FLEXIBLE REAL ESTATE WITH BLOCKCHAIN

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PREFACE

In recent years I have been asked a number of times to think about the application of circular processes with regard to the reuse of materials in buildings. About the issue of circularity itself. Why do so many materials disappear into the ground after years of service in a building? Why doesn't it come full circle and why do we not reuse these materials?

When answering these questions, everyone falls back on their own toolbox. One does it practically, the next deals with the regulations, the other looks at the technological possibilities or influencing behavior, but my toolbox contains tools from the combination of law and economics. Tools that are rarely used in a burgeoning world of cradle-to-cradle, architecture, and real estate, because they are not tangible. Often too abstract to be able to apply directly, while the art of legal and institutional economics is correct, to build a path for everyone in such a way that the people involved automatically walk in the right direction. Adam Smith in his book The Wealth of Nations simply called this the "invisible hand" of economics, with which he also laid the foundation for the current interpretation of economics.

In a world in which only 3% of all materials in buildings are reused in a high-quality way, while this is now 95% with cars, you can say that the invisible hand of Adam Smith cannot yet perform its work as it can is the case in the automotive industry. In this book we therefore look more closely at the design of the invisible hand behind a circular and sustainable application in materials in and for buildings. A special role is assigned to the use of modern technologies and for blockchain technology.

Why this is so and based on which blockchain technology could give substance to the role of the “market master” for the reuse of materials in buildings, associated CO2 accounting and make the real estate market more flexible, is the common thread running through this booklet with various backgrounds. from the science of economics and law and the application of these backgrounds in the daily world of the property owner and property manager.

Simon Duindam

Heerlen, June 2018/Melbourne, October 2022

INHOUDSOPGAVE

1.
The Usual Suspects

In his Public Finance handbook, Harvey S. Rosen has given a face to the "usual suspects" of the economy. With these usual suspects, Rosen means that these are factors why the basic principles of an economy or a market would not work. According to him, these include the following principles:

a. Collective goods
b. Natural Monopolies
c. Adverse selection
d. External Effects
e. Moral hazard

All these five factors are points of attention in the search for why reusable materials in buildings are hardly used. Is there the problem of public goods here, from which no one can be excluded, and the consumption of one person is not at the expense of another, so that in the end no one wants to pay for it and these goods, such as dikes and defense, taxes must be paid.

Or are there information differences between two economic actors who wish to enter a transaction with each other, but do not know each other's characteristics, wishes and history, so that, as in insurance markets or markets for second-hand cars, only the "bad lemons" traded, as George Akerlof taught us in “The Market for Lemons” (1970).

With the waste of materials, you can also think of external effects, including an economist who understands effects, that the production or consumption of a certain good not only has its use for the person who wants this production or consumption, but that this also has consequences for the usefulness of others or external parties. The pollution of the air is a well-known (negative) external effect, but so is the beautiful front garden with flowers, which passers-by can enjoy (a positive external effect).

With each of the above suspects, the question is always which characteristic of a transaction between two people ensures that the transaction does not go through. Is it the non-exclusiveness or non-rivalry of the product or service, the information characteristics of a production or transaction, or the externalities associated with a transaction?

Economics has been looking for years at the characteristics of goods and transactions, and the question is always why people act the way they do. Or in the case of materials in a building, that these materials disappear completely every time, new materials are produced resulting in mountains of waste on the one hand and depletion of the earth's resources on the other. How can this opportunistic behavior be controlled in such a way that materials can be reused repeatedly, the external effects of material use are minimized, and the value of the materials in their function for a building or piece of infrastructure is preserved.

Technological developments can play a key role in the search for solutions to certain issues. ICT technology has turned the world of communication and the organization of this world upside down, whereby (natural) monopolies around post and telephony, as well as newspapers and publishers, saw its original revenue models come under considerable pressure because of increased competition and the possibility of establishing a level playing field between different parties. But every technology can also lead to new (natural) monopolies, such as the internet giants Google and Facebook, where network effects benefit every user from joining the largest party with a view to lower costs and more added value as all users are in the same environment.

Blockchain technology poses a new challenge here, because blockchain technology leaves information unchanged in its ledgers with the help of its inscriptions, excludes information manipulation (asymmetric information), and thus has a major impact on those aspects in our society in which uncertainty due to “moral hazard” and “adverse selection” play a key role. Not being able to use such technology every time means that we must organize a lot of extra things or that what two actors mean in a transaction is conducted in practice that way. In the world of real estate, we therefore speak of inspections, valuations by appraisers and accountants, thick mortgage contracts and various forms of security rights, which must ensure that everyone complies with his or her agreements.

Lawyers for contracts, civil-law notaries for property and mortgage deeds, many matters relating to real estate are recorded to limit mutual mistrust. This also severely limits the possibilities to arrange things differently and creates various external effects, because of which buildings cannot be managed as we would like, and where the life cycle of a building is unnecessarily disrupted. Certainly, in that period in which buildings are empty and the use of the building or the parts of the building does not provide the added value that would be possible in alternative situations, provided that certain legal properties of buildings or materials could also be used.

An economist who has written about this with impact is Ronald Coase in his The Nature of The Firm (1937) and The Problem of Social Cost (1960). What his thoughts have been about this and what Blockchain technology means for his thoughts is discussed in section 2. Then, in section 3, we look at the real estate object itself and which developments affect real estate if we start working with blockchain technology in this sector. In this way we get a picture of the added value of blockchain for the various property owners and managers, so that we can then further investigate which additional economic, legal, psychological, and institutional aspects from an economist's toolbox can ensure a circular economy related to the use of materials in buildings.

2. Ronald Coase

In their book “Blockchain Revolution” (2016), father and son Tapscott give Ronald Coase a prominent place. His 1937 article on The Nature of The Firm and the way in which transaction costs influence the organization of companies, organizations and ultimately society play a central role in their book, because the sequel of the book shows which aspects of society , as well as the organization of transactions and bundling of transactions in companies and organization, blockchain technology is now actually having an effect.

The Nature of The Firm addresses the question, "Why and under what conditions should we expect companies to emerge?" Since modern businesses can only come into existence when an entrepreneur somehow begins to hire people, Coase's analysis continues by looking at the conditions under which it makes sense for an entrepreneur to seek hired help rather than a particular task. to outsource.

The traditional economic theory of the time suggested that because the market is "efficient" (that is, those who are best at providing a good or service do so most cheaply), it must always be cheaper to buy than to hire.

However, Coase noted that there are some transaction costs to using the market; the cost of getting a good or service through the market is more than just the price of the good. Other costs, such as search and information costs, negotiation costs, trade secrets and enforcement costs, can all add to the cost of purchasing through the marketplace. This

suggests that companies will emerge if they can better manage internally to produce what they need and somehow avoid the above (transaction) costs.

However, there is a natural limit to what can be produced internally. Coase notes, “declining returns to the entrepreneur, including increasing overheads and increasing propensity for an overworked manager to make mistakes in resource allocation.”

Coase argues that a firm's size (measured by the number of contractual relationships that are "internal" to the firm and the number "external") results from finding an optimal balance between the competing tendencies of the above. outlined costs. In general, increasing the size of the business will be beneficial initially, but the declining returns noted above will eventually kick in, preventing the business from growing indefinitely.

All other things being equal, a company will tend to be bigger:

- The less the costs of organizing and the slower these costs rise with an increase in organized transactions.

- The smaller the chance that the entrepreneur will make mistakes and the smaller the increase in errors with an increase in organized transactions.

- The greater the decrease (or the less the increase) in the supply price of factors of production to larger firms.

Based on these assumptions, Coase encouraged each researcher to investigate cases in which different transaction costs lead to different forms of organization, and to look at all those costs that we could classify under the costs of coordination and the costs of information and the search for information. In this way we could find out whether improvements in the organization of society could come into their own. Something we also find repeatedly in Tapscott and Tapscott's book about the question of whether Blockchain technology means anything for transaction costs in many areas.

In addition to The Nature of The Firm, Coase authored another important article in 1960. This article “The Problem of Social Costs” continues with the thoughts on transaction costs, as expressed in The Nature of The Firm.

Coase argued that if we lived in a world without transaction costs, people would negotiate with each other to produce the most efficient distribution of resources, regardless of the initial allocation. This is better than assignment through lawsuits. Coase used the example of a nuisance case called Sturges v Bridgman, where a noisy candy maker and a quiet doctor were neighbors and went to court to see who should move. Coase said whether the judge ruled that the candy maker should stop using its machines, or whether the doctor had to put up with the noise pollution, they could make a mutually beneficial agreement about who moves or moves, with the same outcome as a productive activity.

However, many welfare-maximizing reallocations are often ignored because of the transaction costs associated with negotiation. For example, the candy maker may have many neighbors who claim to be "nuisance" - some legitimate and some not that he should investigate, and some neighbors who are nuisance may try to demand excessive fees. In these cases, the transaction costs will pale in comparison to the price signals, which would have led to the most efficient allocation of resources.

In cases such as these with potentially high transaction costs, regulation should produce a result like what would result if transaction costs were eliminated. Therefore, courts should be guided by the most efficient solution for externalities. Coase's ultimate thesis is that laws and regulations are not as important or effective in helping people as lawyers and government planners believe. Coase and others like him wanted a change of approach, to analyze the evidence for positive effects on the cost of actions, as he had done earlier in The Nature of Firm regarding the way companies are organized. And as Tapscott & Tapscott base their analysis and the application possibilities of Blockchain technology. The argument forms the basis of the Coase Theorem, as labeled by George Stigler.

The Coase theorem or the Coase theorem therefore states that private economic participants can solve the problem of externalities among themselves. Whatever the distribution of rights, the parties can always reach an agreement where the result is better for everyone. Coase assumes that the bargaining power of all parties is equal.

The underlying conditions for this statement are:

- no transaction costs

- the damage caused by external effects must be measurable

- a good description of the property rights

- a limited number of parties involved

This statement is an important basis for most modern government economic analyses. Coase has not only left his mark in economics, but also in legal science. This is evident, for example, from the fact that his 1960 article The Problem of Social Cost is the most cited article in American legal science. To achieve an optimal outcome, it is necessary that the ownership rights of the costs and benefits resulting from a transaction are fully and accurately assigned (full contract). This applies regardless of the distribution of those rights in the initial situation. In other words: the optimal outcome can be achieved from various possible starting situations. This result holds under two conditions: (1) that income effects do not play a role, and (2) the negotiations to arrive at the optimal outcome do not require transaction costs.

3. What is Blockchain and Real Estate about?

The underlying idea behind this book is that if we continue to consume scarce resources at the current rate, we as humanity will need a second world by 2030. In other words, raw materials are finite, and we must not only be aware of this, but also act. If you look at real estate in the world, this real estate is full of materials that are now often removed after they are no longer needed.

At present, only 3% of all materials in a building are reused in a high-quality manner and many opportunities and alternative solutions remain untapped. Materials are currently not easily marketable and can be used for reuse, because the value of the materials has not been validated, the quality of secondary materials is doubted and property rights on these

materials are insufficiently established. This leads to large social costs or negative external effects expressed in economic terms. Effects that can be (largely) reversed by correct registration of the identity of materials and by granting and complying with property rights on the objects that currently cause the external effects. Or, in our case, be able to guarantee the property rights to materials, as also described by Coase in the previous paragraph. Property rights that can at the same time resolve the issue of asymmetric information (quality issues), or the “lemon issue” of Akerlof.

Property owners are insufficiently aware of the possibilities for reuse of materials and existing materials are often seen as a cost item in the event of demolition or renovation. In addition, real estate owners currently only write down on materials and are ignorant of the possibilities of applying the value of materials by writing them down. If a building is depreciated, the materials present in the building at that time represent a certain residual value, which is not used as such. A residual value that can also be determined at the beginning of a real estate project with the correct registration of materials, which means that lower financing costs are achieved.

Property owners and experts have indicated something very substantial during the incubation program of the company Block Materials on the Brightlands Smart Services Campus, namely:

- Searching for the right interpretation of sustainability objectives about real estate.

- Being ignorant of the use of residual value of materials and the tradability of materials;

- Not wanting to miss the trend about the possibilities of Blockchain technology related to materials.

Creating value for property owners by making different use of materials in buildings is therefore an important goal. On the one hand by providing insight into materials and assigning them value and on the other hand by means of high-quality (re)use of materials to fulfill sustainability and maintenance objectives. This unites private and public goals.

The Blockchain technology is crucial for two aspects, namely validation and granting of property rights. Validation because the value of materials is recorded and is therefore transparent. Assigning property rights to materials ensures that materials acquire their own identity, are made transparent and are therefore relatively easier to trade between property owners, for both the short and the long term. By means of the identification and Blockchain technology, it is possible to follow the life course of materials (track-and-trace) in areas such as management and maintenance, damage, and relocation of a building. A life course that therefore also gives substance to the concept of Circularity and can form the basis for markets for reusable materials to give substance to one of the aspects of a Circular Economy, namely that relating to building materials.

We could refer to the technically innovative product that is being pursued with this as the 'tradability of materials by means of Blockchain technology'. An actual residual value of buildings leads to higher margins, but only if the underlying materials can also be used alternatively through lease or sale in the future. For this, property rights must be guaranteed by means of Blockchain technology as well as validated by an accountant (also assisted by Blockchain).

Box 1: Which requirements must we consider so that the auditor's report is valid?

An accountant issues an unqualified opinion on the figures if he can verify that the process of inventory and registration of a building about the materials present in a building has been conducted correctly, and that all data has been correctly placed in a database. To this end, the accountant validates the process of inventory and registration in advance, and then checks this based on random samples. If the samples show that this process is going well, the accountant issues an unqualified opinion. The same applies to other defining processes, such as the process of collecting and applying prices, granting, and integrating CO2 allowances and standardizing materials data.

Property owners can write (real) options regarding the availability of their materials over time and in this way also make the materials financially liquid. Because they must deliver these materials later, in accordance with a (smart) contract, they will do everything they can to deliver the materials in accordance with the agreed quality in time. Proprietary rights not only show exactly who the materials belong to, there is also the liability to do with the materials that is promised in agreements.

Box 2: Should a smart contract be automatically linked to a certificate of ownership? Is this a necessary thing? What does such a smart contract look like? Which delivery conditions apply?

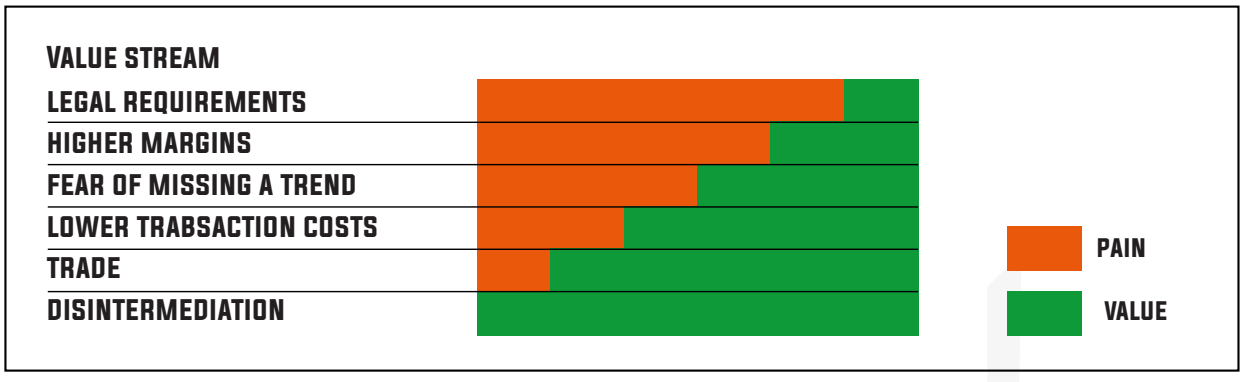
There is no legal difference between a contract and a smart contract. Both are agreements where two parties effect a transaction. Smart or smart/thin refers to the fact that a large number of parts of a regular contract can be designed differently by means of Blockchain technology, because matters such as uncertainty, trust, etc. are better organized by means of a blockchain registration or the associated "token". That is why contracts, including a blockchain registration, can be designed much more easily and/or better implemented by means of technology, even though each contract is in principle unique and the design of contracts using Blockchain technology has its limits.

Smart contracts can play a key role in so-called "low-trust" countries, such as all Anglo-Saxon countries, but also in Belgium and France. In so-called high-trust countries, such as the Netherlands, this effect of reduced legal costs is less, because many aspects of cooperation are not shaped in contracts, but in trust.

Every blockchain registration contains a document, the material passport, which contains data and associated agreements. Delivery terms or other conditions can also be agreed therein, if this is relevant. Both with the property registration, or with the blockchain registration of the value of the materials (standardized material unit). These can be added to the material passport of a material, which is placed in the blockchain.

The value creation in this case is remarkably high because all materials in buildings can also be made liquid in this way. Blockchain technology ensures that transaction costs through the creation of property rights remain low not only in terms of value validation, but also in terms of tradability. The materials and the values of the materials will be made transparent for the owners in their own dashboard. Other data can also be added to this dashboard. Data that may relate to sustainability objectives, management and maintenance contracts and the translation of the values behind the materials into tradable material certificates.

The diagram below can be used to clarify the value propositions for the customer. It is a diagram in which six elements of the value stream in the reuse of materials are discussed and in which each element has value or pain, in accordance with the ordering mechanisms of a Business Canvas Model.



In the remainder of this section, we will explain each part in more detail, so that the value of flexibilization of real estate by means of Blockchain technology becomes clear and an answer can be given to the question why owners of real estate objects should work with Blockchain technology. All components of the value stream have been evaluated in discussions with those involved but have not yet been fully scientifically proven.

a. Legal and moral obligations

Real estate owners feel the pain of legal obligations, such as meeting obligations under the Paris Climate Agreement, meeting a higher sustainability standard for offices (by 2023) or the related financing requirements of banks. But once the pain is gone, there does not have to be any sustainable behavior. A lot of pain opens the market for solutions regarding sustainability of buildings, but the expected returns for the cause of a Circular Economy and the business case of the owner of buildings is low. Legal obligations put the business case in first gear, but the journey (value stream) is slow.

In addition to legal obligations, larger organizations also have moral obligations, such as cleaning up empty buildings that they leave behind because they want to have a new building, as has also been discussed at accountancy firms, for example. In this way, social objections to vacancy are overcome and people can also be held morally accountable.

b. Higher margins

Property owners are focused on reducing the depreciation and renovation costs of buildings and thus increasing their (investment) profits/returns. This is achieved by making an inventory of the residual value of the building in terms of the alternative use of parts of the building, which provides insight into which parts have a positive or negative value. The residual value of the building is determined by the components, but also by the possibility to separate them cleanly, by making these elements demountable, by technologies for separating rubble, grinding, sorting, etc. Sustainability rights, such as CO2 rights play a key role in this. We will explain this in more detail later.

When the prices of materials rise, the residual value of materials becomes increasingly visible. And that also applies to rising prices of energy and CO2 allowances, which are part of the prices of new materials, but much less so for materials that are given a second life.

In the short term, this insight plays into the renovation of buildings and the reduction of the high costs of renovation, but once the renovation is over, this pain is much less important. There is no legal stick behind the door, so the pain is slightly less if these objectives are not met, but with large professional commercial organizations, profit is an important objective. However, it is a one-time gain if only the residual value is inventoried and included in the books. For the time being, it is not a repetitive reduction of various costs associated with a building, except for financing costs, which can be reduced due to a higher residual value. That is why we call lowering the depreciation and associated financing costs the second gear in terms of value creation for a Circular Economy.

c. Fear of missing a trend, losing reputation, or getting an image boost

Large companies always fear the possibility of missing a trend or their reputation, causing the entire company to cease to exist soon. In recent history this has happened with Nokia and Kodak, among others. Missing the capabilities of blockchain technology could be such a pain for large real estate organizations, or organizations that are now making a lot of money from large real estate organizations.

However, to know how a modern technology strengthens its own organization, whether it is a trend, and whether participation in this technology prevents various risks, it is often a wise move for many large organizations to participate in smaller organizations. organizations that are working with this technology within their domain and are also experimenting with it. In such a participation or strategic alliance, previously acquired knowledge is shared for a certain period, it is examined how business processes of large organizations can be improved and things are tried out in the form of a living lab, but at a scale that would be appropriate or matches the size of the business models of a large (real estate) organization. Because if they do not do it themselves, another organization could do it and blow their own organization away.

The pain of this third gear therefore stems from the strategic insight of an organization to miss future (large) returns. Participation leads to greater value, because participation also shows the revenues of the fourth, fifth and sixth gear. For smaller companies that work as suppliers, participation gives them the opportunity to make long-term agreements on a scale that they can only make much later through gradual growth in the first and second gear.

d. Lower transaction costs management

Every real estate object has a large number of management costs. Insight into and traceability of the elements of a building reduces all kinds of transaction costs in the management of a building, such as those related to safety, maintenance, inspection, and other day-to-day costs.

Because these management costs are recurring costs for a large number of buildings, the reduction of these costs per time may be a small amount, but very high in terms of the future time and in terms of numbers of buildings. The insight and traceability of elements in a building can also lead to a different relationship with suppliers of these elements. Elements that cost a property owner a lot to maintain, such as renting light (“light-as-a-service”) instead of buying fixtures, lamps, and electricity. Therefore, the value creation of blockchain technology for these costs is estimated as high.

However, the pain for decision makers is less because efficiency gains are less likely to be on the minds of owners and decision makers than legal obligations or higher profits. Certainly, in those situations where there are no obligations, and the profit of a real estate organization is so high that no one feels compelled to look at the subtle improvements in the cost environment of the maintenance of a building. But once the previous gains from gear one through three are exhausted, it is easier to feel the benefits of this fourth gear.

e. Trade

The residual value of materials in buildings leads to higher profits (acceleration two of the Circular Economy), but only if the underlying materials can also be used alternatively through lease or sale in the future. For this, property rights must be guaranteed by means of blockchain technology and must also be permanently validated (aided by blockchain). Higher profits come into view if the technology can also solve the guarantees regarding property rights and data validation.

If that is the case, the total value stream will be higher, because the materials of buildings for which the alternative yields of the materials cannot yet be used directly, are now tradable through the inventory of materials. Also, by linking the database with the data of the materials to databases with financial options and futures contracts, culminating in a certificate, the property rights of which are guaranteed by registration in the Blockchain. In this way, suppliers can remain the owner of the components/building blocks. They become material banks.

With blockchain technology, they can continue to claim original ownership. Certificates are only issued if the value of these certificates is intrinsically hedged by the underlying value of materials. Building owners can write (real) options regarding the availability of their materials over time and in this way also make the materials financially liquid. Because they must deliver these materials later, in accordance with a (smart) contract, they will do everything they can to deliver the materials in accordance with the agreed quality in time. The value creation in this case is very high, because all materials in buildings can also be made liquid in this way, and blockchain technology ensures that transaction costs through the creation of property rights remain low not only in terms of validation of the value, but also in terms of tradability.

f. Disintermediation

The highest and sixth gear, but one that has so far been described in theory and is not yet felt by owners of real estate objects, is the possibility of complete disintermediation in the real estate transaction chain. Because blockchain technology guarantees property rights, validation of value and data related to materials in buildings will become much, much easier, various forms of services for the guarantee of title and value by appraisers, brokers, accountants, notaries, and inspectors can be eliminated.

The reduction of these transaction costs and/or barriers to transactions makes it much easier to trade, rent or otherwise use buildings and the parts of buildings. It increases the liquidity of real estate and therefore also the whole of the building and the underlying materials. However, to achieve this sixth gear, the benefits of the first five gears must first be visible to various stakeholders, including the legislator. In addition, it is to be expected that many intermediaries in the real estate chain, such as the appraisers, brokers, accountants, civil-law notaries, and inspectors, are not keen on these changes, because the work for them disappears. Therefore, little pain for many, resistance, but large value returns also given the value of the first five gears.

4.
Leland Yeager and the Tradability of Materials

In 1985, Leland B. Yeager, Professor of Monetary Economics at Auburn University, authored the article “Deregulation and Monetary Reform”. In this article he described his reservations about monetary policy in recent years in the United States of America and in particular the development of inflation in those years and the social costs associated with high inflation.

In the article he indicates that money has three functions: it is a medium of exchange, a means of calculation and a store of value. In the current monetary system, the calculation tool is no longer derived from an underlying good. In the past, coins contained certain amounts of metal, which then defined the value of the coin. Today, this value is only assigned by law and is not based on anything. The problem with this is that the value of the currency can be volatile. Since there is no intrinsic value of the currency, beyond the value of the paper or metal called money, everything depends on trust in the government.

Leland then introduces the idea of the BFH system, a money system named after three monetary economists who had previously published about this, namely: Fisher Black, Eugene Fama and Robert Hall. The idea of the BFH system is that a physical component is defined, to which the 'unit of account' is linked. It is defined by a list of different commodities, the use of which is the statistical standard for the population using these commodities.

The difference with the current monetary system is that the value of the 'unit of account' does not depend on the regulation of the quantity or the ascribed value, but it is, as it were, fixed. Only the commodities within the bundle can fluctuate freely in value. The medium of exchange can fluctuate in value due to supply and demand. Because the 'unit of account' times the number of medium or exchanges concerns the total value, the nominal value is also determined by the market. To be able to do this, the 'medium of exchange' is separated from the 'unit of account' (monetary separation). The difference with the former system is that there is now no gold or silver in the coin or vault, but a list with different (building) materials is linked to it. The intrinsic value of the coin is now fixed, as it were, but the share of each (building) material in this coin changes constantly due to the current market price of this material and the amount of this material in the database.

In the case of a 'building materials currency' this is done by on the one hand defining the commodity bundle by entering the different building materials together, the unit or account, and on the other hand entering a certificate or “token,” the medium or exchange. The number of certificates must always correspond to the amount of value hidden behind the certificates in terms of materials, or it must be possible to rebalance quickly if, due to price and statistical differences, the intrinsic value of the materials and the certificates no longer are in balance.

Standardization of the underlying intrinsic value of materials is therefore the basis of the marketability of these materials, in accordance with the BFH standard for building materials. It is also not the materials themselves that are traded directly, but the derived “tokens” or certificates, which can change owners for these certificates through a Stichting Administratiekantoor. For the time being, no use will be made of the blockchain options for trading or payment, if it is not legally clear under which conditions crypto coins are or are not an authorized means of payment. If crypto coins have the tinge of black money, money laundering and terrorist financing about them, the 'unit of exchange' will be a certificate, compare a bearer banknote, as we used to know it.

5.
A MARKET MASTER FOR THE CIRCULAR REAL ESTATE ECONOMY: THE ROLE OF BLOCKCHAIN

As we have seen before, the market for materials in and for buildings is not in equilibrium. A lot of materials are disappearing from buildings that are no longer used or can no longer be used, with all the negative effects on the climate, availability for future generations and additional scarcity that entails. There is no circularity in a physical or economic sense

because the economic cycle does not show the actual costs and benefits of the use of materials due to an insufficient inclusion of external effects. It is striking that due to information asymmetry, the benefits of the materials are overlooked, while with other examples of external effects, the costs of using a (collective) good are not accurately reflected in the price, such as air pollution.

The question is therefore how markets for reusable building materials can be used in such a way that, for example, transition projects for real estate can be conducted in the most sustainable way, whereby the high-quality reuse of raw materials is paramount as much as possible.

The aim is also to boost the stagnant development about the sustainable and high-quality (re)use of materials and to give substance to new products, services, and technologies. This sustainable manner of change can be described, among other things, by examining the differences between demolition and dismantling. In this context, demolition is understood to mean a classic way of working in which the reuse of materials is not an issue, and demolition is the desired way of working, which can also give substance to a Circular Economy, which leads to the reuse of materials.

The Circular Economy therefore wishes to bring about a change about the various uses of materials that are released during the demolition of a house or commercial building. Instead of a demolition process, in which the aim is to achieve the lowest possible costs in man-hours and transport, it wishes to convert the demolition process into a process of demolition and reuse, in which the added value of the released materials is central. Materials released that have already been able to find a buyer in advance.

The aim is to achieve the highest possible value of raw materials, making it easier for homeowners to switch homes, even when a house is demolished, because the raw material value of the house can pay off an increasing part of the remaining residual debt. It also helps that because of the demolition, the ground under the house becomes available again.

In the current demolition process, this added value of raw materials is limited and is characterized, among other things, by the reuse of the released materials as foundations for roads. Because this method of demolition and reuse leads to a lot of transport costs and transport movements, a demolition process involves relatively many environmental costs and a lot of traffic on the road. Precisely because the reuse of materials in this way yields little and involves quite a few costs, most demolition processes are aimed at making the materials disappear as quickly as possible. An important cultural and behavioral element in the current way of working around demolition. And therefore, also a problem about transition issues.

In a demolition process, the activities are aimed at the potential reuse of the various materials that are released during the demolition of a house and the realization of a maximum yield value of all these raw materials. To achieve this, the materials must be properly inventoried, so that when the house is dismantled, the economic value of all raw materials is guaranteed, via the property right of the original owner of the house and the realizable value of these raw materials can also be returned to the original owner.

Deconstruction therefore has a different goal than demolition and people want to do this with a completely unique way of thinking and acting about the use of materials. A course of action which, through its carefulness, protects the owner's right of ownership of the raw materials in a house and is therefore also the basis of new forms of use. A sustainable basis for a Circular Economy in several respects, which is based on the efficient use of raw materials in our society.

At the front of the process, the costs of dismantling are higher, but these relatively high costs pay off because later there is a higher yield of all materials. A higher yield that can be made immediately liquid again through trading itself, by linking option rights or forward contracts to the property rights of materials.

Demolition therefore has an opportunistic short-term cost perspective, while deconstruction has a long-term added value perspective and therefore gives substance to an economic cycle, which is referred to here as the Circular Economy, even though it only concerns the implementation of the Circular Economy for building materials. and not for all materials that we could reuse.

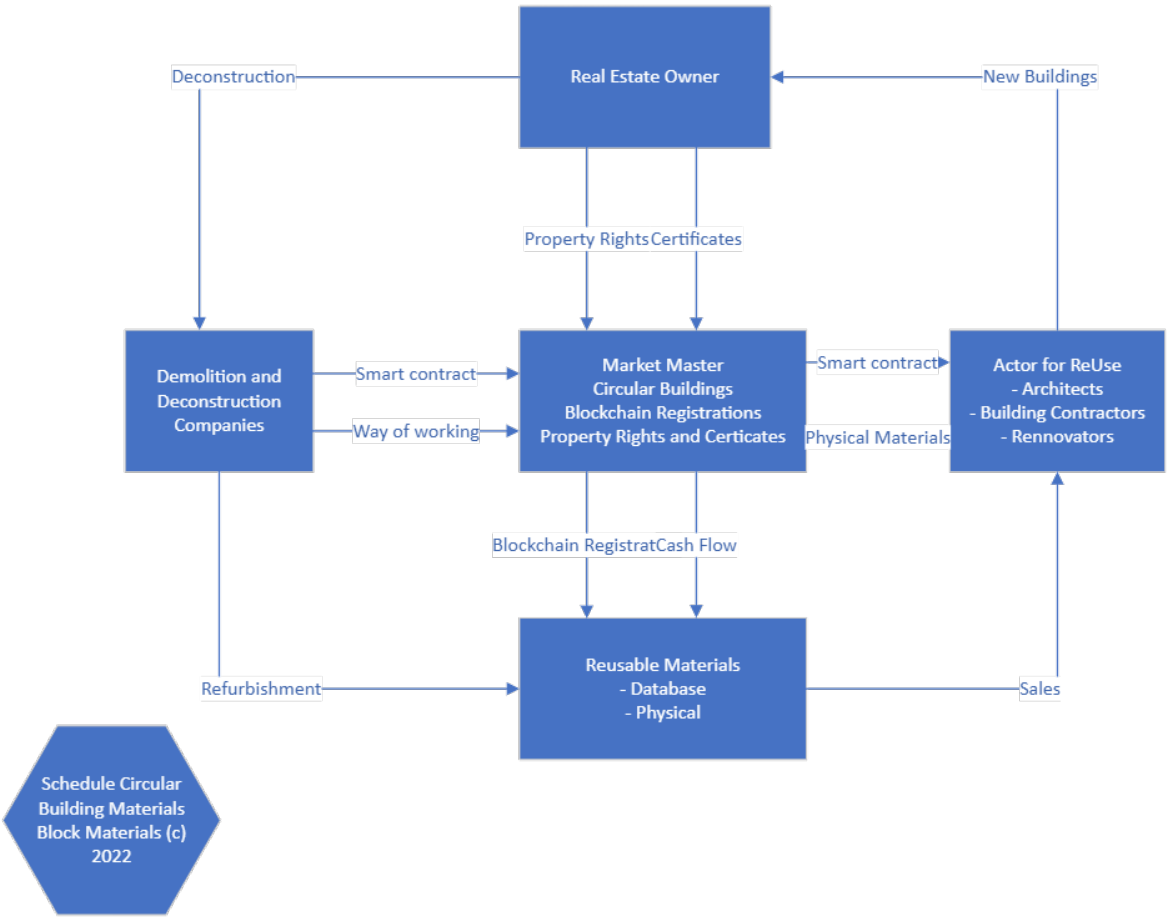
The Circular Economy (Figure 1) is an economic system that is intended to maximize the high-quality reusability of products and raw materials and to stimulate technological developments. Figuratively speaking, there is a need for a machine that follows the life cycle of buildings, swallowing these buildings and ejecting them like stones, as actually shown in the diagram on the next page.

The real innovation lies in the process and product of this cycle. The solution requires a database, a Market Master, a protocol shaped by smart contracts and blockchain registrations. As a result, the property can be converted into (secondary) materials via an amortization process, which can be reused after matching the supply and demand of these raw materials in a database. A database that can also function as a trading system and can therefore also realize faster matches between supply and demand for materials, because both quality and property rights of materials are well defined and recorded.

Or even better: in which the demand for secondary materials from a new technological and economic perspective leads to a boosting of the cycle within the Circular Economy because secondary materials are an engine for innovation. What the province of Limburg in the Netherlands had in factories and industries about construction up to 20 years ago can in this way be given a new and sustainable life, because there is a closed cycle of materials.

The diagram below shows that if property rights are defined, a Market Master for the Circular Economy can be organized based on the blockchain registrations, which underpin this property right. Because property rights are the basis for contracts with demolition companies and re-users, rights to these materials can be established transparently and unalterable. This means that blockchain registrations of property rights serve as a gateway to the Circular Economy based on which (smart) contracts keep the entire system in balance. In this way a cycle of materials can be organized without information asymmetry due to “bad lemons” (Akerlof) and with a limitation of the number of transaction costs, which will be borne by the current owners of materials in buildings.

The market master provides such transparency with the help of blockchain that a Circular Economy can also develop into a market for secondary raw materials, fully in line with the image that many markets cannot do without a (public) market master, as described by Roel in 't Veld (Bestuurskunde 22(3) 2013), also in this case the public market master is not an institution, but a coordination mechanism organized by blockchain based on transparent property rights.



There are various quality requirements associated with the role of a Market Master, which are expressed in the various activities that a Market Master should perform, and which should also be reflected in the way in which property rights in the blockchain and the resulting smart contracts are formulated. The market master is not an actual entity but is the sum of the activities of the various property owners, property managers and services, who by means of their "invisible hand" and the control of this "hand" by means of the registrations and smart contract leads to these results.

The work and responsibilities of all actors consist of:

- Research Circular Economy
- Applying knowledge in instruments and databases
- Applying knowledge in templates and working methods
- Advice and development of market parties Circular Economy
- Auditing of the processes in the Circular Economy
- Manage database
- Circular Economy Driver
- Application of SROI and other social goals

The establishment of a Circular Economy for raw materials and building materials will become an important challenge for the transition of the economies in the coming decades in Europe. Both from the perspective of scarcity, rising prices of raw materials and energy, preservation of the living environment (climate), as well as geopolitical reasons.

Not only does a Circular Economy create opportunities to generate new business based on the materials released from homes and business premises, but the Circular Economy also provides the owners of these homes and business premises with increasing liquidity, making it easier for them to say goodbye to outdated assets. And we can use the released resources for a better life or new business opportunities. A Circular Economy also saves many environmental costs and boosts employment opportunities for employees with a disability. The Circular Economy can therefore be one of the characteristic outcomes of a transition in the economy.

A Circular Economy is not only the cycle for sustainable reuse of materials. It also reflects the idea that a cycle is an economic phenomenon, which provides a lastingly balanced picture about new economic opportunities as well as to a balance in public income and public expenditure.

Any well-functioning market economy, including the Circular Economy, cannot do without a Public Market Master, who can create and enforce property rights, as well as steer the processes that ensure the actual organization of a Circular Economy. It is an institutional anchoring of the ideas behind a sustainable economy, based on the reuse of many materials, blockchain registers and derived “smart contracts” that market parties know how to steer and organize in such a way that they also behave sustainably. And thus, implicitly also be able to pay for the Market Master of the Circular Economy, so that the invisible hand of Adam Smith can function and there is a real market for the reuse of materials.

The significant increase in prices for materials, as well as the underlying energy and Co2 costs, will be a behavioral incentive in this process to make the investments that ensure that the costs of inventory and registration of materials in buildings can be covered. They are an important economic goal through a coherent vision of the Circular Economy.

Box 3: Investments in processing materials.

Investments in the materials cycle are particularly visible among processors of waste streams and producers of materials. If the producers are supplied with clean secondary raw materials, they can also make new materials from these 'waste flows'. Waste flows that have been converted into granulate by processors. With rising prices for materials, the value of 'waste' is no longer estimated based on processing costs of this waste, and thus a disruptive cost item in the chain of material flows. There will now be a positive value of waste raw materials, which processors pay for, because they can pass on higher prices for granulate or other forms of processing to the producers. Producers who save on primary raw materials and CO2 rights by using secondary materials. In the period 2019-2022, this turnaround has gained further momentum, which can be seen, among other things, in the large investments by 'processors' in sorting and processing installations on an industrial scale, bundled supply flows of materials through mergers of waste processors and clustering of producers about the purchase and supply of waste streams/secondary raw materials.

6. Inventory, register, value and liquidate materials

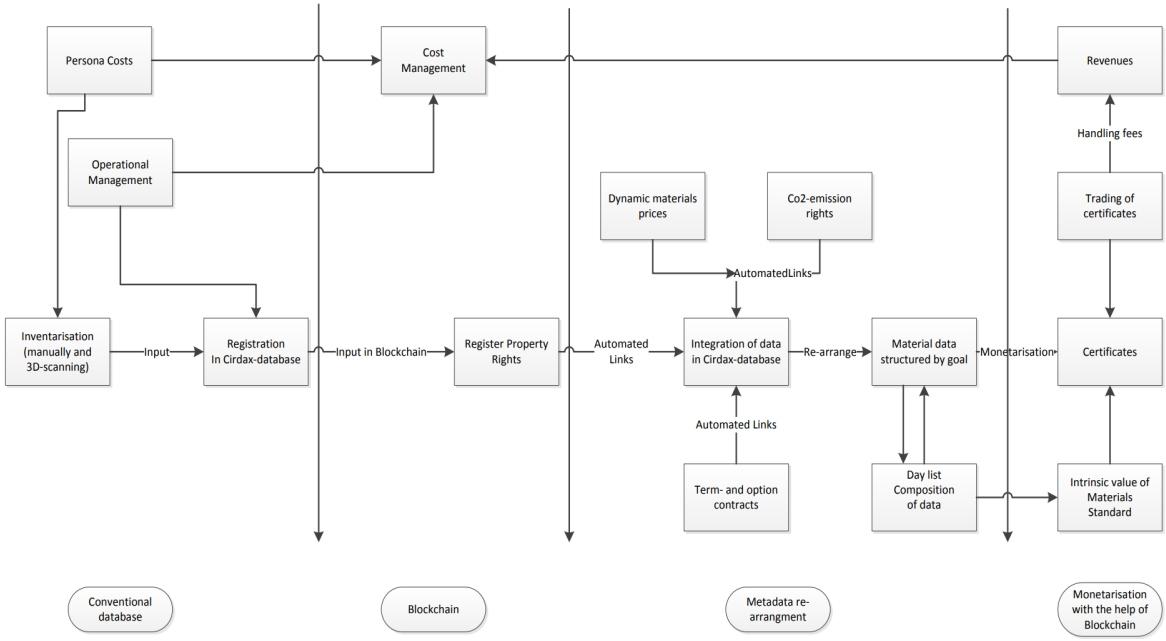
In the previous section we saw that a Circular Economy can work as a cycle if we can inventory and register the property rights of materials in buildings. The figure on this page describes how the processes of inventory, registration, value allocation and liquidation of materials are linked. This scheme also serves as a tool for the integrated ICT architecture behind a Circular Economy for building materials. The main processes will be explained in more detail in this section based on the diagram.

The scheme again presents a cycle, which starts with the activity “Inventory” and runs through “Register”, “Capture ownership”, “Integration of data” to “Aggerate Materials data to target” and “Certificates”. Based on the tradability of the “Certificates” income is obtained, which covers the costs of the organization in terms of Personnel Costs and Operational Costs of parties that perform these activities. The model can also be interpreted the other way around: to achieve tradable certificates, these certificates must have a title of ownership, which is partly recorded by a blockchain registration. We have seen this before.

Box 4: How do we give 'third parties'/buyers access to the platform?

Third parties gain access to the platform by entering their details in such a way that it complies with the General Data Processing Act, as well as in a way that we deal with bona fide customers. Once again, effective use can be made of Blockchain applications that have been made for these purposes, when addressing this issue.

Certificates are based on standardized values of materials, obtained by inventorying materials in buildings, and then aggregated or enriched with data related to sustainability, maintenance and management, dynamic prices and forward and option contracts.



Inventory and Registration is done with the help of specialist consultancy in the field of materials (reuse) and facility services (maintenance) and a conventional database for the registration of the various data, which safeguards the current business operations. Based on the Registrations in the conventional database, Materials Passports from the database are recorded in the Ethereum register by means of Blockchain Technology, so that the ownership rights to the materials in a building are secured. By establishing the ownership of the materials, on this basis, as well as using Blockchain technology, data relating to “dynamic prices”, “CO2 rights”, “Maintenance and Management” and “Forward and option contracts” can be added to the various metadata of the materials, so that an integrated data collection with values is created.

The integration of data must be possible on the smallest part, i.e., the unit of material in a room or building. The requirement here is that metadata about the above data to be integrated must also be able to be linked on the smallest unit. This is also allowed in the conventional database to avoid excessive blockchain registration costs. Subsequently, it must also be possible to aggregate the various data according to purpose, such as distinguishing all wood or all metal present in the system according to the data to be supplied. Or to be classified according to the various parts of the Circular Building Business Model.

It is also possible to order according to the average composition of the materials across all buildings, so that a material standard is created, which makes it clear what can be understood by a standard unit of reusable materials. Such a unit consists, for example, of 20% wood, 25% concrete, 20% metals, etc., arranged according to quality and availability.

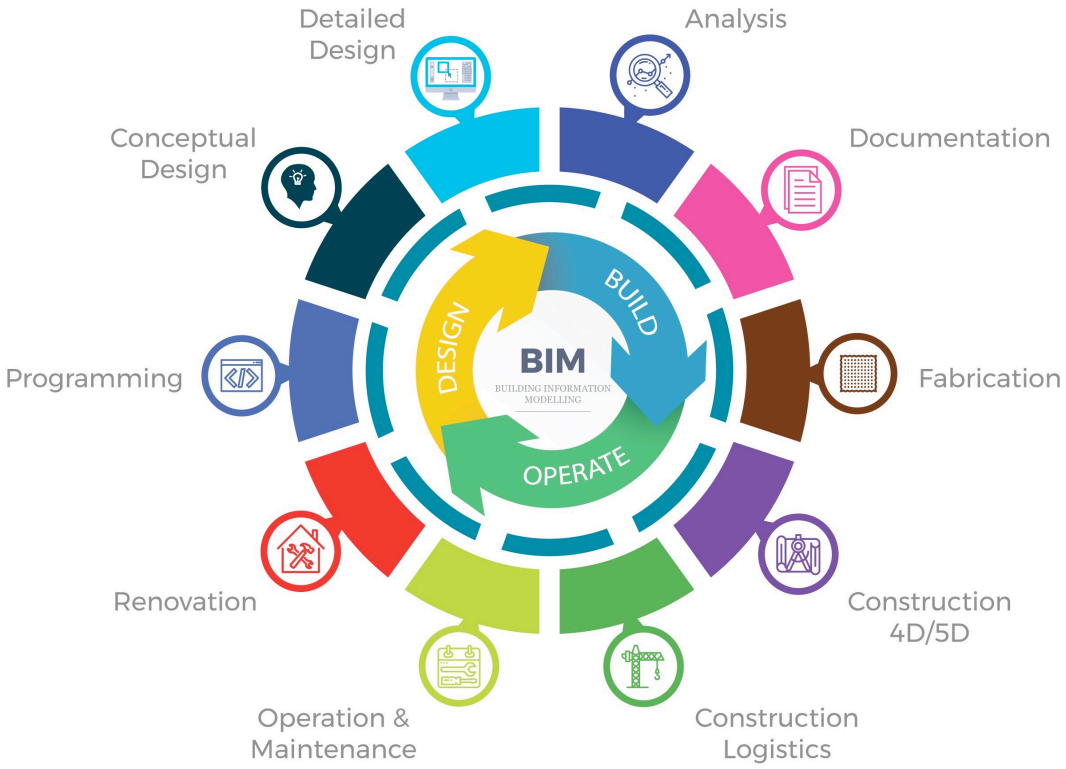
Such a unit represents a certain intrinsic value, which, as the data in the conventional database grows, includes an increasingly defined number of materials, in accordance with what we have described in chapter 4 with the “unit of account”, as Leland Yeager has intended it. For example, it can be determined that 10 or 100 euros in value contains a quantity of materials and linked CO2 rights with a fixed composition and a fixed delivery time. Such a composition could change from day to day due to a different material composition of the standard unit (the probability of this decreases day by day as the available data grows through inventory), the daily and forward prices of materials and the price of the linked CO2 rights. This is the daily list Materials Composition, which will be presented daily on the public dashboard of the Market Master.

Based on this intrinsic value, a Certificate can then be issued, which is also registered via Blockchain technology and made transparent, whereby the value of the number of certificates cannot exceed the intrinsic value of the materials database. The materials certificate then represents ownership of a standard unit of materials, which are stored in buildings and recorded using Blockchain technology based on a previous Blockchain ownership record of the original inventory and registration of materials in a building. This is also called a Tokenized Asset within Blockchain jargon.

In this way, the issuance of the certificates can be organized in a way that contributes to the specific reputation that the use of Blockchain Technology hides intrinsic value. This provides a high value of trust, which can also attract investors. For the time being, the negotiability of certificates will have to take place within the legally permitted standards, such as those relating to money laundering and terrorist financing, and it will be possible to carry out operationally via a separate Trust Office Foundation in which the parties participate that actually also provide the services related to the organizing property rights.

As indicated earlier, making construction circular and the added value for all stakeholders in a Circular Economy will require looking at the entire chain, so that a building can meet the user's needs for as long as possible. A system that is currently widely used in construction is the Building Information Management (BIM) system. Such systems are currently mainly used in the 'Design' and 'Realization' phases.

By also recording the materials in the other phases in BIM, this results in a common language. Since BIM has been developed for the Design, Test and Realization phase of a building, data of the materials for this phase will also be recorded. For the other phases, it must then be determined which data is relevant, so that it can be added to BIM. In this way a complete model of materials is created in which all relevant attributes are available.



7. MAINTENANCE

Buildings are usually not there to be demolished again quickly, but they do require maintenance in various shapes and sizes. Blockchain plays a key role in managing the various maintenance costs in the management of buildings and the issue of flexibilization of real estate. With objects in a building, which can be made transparent and available by means of an inventory and registration in the blockchain and can therefore also be part of an alternative implementation of the maintenance process. As also outlined by Thomas Rau in “Materials Matter” in his example regarding the organization of lamps or light in a building (light-as-a-service).

The basis for services relating to the maintenance issues of real estate is the inventory and registration of those elements in a building to which the need for maintenance is linked. This is in line with inventory processes in real estate units with a view to reusing materials. For each object that requires maintenance, the various maintenance characteristics will have to be added, including ownership, underlying maintenance contracts, etc. This is fully in accordance with the data organization provided in the databases with the material passports, including reports that can be recorded in the blockchain.

In the organization of all data, the BIM architecture, as presented in the previous section, could have a guiding role as a conceptual model for maintenance issues and the data organization behind these issues. Because maintenance processes involve larger amounts than individual materials, the level of detail may be different and individual objects could also be registered in the blockchain. See again the example of light in Thomas Rau's Materials Matters.

Value certificates are not in line with this, because they have a different purpose, namely reuse. However, a certificate can be linked with every registration in blockchain (the 'token'). In the case of maintenance, it is more convenient to include the maintenance plan, maintenance contracts or delivery contracts behind every blockchain registration. No link with certificates, but with (smart) contracts.

The great added value for the property owner of this interpretation is transparency about those aspects of a property unit that require maintenance, as well as the possibility to organize the underlying maintenance processes differently than is currently the case, as stated by Ronald Coase in his article The Nature of The Firm. Do we do it ourselves or outsource certain services. Blockchain technology can make it easier to organize property rights of objects in a unique way, allowing a real estate owner to focus more on the functionality of each object in a building and the object owner to optimize their own costs/benefits, leading to lower maintenance costs for a property owner.

8.
PROPERTY RIGHTS AND THE MATERIALS IN A BUILDING

Property rights based on blockchain registrations form the crucial point of coordination with regard to the reuse of materials in buildings, or as an anchor point for the realization of maintenance processes. The question is, however, on what scale these property rights should be established. This question is related to the issue of optimization of data flows and associated costs of databases and blockchain registrations. In addition, the fact that a public registration in a blockchain of € 2 evokes the requirement to organize data relating to inventory and registration per unit of real estate in a conventional database, and only to record the report on this unit in the blockchain.

In other words, recording every material element in a real estate unit falls outside the economic feasibility of the Circular Economy and means that we must think in terms of aggregated units of data per real estate unit, or aggregated data by type of materials, or by date of availability of materials, or combination of all metadata.

The real estate unit can be a house, apartment, building, floor, or specific physical unit of a certain size. Per unit and per owner, data relating to the inventory of the materials in a real estate unit is recorded in its own database, including the various necessary metadata about characteristics such as owner, space, and specific material elements.

In terms of unlocking the technology, this means that it is not the individual materials in a unit of real estate that must be recorded in the Blockchain, but a bundling of materials. Primarily with regard to the owner and his unit or units of real estate, so that the property rights and method of validation of the underlying values of these property rights on the materials in the real estate units are secured as a legal anchor point for the link with CO2 rights, forward contracts, maintenance - and management issues, liability and registers with current prices of raw materials.

And secondly, in a rebundling of materials across owners' real estate units, so that standard packages of materials can be recorded in the Blockchain, and these standard units can form the underlying intrinsic value for derivative financial products, such as tradable material certificates. Also ordered according to the characteristics of the materials and the date of availability of the materials, whereby through metadata of ownership the owner can always follow his or her materials again, regardless of which reordering has taken place. Combined with a tiered registration in blockchain after inventory, after valuation and after certification, this ensures that the ownership of materials is always traceable and has been correctly translated into values and tradability (liquidity).

Every report that can arise from rebundling and is of a sufficient (standardized) scope, is therefore recorded in the Blockchain, so that this rebundling is guaranteed locally by means of certificates and can no longer be changed and meets the requirements of Transparency, Honesty, Responsibility and Consideration (with users and owners).

Box 5: What does a certificate of ownership look like, and which characteristics should be included?

A certificate is the physical appearance of a registration in blockchain. We could link a certificate to every registration of a material passport (document) in blockchain. The reason a material passport is registered in the blockchain is the basis for the name of the certificate. So, if we register the materials in a building of a real estate owner, as shown in the material passport from Database, in blockchain and thus record them immutably, we have implemented a property registration.

In the owner's personal dashboard, the # code (hash) of the blockchain registration can be seen under the heading Ownership certificates. In the document/material

passport (a PDF) all the characteristics of this property right are shown in terms of owner's name, property unit name (space, building, house, etc.), the quantities of the materials and the characteristics of the materials.

All data that can be found in detail in their own data or database system, but which are bundled per owner in a document in Blockchain. In fact, a certificate is an extra thing. It is a physical representation of a blockchain registration. You could also say that the # of the blockchain registration is the certificate if you only display the certificate digitally in the personal dashboard of the property owner.

The above insight also ensures that recorded data in the database is not first recorded in a private blockchain, but that we take reports of bundled/aggregated data as the starting point for recording these reports in the Public Blockchain. Like the current way of working of notaries in real estate, but now detailed to parts of real estate and the underlying materials, as well as a dynamic and continuous rebundling / aggregation of the data of the materials for reasons of sustainability, minimization of costs of management and maintenance and supply of reusable materials. For each report, a fee is then paid to the Blockchain miner, such as the Eutherium register.

The amount of the fee does determine which parts of a material passport are placed in the blockchain. At a minimum, this requires the #hash, if the costs of data for registration in the Blockchain are very high, which is still the case now (2022). If these costs decrease, more data can be stored in the blockchain instead of in the underlying conventional databases. However, both systems are in balance with each other in terms of desired functionality, because the #hash is a crucial information element that plays a role in the verifications between both systems. If the #hash that is included in a materials passport differs from the #hash that is present in the Ethereum blockchain, then there is an accidental property right.

This way of working requires a special view of reporting from the conventional database, the way in which data can be metadata and which metadata should also be given a place in the reports from a legal and economic perspective. Consider, for example, the right of mortgage that has been granted to a bank on a real estate unit and the consequences that this mortgage right has.

Box 6: How to deal with the issue of ownership of materials if the property is still mortgaged? Who is formally the owner and how does this relate to a certificate of ownership?

If there is a mortgage on a piece of real estate, then in principle there is nothing wrong regarding property rights. The property rights to materials of a building rest with the owner of the building. It will be different if the owner of the building sells the underlying certificates (secured by the blockchain registration). What will he do with

the proceeds of this sale? Must he use it in accordance with the mortgage agreement to pay off the mortgage, or can he use it himself for his own purposes.

The real problems come when an owner can no longer meet their interest and repayment obligations. In that case, in principle, the entire building, including the materials and the rights thereto, will be transferred to the financing provider. If the property owner still owns the certificates on the materials, the lender could trade the certificates and get his money back. If the certificates are no longer in the possession of the original owner, the materials in the building will be lost for the certificate holders because of the exercise of the mortgage right. This damage item will have to be settled when determining the value of the materials in buildings.

The same problem applies to the maintenance obligations of the owner. After registration, certification, and trading of the materials in a building, the owner could decide not to do anything to a building anymore, because of which there is a strong decrease in the value of certain materials Therefore, for existing buildings in the database system, there must always be a periodic validation of the quality of the materials, in accordance with what owners must do under their mortgage obligations, including penalty provisions.

9. SUSTAINABILITY AND CO2 RIGHTS

Inventory and registration of materials in a building form the basis of further insights into the reuse of materials and the maintenance issues that these materials or a bundling of materials raise. We can calculate the alternative value of the materials by linking the prices of these materials and in this way also include the materials in the books of the owner of a company. This could take place in a conventional database, or a digital administration, which shows the lower depreciation costs, but we could also store this in the blockchain.

Inventory and registration of the material characteristics of a building is the basis of the Circular Economy and in particular the recording of the property rights of the materials provides the basis for various cycles, as we have seen before. However, based on the combination of property rights and material characteristics, we can tackle many more matters that are interesting for the implementation of these cycles. These are the time at which materials become available, the effort it takes to remove materials from buildings (dismantle, demolish, or demolish), but we can also say something about the carbon footprint that each material produces.

Careful reuse of these materials can ensure that no new materials need to be manufactured and new CO2 emissions can be avoided. This not only provides an insight into the CO2 accounting of a building, but can also ensure that alternative ways of design, development, use and reuse of materials are discussed, if it is known what a building consists of in CO2 terms and what the value of these CO2 certificates are, if this is put in the perspective of tradable CO2 rights.

Every material has its own CO2 footprint and in particular the use of concrete, steel, glass, and plastic has major consequences for the CO2 accounting of a building. The first registration of the materials in a building can be seen as a 'zero measurement' (Carbon Footprint value at T=0). In addition, we could include the exploitation of the building, such as technical installations (heating, climate control, extraction, sanitary facilities, etc.), provided these installations do not operate on sustainable energy. We could also relate the CO2 print to Maintenance & Management of the real estate object (the painter arrives with a dirty diesel delivery van for regular maintenance).

From a financial point of view, we can say that regular maintenance is cheaper than incidental maintenance and redevelopment. However, if redevelopment is necessary, objects, materials and raw materials are also released. In addition, newly manufactured objects and materials must be placed in the building (to complete the redevelopment phase). In addition to aspects such as 'costs', 'time' (project duration and use of the building at a standstill), the CO2 footprint of materials can also be looked at. You have two tastes here, namely: the gross CO2 value to manufacture an object or material, transport it to location and assemble it, on the one hand, and on the other hand, you can look at the net CO2 value, whereby the gross CO2 value is divided over the expected (realistic) lifespan of the object or material concerned.

The objects, materials and raw materials that are released in the redevelopment and demolition phase are offered on the market. About the CO2 value, a part will have to be returned to the owner of the property if the CO2 value of the object, material or raw material offered is lower than if that party had opted for a new (comparable) product. Of course, after deduction of transport costs and costs for the reuse/recycling process. This view stimulates high-quality reuse of objects, materials and raw materials and is facilitated in the same way in the circular economy with a market master, namely through the trading of CO2 certificates made accessible through the coherent blockchain registrations.

“The CO2 emissions in construction must be reduced. The Building Decree will continue to be amended accordingly. Then there comes a time when you can no longer build without reusable materials. It will go fast if there is a price on CO2 emissions.”

A decision tree should make it clear that the underlying model encourages real estate owners to apply the highest possible reuse with sustainable objects/materials. Not only viewed in the context of CO2 footprint (because there is no incentive yet because there is no legislation in this area yet), but also from the perspective of cost reduction about maintenance.

If we look at it purely, the CO2 value of something expires if you no longer have any property rights for it. Think of the case of Thomas Rau about purchasing light service, then the CO2 footprint is for the account of the light service provider. This also simplifies the underlying calculations. In any case, we are shifting this when it comes to offering objects, materials and raw materials for reuse or recycling. The total value of the CO2 footprint is then reduced by the CO2 value of the relevant object, material, or raw material when the property right of an object, material or raw material is sold.

> *Box 7: What does a CO2 emission certificate look like, and which characteristics should be included?*
>
> *The core of a CO2 certificate is that with the help of these certificates, a reduction in CO2 emissions is implemented and the sustainability requirements for real estate owners can thus be alleviated. It could be indicated for each material how the reuse of these materials leads to a reduction in CO2 emissions, because no new materials must be mined and made for this, with all the associated savings. And how property owners can meet their sustainability obligations through the reuse of materials. Since CO2 allowances have an economic value, this value can be added to the residual value of the materials in terms of prices. Extra value is now added in terms of environmental benefits, which can also encourage various forms of innovation to achieve an even better CO2 efficiency. For everything else, a CO2 certificate looks just like a property or value certificate and is also provided with a blockchain registration that is also visible in the dashboard of the property owner.*

The question remains, however, who will be responsible for the CO2 value of transport and processing processes. You may have to say for transparency that this CO2 value is for the account of the purchaser, because it is precisely the demand for a product or service that triggers a value stream, which does have a CO2 price tag.

10.
Risks and Other Sources of Depreciation of the Registered Value of Materials in the Public Blockchain

Blockchain technology enables us not only to do something with readily available materials from buildings, but also to facilitate future reuse in the present in a legal, economic, and financial sense. By registering property rights to the materials in a real estate unit in the public blockchain based on materials reports, the current reuse value of these materials can be determined by linking the daily prices of the materials and the associated CO2 rights to the units of materials and this value is to the owner of the real estate unit.

We can make the securities negotiable and liquid by packaging this right of ownership in standardized units of value of materials and using this intrinsic value as collateral for the issuance of negotiable material certificates. In a legal sense, these material certificates entitle the holder to the availability of the underlying materials, of which all data and ownership rights can be found in the Blockchain, as described in the previous paragraphs. Availability for which the owner is also liable.

However, in daily practice, anything can happen with the underlying basis of registered materials. For example, there may be fire, vandalism, improper use, incorrect disassembly, or demolition, because of which the underlying value on the recorded materials is lost. A real estate owner can also go bankrupt. Risks that are real in nature and therefore must also be included in the valuation of the materials.

To a considerable extent, this can be tackled operationally by including validation moments or maintenance moments in the contract at the start of an inventory of a real estate unit or when trading certificates or by using the actual presence of the materials or specific technology for the (statistical) validation of the registered value. For example, by applying a specific Tag or QR code per property unit, which can also be linked to the ICT and Blockchain infrastructure.

There is also a risk that the value of the materials in a real estate unit will not accrue to the owner of this real estate unit, because for whatever (business) economic reasons a mortgage lender claims its security rights. In this process of collateralization, which often accompanies bankruptcy, property rights can be diluted or otherwise lost. Rau's Material Matters also talks about these cases and the role of 'right of restriction' in this. Here the Blockchain registration replaces the Enclosure Right, but both cannot cope well with the forces of property right in the case of securities such as pledge and mortgage right, causing damage to the value of the goods registrations.

In all cases of risks in future use of the value in a real estate unit, damage will have to be considered. This means that calculation of values in a database must be discounted for these risks, and we must always clearly calculate the amount of this discount based on actual incidents. This will be difficult in the beginning, but with more data and more time, this piece of information can also be standardized using statistical and econometric models.

This means that we cannot use the entire value of materials in the database for the repacking to standard units, but for example 98%, or that we only spend 98% on certificates, because we have adjusted our intrinsic value of the standard unit of materials to the risks. In this way we can also discount future available materials to the value of the standard unit and there will be one standardized certificate. In doing so, we must be transparent about all underlying values. Therefore, the risk discounting must also be communicated transparently.

11. MARKETABLE MATERIALS IN BUILDINGS: HOW LIQUID CAN A BUILDING BE?

Data is an important raw material for the Circular Economy with building materials. Data that, using econometric and statistical methods and techniques, contribute to the robustness of the flexible infrastructure that we want to create for property owners. The basis for this is created by guaranteeing the property rights to parts of buildings with the help of Blockchain technology, but this basis is given a face by working with "big data", which in turn is a derivative of these property rights.

Big data that, through repackaging, leads to standardized units of materials, which function as collateral for the issuance of certificates, which are negotiable. The extent to which the different units of material can be standardized, including transparency with regard to the composition of the underlying materials, discount rates with regard to time and damage and the value of underlying CO2 allowances, also ensures that all different fruits can be compared and certificates are given a higher degree of tradability, including the options to convert the certificates into euros.

> *Box 8: What role does the time factor play in residual value determination? Suppose the residual value is calculated on 1-1-20202, then this counts for that day as a 'photo opportunity', but how does this relate in the long term, for example in three years, will the value then become more/less? Which factors influence the residual value (apart from daily prices)? What can we advise or act on this?*
>
> *Time plays a crucial factor in valuation. On the one hand, a euro now is worth more than a euro later. How much that is depends on discounting factors, for which 10-year government bond yields are the norm. For example, if this is 1%, the value calculation between the inventory date and the time of delivery of materials must consider the fact that the value of the materials decreases by 1% each year, including the interest-on-interest effect. In addition, time plays a role in the quality of the underlying materials, because the longer the materials remain in a building, the longer they can be used.*
>
> *Furthermore, time plays a key role as the prices of materials change over time. Because certificates are issued at a certain point in time, the composition of the materials may change from time to time with a fixed value of €100 and can lead to certificates being worth at the time of trading. The value and composition of the materials should therefore be published daily. This also supports the owners of the certificates, and they can be further advised about the diverse options.*

Commissions and transaction costs are charged on every issue of a certificate and every trading of the certificates, which form the income for services for the Circular Economy and from which the costs of these organizations are paid. The initial issue commissions also represent the costs incurred for its entire business and personnel costs, including the public blockchain records of the property, as well as rearranging the materials so that they can be certificated and registered.

When trading certificates, we must deal with the provisions arising from the Civil Code, the various laws regarding the trading of financial products and unusual transactions, such as money laundering and terrorist financing. Where everyone who hears about Blockchain immediately thinks of payment for products with crypto coins, this is the wrong way of thinking for the flexibility of real estate. A central element for the flexibilization of real estate is that Blockchain enables everyone to secure the property rights to materials in buildings in a much more effective way, so that a market is created, which is also implicitly hidden behind the concept of Circular Economy.

If legislation regarding the correct use of crypto coins is not yet clear, trading of certificates can simply take place via a Stichting Administratiekantoor. As soon as there is mediation and acting for own account, various consumer protection obligations may also apply. Obligations that can also simply be fulfilled, so that there is an actual market with optimal trading opportunities and forms of liquidity of materials.

Box 9: How to deal with component VAT?

Deductible VAT or transfer tax will be charged on every transaction. Settlement takes place through the monetary side of the trading platform. This is a regular payment platform. It will also have to be examined to what extent there is also transfer tax and the various elements of profit taxes, via legal entities (corporate taxes) or individuals (Income taxes).

12.
AND NOW WHAT?

Blockchain technology allows us to look at specific issues in society differently. In this book we have done that in the context of buildings and real estate. Based on economic insights dating back many decades, we have seen that blockchain gives a different view on transaction costs, asymmetric information, and property rights, which can give the "usual suspects" of economics a distinctive character. A new character with which we can give substance to a Circular Economy

As we have seen, a Circular Economy for building materials starts with the granting of property rights based on the inventory of materials and objects in a building. Property rights that are partly created by registration in the Blockchain ledgers and thereby give substance to a rich balance full of new values of the materials, savings on CO2 emissions with CO2 accounting and other interpretations of the management and maintenance of buildings.

The world is open to take advantage of these opportunities. Especially now that the prices of materials are rising to such an extent that every building has become a “gold mine.” Get started now!

Flexible real estate with blockchain

While everyone who hears about blockchain immediately thinks of payment for products with crypto coins, this is the wrong way of thinking about the flexibilization of real estate.
A central element for the flexibilization of real estate is that blockchain enables everyone to secure property rights to materials in buildings in a much more effective manner. So that a market for these materials arises, which thus gives substance to a circular economy for building materials.

How this market functions, what values are created for owners by property rights to the materials, and how these values translate into revenue models for property owners, property managers, and service providers is the common thread running through this book.

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