Gian Marco Solas *

INNOVATION LETTER

INTERRELATION OF HUMAN LAWS AND LAWS OF NATURE? CODIFICATION OF SUSTAINABLE LEGAL SYSTEMS

'It is mathematically impossible to build a just world without measuring and representing human laws like the other laws of nature'

Abstract

The aim of this Innovation Letter is to raise the problem of the interrelation between human laws and the laws of nature and to propose the codification of sustainable legal systems to measure and potentially foster human progress in universal mathematical terms. It does this initially by providing a brief theoretical and mathematical introduction about key legal and physics-based frameworks, as a way to begin their unification. Followed by outlining simple applications for the codification of sustainable legal systems, with a view to calculate the unexpressed value of legal systems and to potentially optimise it with a public-private Intitial Public Offering (hereinafter IPO)-type of process powered by modern technologies.

JEL CLASSIFICATION: A10, B10, B15, B40, B50, C00, C02, C32, C60, C71, C80, D30, D41, F00, K40, N01, 010, O30, P11, Q01, Q40, R00

SUMMARY

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1 Introduction

The idea that there is an interrelation between human laws and the laws of nature is as old as human society, often recurred in history, and particularly in crucial moments for the development of science and legal orders.[1] The problem has again gained traction in the last decades and in different spheres of human knowledge, the questions are many but can in fact be summarised by the philosophical problem as to whether human laws "fit" or "contrast" the laws of nature or otherwise whether and how the latter can be used to measure – and potentially build "more just" - legal systems. The first part of the problem is mainly legal in nature: can we, for instance, defy gravity or thermodynamics by contract or international treaty? Or what is the hierarchical relationship between human laws and the laws of physics? The questions appear pivotal as - in a moment of high uncertainty and the crumbling of international law - universal mathematical laws provide objective criteria for resolution of conflicts and to potentially support the (re)construction of legal orders. The second part of the problem also has an economic and technological nuance. It relates to the potential engineering of sustainable legal systems where fundamental rights enshrined in the United Nations Sustainable Development Goals (UN SDGs) would be effectively implemented. On this basis, the Innovation Letter proposes the codification of sustainable legal systems to both raise and potentially tackle the said problem(s). To do so, paragraph 2 briefly reports on the main and most recent legal and physics-based theoretical frameworks, as well as on their interrelation, also in simple mathematical terms. Paragraph 3 proposes a basic model for the codification of sustainable legal systems to test such interrelation with modern technologies, to measure, and potentially foster human progress in universal mathematical terms. It concludes that such an approach may bring at least one socio-economic improvement, ie the calculation of unexpressed real economic value and on this basis, prompt for legal system optimisation with a public-private IPO-type of process powered by modern technologies.

[1] There is evidence that the concept has been studied by Socrates, Plato and pre-Socratics, but also in previous civilisations, for instance on Eastern, African and Indian philosophy, although evidence is limited by the availability of material records. In Ancient Rome, Seneca discussed natural law in relation to meteorology in *Naturales Quaestiones*. This work is about taking 'measure of God' (1.17), to 'walk through the universe' (*mundum circuire*; 3.1), to celebrate the works of the Gods (3.5), and to free us from fear induced by natural events (6.4). See Seneca, in Edward N Zalta and Uri Nodelman (eds), *Stanford Encyclopedia of Philosophy* (Stanford 2007), <https://plato.stanford.edu/entries/seneca/#PhyThe> accessed 19 May 25. Other authors who have discussed the problem are, for instance, Hobbes and Locke. The first, in his famous *Leviathan* of 1651, starting from a mechanistic understanding of human beings and their passions, wondered what life would be like without government, a condition which he calls the 'state of nature'. In that state, each person would have a right, or license, to do everything to anyone, which would lead to a 'war of all against all' or men to be a 'wolf of other men' (*bellum omnium contra omnes* or *homo homini lupus*). Locke in his Second Treatise of Government of 1689 described property rights as natural rights of the individual, although linked mainly to labour. In France, Montesquieu analysed – in his *Esprit des Lois* of 1748 – the role that geographical conditions have in the shaping of human law. In the United States, the Constitution of 1787 was said to be Newtonian in design, with its carefully crafted 'checks and balances', structured ideally like a 'machine that would go of itself' potentially to meet the crises of the future. See Michael Kammen, '*A Machine That Would Go of Itself: The Constitution in American Culture*' (New York, Alfred A Knopf 1986). See also Laurence Tribe, 'The Idea of the Constitution: A Metaphor-morphosis' (1987) 3(2) Journal of Legal Education 170.

2 Interrelation between human laws and the laws of nature?

Several recent contributions in both the domains of law and physics have discussed the idea that there is an interrelation between human laws and the laws of nature. One of the first modern papers addressing the topic directly is Professor Tribe's, edited by the young future President Obama, on the 'curvature of the constitutional space'[2]. The paper is an interesting attempt to reflect on how legal decisions, in particular judicial ones, can be explained by physics, namely with Einstein's theory of general relativity and the space-time curvature. A more robust attempt was made more recently by Professor Bin[3], who recalls that most continental European orders are influenced by the Kelsenian Pure Theory of Law, central to which there is the notion of a 'basic norm (*Grundnorm*)' - a hypothetical general and abstract norm, presupposed by the theory. From this norm - in a hierarchy of empowerments - all 'lower' norms in a legal system, from constitutional law downward, are understood to derive their validity, hence their authority or binding effect. The Pure Theory is intended as rigorous legal positivism, so that 'legal science' for Kelsen is to be separated from legal politics, must be developed as an autonomous discipline, seemingly supporting a 'Newtonian view of the law', and as something ontologically separated from the rest. Bin concludes that this view must be surpassed as the law cannot be detached from its authors and interpreters, like judges, who not only interpret but also confer validity to the law. This perspective somehow mirrors the debate in physics where, for Einstein, in understanding physical reality the "background" cannot be abstracted from the "foreground": "when a body moves, or a force acts, it affects the curvature of space and time -- and in turn the structure of space-time affects the way in which bodies move and forces act"[4]. From this angle, the point raised appears to be particularly interesting because today's physics seems to be divided between theories 'of the very big… and the theory of the very small... The problem is that they stand in conflict with each other. They are based on two different principles, two different mathematics, and two different philosophies'[5].

Can the interrelation of human law and the laws of nature allow to unify the main theoretical frameworks and, if yes, what are the implications and socio-economic improvements? To test this assumption, let us first recall Newton's famous formula,

$$F = MA \qquad [1]$$

Whereby the force (F) applied to a body equals the mass (M) multiplied by the acceleration (A). Let us take a case where Mark is driving his car and comes to a stoplight

[2] Laurence H Tribe, 'The Curvature of Constitutional Space: What Lawyers Can Learn from Modern Physics' (1989) 103 Harvard Law Review 1.
[3] Roberto Bin, '*A discrezione del Giudice, Ordine e Disordine, una prospettiva quantistica*' (Franco Angeli 2013).
[4] Stephen Hawking, *'A Brief History of Time: From the Big Bang to Black Holes'* (Bantam Press 1988) 29, 33.
[5] Michio Kaku, *'The God Equation. The Quest for a Theory of Everything'* (New York, Doubleday 2021).

of the legal system X signalling red. In such a case, the law ('λ')[6] of X expressed in the stoplight stops the motion of the mass 'Mark+car'. The equation describing the case can be written as follows:

$$\overrightarrow{MA} = \overleftarrow{F\lambda_X} \qquad [2]$$

where the arrow signals a vectorial force indicating the direction of the legal force and of the mass in acceleration. Let us now represent the red $\overleftarrow{F\lambda_X}$ or the green $\overrightarrow{F\lambda_X}$ at the stoplight, using a typical Cartesian graph for simplification, to show how the municipal law expressed in the stoplight curves the velocity of the car in the real-world space-time to maintain order in X.

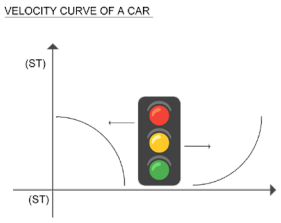


Figure 1

This simple example allows consideration of the idea that legal systems can be treated as complex systems, recently explored, for instance, in *The Physics of the Law*[7] or in *The Ecology of Law*[8] and many others, and that human law is also a law of nature. On applicative and experimental levels, it could allow, for instance, the measurement of legal pressure, weight, friction or inertia, or its thermodynamic effects in specific cases and via evolutionary and cause-effect pathways, as well as its quantum dimension. That is of interest from both a legal and economic perspective. In a recent publication it was proposed using the interdisciplinary methodology to measure markets with a view to fostering global competition litigation[9]. Faced with a practical obstacle that a market could not be calculated with the traditional tools of economics, the article adopted some concepts from history and physics – namely from fluid mechanics and thermodynamics - to better understand its state, limits, and potential for innovation. It suggested that such an approach could help practitioners and authorities improve decision-making, with possible improvements for legal systems in terms of competitiveness and potential optimisation. Such considerations prompt reflection as to whether and to what extent it

[6] λ was first used as a probabilistic factor to evaluate risk of legal claims in Gian Marco Solas, *'Third Party Funding. Law, Economics & Policy'* (Cambridge University Press 2019) Chapter 5.

[7] Pierpaolo Vivo, Daniel Martin Katz and JB Ruhl (eds), *'The Physics of the Law: Legal Systems Through the Prism of Complexity Science'* (Lausanne, Frontiers Media SA 2022).

[8] Fritjof Capra, Ugo Mattei, *'The Ecology of Law: Toward a legal system in tune with nature and community'* (Berrett-Koehler Publishers 2015).

[9] Gian Marco Solas, 'Third Party Funding, new technologies and interdisciplinary methodology in global competition litigation' (2025) 1 Global Competition Litigation Review 17.

is possible to measure human laws like other laws of nature and potentially "engineer more just legal systems" relying on the said interrelation, for instance, using modern technologies for a contemporary codification of legal systems.

3 Codification of sustainable legal systems

Codifications are widely experimented legal processes to reorganise human law and legal systems following the periods of socio-economic turmoil. Examples of codifications are the Constitution of Solon[10], the Iustinianus codification[11], the Napoleonic codification(s)[12], the EU Treaties[13] and all the Charters on human rights or the constitutions[14]. Codifications of the law have occurred in most of the legal systems worldwide, the civil law jurisdictions, distinguishing them from those of common law where instead the *stare decisis* jurisprudential rules prevail[15]. To begin testing the said interrelation, let us model codifications in physical terms as progressive "historical cycles" identifying the spatio-temporal positions of each codification and the hypothetical volume (V) of legal (λ) work (W) to shape all the mass (M) and energy (E) in legal systems.

[10] The Solonian constitution was enacted by Solon in the early 6th century BC in Ancient Greece. At the time of Solon, the Athenian State was almost falling to pieces in consequence of dissensions between the parties into which the population was divided. He promulgated a code of laws embracing the whole of public and private life to revise or abolish the older laws of Draco. Under these reforms, all debts were abolished and debt-slaves freed. He reduced the power of aristocracy and citizens were divided based on their land production.

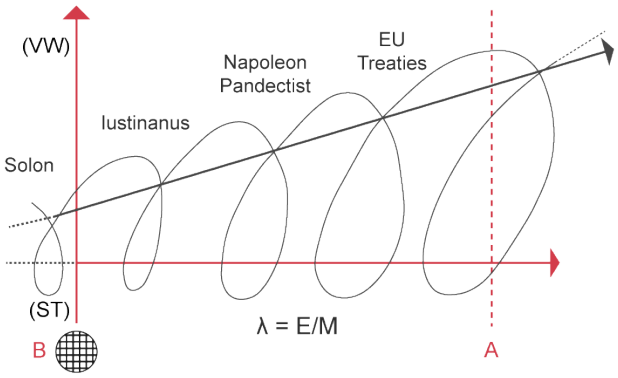
[11] The *Corpus Juris Civilis* ('Body of Civil Law'), which is the modern name for a collection of fundamental works in jurisprudence, enacted from 529 to 534 by order of Justinian I, Byzantine Emperor, to 'repair' the legal order. The work was planned in three parts: the *Code* (*Codex*) is a compilation of imperial enactments; the *Digest* or *Pandects* is an encyclopedia composed of mostly brief extracts from the writings of Roman jurists; and the *Institutes* (*Institutiones*), a student textbook mainly introducing the *Code*. All three parts, even the textbook, were given force of law. They were intended to be, together, the sole source of law; reference to any other source, including the original texts from which the *Code* and the *Digest* had been taken, was forbidden. Nonetheless, Justinian found himself having to enact further laws and today these are counted as a fourth part of the Corpus, the *Novellae Constitutiones* (*Novels*, literally *New Laws*).

[12] The Napoleonic Code (In French, *Code Napoléon* or *Code civil des Français*, normally referred to as *Code civil*) is the French civil code entered into force during the French Consulate, on 21 March 1804 and still in force, although frequently amended, as way to create a clear rational legal order after the tumult of the French revolution. The code, with its stress on clearly written and accessible law, was also a major step in replacing the previous disordered patchwork of feudal laws. It is regarded as one of the few documents that have influenced the whole world, working as model for most civil law jurisdictions.

[13] Among the many, it is worth recalling the Treaty of Paris (1951) establishing the European Coal and Steal Community, or the Treaty of Rome (1957) establishing the EU internal market.

[14] Amongst many of these, it is worth recalling the Universal Declaration of Human Rights adopted by the UN in 1948 and the EU Charter of Fundamental Rights entered into force in 2009.

[15] Ugo Mattei and Luca Pes, 'Civil Law and Common Law: Toward Convergence?' in Gregory Caldeira, Daniel Kelemen and Keith Whittington (eds), *The Oxford Handbook of Law and Politics* (online edition, 2008; Oxford Academic 2009).



PATTERN OF CODIFICATIONS OF THE LAW IN CIVIL LAW JURISDICTIONS (NON EXHAUSTIVE).

Figure 2

Let us take the model and pattern for simplicity as a relatively objective way of describing the history and progress of legal systems. We acknowledge that in each codification the technology available allowed larger and larger access to legal systems and the economy: from wax tablets to papyrus to mass printed civil codes and computer coded legal texts. To explain the application of the model we recall the famous formula of Einstein's special theory of relativity

$$E = MC^2 \qquad [3]$$

where 'E' is energy, 'M' is the mass and 'C^2' the universal mathematical constant representing the speed of light squared as the ratio between all E and M in the universe. Let us recall the above legal factor λ. Interestingly enough, λ is also present in Einstein's theory of general relativity as the cosmological constant, then used to explain the expansion of the universe, as well as to represent wavelengths. We shall consider how it could serve the "expansion of our universe" with an experimental process of codification. That means to write the existing law in code with modern technologies with a view to measure and represent it like other laws of nature, and to potentially engineer and build ordered and sustainable legal systems. In this experiment, we use the law as light, as the beacon of science, as a tool to understand what we cannot, can or must do in specific legal frames of reference, based on applicable law and including the UN SDGs as a universal benchmark for sustainability. We express this assumption in the following equation

$$\lambda = C^2 \qquad [4]$$

Now assume cutting a section of the spiral in Figure 2 (dotted line A), we will obtain section (B) representing hypothetically the global legal system(s). Let us take a fraction of it, a simple city, which we call again X, a system that would look like Figure 3 and that we can model for simplicity and transferability like in figure 4.

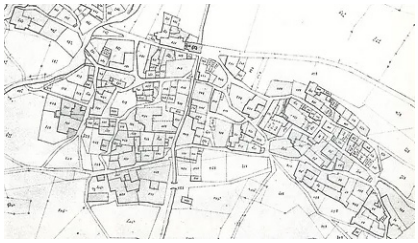


Figure 3

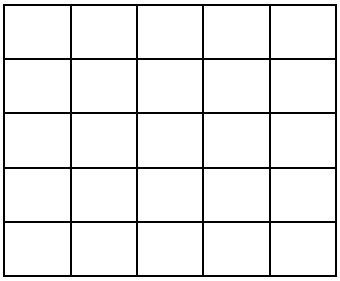


Figure 4

We assign individuals and assets of X a colour depending on the *lato sensu* biological and physical situation, like the stoplight in Figure 1 above:

- We identify in green every legal fraction (asset) of X or individual that are in 'optimal state' according to the applicable law and UN SDGs, the 'active life' or 'energy' of the system. That means for instance a private house or a public building well maintained, a business doing well, or an individual being healthy, in relatively good conditions, working or studying etc.;
- in yellow we identify those situations that are 'so-so', 'inertial', those that need some work or attention: it could be a private or a public building not well maintained but still performing a function (like a house guesting people), a business surviving but not thriving or an individual living through difficult conditions. In other words, those that raise some sustainability issues and that are slowly degrading unless taken care of;
- in red we measure those situations that are chaotic or abandoned, the "entropy", the "end cycle" or "waste", like a totally abandoned building or land plot, a bankrupted business, criminal or homeless individuals, etc.[16]; situations that normally require resolving disputes or otherwise entail legal complexity and that clearly raise sustainability issues and public policy concerns.
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Figure 5

[16] Nicholas Georgescu-Roegen, *The Entropy Law and the Economic Process* (Harvard University Press, Cambridge 1971).

In this measurement, we obviously include standard economic markers such as consumption and production, as well as strengths of X, like outstanding natural, cultural or historical resources or agricultural or manufacture productions and such. Anything that makes the system unique and "attractive", that has "gravitational-like effects". On this basis, recalling [3] and [4], we propose the following equation for the codification of any legal system (town, municipality, or aggregations thereof, like provinces, regions, states etc).

$$\lambda_X = \frac{E_X}{M_X} \qquad [5]$$

which suggests using the applicable law and the UN SDGs as "rules of the game", to measure the unexpressed mass, the 'entropy', to then transform it into 'new energy' or 'life' for the system via smart contracts, legal claims and administrative decisions. The codification as such allows to then design and measure competitive legal processes, with a view to potentially expressing the full potential and to reach an ideal relativistic equilibrium as in the following figures.

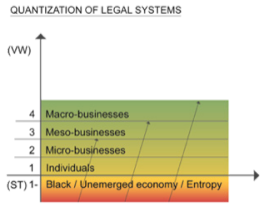


Figure 6

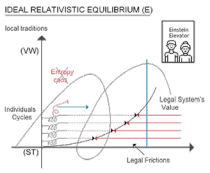


Figure 7

Figure 8

The model in Figure 4 suggests the "quantisation of legal systems". While it is not the purpose of this paragraph to discuss quantum physics, it is important to recall some of its concepts to explain its application to a legal system. One is "quantum entanglement", the phenomenon of a group of particles being generated, interacting, or sharing spatial proximity in such a way that the quantum state of each particle of the group cannot be described independently of the state of the others[17]. The other interesting concept is the "quantum jump", the transition of a system from one energy level to another[18]. In quantum physics, when the system absorbs energy, there is a transition to a higher energy level; when the system loses energy, there is a transition to a lower energy level. For the codification, we use model 4 to first approximately classify entangled mass and energy as above. Then, recalling the idea that money can be considered as energy[19], to fund the

[17] Yunpeng Tao, 'Quantum entanglement: Principles and research progress in quantum information processing' (2024) 30 Theoretical and Natural Science 1, 263-274.

[18] Mazen Khoder, 'A Concept of Universal Quantum Jump' (2020) 44 (LXX) Matematichki Bilten 1, 37-51.

[19] Sergey Rashkovskiy, 'Economic Thermodynamics' [2022] ARxIV <https://arxiv.org/abs/2106.08964> accessed 15 June 2025; Sergey Rashkovskiy, 'Thermodynamics of Markets' [2021] ARxIV <https://arxiv.org/abs/2010.10260> accessed 15 June 2025.

effort to reach the ideal equilibrium projected by every system, systematising life and work cycles according to empirical measurements and the applicable law like in figure 5 and 6. The models will not be explained further at this stage but rather proposed as analogical or even just metaphorical tools to test the said interrelation in specific legal systems, while continuing their conceptual and mathematical development for future publications[20].

4 Conclusions

This Innovation Letter aimed at raising the problem of interrelation between human laws and the laws of nature, namely with a brief report of the main legal and physics-based theoretical frameworks and with some simple examples and mathematical equations. To test the improvements of such an interrelation, it proposed the codification of sustainable legal systems to measure and potentially foster legal systems' progress in universal and mathematical terms. That means, in practice, once the unexpressed or abandoned mass ("entropy") is measured in specific systems, to put in place an IPO-type of process for legal systems, entailing the tokenisation of assets for fundraising and governance of codified legal systems; as well as the usage of empirical data powered artificial intelligence machine learning, predictive, generative tools for markets to emerge, and to enforce the law.

Sample of a real case study analysed, Masainas, a small town of roughly 1,000 inhabitants by the sea in Sardinia famous for its artichokes

The calculation of unexpressed "entropic" mass reveals assets or potential like on the left of the column below in Figure 7, that need capital to be built and/or started as per column right. The potential for 10 businesses in agriculture, manufacturing and services related to the artichoke value chain of Figure 9 below, and energy production calculated with AI tools based on the strengths of X, as well as on (part of) the production that could be internalised based on consumption. The hypothetical tokenisation of the assets would allow for regulating ownership, usage and/or governance according to the applicable law, like in the example of Figure 8 below, as well as to "gamify" legal systems and provide transparency and certainty about economic and legal data. N.B.: the calculation is approximate and subject to further empirical analysis. The token distribution and governance proposal are hypothetical and subject to agreement by concerned parties.

[20] The problem will be treated in a forthcoming essay, G M Solas, "De Lege et Amore – Theory of Interrelation & Sustainability", as well as in other publications.

ASSETS / POTENTIAL	***CAPITAL NEEDED***
10 businesses in the artichoke value chain	*2,000,000 EUR*
100 buildings or land units	*30,000,000 EUR*
2 energy plants	*2,000,000 EUR*
Legal costs	*1,000,000 EUR*
Total	***35,000,000 EUR***
Total token	***100,000 x 350 EUR***
Token: *rights to products from companies; property or use of buildings; energy; or dividends from sale*	

Figure 9

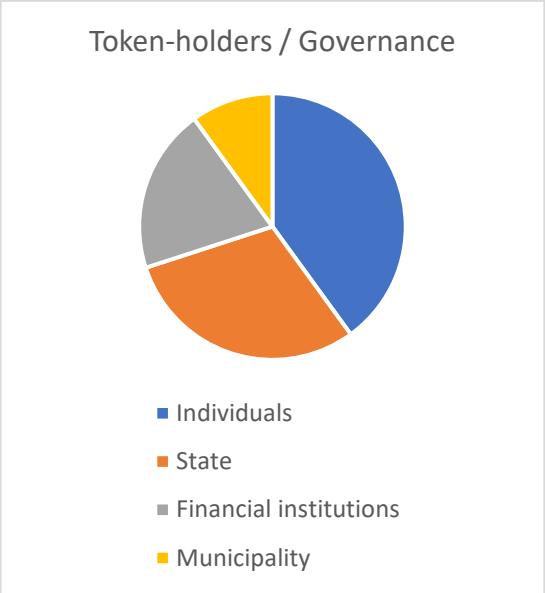
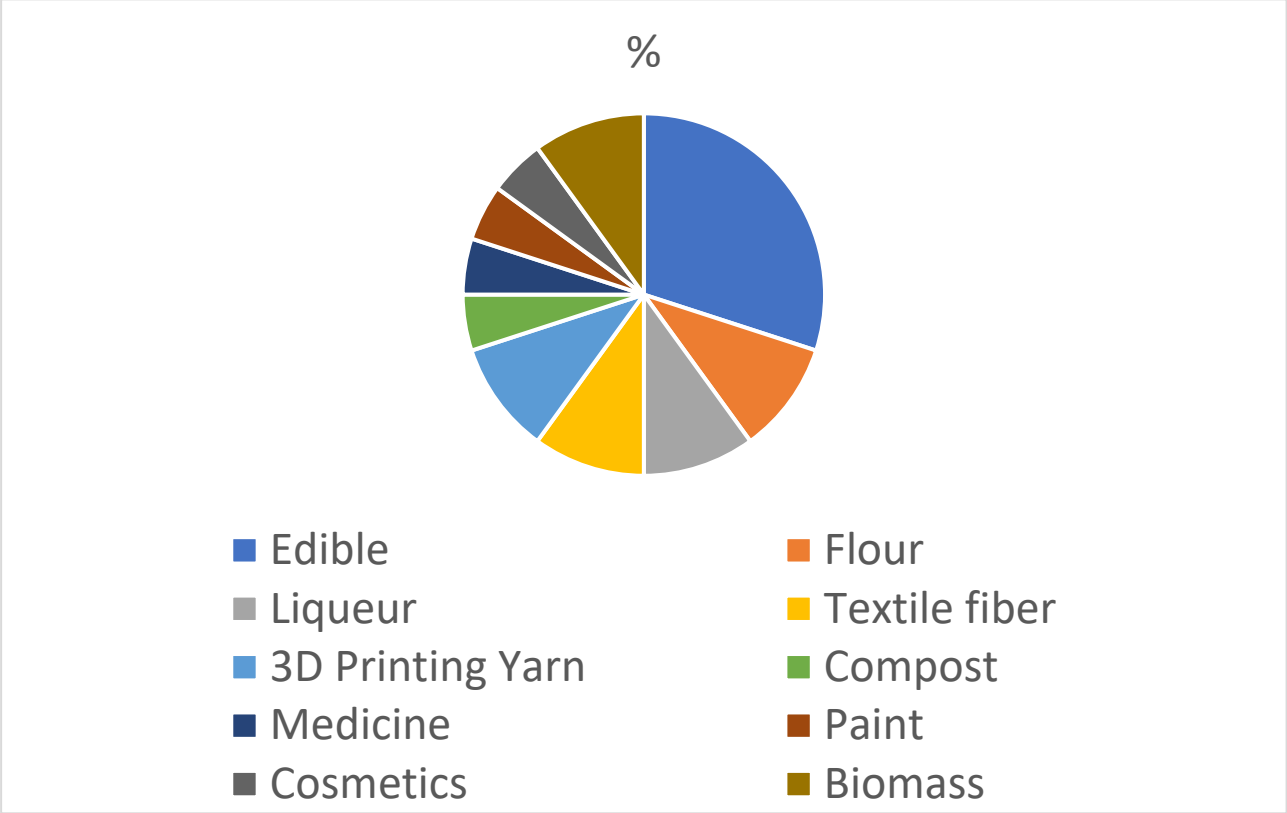


Figure 10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Edible
Flour
Liqueur
Textile fiber
3D Printing Yarn
Compost
Medicine
Paint
Cosmetics
Biomass

Figure 11