Future Transformational Outlook for the Digital Society and Economy

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Abstract: The comprehensive understanding of the mixed cyber-physical world requires a suitable exploration paradigm that is able to handle both tangible and intangible assets of the new extended digital reality. Talking about the future inevitably opens the hybrid human-machine combination of knowledge, experience and simulated experiments towards a combined effort of multifactor treatment of the upcoming digital society. Going beyond with the future economy transformation, the present beliefs for a utopian blockchain implementations of digital currencies will unprecedently clash with the slower social changes, creating a gap of speeds and uncertainty changes. Whilst the COVID-19 pandemic has already indispensably shown us that the digital transformation could be significantly fostered with new approaches like: "work from home", "digital trading" and "digital shopping", the comprehensive analysis of these changes and the foreseeing of future trends is a challenging effort. The paper outlines a methodological approach with both analytical & machine simulated parts that have already proven successful forecasting results on the future digital transformation effects, based on hybrid morphological & system-of-systems analysis. The prognoses are presented in a multidimensional space of subspaces with different dynamics interactions, producing useful foresight generalizations. Further, validation and verification with hybrid human-machine multicriteria stochastic and real-world interactive evaluations are also presented for completeness. A final wrap-up discussion on the obtained results and future trends expectations is given as a conclusion.
Keywords: Digital Transformation, Future Economy, Scenario Landscape Establishment, Holistic Analysis, Results Interactive Evaluation

INTRODUCTION

The new societal leap to the digital world is obviously going to transform most of our lifestyle and philosophy of life in the near future (Minchev et al., 2019). Joining humans with machines in ever closer unions looks quite fascinating for the new generations, inspired by futuristic computer games and movies, but also opens numerous unexpected effects of transhumanization and singularity (Harari, 2017; Taillandier, 2021). The future privacy understanding will naturally be changed, while gaining also a digital dimension and becoming quite vulnerable due to the innovative nature of the digital transformation (Walsh, 2018). Extending the present cyber-physical reality with multiple sensors and autonomous artificial intelligence (AI) definitely provides precious opportunities for obtaining new senses due to Big and Rich Data (emerging from multiple IoTs and social networks, banking and smart

web services) cloud based high performance computing (HPC) and knowledge handling. The resulting advancement and mixed objective reality are also going to be transformed on the governance and economic perspective base. On one hand – the new elite, using tech innovations is already looking naturally for a bigger scale and effective population control in the smart digital society (Drinhausen & Brussee, 2021); on the other hand – the technological transformation of economics is producing numerous products and values that have no material but only digital sense, while gaining fast popularity (UN, 2021). Above all, the climate change response is also affecting our reality in an unprecedented manner (Frank et al., 2018), complicating the situation, together with recent COVID-19 pandemic boom (Gloster et al., 2020), that probably will evolve with other biotope harmful responses due to the environmental external influences (Bostrom & Ćirković, 2008). These changes have created a puzzling situation for the future evolution, resulting from the constant need for economic growth and the resulting effects for a new smart economy and society establishment that, though looking quite fascinating, are naturally divisive to the world. The smart machines and robots could certainly be quite helpful but the singularity modus for artificial intelligence (Schwab & Vanham, 2021) is still lacking the moment when machines will become clients and start to pay taxes, even though they are already "entering" the jobs market (Autor, Mindell & Reynolds, 2020). So, ideas like: Universal (unconditional) Basic Income, Combined Digital Value (moving both digital and real values to the stock and jobs market), digital currencies usage and banking transformation are already getting traction. This new human-machine closer hybridization, though providing a deeper interworking and augmenting of the human capabilities is also creating a "transcending reality" (Leonhard, 2016) for comprehensive security handling, adding innovative cyber wars, crimes and other smart attacks, towards humans, machines and smart infrastructure mix.

The paper presents a methodological framework for comprehensive exploration of the future society and economy transformation towards the next 10-15 years, joining both expert knowledge and machine simulated results with selected reference data. The obtained foresight examples are finally assessed by development trends multiple scenario evolution simulated matching with experts' future beliefs discussions, concerning the scenario landscape meaning for the future digital society and economic dynamic progress.

METHODOLOGICAL FRAMEWORK

The exploration framework is actually encompassing tailored ideas from (Minchev et al., 2019) and (Minchev, 2020b), trying to understand proactively the future of digital society and economy multiple transformation aspects. This rather demanding foresight methodological outlook has been successfully organized (see Figure 1) within three stages: (i) Scenario Landscape Establishment, (ii) Holistic Analysis; (iii) Results Interactive Evaluation.

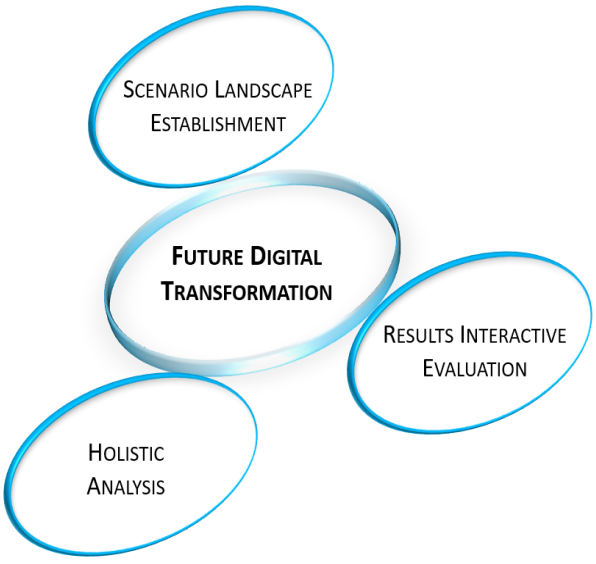


Fig. 1: *Methodological framework for future digital economy & society transformation exploration, adapted after (Minchev et al., 2019; Minchev, 2020b).*

The presented generalized framework is practically combining expert, reference and simulated data with morphological analysis for initial establishment of resulting scenario combinations. Further, the findings obtained are holistically organized for sensitivity system analysis and foreseeing the upcoming roles of important key assets from the digital society and economy ongoing transformation. As far as the obtained prognoses consider the future – a suitable interactive results assessment is finally proposed, using both machine trends simulation validation and user-based proactive verification. More details on the outlined methodological framework implementation will be presented next.

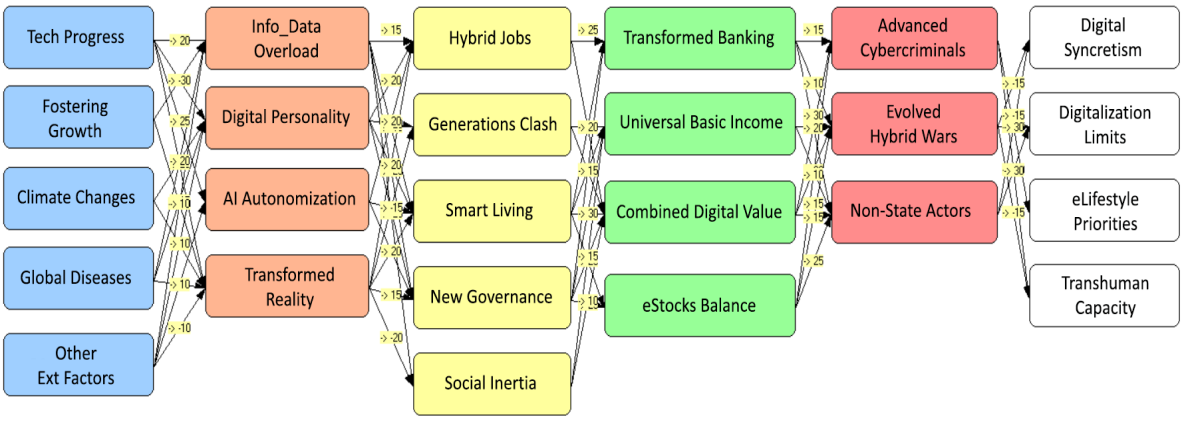
IMPLEMENTATION DETAILS

Scenario Landscape Establishment

The practical realization of this stage is implemented, defining a convex multidimensional hull with scenarios of "plausible" and "implausible" future. Successful proactive approximation naturally requires expert knowledge and beliefs combination with adequate model paradigm and relevant quantitative assessment. In this sense, the morphological analysis idea has been further accomplished as a method for large number of objects classification (Zwicky, 1969), establishing a cross-consistency scenarios matrix (Popper, 2008). Being quite noisy, the utilized expert data fused with selected reference beliefs naturally requires different evaluation techniques for uncertainties handling (Atanassov et al., 2016; Smarandache, & Dezert, 2009; Kochenderfer, 2015). Above all, a suitable scenario filtering method is also required as the complete combinatorial exploration is quite resource consuming and not always useful. Thus, an extension of fuzzy sets, together with logical driving factors and gaps of the future objective dual weighting combined evaluation has been further accomplished, following (Minchev, 2020b).

The idea is to build a multidimensional space of mutually exclusive alternatives of the cross-consistency matrix, while keeping similar or different numbers for each of the studied dimensions of interest. The so far stated ideas have been practically realized with I-SCIP-MA environment, discriminating three types of scenario combinations: active (tangible), passive (intangible) and neutral. The outlined classification is achieved with RCW (Relative Common Weight) fuzzy weighting over the arcs of a unidirectional graph, representing selected plausible & implausible scenario combinations with multiple dimensions and alternatives (Minchev, 2015).

A graphical illustration with a unidirectional graph model and resulting cross-consistency scenarios matrix, exploring digital society transformation and economic future proactive identification towards the year 2036 is presented in Figure 2.



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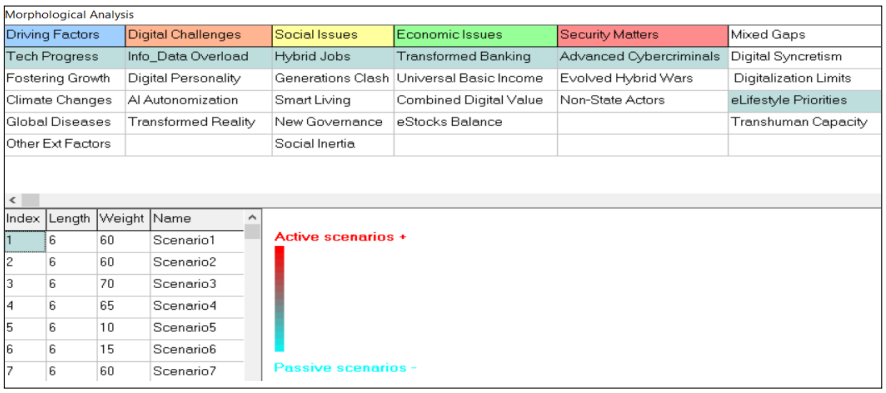


Morphological Analysis

Driving Factors	Digital Challenges	Social Issues	Economic Issues	Security Matters	Mixed Gaps
Tech Progress	Info_Data Overload	Hybrid Jobs	Transformed Banking	Advanced Cybercriminals	Digital Syncretism
Fostering Growth	Digital Personality	Generations Clash	Universal Basic Income	Evolved Hybrid Wars	Digitalization Limits
Climate Changes	AI Autonomization	Smart Living	Combined Digital Value	Non-State Actors	eLifestyle Priorities
Global Diseases	Transformed Reality	New Governance	eStocks Balance		Transhuman Capacity
Other Ext Factors		Social Inertia			

Index	Length	Weight	Name
1	6	60	Scenario1
2	6	60	Scenario2
3	6	70	Scenario3
4	6	65	Scenario4
5	6	10	Scenario5
6	6	15	Scenario6
7	6	60	Scenario7

Active scenarios +

Passive scenarios -

b)

Fig. 2: *Digital society and economic future transformation proactive morphological analysis model (a) and resulting cross-consistency matrix (b) towards 2036, in I-SCIP-MA environment.*

The resulting findings are clearly demonstrating the filtration effect from the morphological analysis application, selecting in a matrix M, roughly almost 1/4 of the whole scenario pool: N1' = 8612 (positive – 7207 (RCW > 0), negative – 1263 (RCW < 0) and neutral – 142 (RCW =0), N1 = 28800.

In brief, the scenario results from this analysis towards the year 2036, could be summarized as follows:

The scenarios with highest intangibility are mainly addressing: fostering economic growth (concerning economic extension just with political will and no reasonable market advancing, that could be definitely problematic after some time (Meadows, Randers & Meadows, 2004)) and other external factors (having natural, manmade or technological origin, not included in details for the current analytical modelling) as driving factors. Combined with: natural social inertia, smart living (mostly addressing the new generations) and new governance (adding AI in the decision-making process, especially towards smart environment of living and big data processing) for the new digital society transformation instability (Schwab, & Vanham, 2021; Autor, Mindell & Reynolds, 2020; Leonhard, 2016).

From economic perspective, the banking transformation and digital stocks (eStocks) balancing, though quite innovative (KPMG, 2019; PwC, 2019a) could generate mostly instability in the above context, adding Combined Digital Values to the market and getting perspectives for great speculation in the next 10-15 years ahead especially also due to unplanned external effects (to mark other man-made or natural crises).

This new mix is also challenged from advanced cyber criminals (implementing AI) and evolved hybrid wars by means of adding AI and other attack vectors (to note global diseases like COVID-19 pandemic having psychological, physical and social effects (Ding et al., 2021; Gloster et al., 2020; Mladenova, 2020) for the newly transformed and overflooded socio-economic mixed reality with autonomized AI inclusion.

The mixed (human-machine) gaps in this intangible scenario set are mostly related to the future transformed people's (transhumans, marked as the people of the future (Harari, 2017; Taillandier, 2021)) capacity of handling the future digital changes that normally will have problems with their new lifestyle (eLifestyle) priorities (recently shifted with the pandemic lockdowns and resulting cyber threats (Minchev, 2020c)) and overall transformation by means of digital syncretism (global amalgamation of different social beliefs, values, traditions, cultures, etc.).

Luckily, the morphological analysis is also presenting a tangible scenario set, addressing: technological progress, climate change and global disease, hopefully to be controlled by the future digital society.

This normally is achieved via certain social and economic measures, to note: hybrid

(human-machine) jobs and smart reality symbioses, that naturally extend our capacity and views (Walsh, 2018; Minchev, 2019). The idea for a "Universal Basic Income" (being in a way a social tool but, easily implemented in the future digital economy of new combined values) is a test to the new reality transformation, to effective governance and to its acceptability by the future banking structures, using mostly blockchain technologies.

The biggest gap here is however the digitalization's natural limit, that is expected to regulate the future, while producing new challenges, like: advanced layering, provoked by the appearance of new divides through digital transformation (Chobanova, 2021), and the hidden role of non-state actors in the process. The problem is of significant importance for the future hybrid wars advancing, being a tool for other countries and non-state actors to enact hidden competitive interventions, together with AI autonomization attacks (The European Centre of Excellence for Countering Hybrid Threats, 2021; Cohen et al., 2020).

Though quite interesting, the morphological analysis findings are rather bounded and static, lacking deep system causality feedbacks, while providing the exploration hull, outlining and implementing dual relations evaluation (on the "Drivers" and "Gaps" dimensions as stated before). However, we are still missing the potential holistic nature complexity of the studied problems from the dynamic perspective. So, a further deeper system-of-systems exploration has been performed in the next section.

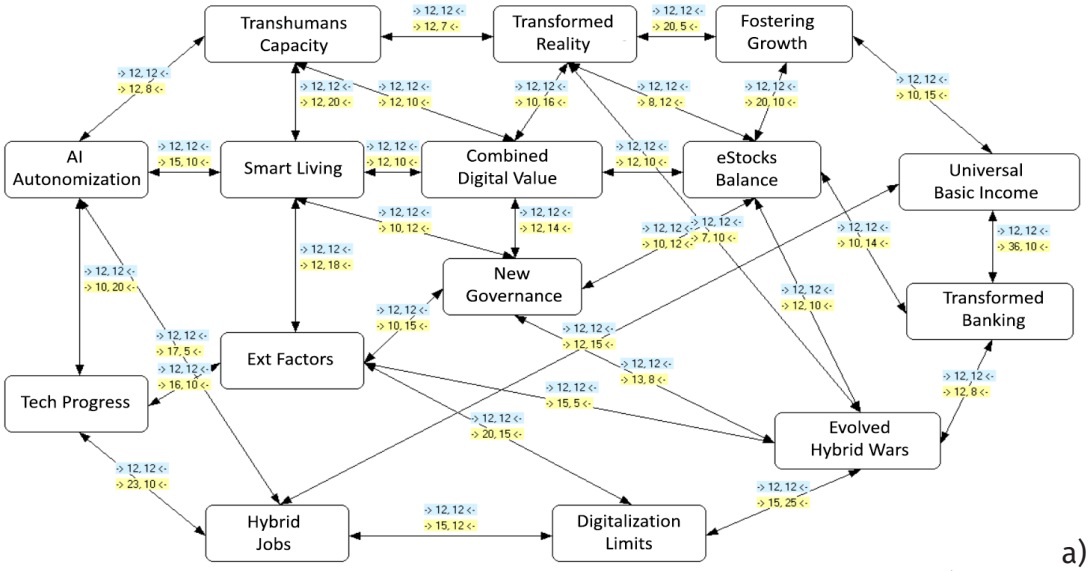
Holistic Analysis

Approaching the holistic thinking with system-of-systems modelling (Vester, 2007; Sayama, 2015) could get us closer to the multidimensional mixed reality dynamics of the near future. This is practically achieved by adding causality in the modelling process, and thus understanding some details, while blurring others. As far as no modelling tool is capable to get us close enough to the objective reality multidimensional variability, the proposed approach is at least reasonable and comprehensive enough from both Control and System Theories perspectives (Miranda, 2015; Metcalf, Kijima & Deguchi, 2021). The presented solution is giving us a capability to outline the basic future behavior of entities of interest in a multidimensional and interconnected holistic system, providing at the same time potential for a suitable future forecasting with relevant uncertainties handling. Being complex enough, these expectations will be further described, in more detail, from the modelling paradigm perspective, while the dynamics is additionally studied in the next section.

The model has been created using "Entity-Relationship" interpretation with additional attributes description, providing a possibility for a multi-agent interpretation – a useful solution for the dynamic exploration of the model evolutionary behavior (Minchev, 2015). The practical implementation has been organized in I-SCIP-SA environment, over a weighted graph (giving entities, labeled nodes & relations – weighted arcs interpretation) with "many-to-many" multidimensional interconnectivity, assuring substitution of a certain entity or relation with another sub system model.

The overall holistic system assessment is presented in a *3D Sensitivity Diagram* with four key zones (mimicking a multidimensional space with sub-spaces): *Buffering* – Green, *Passive* – Blue, *Active* – Red & Critical – Yellow. All entities disposition for a certain sub-space, actually depends on the Influence/Dependence ratio, giving a resulting assessment of their *Active* or *Passive* role in the zone of interest. Additionally, a time variable for the whole multidimensional space is also accomplished, providing dynamic representation of the holistic system sensitivity discrete changes.

The outlined ideas are finally generalized in a holistic system assessment discrete model of digital society transformation and economic future proactive exploration (encompassing 15 entities and 32 bi-directional relations in 12 steps, see Figure 3) from the year 2021 towards 2036.



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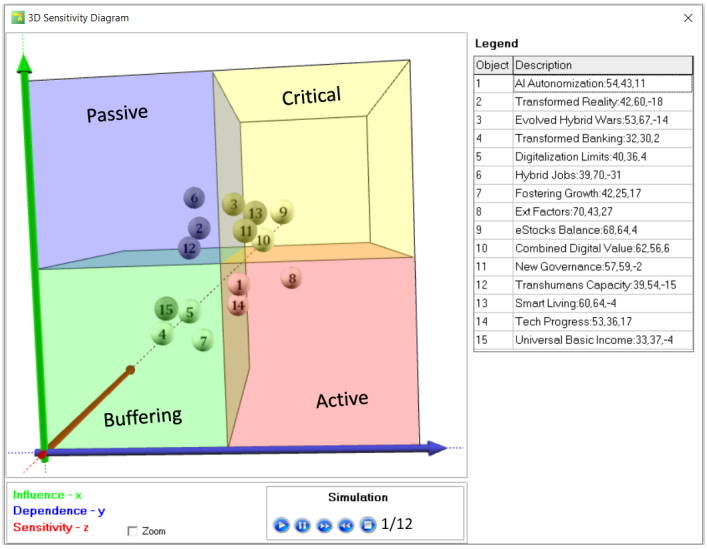

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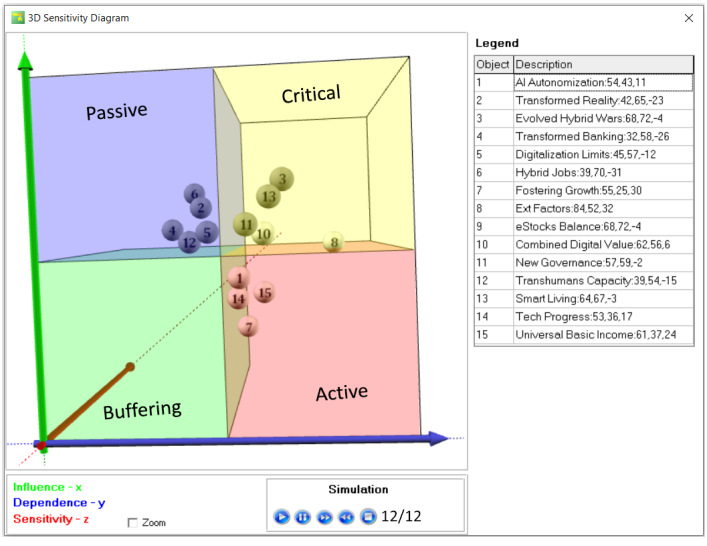

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Fig. 3: *Digital society and economic transformation future holistic system analysis model (a) with resulting 3D Sensitivity Diagram examples for the present – 2021 (b) and future – 2036 (c), in I-SCIP-SA.*

The presented system model is addressing the following resulting sensitivity classifications, taking in to account a strategy for no buffering entities usage towards the future, assuming less uncertainties in the results:

In 2021:

Buffering: "Transformed Banking" – 4, "Digitalization Limits" – 5, "Fostering Growth" – 7, all *Active* in the zone, "Universal Basic Income" – 15, *Passive* in the zone; *Active*: "AI Autonomization" – 1, "Ext Factors" – 8, "Tech Progress" – 14, all *Active* in the zone; *Passive*: "Transformed Reality" – 2, "Hybrid Jobs" – 6, "Transhumans Capacity" – 12, all *Passive* in the zone; *Critical*: "Evolved Hybrid Wars" – 3, "New Governance" – 11, "Smart Living" – 13, all *Passive* in the zone & "eStocks Balance" – 9, "Combined Digital Value" – 10, both *Active* in the zone.

In 2036:

Buffering: have not been defined, as being moved to the other three zones, according to the simulation objective; *Active*: "AI Autonomization" – 1, "Fostering Growth" – 7 , "Tech Progress" – 14, "Universal Basic Income" – 15, all Active in the zone; *Passive:* "Transformed Reality" – 2, "Transformed Banking" – 4, "Digitalization Limits" – 5, "Hybrid Jobs" – 6, "Transhumans Capacity" – 12, all *Passive* in the zone; *Critical*: "Evolved Hybrid Wars" – 3, "New Governance" – 11, "Smart Living" – 13, all *Passive* in the zone, "Ext Factors" – 8, "Combined Digital Value" – 10, both *Active* in the zone.

In brief, the analytical results from this holistic system analysis for the present (2021) and future (2036) of the digital society and economic transformation, could be summarized as follows:

Apparently, the key driving factors towards year 2036 will be mostly related to technological progress, AI advanced autonomization, adding also expectations for fostering growth and Universal Basic Income, caused by the economic delay due to the pandemic crisis that hopefully will be compensated with economic and technological transformation.

However, digital society changes naturally generate hidden threats that are going to emerge from future hybrid situations and activities, requiring an extended machine and AI role, new transformed smart reality establishment and transhuman capacity augmentation, implementing new mixed senses with deeper sensors and faster communications integration (Leonhard, 2016).

From an economic perspective the outlined threats are going to address the transformed banking system (adding digital values to the present market) on one hand, and on the other – probably reach the technological limits of the digitalization in general. A situation that normally will go beyond to the fifth wave of the adoption of quantum technologies (PwC, 2019b).

Finally, some critical issues that are expected to appear around the new smart reality and economy have to be expected with the evolved hybrid wars, smart living and new governance, incorporating advanced AI, actively dominated by "Combined Digital Value" idea (adding digital values from the eStocks of the present market economy) and other external factors (originating from natural, manmade or technological fields, as well as in combined forms) that could cause transition turbulences (Guillen, 2020).

These findings definitely generate a complex symbiosis of both technological and human advance in the near future digital society and economy changes. However, it is important to note here that the transitions within the years could have multiple trajectories, evolution strategies and sub-systems dynamics. So, the problem requires a deeper exploration by means of potential multidimensional future assessment, marked in in the following section.

INTERACTIVE EVALUATION OF RESULTS

Potential proactive evaluation of the future trends is one of the key moments related to the applicability of modelling results in the study of future objective reality transformation. Combining expert opinions, beliefs and machine simulations with suitable multi criteria dynamic assessment could be a

useful step for proactively approaching the validity of future forecasts. A key problem to be solved here is the study of different dynamics coherence, i.e. synchronization of multidimensional sub-systems interactions (Panchev, 2001).

Further, a verification of the results could be performed with interactive assessments (table-top exercises, discussions, computer assisted exercises, mixed reality simulations, etc.), concerning the suitable time dynamics and multidimensional coherence understanding, looking for coincidences within specific moments of mutual interest both from validation and verification processes.

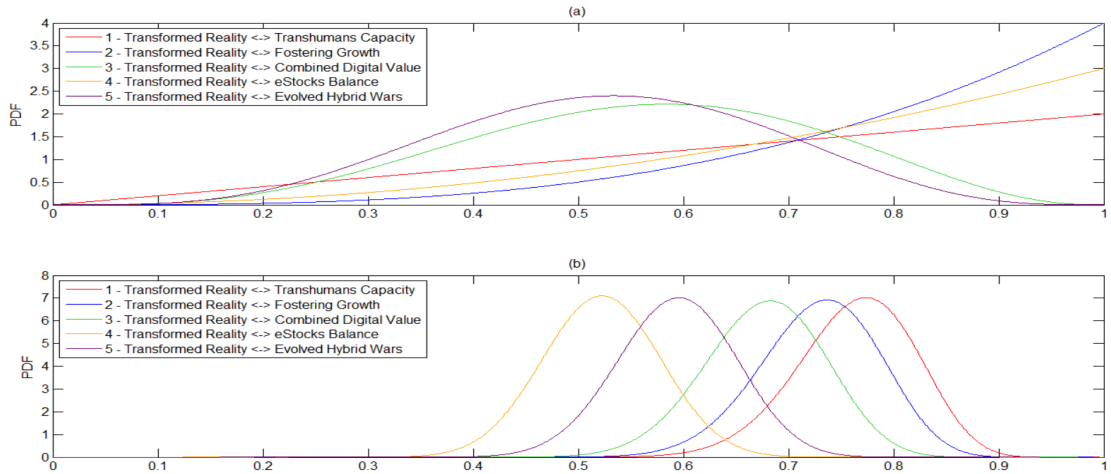
Machine Simulation

Following these notes, two approaches are marked for the validation process: (i) Probabilistic distribution with Forrester's simplifications for a single stage foresight exercise (implementing Beta, either Dirichlet distributions, according to the scale of interest) or (ii) Work with multiple stages, by extending (i) in the Kondratiev sense (using four-cycle stages: *Prosperity, Recession, Depression, Improvement*) (Minchev et al., 2019).

As far as the practical implementation of these validation ideas requires a suitable context both morphological and holistic system modelling (see 3.1 & 3.2) dynamic exploration could be implemented, following (Minchev, 2020d) within Quasi Monte-Carlo simulations over an HPC experimental architecture (Karaivanova, 2012).

Being a rather significant computational task, however, the multiple sub-systems of interest in parallel exploration require a different dynamic of coherent modelling, studying and simulation.

A generalized solution in this sense is the extension of (Minchev, 2020d) with the following: (i) the multidimensional relations in the holistic system model are represented with positive Z_p and negative Z_n quasi periodic Kondratiev's stochastic approximations of S-shaped curves, where the system sensitivity is calculated as: $Z_s\ (Z_p, Z_n)$; $Z_i\ (I_i, D_i, S_k) = P\ (I_i|S_k)$ x $P\ (D_i|S_k)$, P (...) – Bayesian probability, I_i – system influence, D_i – system dependence, $i = \{p, n\}$, S_k – selected k^{th} scenario from the scenario cross-consistency matrix M. (ii) The relevant value for a particular time and moment of interest is obtained with the basic oscillator concept Z_b, calculated regarding selected evolutionary scenario set objective M and holistic system sub-model. The multidimensional system coherence is handled with general oscillator Z_g dynamics, providing intersystem communications for lower than the whole system size. The criteria of success could be evaluated following the ideas from (Minchev, 2020a) and (Minchev, 2021) while assuming irregularities between different S-phases, and strict consecutiveness, as social processes are inert and phase jumps (e.g. from *Recession* directly to *Prosperity*, omitting the other two (Minchev et al., 2019)) are difficult to be expected in real life.



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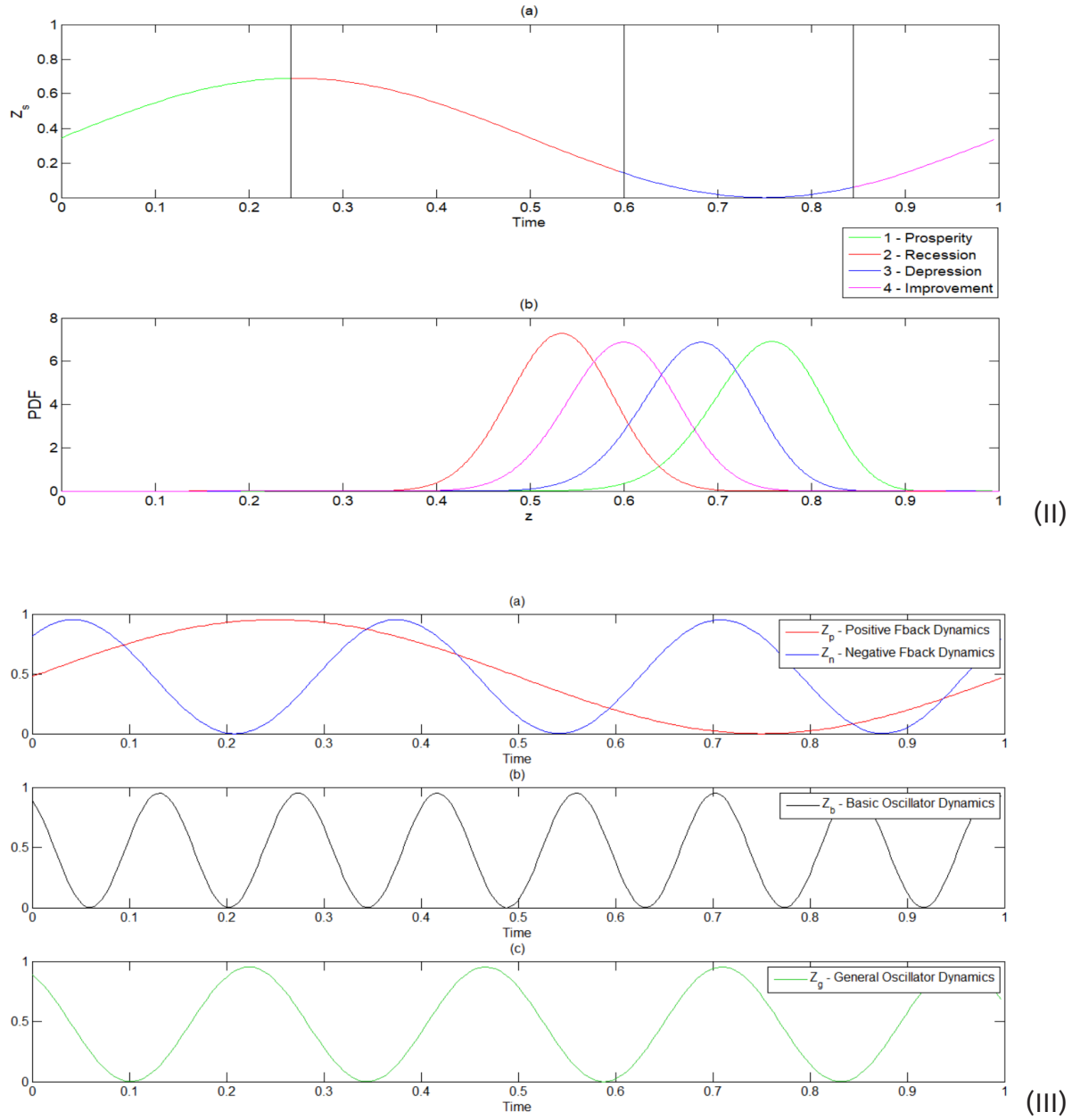

Fig. 4: *Generalized probabilistic validation example for "Transformed Reality" final results (I) with system sensitivity Zs dynamics (II) & dual feedbacks, multidimensional synchronization (III) ideas to 2036.*

The presented results on the "Transformed Reality" future to 2036 are giving priorities to "Transhumans Capacity", "Fostering Growth" and "Combined Digital Value", though "Evolved Hybrid Wars" & "eStock Balance" are also marked with significant probability (P ≥ 0,5).

Obviously, exploration of different sub-systems models is quite useful, especially due to multiple phases overlapping ambiguities that, with additional oscillators (Z_b – basic and Z_g – general) implementation, are resulting in a deeper & more concrete future dynamics multidimensional understanding, assuring key stages coherence and thus claiming reliable results.

As far as all these simulations feature a bounded human factor role, the presence of some additional gaps and uncertainties needs to also be considered in the future with additional verification.

Proactive Verification

The verification was practically organized within two hybrid events in the last two years: "Hybrid Round Table: Digital Transformation Extended Future Outlook: Challenges, Adversaries, Divides & Opportunities" (Hybrid Round Table, 2020) and "Hybrid Workshop: Future Digital Transformation & Security Challenges" (Hybrid Workshop, 2021), both part of the Secure Digital Future 21 international expert forum within more than 60 countries' efforts (Secure Digital Future 21, f.d.). About 80 participants and different subject matter experts from 10 countries (Bosnia & Herzegovina, Bulgaria, Brazil, Indonesia, Israel, Italy, Romania, Serbia, Ukraine and the USA) took part in the events.

Selected moments from the discussions and generalized results in four basic areas ("Technological", "Social", "Economic", "Security" issues) with five parameters each (taking both *Positive* & *Indefinite* assessments) are presented in Figure 5.

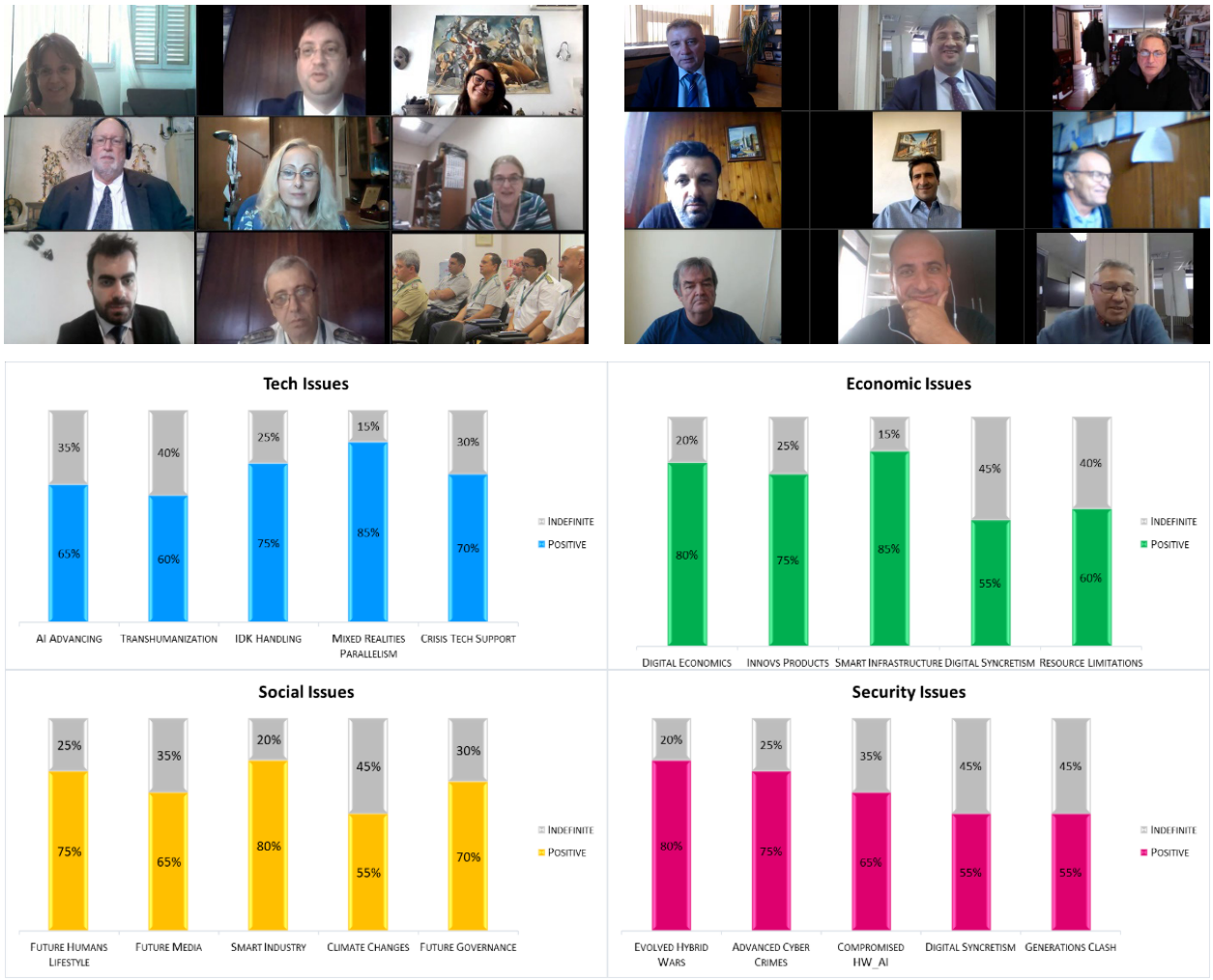

Fig. 5: *Aggregated discussions verification results towards 2036 for digital society and economy transformation with human factor proactive role, produced from (Hybrid Round Table, 2020; Hybrid Workshop, 2021).*

The results towards 2036 outline several generalizations that could be concluded as follows: (i) the technological progress is expected to practically support the future crisis management (natural or mixed) and transhumanization, getting advantages from AI development, realities (objective and simulated) mixing and parallel existence, together with the adequate information, data and knowledge (IDK) handling; (ii) the new social transformation is quite uncertain on the climate changes effects (mostly expected

to really deepen towards 2050 (Lennox, 2020) and future media (probably due to deep fakes constantly progressing in the new digitally mixed reality). Apart from these findings, the future industry, lifestyle and governance are going to positively affect the new transformed society; (iii) smart infrastructure, economics and innovations hopefully are going to positively support the new situation, while not for all of the people globally (due to the existence of natural divisions), taking Universal Basic Income (UBI) and resource limitations as bounding factors; (iv) regarding the future security issues, the clash of new generations (adding digital fatigue and attention deficit with simultaneously faster dynamics of even searches for the young versus the old (Minchev et al., 2017; Ben-Israel, 2021) being both digitally overflooded with the pandemic "work from home" or "study from home" lockdown approaches), combined with digital syncretism and compromised-by-design (both hard- and soft- ware, either because of human mistakes, improper evolutionary programming or planned production gaps) are also going to establish new types of advanced hybrid wars and cybercrimes (by means of hostile AI implementation, inter-state competitions, etc.).

CONCLUSIONS

The analytical understanding of the future society and economy digital transformation from the present perspective towards the year 2036 is an uncertain and challenging task. Providing a comprehensive outlook to this problem obviously requires the joining of human and machine efforts with a suitable exploration framework.

The approach presented has definitely outlined important moments from these changes, noting the mixing of technologies and people in a new smart reality fostered by the pandemic.

Obviously, the expectations for accelerated climate change are also going to support this transformation. However, it is important to note here the resulting economic limitations, reckoned also as cyclical crises that naturally could be overcome with extending the market with new digital stocks, currencies and banking.

This solution as part of a future digital governance approach, together with mixed human-machine jobs, Combined Digital Value, Universal Basic Income sharing, IoTs & AI supportive of new skill and sense implementation (if spread amongst sufficient states around the world) will inevitably guarantee the future economic transformation to a new level of stabilization.

Successfully handling the security and resilience of this new digital society requires also significant investments and a new understanding of privacy for effective handling of the inter-state and organizational competitions (both formal and informal) projected in technologically advanced hybrid wars, cybercrimes, lifestyle syncretism and generations clash.

Thus, the fostered digital society and economy transformations have to be considered quite fragile if other external factors and constant growth are expected for the near future.

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