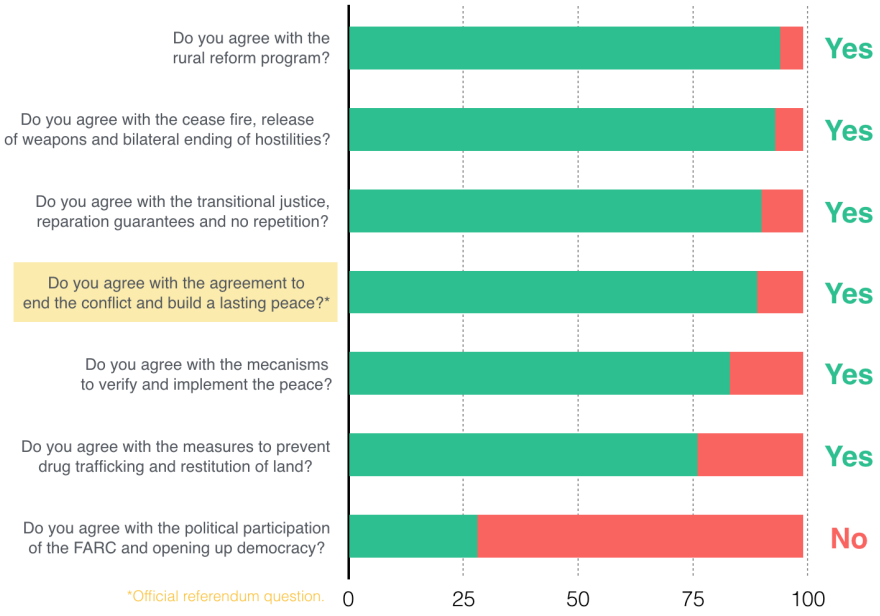

Figure 1: (DemocracyEarth; 2018)

This same principle could have been applied during the "2016 UK European Union membership referendum", where the voters were given a relatively simple question ("Should the United Kingdom remain a member of the European Union or leave the European Union?") summarising a very complex subject. With a mere 51.9% of the voters answering negatively to this over-simplified statement (Commission; 2018), this referendum was proven valid and enacted even though 48.1% of voters were left unhappy, ultimately challenging the very core of the liberal democratic system.

2.3 Political Parties

A political party is an organised group "of people who share the same views about the way power should be used in a country or society" (Collins; 2018) though democratic elections or by revolution. Modern parties as we know them date as far back as the 19th century in Europe and the US, and spread throughout the world in the 20th century. (Britannica; 2018b) This spread led to the liberal democracy system becoming the (Kopstein et al.; 2014), which is a form of Representative Democracy.

One issue with the modern society is the partisanship to a specific political party in the same way as a sports-club fan, or a religion for instance. People, due to their parents or relatives believes, tend to choose a specific party and committing to it unconditionally in the hope of winning the elections by "beating" the other parties. This behaviour lead to "less-informed voters on issues who tend to blindly support their own party" (of Kansas; 2015).

One political party cannot provide the best solutions for each and every issue that matters to an individual citizen, let alone a full majority of the citizens of a country. For example, here in Ireland, voting for either of the 2 main parties (Fine Gael (FG) and Fianna Fail (FF)) makes very little difference except from an historical point of view. Furthermore, trying to compare the political catch-all agenda of both parties can prove to be a complex task due to their similarities as well as their lack of clear opinions

on various issues. It is unfortunate that the electorate is kept divided on an historical question instead of the real issues that the parties should promise to tackle.

Since parties may not well represent the public opinion, people are disincentivised to cast their vote, as was seen for example in the "2016 32nd Dil General Election". The percentage of electors who voted was just over 65%, with the 3 most popular parties being Fine Gael at 25.5% of the total votes, Fianna Fail at 24.4% and Sinn Fein at 13.9%. However, these number fall drastically when compared to the actual total electorate at 16.5%, 15.7% and 8.9% respectively. Furthermore, the total number of electorate who did not vote is still higher than the total number of votes FG and FF combined. (of the Oireachtas Service; 2016) Moreover, as of the 2016 Census in Ireland, it was found that over 11% of the population in Ireland was of non-Irish nationals who may not be entitled to vote on all the elections and referendums in Ireland, however long they will stay in the country, notwithstanding the fact that that they may directly be affected by the outcomes of these votes. (CSO; 2016) (CitizensiInformation; 2018)

Due to lack of trust, representation and citizens disconnect with politics, they are now more likely to vote for new political parties instead of the traditional ones as it happened in France with "La Republique En Marche!", "Podemos" in Spain or "Syriza" in Greece for example. An important challenge in Ireland will be to understand "how well voters are represented by existing political parties, and to identify gaps in the policy space that future political entrepreneurs may seek to exploit" (Costello; 2017), as it was seen recently in a few countries such as Hungary or Brazil just to name a couple. Furthermore, with this decreasing interest of the citizens in politics and traditional parties, this forces the parties to rely on corporate donations, which is a vicious circle as this, in turn, increases the public distrust in the political scene.

2.4 Democracy

The term "democracy" originates from the Greek dmos ("people") and kratos ("rule") which describes a political system originating specifically in Athens around the 5th century BCE. (Britannica; 2018a) Athenian democracy was one of the first documented democracy in the world which was also a Direct (/ "Pure") Democracy (i.e.: the citizens participate directly in the decision making of the government). An interesting aspect of the Athenian Democracy is that the officeholders were randomly selected (by "sortition", which is a form of lottery) from the voting population in the same way as a Jury Service in a court of law currently works. Due to societal factors such as: increasing population, logistic cumbersomeness of organising votes for every issues, slow communication, increasing complexity of the political system, limited availability of public information, lack of citizen time to spend on politics etc., this gave rise to a new type of democracy (especially in the western world): Representative Democracy. In this system, the citizens elect a representative of themselves in order to make decision on their behalf in the government. The issue with the current Representative Democracy system of today is that it "has been set according to the technological and institutional limits of prior centuries" (Darcy W. E. Allen and Potts; 2017). Voting once every few years in order to elect a "representative" is not a suitable solution anymore in the current information and technology advanced society. This has led, specifically in the western societies, to what is called the "Democratic Fatigue Syndrome" which is characterised by, for example: low voter

turnout, declining party membership, political paralysis, chronic electoral fever, distrust or exhausting media stress. (Stone; 2017) Furthermore, it is argued by two PhD students that "the existing (election) voting systems, e.g., representative democracy, have many limitations and often fail to serve the best interest of the people in collective decision making. To address this issue, the concept of liquid democracy has been emerging as an alternative decision making model to make better use of "the wisdom of crowds"" (Zhang and Zhou; 2017)

Liquid Democracy:
With the advent of new technologies (internet, mobile phones, cryptography), a new type of democracy is increasingly becoming possible: "Liquid Democracy". This is a mix of the advantages of both Direct and Representative Democracy where the electorate can vote on every issue, but they can also transfer their voting power to someone they trust, or better informed on a particular subject or domain. Should the trust be broken between the voter and his/her delegate, the voter can simply retract (hence the term "liquid") the delegation and choose another delegate or vote themselves on a specific issue or topic. This meritocratic system incentivises the delegate to maintain a good track record, increasing a sense of responsibility and accountability. Liquid Democracy can be summarised as "a method of collaborative decision making that allows equal members of a community to either express their decisions on a matter directly, or empower a proxy to act on their behalf, whereby thus received power can be transferred further". (Paulin; 2014) Back in 2015, Google has been experimenting successfully with liquid democracy on their internal corporate social network (Hardt and Lopes; 2015).

2.5 Existing Solutions

There are many initiatives, associations and think-tanks worldwide that aim to promote aspects such as: blockchain voting, liquid and direct democracy and decentralised governance.

For example, in Australia, a political movement called "Flux" uses issue-based direct democracy (IBDD) in order for the population to directly participate in parliament, employing distributed public ledger technology. Once the MPs and senators are elected though this "party", these representatives "give up their autonomy and vote according to the people"[1].
Voting for bills and not for politicians is a great first step towards implementing issue-based direct democracy, but it focuses solely on the parliament bills voting and it doesnt account for citizens to directly propose ideas and solutions to issues that matter to them.

As previously mentioned with the FARC example, DemocracyEarth Organisation proposes a tool called Sovereign which is a decentralised democratic governance protocol. The platform itself is simple and functional, but the organisation seems to be at a very early stage with no clear next political step in their project except for their public ERC20 token (VOTE) sale started in November 2018.[2] [3]

DemocracyOS is an Argentinian open-source platform for a participatory government where people can propose, debate and vote on changes and political proposals of the population. Unlike the 2 previous examples, this one does not rely on the blockchain

[1] VoteFlux: `www.voteflux.org/about/what-is-flux`
[2] Sovereign: `www.sovereign.software`
[3] DemocracyEarth: `www.democracy.earth`

and the project doesnt appear to be active for over a year based on its social media and GitHub activity. [4]

A myriad of other project such as D-Cent, MiVote, Followmyvote, Agora, Voatz, Vote-Watcher, Coalichain, Liquid.us, or Opensourcepolitics propose similar tools of governance but none of which are ready to be mainstream.

The Policy Positioning Tools (PPT) for Political Parties is a guide and framework that invites political parties within a country or region, before an election, to participate and promote their individual policy positions on common issues. Through this tool, people can critically assess and compare the parties, policies and candidates that best align with their opinion on a wide range of issues. Through a Voting Advice Application (VAA), parties can clearly outline their position on issues that are easily understood by the voters. VAA ultimately "produce a customized overview of which parties align most closely with a voters opinions on certain issues" (Eddy Habben Jansen; 2016). A PPT consists of compiling the responses of the positions of each party on a list of simple, pre-defined statement, as for example:

Table 4.2

Example of party scorekeeping in a simple Excel sheet

Statement	Party response
Pension system should mainly be based on private pension funds.	agree
Every person—regardless of their work scope, positions and work experience—should be assigned an equal pension.	agree
Every pensioner should receive an equal amount of pension.	agree
The state should financially support the private sector in order to promote the employment of citizens.	disagree
The state should fully delegate the employment of citizens to the private sector.	agree
Free professional training should be a priority of the employment policy.	disagree
Families with many children should be granted free outpatient services.	disagree
…	…

Figure 2: Example of Party Scorekeeping

These statements can then be turned into a VAA through which a voter will be able to give his/her opinion on each of the statements. Following this, the voters will then be given the name of the party that best suit their opinion.

In Ireland, an interesting initiative was to launch the platform [5] whichs goal is to "make elections in Ireland more transparent and to give voters the information they need to make the right decision". Indeed, a research carried out in Ireland "shows that there

[4]DemocracyOS: `www.docs.democracyos.org`

[5]Which Candidate Ireland: `www.whichcandidate.ie`

are often significant differences in the policies supported by parties and the views of their voters" (Costello; 2016). Being presented with a candidate that best matches the voters opinion is of great help to the voter. However, if for instance a voter is presented with his/her best match being at 67% and the second best match being at 44%, this means this means that the most suitable candidate will not be in line with the voters opinion on one third of the important issues.

All of these projects are a great starting point towards improving the way general politics and parties currently work. Not a single one seems to be ripe enough to tackle all of the issues previously mentioned, but a combination of some of the different aspects proposed could provide a great solution for an issue-based democracy in Ireland.

3 Methodology

Background: The representative democracy in place in place in many places around the globe has not evolved since the last century and, in its current form, does not seem to be relevant anymore in a fast changing, technological and information-based society. The disconnect between the electorate and the politicians is greater than ever, which leads to greater abstention during important electoral periods and punishing votes towards the extreme parties as seen in numerous countries over the past few years. The proposed solution needs to enable citizens to directly propose solutions to their everyday issues but also voting directly on each proposal or giving the right to a trusted fellow citizen to vote on their behalf. Due to its nature, this project research methodology relies more on the qualitative, exploratory and historical research than quantitative research.

Research Objectives:

- Break-down the different aspects that encompass "Direct Democracy" such as: voting, democracy, referendum, parties etc.
- Carry out an in-depth understanding of each of these aspects including history, trends, potential improvements and issues in Ireland and worldwide.
- Make a critical analysis of the current "state of the art" existing solutions, aiming to tackle the issues of political parties, voting and democracy, more specifically on the blockchain.
- Armed with a deep understanding on the political field, propose a viable solution that will help tackle the issues discovered or at least propose some improvements.

The aim of this research is to evaluate:

- If political parties are really necessary in order to form and maintain a government. And if not, how could parties be replaced.
- If it is conceivable to vote on issues instead of parties and representatives.
- To what extent can the Wisdom of Crowds help form and guide a government.

- If the current democratic system is suitable for our modern society and compare it against Liquid Democracy.
- What are the barriers of electronic voting (on a dedicated machine or on the internet).
- If the Blockchain is really necessary to implement the concept of Liquid Democracy and if so, is a DAO the best solution.

The following points are outside of the scope of this research:

- Whether it can be applied to every country worldwide.
- Evaluating the appetite, acceptance, maturity of the public and the government for such a solution.
- Tyranny of the Majority: whether letting the majority of a population rule at the expense of the minority is a suitable democratic system or not.
- A strong user authentication to the platform is assumed and the interface is directly handling interactions with the Blockchain such as: private key storing, transactions fees etc.
- The Blockchain is presumed secured hence security concerns are overlooked.
- GDPR aspects of the platform.

It is important to note that numerous of the reviewed existing projects wish to completely remove the government as an institution or the parties in an anarchic way. This is not the aim of this research as it acknowledges the need for some sort of government. Instead, the aim of the solution is more focus on improving the governments functioning. It goes the same with the need for a blockchain. A substantial amount of the reviewed projects are "decentralising" sometimes with no particular added benefits. Only a certain level of decentralisation is required for this project with clearly highlighted benefits.

Research Question:
"To what extent can the blockchain be used to implement the concept of Liquid Democracy in Ireland, therefore disintermediating political parties and revolutionising the way citizens interact with politics?"

Evaluation Objectives:
The main evaluation objective is to provide an in-depth understanding of how does the proposed solution compare against the current political system. Understanding the advantages this solution brings but also its possible challenges which could be a barrier to its implementation. With no hard evidence of Liquid Democracy being implemented at the government level worldwide, some aspects of the evaluation are expected to be hypothetical, based on correlational research. The political area of the research question being extensive, the evaluation will narrow its focus down to the following sub-subjects:

- Can/Should the blockchain be used?

- Implementing the concept of Liquid Democracy in Ireland.
- Disintermediation of political parties.
- Revolution of the way citizens interact with politics.

4 Implementation

Introduction: Thanks to the recent developments in the web and Blockchain technologies, it is now possible to propose a solution that can help implement a liquid democratic system while taking advantage of the, yet untapped, Wisdom of Crowds at the government level. Unique in its kind, this solution is expected to restore trust in politics by empowering citizens to be directly involved in the decision making of the government.

Proposed solution: The proposed solution is a web-platform (as well as mobile application in the future) where every Irish voting citizen can authenticate in the same way as they currently do on the Revenue website using their PPS number, date of birth, password and an additional Multiple Factor Authentication (MFA). Once securely logged-in, the user will have the option to browse through some of the issues (sorted by topics), that need to be addressed by the government, and directly cast their vote on each specific issues. They can do so anytime that best suit them, as long as it is before the predefined deadline. For each issue/proposal, the voter is automatically given a number of 10 votes (tokens) with which they can express the importance (sentiment) they give to that specific issue (weighted voting). This is an improvement over the current binary yes/no answer as it gives a clear picture about the importance that the electorate gives on each issue, hence avoiding time-wasting on non-important issues for example.
Beyond voting for each issues, the citizens will be able to directly propose issues that, in their view, should be addressed by the government. A maximum of 12 issues per year per citizens will be set in order not to "pollute" the system.
Each proposed (pre-curated) issue will be available for all citizens to vote on (approve or deny the proposal) as well as cast the level of importance (from 1 to 10) they attach to it and comment on it by suggesting how to improve the proposal. Each useful comment can in turn be "upvoted" in the same way as done on Reddit for example. Once the weight of approval has reached 10% of the voting population (i.e. for a population of 4 million citizens, the number of approved votes/token has reached over 400,000 which could represent only 40,000 people if all voters cast their 10 tokens in favour of the proposal), the proposal/issue will be curated by independent political experts whose task will be to clearly summarise the impacts and implications of the proposals as well as remove any bias and incorporate the relevant highest voted comments to the proposal. These curated proposals will then be re-submitted for a second round of votes to the electorate. This second round of voting will help avoid the misinformed voting issue as seen namely in the (initial) Brexit vote.

Delegating votes: Instead of voting themselves on issues that they are undecided about, the voters can delegate their voting token(s) to a trusted individual who can, in-turn, also do the same. Voters also have the option to delegate their voting power on all issues related to topics that does not concern them. For example, a childless citizen can delegate his/her voting power to a trusted fellow on all issues related to childcare and education

for example.
The delegation of voting power can be retracted instantaneously any time by the citizen who may be displeased by the performance of their representative, thus effectively creating a real-time feedback loop.

Following up with the issues: The initial submitter of the proposal has the option to be responsible (and directly accountable) for the implementation of the proposal or to let the delegate with the highest number of liquid votes be responsible for ensuring it gets implemented.
When an issue has been marked as completed, voters will be able to evaluate the way in which it was addressed, hence creating another feedback loop, this time on the acceptance of the implementation.
In order to avoid too many "dual-mandate", a representative in charge of an issue can only accumulate up to 5 different issues to tackle at any given time, related or not. Furthermore, this system does not provide a long-term secured job as the representative can be "overthrown" instantly should the progress on the issue not be satisfactory or their popularity falling below a specified threshold.

Implementation: In order to implement liquid democracy in Ireland, it is proposed to create a new neutral party (not left nor right nor centre). It will initially aggregate the issues proposed by each of the parties of the political landscape to be vote on. After these elections, whether the neutral party is in charge of the government or not, the process of issues-proposing will be a regular, constant one. The political representatives (ministers: prime, health, transports) will be initially, temporarily, appointed by the "party" before being directly appointed by the voters. Afterwards, anyone (ideally subject matter experts) making a successful proposal or the most popular "liquid representative" will be in charge of the given issues. This meritocratic system offers a solution for each citizens to directly apply their civic duty by working on improving the society they live in.
The platform will offer a "social-media"-like interface where one voter can follow other trusted voters as well as see each proposals made by the voter. This will lead to the gamification of the platform hence incentivising users to make useful proposals. Reputation of the voters will also play an important part of the platform in that the comments of those with a higher reputation (useful contributions to the proposals) will appear higher in the list of comments than those with a lower reputation (with also the possibility of sorting by newer comments).

Why on the Blockchain?: As previously mentioned e-voting, over the internet or through bespoke machines, does not provide enough security, which could undermine the democratic process of an election. However, with the advent of the blockchain technologies, this is coming to a change.

History of the Blockchain: Blockchain was first introduced in 2008 by an anonymous author, with the pseudonym of Satoshi Nakamoto, through his paper "Bitcoin - A Peer-to-Peer Electronic Cash System". Blockchain is one of the most common type of Distributed Ledger Technology (DLT), which is in itself merely a database that is distributed across multiple locations. Blockchain is a more specific form of DLT due to the way it structures transactions into blocks. Each of these blocks are added after the previous one (every 10 minutes for the Bitcoin network) and secured using a one-way encryption algorithm.

This produces a very specific unique signature called a "hash" (of 64 characters using the SHA-256 algorithm currently in use by the Bitcoin network) which changes dramatically should the slightest information change in the transaction. The signature of the block will be encoded into the next block, linking them like a chain, so that if any prior block is tempered with, the subsequent blocks will not be valid anymore. (Buterin; 2014)
The consensus mechanism used for validating the transactions of the network is called Proof of Work and consists of users "lending" their computers processing power to "verify and record payments into the public ledger" (Swan; 2015) in exchange for a reward. Due to the high energy consumption of this process, other consensus mechanisms are being implemented such as Proof of Stake, Proof of Identity or Proof of Burn, among others.
Beyond the currency aspect of the Bitcoin (commonly referred to as "Blockchain 1.0"), the concept of Smart Contracts (commonly referred to as "Blockchain 2.0") became popular with the onset of the Ethereum blockchain technology. The Ethereum Blockchain can be compared to a decentralised computer, and a smart contract is basically a program that runs on the blockchain. These programs are written in a programming language called Solidity and consist of a set of rules that govern the functions of the contract. Once deployed, these rules cannot be altered without the consensus of the networks users.
Smart Contracts introduced the concept of Decentralised Autonomous Organisation / Cooperation / Government (DAO/DAC/DAG). DAOs have the potential to revolutionise the human social institutions by automating governance and transferring it away from humans responsibility to hard-coded rules on the blockchain that cannot be tampered with. These provide a fully autonomous organisation with no single leader where the rules and structure of a traditional organisations are replaced by a series of coded smart contracts, thus eliminating the need for centralised control. Typically, in a DAO, the ownership is represented by tokens owned by individuals, which gives them voting rights on all topics governed by the smart contracts. (McNally; 2017)

Blockchain technologies usually have the following characteristics:

- Trust/Trustless: as mentioned by Goldman Sachs, Blockchain is the "New technology of Trust" (Sachs; 2018). Indeed, instead of having to rely on trusted third parties to do their work, the protocol of the blockchain works by "trust by computation", which is a shift from "trusting people to trusting math" (Antonopoulos; 2014), thanks to publicly available (open-source) coded rules which cannot be tampered with. A key element to successful election is trust. Should the results be contested by one party or another, this will lead to conflicts and lack of trust in the political system.

- Decentralised: instead of relying on a central authority to validate, store and maintain the transactions on the blockchain, these operations are carried by each node on the network hence reducing the risks of corruption, censorship or single point of failure.

- Distributed: is the process of storing transaction information in multiple different nodes hence reducing the dependency on a single node. (Olnes et al.; 2017). As in a backup solution, should one of the nodes fail, others are available to relay the information. Being a type of DLT, a blockchain is necessarily distributed.

- Transparency: "every ledger entry is verifiable and retraceable across its full history (accountability)" (Maupin; 2017) by anyone having access to the network.

- Pseudonymous: most blockchain use public keys to make transactions in the same way as an email address. All transactions can be traced back to that public key but not to identify the person transacting with it.
- Disintermediation: Based on a Smart Contracts rules a contract can for example self-execute once specific parameters have been reached without relying on the performance of a third party.
- Immutable: "Blockchain as an append-only and immutable global database" (McCorry et al.; 2017). In principle, once a transaction has been recorded in the blockchain, it cannot be reverted without the approval of the majority of the network.
- Scalability: considered an issue with the Bitcoin blockchain and its 7 Transactions Per Second (TPS) cap or the Ethereum blockchain and its 15 TPS, other projects such as EOS have the potential to scale and allow millions of TPS (Bach et al.; 2018).

Some of the essential requirements for a successfully secure e-voting platform are: "privacy, anonymity, accuracy, authenticity, eligibility and verifiability" (Huszti; 2011). All of these requirements are supported and even improved by the use of the Blockchain in a voting system, although the eligibility could be further enhanced depending on the type of blockchain used. There are 3 main types of Blockchain:

1. Public: is a blockchain where anyone and everyone can participate and contribute to the network. Most of the mainstream (highly volatile and speculative) cryptocurrencies (Bitcoin, Ethereum, NEO) are public as they have "no single owner; are visible by anyone; their consensus process is open to all to participate in; and they are full decentralized" (Sultan et al.; 2018).
2. Private: is a blockchain that is controlled and managed by a central entity, usually a corporation, where only authorised/invited person can read from and/or write on. It does not require a consensus algorithm nor mining and has a much faster transaction speed. It could be argued that this is not a type blockchain per-se as it doesnt fulfil most of the characteristics of a blockchain mentioned above.
3. Hybrid/Permissioned: is a mix between the Public and the Private blockchain in the sense that it is publicly available but only to those who have been authorised to (either automatically, by following a set of rules, or manually). in this scenario, a few trusted decentralised mining servers (nodes) can be centrally selected and controlled in order to (partly) decentralise and distribute the blockchain among the network.

The Hybrid/Permissioned will be the type of blockchain selected for this project as it allows to screen (by a centralised body, the government) only eligible citizens to cast their vote as well as low transaction cost (due to no need for mining) while keeping control over the rules to be applied and maintaining confidentiality and verifiability. It provides the best of both worlds (decentralisation and scalability) for this specific project. "These ledgers present advantages over both fully distributed blockchains and traditional databases" (Atzori; 2015).

5 Evaluation

Introduction: Although very much at the stage of concept, with no visual front-end user interface available yet, it is apparent that the idea of implementing Liquid Democracy in Ireland, powered by the Blockchain, would help improve politics and solve a few problems namely: improving the representation of the democratic system and curbing the growing dissatisfaction of the citizens in politics.

5.1 Improvements over current liberal democratic system:

- **Enabling secure e-voting:** As previously mentioned, e-voting brings important security concerns which can be overcome, thanks to the use of the permissioned blockchain used by the proposed system. With the current physical voting system, the voter has to trust that his vote was cast as intended with no way to checking it. Blockchain voting will enable users to track how their votes was actually used. Another great advantage that e-voting brings over physical-voting, other than faster results and cheaper polling, is remote voting. Instead of having to travel to a voting station on a specific day to cast ones vote, the voter now has the possibility t casting their vote from wherever they are physically located. By removing this barrier of physical-voting, this is expected to increase the voting turnout hence having voting results more representative of the population.

- **Upgrading binarity of the votes:** Thanks to the "weight" option of the smart contract, it is now possible to gauge the importance that the citizens give to each issues. Moreover, this also enables a second dimension of democracy, in the voting process, such as that for a proposal to be passed, it needs to get a majority votes in favour but also having a positive opinion on the subject. This means that the vote of the person to which the subject matters more, have a bigger weight than those with little opinion on the subject, hence further increasing the representation of the electorates opinion.

- **More frequent, granular and cheaper polling:** Instead of voting once every few years for a party or a representative that may not best reflect the citizens values, or for an expensive state-run referendum that may over-simplify complex issues fitting multiple issues under the umbrella of a single question, the proposed solution allows to poll the population as often as needs be in order to break-down each issues to a single one that is easy to understand. It is also considerably cheaper, as with the submitted solidity code, voting on an issue cost on average around 110,000 Gas or 0.02329 Euros (at an average price of 2.9 Gwei of Gas price with a conversion rate on the 14/12/2018 of 1 Eth = 73.27 Euro)[6] [7]. With an electorate of over 3.3 million people for the 2016 General Elections in Ireland, if these were all to vote on an issue, this would cost around 75,000 Euros. This is considerably cheaper than the cheapest Referendum back in 2002 at 10.8m Euros (Times; 2016). This means that the cost of that one cheapest referendum could instead be used to fund the voting of around 150 issues. Furthermore, the solidity code could certainly be optimised for better cost efficiency (by adding a layer of IPFS, for example) or another platform than Ethereum could be used in order to further reduce the costs.

[6] CoinGecko: `www.coingecko.com/en/price_charts/ethereum/eur`

[7] Eth Gas Station: `www.ethgasstation.info/calculatorTxV.php?curr=eur`

- **Upgrade of the democratic system:** The current representative democratic system does not appear to be suitable for our modern society. The concept of an issue-based liquid democracy appears to be the best compromise between direct and representative democracy, primarily thanks to the transfer of voting power to a trusted individual and the meritocratic system incentivising the representative to maintain a good track record. Although it is proven that the democratic system is in need of an upgrade, it is not possible to judge whether liquid democracy is indeed the most suitable solution. During the 2016 General Elections in Ireland, a party called Direct Democracy Ireland (D.D.I.) proposed to implement direct democracy in Ireland, but failed to gain traction as they gathered a mere 6,481 votes. Whether the party was out of phase with the reality or the citizens were not ready for a change remains to be seen in the future.

- **Harnessing the Wisdom of Crowds:** The proposed system ultimately will enable anyone to propose, in just a few click, solutions to their everyday issues and problems. Not only this will bring to surface issues that governments may currently not be aware of, but more importantly, the solutions proposed to fix these issues will come from a much broader audience than the few expert politician, hence ultimately leading to better solutions. Harnessing the Wisdom of Crowds at a government level to tackle the constituencys issue has yet to be proven effective as, at the time of writing, it is not documented to have been implemented anywhere. Even though not new, it is strange that this appealing concept hasnt been put in place. Maybe the technology was not advanced enough to enable this, until now.

- **Redundancy of the party system:** Instead having to make compromises by voting by "the least unsuitable" party or candidate, the proposed system enables the users to directly vote on each issues hence providing a fully representative system for each individual voter. In addition, issue-based direct democracy is expected to help curb the rise in populist and extremist parties. Indeed, instead of voting for an extremist party just because it promises to tackle emigration issues (for example, as it is topical nowadays) at the expense of other less pressing issues to a voter, the latter would have to choice to vote only on that specific issue instead of undermining democracy in itself by voting for a party and the rest of its ideologies.

5.2 New Issues / challenges / limitations:

- **User friendly system:** Quintessential to the sustainability of the platform is its user-friendliness. The authentication should be as secured as the "myAccount" platform from Revenue and no more complicated. At first connection, the voter should be able to vote on any available proposal within 5 minutes of logging in, after viewing a short tutorial. No emphasis or mention should be put on the Blockchain aspect of the platform, as it merely a feature, only highlighting its benefits. Indeed, "Decentralization is not always the best choice for all organizations and there are limits to what blockchains are suited for" (Atzori; 2015).

- **Voter fatigue:** As the process of voting is a continuous, constant one, it is expected that a certain segment of the population would become "tired" of having to cast their votes on a regular basis (Augenblick and Nicholson; 2015). Should this phenomenon emerge, some sort of voting incentivisation could be put in place in

order to keep that segment motivated. However, as the benefits of liquid democracy start to prove themselves, users will become organically incentivised to vote and make proposals.

- **Digital divide/exclusion:** As with any projects taking advantage of digital technologies, the question of its access by the whole population is raised. However, with 93% of the Irish consumers owning or having access to a smartphone (Deloitte; 2018), this could actually prove to be an improvement over the physical voting. Furthermore, being a web-based platform accessible constantly, the small percentage of population not having access to a smartphone could also use the computers available at most of the public libraries nationwide for example.

- **Vote Tracking:** The feature of allowing users to track their vote has the advantage of bringing trust in the system but could lead to deviance in the intended use of the system. For example, if a user wants his proposal to be accepted, he could potentially create a voting "black-market" promising to financially incentivise anyone that can prove him they voted in favour of his proposal. Common sense of the voters is expected to prevail, but this issue seems only possible to tackle by removing the vote-tracking feature from the user.
  Another potential concern with voting on the blockchain is the aspect of the voting results to be publicly available in real-time. This could possibly lead to the "bandwagon", "herding" or "self-fulfilling prophecy" effect (Simon; 1954) whereas voters simply follow the trending choice, as this is what most voters chose. On the other hand, this could also have the effect of raising awareness about a rising polemic decision on a subject and shaking up the public to counter that decision and possibly avert a situation such as the Brexit one.

- **Binarity of votes:** Even though a new dimension of sentiment has been added to the vote, the main answer is still very much binary. A proposed future development is to add a functionality of Multiple Choice Question proposals as seen in the "`www.whichcandidate.ie`" platform and enable voters to make proposals such as: "What should the priority be in the next budget? A) Prioritise increased spending on public services, B) Prioritise tax cuts, C) Prioritise reducing the national debt, D) None of the above". This could further enhance the democratic system by guiding the voter towards a more structure proposal.

5.3 Research Question:

With this in mind, the evaluation of the sub-topics of the research question can be answered as follows:

- **Can the blockchain be used?** Blockchain is clearly essential to the long-term success of the proposed solution. Indeed, the transparency and immutability aspects, of it are particularly essential in providing sufficient trust of the voters in the system. More and more Blockchain applications are being experimented with, at the government level worldwide, proving an increased general interest and maturity on the subject, hence its suitability.

- **Implementing the concept of Liquid Democracy in Ireland.** The benefits of Liquid Democracy are evident. Enabling the citizens to directly vote on issues, as

seen in referendums, directly make proposals and to have the option of delegating ones vote to a trusted fellow citizen would help restore trust in the political system. However, being a ground-breaking subject, it remains to be seen if the solution will be practical enough to accepted by both the citizens and the government.

- **Disintermediation of political parties.** With such a solution in place, the political party system would undoubtedly be made redundant. This is believed to be a great improvement as parties cannot be sufficiently representative of the population. Instead of having to fit to the program of a party and make compromises, a representative could be free to propose any solution they see fit. Anyone (subject matter experts and trusted delegates) could become "politicians" by being in charge of issues, thanks to this meritocratic system enabling direct accountability.

- **Revolution of the way citizens interact with politics.** Although the system clearly revolutionises the way citizens interact with politics by empowering them, it should ideally be perceived as a logical evolution of the political system instead of risking to scare the citizens by appearing too radical. A progressive approach should be taken, starting at a local/regional level before letting it organically grow at a national level. Furthermore, it can be questioned whether the crowds are wise enough to govern themselves for their own greater good.

6 Conclusion and Future Work

The current liberal democratic system in place in most of the western-world clearly has room for improvements. The proposed implementation of Liquid Democracy as an improvement appears to be the best compromise as it combines the advantages of direct (issue-based) and representative (delegation) democracy. Letting citizens vote on each issue and directly proposing solutions to these issues opens new opportunities by tapping into the concept of Wisdom of Crowds in politics, whereas the solutions of the many citizens are better than those of the few specialists (politicians). This disintermediation of the political party and direct involvement of the citizens in the political agenda in Ireland is the innovation in democracy that the country needs, enabling a "government of the people, by the people, for the people" (Abraham Lincoln). The proposed solution proves that it is possible and viable to implement Direct Democracy, as the blockchain technology is ripe and is essential to the project. Further works need to be made in order to build a platform that is user-friendly and scalable for the electorate to be using on a regular basis. If the people (citizens and government) are ready for this change, this solution could, technologically, be implemented as of today, bringing back the trust of the people in the government that is deeply lacking today.

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