



Large Image: Piet Mondrian, "Broadway Boogie-Woogie", 1942-1943, Painting currently at MOMA, New York

Small Image: "Tokens from Tepe Gawra, present day Iraq, ca. 4000 BC", University of Pennsylvania Museum, Philadelphia. Referenced by Denisse Schmandt-Besserat

## City Coins, Whitepaper v1.0

Alfonso Govela

DigitalCivix

## City Coins

*“Men come together in cities in order to live;  
They remain together in order to live the good life”  
Aristotle*

### 1. Cities

Cities are but interactions. There are multiple interpretations of cities, their origins and evolution, but we concentrate here on the actions of its inhabitants, their effects and influences, among themselves, with their built environment and their natural surroundings through different moments in time within fluctuating limits of place.

#### Systems and Functions

Cities are built environments in nature. Lewis Mumford said that Cities, after language, are the second most important invention of humanity, and –we add- the cradle for counting and writing. Cities are systems of systems that society and culture create in order to grow and survive. Cities are not containers of social relationships but social relationships in themselves, built in a place and transformed through history. Culture shapes and, in return, is shaped by its habitat. Both Cities and Culture are emergent interrelated processes.

The constructional and functional structures of cities have many orders and diverse hierarchies that socially and geographically overlap to subdivide and control territories, conduct flows –of persons, energy, matter and information– organize public and private spaces, house and serve its inhabitants, provide security, promote markets, catalyze creativity, create and transmit knowledge, provide identity and sense of belonging, establish norms and regulations, agree on policies and build governance with consent.

Systems of Land, Infrastructure, Mobility, Public Services, Health, Education, Security, Energy, Industry, Commerce, Environmental Management, Culture and Finance – among other city components – strive for efficacy and efficiency, while laboring, at times, to align with collective goals that prime equal access to opportunities and social inclusion as ways to achieve prosperity, sustainability, happiness and quality of life.

Not an easy task, neither a simple one.

#### Complexity

Cities are complex adaptive systems<sup>1</sup> of interdependent units with many diverse interactions, plenty with apparent non-causal behavior, embedded in multiple feedback and feed forward cycles, with wide dispersion of actors with different powers of decision, with organizational structures difficult to take apart or decompose, but capable of being, and with luck remain, elastic and resilient enough to restructure themselves and to respond with solidarity in chaotic situations<sup>2 3</sup>.

#### Cooperation and Collaboration.

Synergy and self-organization are two fundamental aspects for such complex systems. Through cooperation actors add power and new value to the interaction of their individual activities. The social process of working to put something together increases the capacity of systems to transit to more desirable states and to learn from making

these transitions happen, and permits the emergence of organizations with new features, properties, and processes.

How to influence collective behavior frequently falls between two human reactions: to force or to reward. The idiom, “The Carrot or the Stick”, exemplifies the process of deciding whether to induce behavior through enticements or penalties. Recent studies show dramatic results when the two are combined. Rewards and punishments are best complements in producing cooperation, and demands for rewards depend on the availability of punishments<sup>4</sup>.

### *Discretization of transactions.*

In this systemic framework for built environments, citizens and transactions are our basic building blocks to describe a set of urban conditions or states, and a set of actions to transit from one state to the next. When something is done or performed, when it has an effect or an influence, when goals are reached and jobs accomplished, the acts and conducts of citizens become the pulse of city life. Their discrete actions impact, their deeds become illustrative of intentions, and their transactions transfer value.

## **2. Currencies**

Values, of diverse kind, change hands through gifts, involuntary transfers, or reciprocal exchanges<sup>5</sup>. Through history different artificial instruments facilitated these exchanges with evolving levels of abstraction, measurement and documentation<sup>6</sup>.

### *Money*

*Actual goods* were counted and exchanged in markets since Neolithic times. Early into Bronze Age little clay tokens appeared as the abstract representation of such goods. Tokens made counting possible, *Bullae* or packaging of tokens in small baked clay “envelopes” sealed trust for transactions over long distances. Accounting methods followed on. The transformation of these tokens into graphic symbols detonated the beginnings of writing in clay tablets<sup>7</sup>.

*Monetary units* became the abstract measures of value for actual goods and services. Homogenization of value in an interrelated system of correlations made for an easy exchange of goods.

*Market Values.* Monetary units fixed market values and mixed specific and abstract realities. Sale prices and salaries became the attribution of a market value to goods and services.

*Monetary instruments.* As dynamic markets grew richer and more complex, new exchange forms were needed for faster and more effective transactions. Accounting documents registered transactions allowing for delayed exchanges in time and space. Debt became acknowledged and its payment inter-compensated in accounting systems. Measuring actions -assigning market values- mixed with market actions –transactions of goods-. Layers upon layers of transactions of the very same accounting documents accumulated into monetary systems.

Tokens abstracted objects in order to measure and document their transactions, but Tokens had no intrinsic value. Commodities -that is "any thing intended for exchange"<sup>8</sup>

have value, but this value is derived by judgment made about them at exchange, therefore “exchange is not a by-product of the mutual valuation of objects, but its source”<sup>9</sup>.

A mediator between things appeared: Money. Money abstracted value with a “universal equivalent of all values”<sup>10</sup> and became a powerful medium of exchange. As such, it put a distance from traded objects, brought new attention to the dynamics of mediation, made possible different accepted forms of currencies, and detonated a progression of recursive layers of mediation instruments.

Currency became anonymous, uniform, dynamic, guaranteed and controlled by the State. Financial Institutions accepted deposits and performed lending activities. Scriptural money, or money stored as numbers on a register, made payments and settlement of debts easier through clearing of respective accounts. It made possible a new monetary circulation. Scriptural money and cash –banknotes and coins– became the total money supply of national currency systems.

Money, the mediator, became “a matter of functions four: a *medium*, a *measure*, a *standard*, a *store*”<sup>11</sup>. Through history, its success to store value made money the ultimate value in itself. Thus, for many, it came to be: “money means everything”.

But, an alternative vision is worth remembering: “Money is Memory”<sup>12</sup>. Thirteen years before Blockchain made digital trust and Bitcoin<sup>13</sup> possible, Narayana Kocherlakota showed that “any allocation that is feasible in an environment with money is also feasible in the same environment with memory”<sup>14</sup> and “from a technological point of view, money is equivalent to a primitive form of memory”<sup>15</sup>. With Crypto Currencies this memory is decentralized, shared, transparent, and validated by consensus.

#### Alternative Currencies

Alternative Currencies identify and attend market situations where money by itself is of no help, but where money, as a medium of collective memory, keeps its power to accelerate economic growth.

Alternative currencies function as a medium of exchange of their own. They address specific issues relevant to local and regional communities, economic sectors, business interests, as well as particular social, environmental or political goals. They may complement legal tender and some can be valued by and exchanged to national currencies as well.

Alternative currencies have been created to solve particular difficult conditions but, when relevant, they remain in use even after the original situation has changed<sup>16</sup>. In the past 30 years there has been an explosion of these instruments. In 2003 there were well over 4,000 such currencies worldwide<sup>17</sup>.

The importance of such monetary innovations for social development has fueled the growth of what is called “multiple moneys”<sup>18</sup>, attracting the interest of scholars, activists and practitioners, who recognize that money, besides reflecting value, is a complex social institution that in itself “binds networks, supports social cohesion, transmits information and allows for variation and mutation of socio-economic systems”<sup>19</sup>.

Work is underway to understand the nature of local alternative currencies, to define and agree on their categories of use<sup>20</sup>, and to construct a body of knowledge for this “Community, Complementary and Local Currency” systems (CCLC) as they are called.

CCLC envision money as a bond and link for the building of a community in its territory, as a medium for institutionalizing community itself and their exogenous actors, and as a vector catalyst to explore new perspectives of community and territorial development<sup>21</sup>.

The success of CCLC rests on collective confidence on issuing entity and balance of four operative dimensions: *territory*, *actors*, *activities*, and *regional dynamics*. That is: sovereign authority over monetary space, circulation size, transactions, and multiplier effect, just as regular money does. But CCLC does this with a key difference: decentralizing control in a territory of collective creation that allows for self-determination, community-empowerment, and self-organization.

### Data as a Currency

Digital technology supports new monetary instruments but, most important, it registers information about objects being transacted, just as old clay tokens did before anonymous currency, but now in colossal volumes.

A new *space of flows* complements our traditional *space of places*<sup>22</sup> as Internet connects global networks, and Mobile Technology provides personal nodes for communication and information processing. Massive human and machine interactions are possible and their records become new wealth: Data.

“Data is the new oil”. As crude, that unrefined has no use, “data must be broken down, analyzed for it to have value”<sup>23</sup>. The metaphor of energy makes the analogy go further. The difference between a barrel of oil and highway traffic is the conversion of Potential to Kinetic Energy<sup>24</sup>: the power to set objects in motion. Analytic insights convert Data Potential to actionable decisions that realize their Kinetic Value permitting a Network Effect “*where data can be used at the same time across multiple use cases thereby increasing its value to the organization*”<sup>25</sup> and produce cascading impacts along multiple value chains.

Economic value of data is a progression between three stages: data as a *cost* –to be minimized and its value relinquished– data as a *tangible asset* –with the associated processes of a physical asset: supply chain management, asset capitalization and depreciation– and data as a *currency* to “leverage the Multiplier Effect internally, then expand it to include value chain partners, and then one day soon, I think, exchange or barter data and the associated analytics for goods and services.”<sup>26</sup>

The relevance of data lies in its *kinetic potential for insights or knowledge*. Its source of value lies in the *exchange of data and analytics* with a new *Data Currency*.

### **3. Values**

If exchange is the source of value, “objects circulate in different *regimes of value* in space and time”<sup>27</sup>. Cultural and historical frameworks create diverse sets of value in specific social situations. Measuring them, beyond the abstraction of money and the

traditional profit and loss statements, is an expanding field of research and practice<sup>28 29</sup>. It encounters difficulties to include intangible benefits, along different times of assessment, and through the cross-sectional nature of human actions.

Among social impact measuring tools, the Social Earnings Ratio, *Seratio* or *S/E*, stands out as a form of “measuring sentiment and converting into financial value”<sup>30</sup>. It is a single number metric, curated by a non-profit standard body: CCEG, Center for Citizenship, Enterprise and Governance, with an automated algorithm that uses Big Data, Social Media and Sentiment Analysis. *S/E* includes 18 metrics and 5 interdependencies. Its theoretical framework provides digital articulation of values throughout a sequence of levels: from mind, to citizen, family, community, organizations, regional, national, and global. *Seratio* Blockchain proposes an Internet-of-Values, *IoV*, through several white Papers: Currency of Intangible Non-Financial Value<sup>31</sup>, Values Based Impact Interventions<sup>32</sup>, Impacting with Value: Capture-Translate-Transact<sup>33</sup>, THE OPEN SOURCE: *Seratio* Platform Architecture. Sandbox for Non-Financial Enterprise Solutions<sup>34</sup>, Blockchain Educational Passport: Decentralized Learning Ledger (DLL)<sup>35</sup>, and Cryptocurrencies with Values, Transacting Goodness, the *Seratio* Coin<sup>36</sup>.

There is still a pending level to include, though, in this array of value measurements for the real world: “cities”.

#### Unit of Measure

Explosive urban growth fuels interest on City Standards, Indexes, Indicators, Profiles or Protocols. Our need for tools to understand, manage and plan the construction of our urban planet is evident.

However, studies of the use of urban sustainable indicators (SDI)<sup>37</sup> find lack of consensus both in conceptual frameworks and in the approach for the selection and number of indicators, as well as ambiguity in their definitions, objectives of use, selection method and access to qualitative and quantitative data.

Which constants are fundamental for this endeavor is neither a straightforward nor meaningless question.<sup>38</sup>

Cities are created and enjoyed by citizens. That is our basic constant. Citizens consume and produce cities. Their actions use up resources, bring forth results, and cause impacts in its territory. Behind every action there is a transaction between citizens and city systems. For each transaction there is a register of actors involved, values exchanged, location and time. The data of this transaction can be a tangible asset to trade. These individual registers are segregated now in administrative silos. A convertible unit of reference can liberate its kinetic value, detonate its network effect, and make its trading possible.

We propose *CityBit*, *CB*, to register and measure city use and city making for transactions geo-located within its limits. *CB* is a standard register of data on individual citizen transactions that consume resources, produce results, and have impacts on city life. It is the unit of account that registers what, where, when, and how much is exchanged in citizen interactions. It is a uniform record of transactions. *CB* is the parameter to observe and measure consumption and production of cities, similar in its

function to Ether Gas, the unit of measurement for computational use for running a transaction of a contract in Ethereum. *CB* relates tangible and intangible values, payment and sentiment, and adds meaning to city assets and liability, profits and losses of urban life.

#### *Standard of value*

*CB* can provide equivalence of value among different units of measurement for each city systems.

Each system has its own units of measurement: kilowatts for electricity, cubic meters for potable water, square meters for land and construction, number of students for education, patients for health care, passenger-distance for transportation, to name a few. Indicators derived from these parameters inform on achieving their particular goals, but interrelations between sets of indicators of different systems are complex and difficult. There are several theoretical approaches to address this issue.

Urban Metabolism<sup>39</sup> envisions cities as living organisms with processes that need to occur in order to maintain life. Urban Metabolism is “the sum total of the technical and socio-economic processes that occur in cities, resulting in growth, production of energy, and elimination of waste”<sup>40</sup>. It uses material flow analysis in a big picture quantification of inputs, outputs, and storage of energy, water, nutrients, materials and wastes for an urban region.

There are at MIT<sup>41</sup>, and other universities<sup>42 43</sup>, advances into a new City Science that leverage data analysis, sensor technologies, and urban experiments to provide new insights in a data-driven approach to urban planning. This approach goes purposely beyond the concept of Smart Cities.

*CB* can provide the “small picture” of citizen transactions in the space of flows and the space of places. *CB* is our contemporary token to keep track of flows of people, goods and services, our counting device to determine the number of items –transactions- in a collection –data silo-. As in Neolithic, these counters stand for real goods –data- and by doing so they abstract commodities -operative information- from reality –operating city systems-.

Indicators should be “clear, simple, scientifically sound, and reproducible”<sup>44</sup>; criteria for their usability should provide: “salience, credibility and legitimacy”<sup>45</sup>, while being “well-founded, limited in number, broad in coverage of Agenda 211 goals, obtainable at a reasonable cost-benefit ratio, using data published officially, and must be able to reflect every aspect of urban development.”<sup>46</sup>

*CB* can be:

- A standard constituent for every citizen transaction, and a social value unit for an accounting framework of Urban Metabolism and its material flow analysis.
- An identifier of inputs and outputs, within sectorial system’s boundaries, for data-driven City Science research.

- A commodity to back a new social currency: City Coins.

#### 4. City Coins

City Coins (CC) is a place-based crypto currency of city values backed by citizen data – *CB*– with measurable social impact –*Seratio Coin, or SC*<sup>47</sup>.

City Coins are a medium of payment for transactions of city values, a unit of measure for city uses, a standard of value for city systems, and a store of wealth for values shared by particular communities in specific locations.

City transactions are interchanges of city values on goods and services. City use is the production or consumption of city resources. City systems are the interrelated interactions between actors, actions and components of its environmental, social, economic and built environment. City wealth is the accumulation of tangible and intangible city assets and their capacity for sustainable reproduction. City capital is the economic value of city systems. City equity is the real value of ownership in city systems investment. Citizens can stakeholders and stake owners of their own urban environments.

CC complies with the four functions of money: a *medium*, a *measure*, a *standard*, a *store*; attends the four dimensions of alternative currencies: *territory*, *actors*, *activities*, and *regional dynamics*; and liberates the kinetic value of city data to become a *tangible asset*, and a *data currency*.

CC has three potential uses: a *financial instrument*, a *community currency*, and a *data currency*. All share one fundamental goal: make stakeholders wealthier when engaging in producing and consuming cities.

##### Financial Instrument

Cities have different revenue structures, but similar expenditure responsibilities<sup>48</sup>. City revenues come from taxes or user fees: taxes on property, local income, sales, or utilities; and payment of fees for access to infrastructure, transport, or public services. City expenses go to administrative expenditures, education, security, housing, health, transport, public services, infrastructure construction, and interest payments on debt.

Cities finances are always strained and balancing city budgets frequently is a political minefield. Fiscal strategies are similar: cut expenses, boost revenues, spend more efficiently, try to share burdens, and, recently, explore creative revenue raising innovations.

Local authorities issue Municipal Bonds or debt securities to finance capital expenditures, and Real Estate Investment Trusts provide private investors with liquid stakes on property ownership and finance. CC can complement these instruments by monetizing non-financial value<sup>49</sup>, and reinforcing communities of stakeholders. As tokenized investments, CC can provide a measurable set of non-monetary values to complement financial analytics and open up opportunities for crowdsourcing in finance.

CC can provide an investment vehicle for public-private partnerships for infrastructure construction, crowdsourcing opportunities to help cover costs of public services, as well



as a fertile ecosystem of innovation for creative revenue raising alternatives and new city business models.

### Community currency

Beyond this financial benefit, CC can impact the structure of social relations. CC can be a bond and link for building communities in their territories. As a platform for local currencies, CC can help launch particular initiatives to empower bottom-up organization, improve productivity, boost local consumption, promote voluntary cooperation and coordination, and increase quality of life. CC can help build democratic institutions and sustainable economies.

CC can enable incentives and deterrents to engage citizen in specific participation modes of collaboration that encourage synergy, and the emergence of self-organizing environments where feedback and feed forward cycles can foster learning and planning.

Traceability of CC flows can evidence emergent patterns of social relations in the territory, and document best practices for institutional development and capacity building. Urban planning can use CC transactions as a complementary instrument to document, measure and evaluate city conditions; formulate plans; promote actions; define policies; establish planning constraints and key performance indicators; achieve efficacy and efficiency; operate and run city systems; fundraise policy-making, programs, and projects; strengthen communities through ownership of proposals; and permit transparency and accountability.

City living is still a learning field in need of Civic Literacy. CC can be a governance instrument for responsible citizenship informed, organized, effective and politically active to sustain its natural environment, its social and economic development.

### Data Currency.

*CB* –City Bits, our uniform data register– is a unit of account for city transactions on goods and services paid with CC. As such CC can increase the value of collaboration by helping cities make their data “liquid”<sup>50</sup>, that is open, widely available, and in shareable formats, increasing the potential to turn data flows into data currencies, and helping data break out of administrative silos by engaging citizens, the actors that create information.

Citizen pay CC to interact with city systems, and receive goods and/or services plus a *CB* record with anonymous, validated, basic data for each of transaction. *CB* are kept and stored by citizens. *CB* can be exchanged later on for more CC, and/or be sold at open data markets. Through CC *CB* can have, or not, a parity to legal tender.

In the old gold standard, Paper money had a value directly linked to that commodity, and countries agreed to convert paper money into a fixed amount of gold. In principle, mining of the metal had to be done before printing the notes, and gold reserves were kept in Central Banks. CC operates in a Data Standard. CC has a value linked to the registry of exchange of this commodity, and returns this value to users for further exchange to CC. Mining is done while paying, and storage is distributed among users. Open data markets can trade *CB* directly from citizens, with fluctuating values depending on the demand for particular type of data registered.

CC register tokens for transactions, and gives them back to citizens so they have the power to save and exchange. A Point of Transaction Interface can register *CB* as citizens interact with, and across, city systems; similar to proposed retail Point of Sale systems for value transactions<sup>51</sup>. As this digital asset, *CB*, is exchanged for CC, CC wallets can become individual databases of city life.

CC, as data currency, can make a major impact on the economies of cities as a platform for facilitating data collection and sharing, encourage vibrant ecosystems of developers that turn data into valuable instruments, protect intellectual property and privacy, analyze and release metadata, promote open data marketplaces, and build community governance through norms and rules to discourage malicious practices.

## 5. Tools

The technical foundations of CC are: *Transition Systems*, as a conceptual framework, and *Blockchain*, as a crypto-based digital ledger.

### Labeled Transition Systems

As complex adaptive systems, we can describe Cities as a labeled state transition system or a tuple  $(S, \wedge, \rightarrow)$  where  $S$  is a set of states,  $\wedge$  is a set of labels, and  $\rightarrow$  is a set of labeled transitions.

- $S$  are combinations of actors, objects and resources at particular city locations in space and time,
- $\wedge$  Labels represent different city systems, and the conditions that trigger their transition between states,
- $\rightarrow$  Is a set of labeled transitions or citizen transactions that, when executed, transform a current state into a new city state in space and time. Each labeled transitions, paid by CC, generate a *CB* record.

Each City System –Land, Infrastructure, Mobility, Public Services, Health, Education, Security, Energy, Industry, Commerce, Environmental Management, Culture and City Finances– can have a formal description of States, Labels, and Transitions, to describe their functions, and interrelations. Ambient Calculus can help process relationships between these independent, but interrelated, systems, but describing its application is beyond the scope of this whitepaper.

### Blockchain

In its simplest description, Blockchain is a digital ledger with a secure process to register transactions. In its larger implication, Blockchain is the enabler of a decentralized economy. Its capacity to eliminate the middleman, guarantee digital trust inter pares, be transparent and secure, keep immutable records, permit traceable audit trails, reach agreements by consensus, and automate “smart” contracts makes possible a radical transformation of digital social interactions.

### Ledger

Blockchain is a distributed digital ledger, transparent and immutable, that verifies its registers through a network of nodes that permanently validates, reconciles and relays every transaction.

CC transactions and corresponding *CB* are registered in this ledger. Private wallets of *CB* can become individual databases of city use and city making. Histories of transactions for city systems can be made available for understanding ownership of city assets, provenance and trends, measure efficiency of city systems, and perform backward or forward modeling for inverse problem studies,

### *Smart Contracts*

Rules for interacting with the Ledger can be encoded in computer programs, or “smart contracts”, that perform automatically when stipulated conditions occur. Sequences of coded instructions match sequences of desired events. One smart contract for CC is to create anonymous *CB* and assign their ownership to citizen’s wallets. Coding the logic of city systems can be a fertile ground for innovation and entrepreneurship.

### *DAOs*

City Systems can run Smart Contracts, becoming “DAOs” –Decentralized Autonomous Organizations– with collections of coded functionalities to increase their efficiency and efficacy.

### *Ecologies of DAOs*

Interactions between DAOs and their built environment shall form ecologies of independent, but interrelated, city systems. CC and *CB* can be the fuel to consume, and the commodity to trade, to reach better urban futures.

## **6. Conclusion**

CC register city interactions, beating the rhythm in the pulse of city life.

As a place-based crypto currency of values, CC can be –as money is– a medium, a measure, a standard, and a store, to register citizen transactions, and track their effects and influences.

As an alternative currency with measurable social impact, CC can promote synergy and self-organization to build communities in places, and to explore new perspectives of social and territorial development.

As a data-backed currency, CC can promote citizen ownership of their own city life information, making data liquid for exchange markets, and ecosystems of creative innovation.

---

## **Notes and References**

<sup>1</sup> For a simple introductory explanation watch “Complexity Science: 7 Complex Adaptive Systems” by Complexity Labs Video. Retrieved July 22, 2017 @ [https://www.youtube.com/watch?v=r10yFwcGx\\_o](https://www.youtube.com/watch?v=r10yFwcGx_o)

<sup>2</sup> Bertuglia, C. S., Bianchi, G., Mela, A., Eds. (1998). *The City and Its Sciences*. Physica-Verlag, Springer Verlag, Heidelberg, 23-45

<sup>3</sup> Casti, J. L. (1986), *On System Complexity: Identification, Measurement, and Management*, in Casti John L., Karlqvist Anders (eds.) *Complexity, Language and Life: Mathematical Approaches*. Springer Verlag, Berlin, 146-173

- 
- <sup>4</sup> Andreoni, J., Harbaugh, W., Vesterlund, L. (2002), *The Carrot or the Stick: Rewards, Punishments, and Cooperation*. University of Oregon Economics Department Working Papers, University of Oregon Economics Department.
- <sup>5</sup> Greco, T. (2009). *The End of Money and the Future of Civilization*. Chelsea Green Publishing. Kindle edition. Pag. 88
- <sup>6</sup> Grau Figueras, M., Chalaux de Subirá, A., (1997). *Essay on Currency, Market and Society*. Centre d'Estudis Joan Bardina. Barcelona. Retrieved July 29, 2017 <http://chalaux.org/ammsukin.htm>
- <sup>7</sup> Schmandt-Besserat, D., (2014). *Tokens in China, Europe and Africa – The significance*. The University of Texas at Austin, USA
- <sup>8</sup> Appadurai, A., (1986). "Introduction: commodities and the politics of value," in Arjun Appadurai (ed.), *The Social Life of Things: Commodities in a Cultural Perspective*, Cambridge University Press, p. 3.
- <sup>9</sup> Ibid. Pag. 4
- <sup>10</sup> Simmel, G. *The Philosophy of Money*. Routledge Taylor and Francis Group, London and New York. Pag. xix
- <sup>11</sup> Historic mnemonic rhyme for functions of money described by Jevons, W. S. in *Money and the Mechanism of Exchange* (1875)
- <sup>12</sup> Kocherlakota, N. (1996). *Money is Memory*. Federal Reserve Bank of Minneapolis. Research Department Staff Report 218
- <sup>13</sup> Nakamoto, S. (2009). *Bitcoin: A Peer-to-Peer Electronic Cash System*. Retrieved August 7, 2017 <https://bitcoin.org/bitcoin.pdf>
- <sup>14</sup> Kocherlakota, N. Op. Cit, pag. 1
- <sup>15</sup> Ibid.
- <sup>16</sup> WIR Franc is a Swiss electronic currency created in 1934 to solve currency shortages at a time of global financial instability. Founded as a business group cooperative to actively combat the economic crisis with the help of a "ring exchange system". See "[60 Years WIR Business Circle Cooperative -Origins and Ideology](#)". *WIR Magazine* (September 1994). Retrieved 1<sup>st</sup>. August 2017.
- <sup>17</sup> Costanza, R. Et al. (2003). "Complementary Currencies as a Method to Improve Local Sustainable Economic Welfare", University of Vermont, Draft, Dec. 12th, 2003
- <sup>18</sup> Ibid.
- <sup>19</sup> Gómez, G., (2015). Op. Cit
- <sup>20</sup> Blanc, J. (2011) 'Classifying 'CCs': Community, Complementary and Local Currencies' *International Journal of Community Currency Research* 15 (D) 4-10 <www.ijccr.net> ISSN 1325-9547 <http://dx.doi.org/10.15133/ijccr.2011.013>
- <sup>21</sup> Fare, M., de Freitas, C. and Meyer, C, (2015) *Territorial Development and Community currencies: symbolic meanings in Brazilian Community Development Bank*. *IJCCR* 19 (D) 6-17 <www.ijccr.net>
- <sup>22</sup> Castells, M. (2004). *Space of Flows, Space of Places: Materials for a Theory of Urbanism in the Information Age*. Graham S. (Ed) *The Cybercities Reader*. Routledge Urban Series Reader, London and New York.
- <sup>23</sup> Palmer, M. (2006). *Data is the new oil*. ANA. Retrieved August 7, 2017 [http://ana.blogs.com/maestros/2006/11/data\\_is\\_the\\_new.html](http://ana.blogs.com/maestros/2006/11/data_is_the_new.html)
- <sup>24</sup> Schmarzo, B. (2017). *Data is a new currency*. Dell EMC Services. Retrieved August 7, 2017 [https://infocus.emc.com/william\\_schmarzo/data-is-new-currency/](https://infocus.emc.com/william_schmarzo/data-is-new-currency/)
- <sup>25</sup> Ibid.
- <sup>26</sup> Ibid.
- <sup>27</sup> Appadurai, A.(1986) Op. Cit.
- <sup>28</sup> Dadayan, L. (2007). *Measuring Return on Government IT Investments*. In Remenyi, D. Brown, A. (Eds.) *Proceedings of the 13th European Conference on Information Technology Evaluation*. Genoa, Italy, September 2007
- <sup>29</sup> Private conversation with Prof. Peter Burgess. TrueValueMetrics.
- <sup>30</sup> Social Earnings Ratio, Wikipedia, Retrieved August 21, 2017 [https://en.m.wikipedia.org/wiki/Social\\_earnings\\_ratio](https://en.m.wikipedia.org/wiki/Social_earnings_ratio)
- <sup>31</sup> Taghiyeva M., Mellish B., Ta'eed O. (2016). "Seratio Blockchain: Currency of Intangible Non-Financial Value". *Seratio Blockchain White Paper 1.2*. Retrieved August 22, 2017 [http://www.the-blockchain.com/docs/Seratio%20Blockchain%20Whitepaper%20\(26%20October%202016\)%20\[v1.2\].pdf](http://www.the-blockchain.com/docs/Seratio%20Blockchain%20Whitepaper%20(26%20October%202016)%20[v1.2].pdf)
- <sup>32</sup> Taghiyeva M., Aujogue K., Beer H., Mellish B., Ta'eed O. (2016) "Seratio Blockchain: Values Based Impact Interventions". *Seratio Blockchain White Paper 2.14*. Retrieved August 22, 2017 [https://www.researchgate.net/publication/316701670\\_Seratio\\_Blockchain\\_Values\\_Based\\_Impact\\_Interventi](https://www.researchgate.net/publication/316701670_Seratio_Blockchain_Values_Based_Impact_Interventi)

---

[ons\\_Maryam\\_Taghiyeva\\_MA\\_Dr\\_Kelig\\_Aujogue\\_PhD\\_Dr\\_Haley\\_Beer\\_PhD\\_Barbara\\_Mellish\\_MBA\\_ACIB\\_MIRM\\_Prof\\_Olinga-Ta'eed\\_PhD\\_FloD\\_Seratio\\_Blockchain\\_White\\_Paper](#)

<sup>33</sup> Taghiyeva M., Abdu S., Mellish B., Ta'eed O. (2017) "Impacting with Value: Capture-Translate-Transact-Report. Proof-of-Impact Transaction Platform". Seratio Blockchain White Paper 3.05. Retrieved August 22, 2017 [http://www.the-blockchain.com/docs/Seratio%20Proof-of-Impact%20Transaction%20Platform%20\(11%20Feb%202017\)%20\[v3.05\].pdf](http://www.the-blockchain.com/docs/Seratio%20Proof-of-Impact%20Transaction%20Platform%20(11%20Feb%202017)%20[v3.05].pdf)

<sup>34</sup> Taghiyeva, M., Abdu, S., Nho Thong, D.N., De Souza, D., Zou, R., Wise, W., Mellish, B., Ta'eed, O. (2017) THE OPEN SOURCE: Seratio Platform Architecture. Sandbox for Non-Financial Enterprise Solutions. Seratio Blockchain White Paper 4.03. Retrieved August 22, 2017 [https://www.researchgate.net/publication/316701588\\_Seratio\\_Blockchain\\_Architecture\\_An\\_open\\_source\\_blockchain\\_transaction\\_platform\\_enacted\\_by\\_non-financial\\_Proof-of-metrics\\_that\\_govern\\_the\\_extent\\_of\\_the\\_transaction\\_and\\_evaluate\\_the\\_benefits](https://www.researchgate.net/publication/316701588_Seratio_Blockchain_Architecture_An_open_source_blockchain_transaction_platform_enacted_by_non-financial_Proof-of-metrics_that_govern_the_extent_of_the_transaction_and_evaluate_the_benefits)

<sup>35</sup> Devecchi, C., Hadawi, A., Turner, S., Armellini, A., Brooks, I., Mellish, B., Pettford, N., Ta'eed, O. (2017). Blockchain Educational Passport: Decentralized Learning Ledger (DLL). Seratio Blockchain White Paper 5.03. Retrieved August 22, 2017 [https://github.com/seratio/whitepaper/blob/master/SERATIO%20WHITEPAPER%20Educational%20Passport%20-%20Distributed%20Learning%20Ledger%20\(30%20April%202017\)%20%5Bv%205.03%5D.pdf](https://github.com/seratio/whitepaper/blob/master/SERATIO%20WHITEPAPER%20Educational%20Passport%20-%20Distributed%20Learning%20Ledger%20(30%20April%202017)%20%5Bv%205.03%5D.pdf)

<sup>36</sup> CCEG (2017). Cryptocurrencies with Values: Transacting Goodness. Retrieved August 22, 2017 [https://www.seratio-coins.world/Assets/other/Seratio%20Token%202017-30%20Whitepaper%206.0%20\(11%20August%202017\)%20\[v%206.17\].pdf](https://www.seratio-coins.world/Assets/other/Seratio%20Token%202017-30%20Whitepaper%206.0%20(11%20August%202017)%20[v%206.17].pdf)

<sup>37</sup> Tanguay, G.A., et al (2010), Measuring the sustainability of cities: An analysis of the use of local indicators. Elsevier, Ecological Indicators, Volume 10, Issue 2, pages 407-418

<sup>38</sup> For physical constants Lévy-Leblond classifies "three types, properties of particular physical objects, characteristics of classes of physical phenomena and universal constants". See Levy-Leblond, J. -M. Toraldo di Francia, G. (Ed.). (1979). *The importance of being (a) constant*. Netherlands: North-Holland.

<sup>39</sup> European Commission (2015). Indicators for Sustainable Cities. Science for Environmental Policy, In-Depth Report, Issue 12

<sup>40</sup> Kennedy, C., Pincetl, S., Bunje, P. (2010) The study of urban metabolism and its applications to urban planning and design. Elsevier, Environmental Pollution XXX pag 1 - 9

<sup>41</sup> City Science. MIT Media Lab, Retrieved August 7, 2017 <https://www.media.mit.edu/groups/city-science/overview/>

<sup>42</sup> Master in City Science. An Advanced Program between the schools of Telecommunications, Industrial and Civil Engineering and Architecture of the UPM (Universidad Politécnica de Madrid). Retrieved August 7, 2017 <http://www.citysciences.com/en/about/welcome>

<sup>43</sup> Master of Sciences in Professional Studies: City Science. RIT Dubai, Rochester Institute of Technology, NY, Campus of Dubai. Smart Dubai, and Dubai Silicon Oasis Authority. Retrieved August 7, 2017 [https://www.rit.edu/dubai/city\\_science](https://www.rit.edu/dubai/city_science)

<sup>44</sup> European Commission (2015), Op. Cit.

<sup>45</sup> Ibid.

<sup>46</sup> Ibid.

<sup>47</sup> CCEG (2017). Op. Cit.

<sup>48</sup> Wallin, B.A. (2005), Budget for Basics: The Changing Landscape of City Finances. A Discussion Paper Prepared for the Brookings Institution Metropolitan Policy Program.

<sup>49</sup> Private conversation with Prof. Christopher Leinberger, Brookings Institution.

<sup>50</sup> Manyika, J., Chui, M., Groves, P., Farrell, D., Van Kuiken, S., Almasi Doshi, E. (2013), Open data: Unlocking Innovation and performance with liquid information. McKinsey Global Institute, McKinsey Center for Government, McKinsey Business Technology Office.

<sup>51</sup> Private conversation with Prof. Peter Burgess. TrueValueMetrics.