QUALITY 5.0: FROM CHALLENGES TO REALITY

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A B S T R A C T

The A world is in process of rapid changing in all areas of living. In all of them exists old and new problems with urgent needs for solving. Transition from Industry 3.0 to Industry 4.0 changed view on industry in 21st century and also there are answers on challenges based on Quality 3.0 and Quality 4.0 concept. In last ten years is developed concept of Japan's „Society 5.0" which needs Quality 5.0 concept. This is main motive for researching possibility for transition quality into Quality 5.0.

In the paper are presented basic information about Industry 4.0 and Quality 4.0 based on new challenges in 21st century. Based on literature and own research is defined concept of Quality 5.0 and ways of transition to Quality 5.0, essecialy in transition counties as Serbia in next 30 years. The first analysis pointed out that it is possible with using smart technologies, smart leadership, smart people and other smart „things" for achieving smart/integrated quality, quality of life, resilience and all human-centric achivities.

1. INTRODUCTION

The trend in 21st century is to establish smart society in which is included more than 27 smart components. For this research are interesting smart industry (Industry 4.0) and smart quality (Quality 4.0). This process in located in all technology advanced states, but also in some states with big Intellectual Capital (IC). These concepts are defined for each components of smart society. There is problem of integration and incuding human being and problems of sustainability, quality of life, resilience etc. These are challenges for developing concept of Quality 5.0 dedicated to „Society 5.0" development ed in Japan. It is great transition with for fundamental themes (CSTI, 2019):

- creating new values for industry development in future and social transformation,
- reorgnising economic and social challenges,
- higher support for science,
- technology and innovation (STI), and
- establishing sistem cycles of human resources, knowledge and capacity for innovation.

For its realization is nesessary investment in R&D minimum 4% of GDP from private and public sector, from state government minimum 1 percent. With introduction „Society 5.0" in Japan expect enhancing GDP circa 3.3%. The goal of „Society 5.0" is to achieve economic rise/wellbeing and in same time overlapping social challenges and in total prosperity of global society.

According Tompston N. (2014) are recognised four waves of changes until year 2050., i.e.:

1. first wave (2010-2020) with slow development of technologies and first introduction of smart solutions,
2. second wave (2020-2030) with development strategy innovation related to RFID, telemetrics, integration, etc.,
3. third wave (2030-2040) with self-asembly, masive 3D printing, self purchasing, etc.,
4. fourth wave (2040-2050) with paradigm of confidence, supported by advanced robotic and AI, autonomuos vehices, sensing material

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In smart society is higher role of ethical and well-being aspects. Etical government realizes through: (1) impact of regulatives, (2) regulation of collective actions, (3) building/modernising existing regulation, (4) anticipating strenght of transformation of collective adaptive systems (ACS), (5) balancing government decisions, (6) decising adaptive government, etc. Based on Deloitte (2018) are emphasized challenges in smart cities which need quality answers in following areas:

- smart economy,
- smart environment,
- smart living,
- smart mobility,
- smart quality and safety and
- smart education.

Transition of concept Industry 4.0 to Society 5.0 has impact on planning big social transformation in Japan with destroying five walls related to:

- ministries/agencies,
- legal system,
- technology,
- human resurces and
- social acceptance.

A transition from Industry 4.0 to Industry 5.0 is practicaly transformation of digital manufacturing to digital society (Skobelev P.O., Borovik S.Y., 2017) with convergence of science and technologies in society 5.0 from technology to society.

A concept of enterprise value management defined for smart enterprise in Industry 4.0 could be make broader for Society 5.0 and Quality 5.0 (Fujitsu Consalting, 2002).

According Kearney A.T. (2017) value dimensions from converging technologics have levels:

1. value for the factory,
2. value to the firm (enterprise),
3. value to the industry,
4. value to society, and
5. value to the individual.

In all of the levels are included elements of Quality 4.0 (level 1, 2 and 3) and Quality 5.0 (level 4 and 5).

Kueper D. et al. (2019) analyzed Quality 4.0 and concluced that cca 63% companies had not decision or plan for it, but only 16% had some form of implementation. The challenges of implementation were: (1) cost of quality check, (2) first-pass yeald, (3) defect rate, (4) rewark rate, (5) on-time delivery, (6) customer satisfaction, (7) waranty claims, and (8) product-related complaints. All challenges are base for Quality 4.0 and Quality 5.0, also on levels 1 and 2 in value creation.

A Quality 5.0 concept is connected with Industry 5.0 (Nahavandi S., 2019) with advanced technologies: (1) networked sensor data interoperability, (2) multiscale dinamic modeling and simulation: digital twins, (3) shopflor trackers, (4) virtual training, (5) intelligent autonoumous systems, and (6) advances in sensing technologies and machine cognition.

In Industry 5.0 is appropriate to use concept of Lean Innovation because is based on value management (Ozkeser B., 2018). Relations among Quality management in the 21st Century and Industry 4.0 are analyzed in Gunasekaran A., Subramanian N., Ngai E. (2018).

In this research are emphosized following quality tapics for Industry 4.0:

1. economic aspects,
2. decision models in quality,
3. business models,
4. human aspects in quality (including leadership),
5. technological aspects in quality.

Authors conclude that is necessary to make alignment between human aspects and technology revolution in quality management.

A concept of Quality 5.0 is connected with concept Society 5.0. According CSTI (2019); Filip, D. et al. (2014); Nakićević N. et al. (2019) and Smith J. et al. (2018) are defined fundament goals:

- goal 1: Leave N_0 Person Behind,
- goal 2: Empower Users through Good Digital Identies,
- goal 3: Make Business Work for People,
- goal 4: Keep Everyone Safe and Secure,
- goal 5: Build new rules for a new game,
- goal 6: Broke through the data barriere

Author concluded that start is begining.

2. CHALLENGES IN 21ST CENTURY

In 21st century are expecting a lot of challenges (Klein F., Bansal M., Wohlers J., 2017). In this study are emphasized the megatrends of tomorow's world devided into five cathegories:

- society,
- technology,
- environment,
- economy, and
- politics.

For Society 5.0 and Quality 5.0 are specialy highlined:

- artificial intelligence,
- augmented reality,
- digitalization,
- IoT,
- climate change,
- cencentration on wealth,
- demand for custimization,
- environmental awareness,
- focus on transparency,
- globalization,
- partnership models,
- resource scarity,
- sharing economy,
- social media,
- industry consolidation,

- urbanization,
- geospatial technology,
- terorism defence, etc.

A way from Industry 4.0 to Society 5.0 and Quality 5.0 needs a big societal transformation, with challenges to avoid or override barriers related to:

- ministries and agencies,
- legal system,
- technologies,
- human resources,
- aging of populations, etc.

The challenges are related to:

- data availability, security and accuracy,
- technology,
- competences,
- oppeness,
- ecosystem,
- project solutions,
- security of realized system.

A big challenge is related to citizen, i.e. happiness or quality of life in modern society (Kanazawa S., Li N., 2015). It is now element of concept Quality 5.0.

In Gladden M. (2019) is analyzed „Society 5.0" from aspect of antropological posthumanized societies in future. In this study is asked answer on questions:

1. how different types of human and non-human members can collaborate, besides difference among them,

2. how can make concept dinamics of members of „Society 5.0", and
3. in which aspects are different members of „Society 5.0" from societies 1.0 to 4.0.

At the end are stated three questions:

1. does exists samting real new in concept 5.0? Answer: is positive.
2. does the paradigm Society 5.0 could be apploed aut from Japan? Could with some adaptations.
3. How have to collaborate all stakeholders in purpose of realization of Society 5.0? Answer: on theoretical and organizational level.

As extension of Society 5.0 is developed concept „Living Laboratories" and „Living Services" (Fjord, 2015) based on IoT in broad applying and close relations among people, machines and environment.

In Society 5.0 a quality has higher impact and „glue" role. A complexity of these reguests, challenges, needs to develop a new paradigm: Quality 5.0, what is explained in next chapters.

3. CONCEPT OF QUALITY 5.0

Quality 5.0 concept in Society 5.0 is directly related with sustainability, sustainable digital innovation, digital culture, social innovations, quality of life. In figure 1 is presuted quality in context of sustainability.
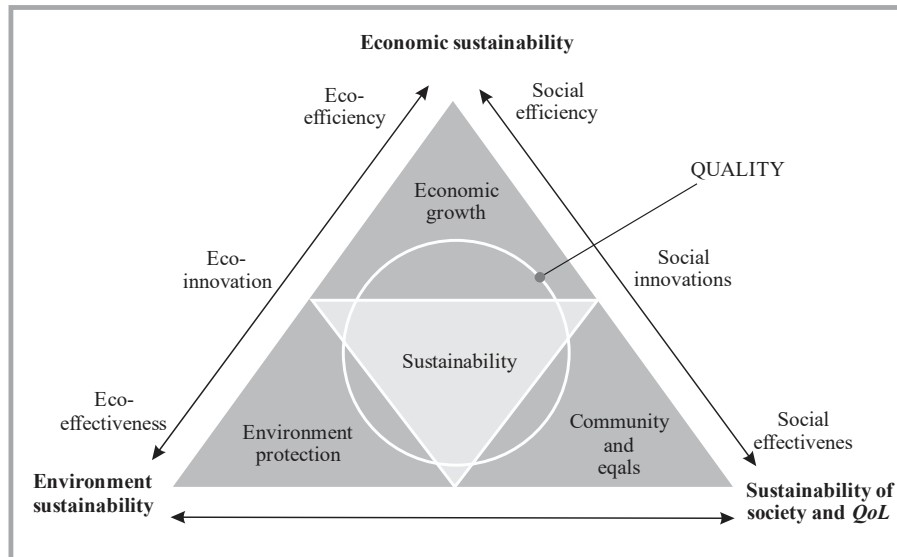

Figure 1. Quality in context of sustainability

In this model quality is incorporated in all elements of Society 5.0. It is enabler of economic growth, sustainability, environment protection, community and equals of peoples, and sustainability of society and quality of life (QoL).

It is defined for extension of existing situation (Quality 3.0/Quality 4.0 in first phase) and creating new reality in future (second phase). On figure 2 is presented

structure of concept Quality 5.0 and relations with environment.

This concept started from a quality practice (on the button) devided with different areas, as industry, education, food, etc. On higher level is quality science with different themas. Each thema has different depth of development and introduction in practice. On higher levels are Quality 4.0 and Quality 5.0 conects with mutial relationships, and also relationship with

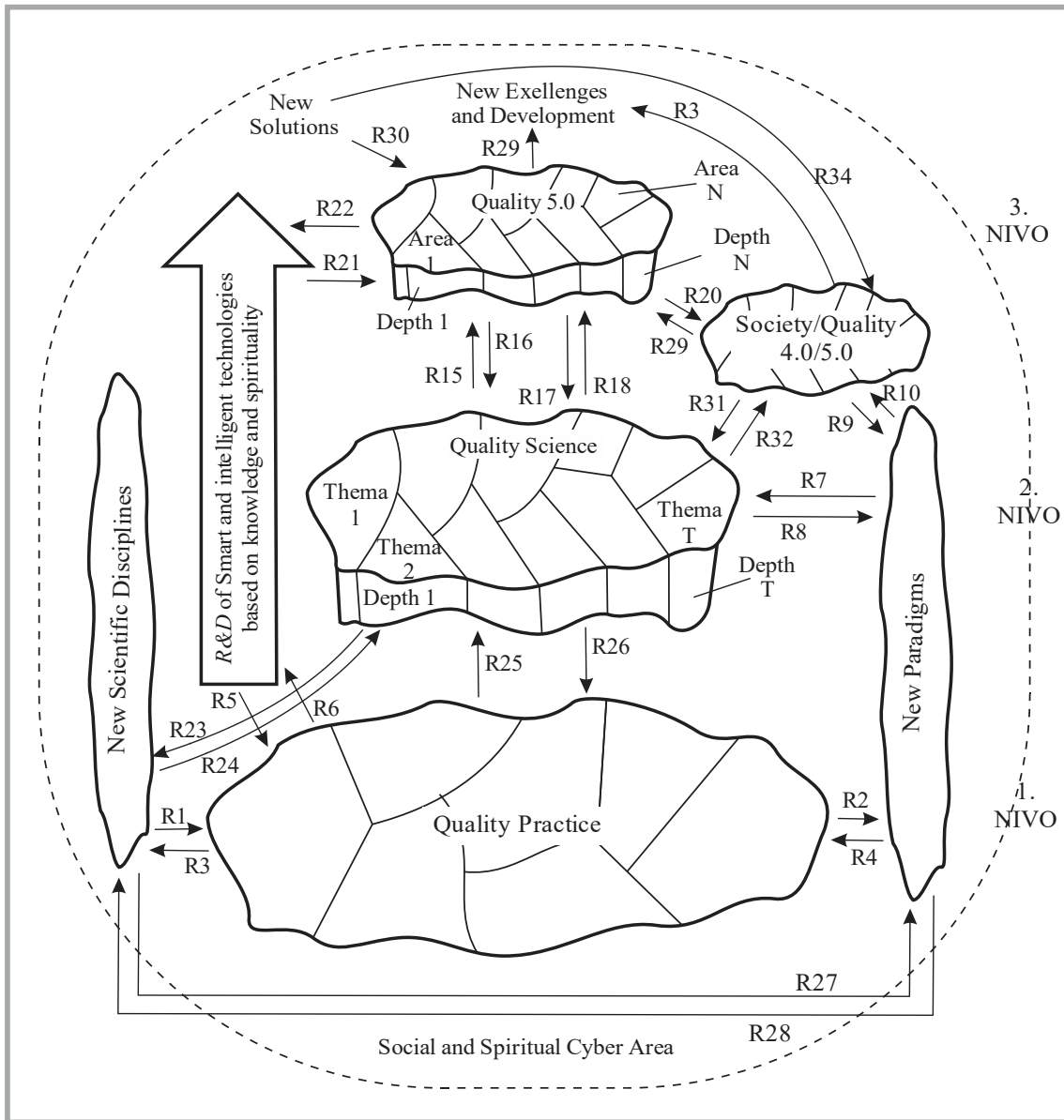presented entities in social and spiritual cyber area (environment).

Figure 2. Levels to achieving a Quality 5.0

A Quality 5.0 consists from different areas (1 – N). Each area of quality has own depth. Through relation R19 and R20 is performed correspondence with socialy 4.0/5.0 as present level of development. On the highest level in the model is Quality 5.0 which has inputs through relations:

- R3: new technological, social and other solutions,
- R21: research and development of intelligent technologies based on knowledge and spirituality,
- R19: common elements from Society 4.0/5.0, and
- R15, R18: new themas from paradigm „Quality Science" (on second level).

On second level is emhasized:

- Quality science and
- Society /quality 4.0/5.0.

Each relation in this level with elements in other levels has own content, related entities and in total own antology. An egsample, R24 represent impact and results of research of concios fields on innovativeness or a.e. sustomer decision.

According Jacob D. (2017) LNS research a Quality 4.0 has 11axes, i.e.:

1. data,
2. analitics,
3. connectivity,
4. collaboration,
5. application development,
6. scalability,
7. management systems,

8. compliance,
9. culture,
10. leadership, and
11. competency.

Each axis has own sub-elements.

She highlined scentific method versus data science. On this approach Quality 4.0 is defined as CIA:

- C (Connectedness),
- I (Intelligence) and
- A (Automation).

in appropriate Quality 4.0 Ecosystem. In center of this system are Neural Networks and Deep Learning. Some

elements of her model of Quality 4.0 are oriented to excitement (drive out fear, build safety and quality culture, and find meaning and purpose) and on this way is connected with Quality 5.0 concept.

Mourtzis D. et al. (2019) emphasized aspects of internal complexity and ICT based relations in digitalized manufacturing system (Cyber-Physical Systems) of Industry 4.0.

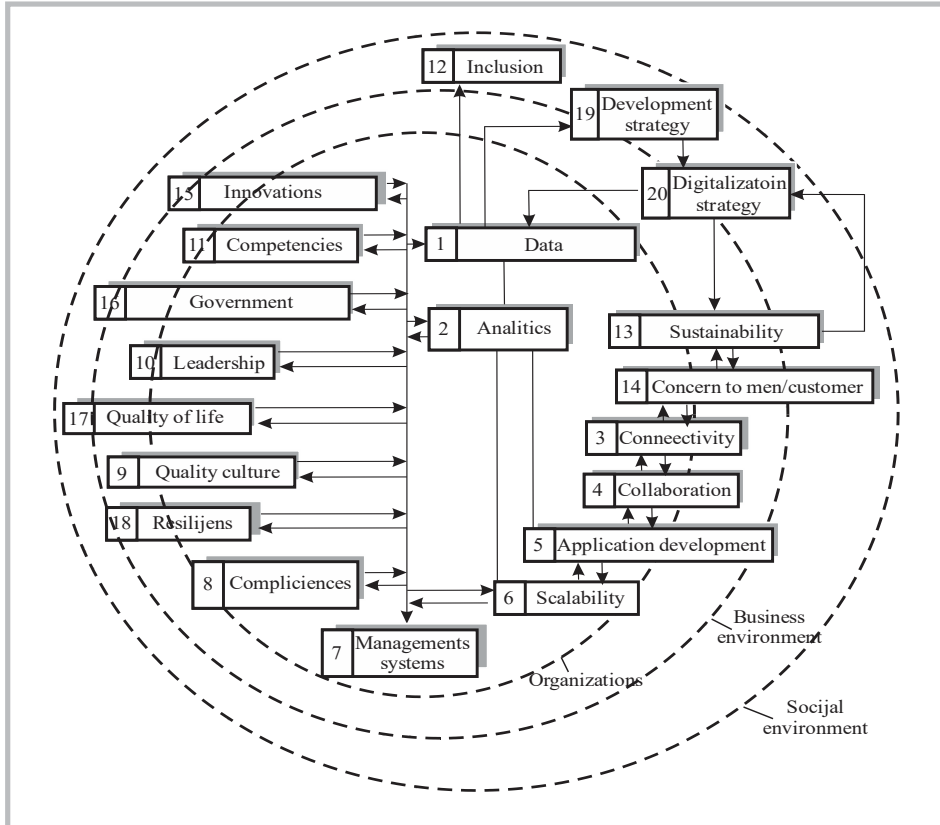Integration of Quality 4.0 and Quality 5.0 concepts are presented in figure 3.

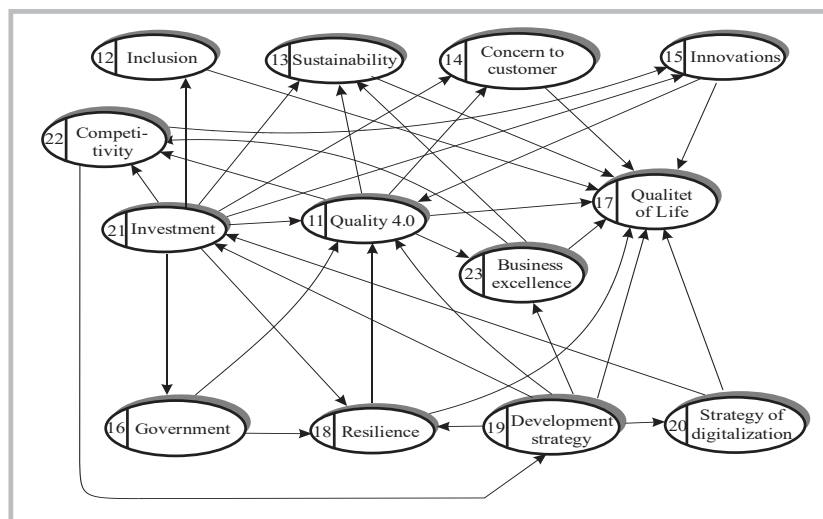**Figure 3.** Integration Quality 4.0/Quality 5.0

Figure 4. Integrated Quality 5.0 model

In purpose to make concept Quaality 5.0 is necessary to integrate Quality 4.0 with external entities. Besides previos described variables (1-11) in Quality 4.0 model and (12-18) in Quality model, in integrated Quality 5.0 (figure 4) are included variables (Arsovski S., 2019):

- V19 – strategy of development,
- V20 – strategy ofdigitalization,
- V21 – level of investment in Quality 5.0,
- V22 – competitivity level, and
- V23 – level of business excellence.

There are a lot of relations and problem in model testing are data (present low level), its reliability in future and appropriate methods. Proposed solution is to concept national project „Quality 5.0" to find optimal strategy to transit from existing Quality 2.0/3.0 to Quality 4.0/5.0.

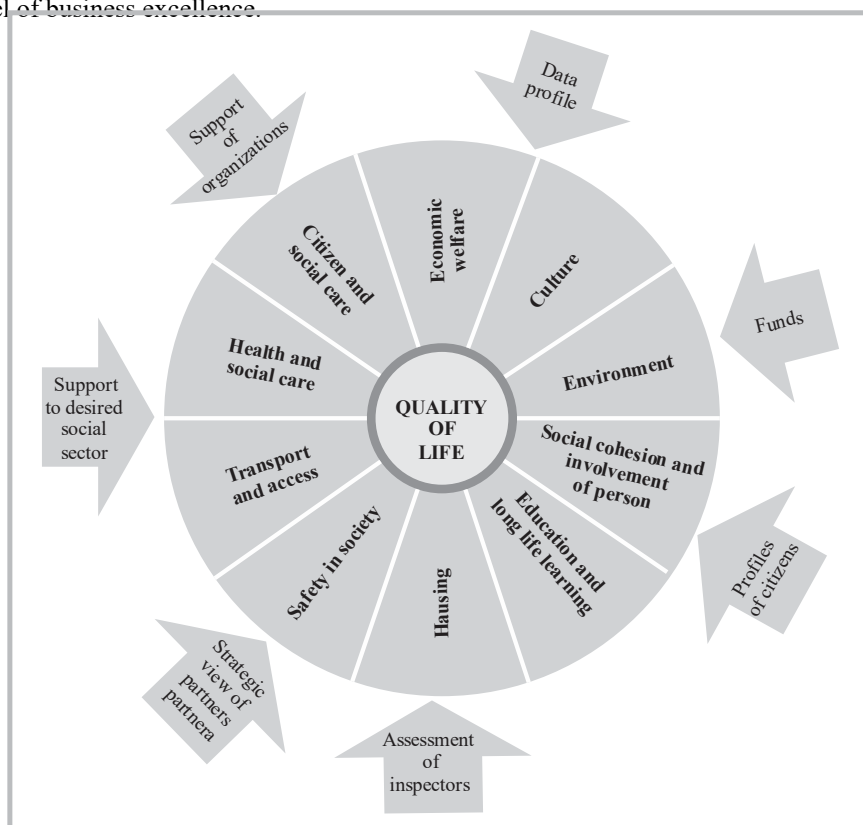Quality 5.0 is very closely connected to Quality of Life (figure 5).

Figure 5. Impacts on Quality of Life (QoL)

After analysis elements of Quality 5.0 concept is posible to define appropriate ontology (figure 6), based on Zdravković M. et al. (2011). Each of impacts has different mutual collision. Because that on level of local community is necessary to develop strategy of sustainable community (Arsovski S., 2019).
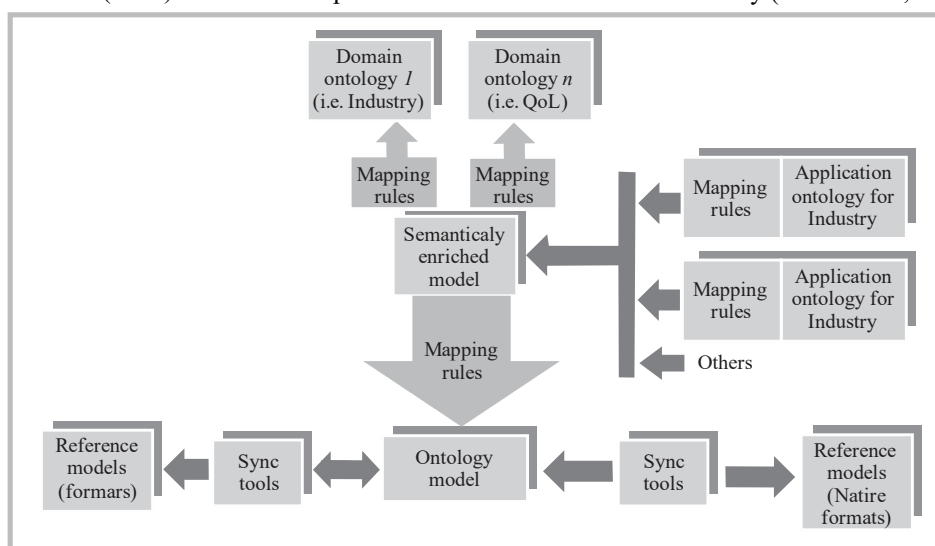

Figure 6. Framework for semantic environment of reference models for Quality 5.0

For this framework are crutial domain antologies and mapping rulls, tools and application ontologies for different ellements of Quality 5.0, presented through hierarhical model (figure 7).

On the top of puramid is quality of person, as highest goal of our civilisation. A Quality 5.0 is enabler together with QoL. On lower level is smart society (platinum Society 5.0) based on resources, smart technologies, resilience, sustainability and success of each component of smart society. A base for all are needs, requests and hopes of people.
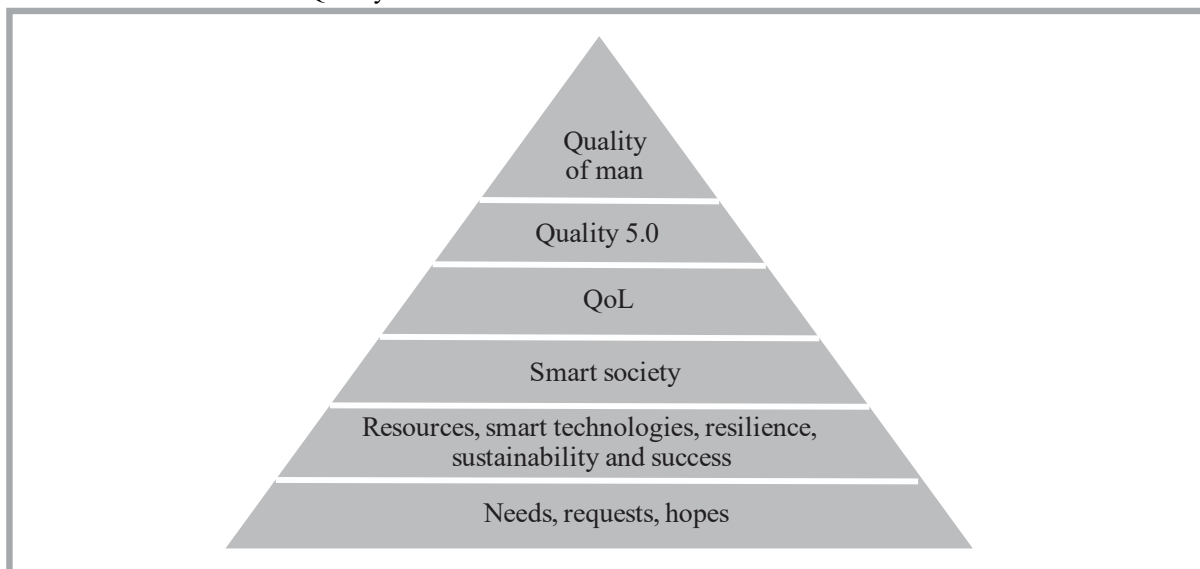

Figure 7. From human needs to Quality 5.0 and Quality of men

On this way, this pyramidal model with quality of men is simular with Japan's pyramid od Total Quality Management with men on the top.

4. WAYS TO REALIZATION OF QUALITY 5.0 IN SERBIA

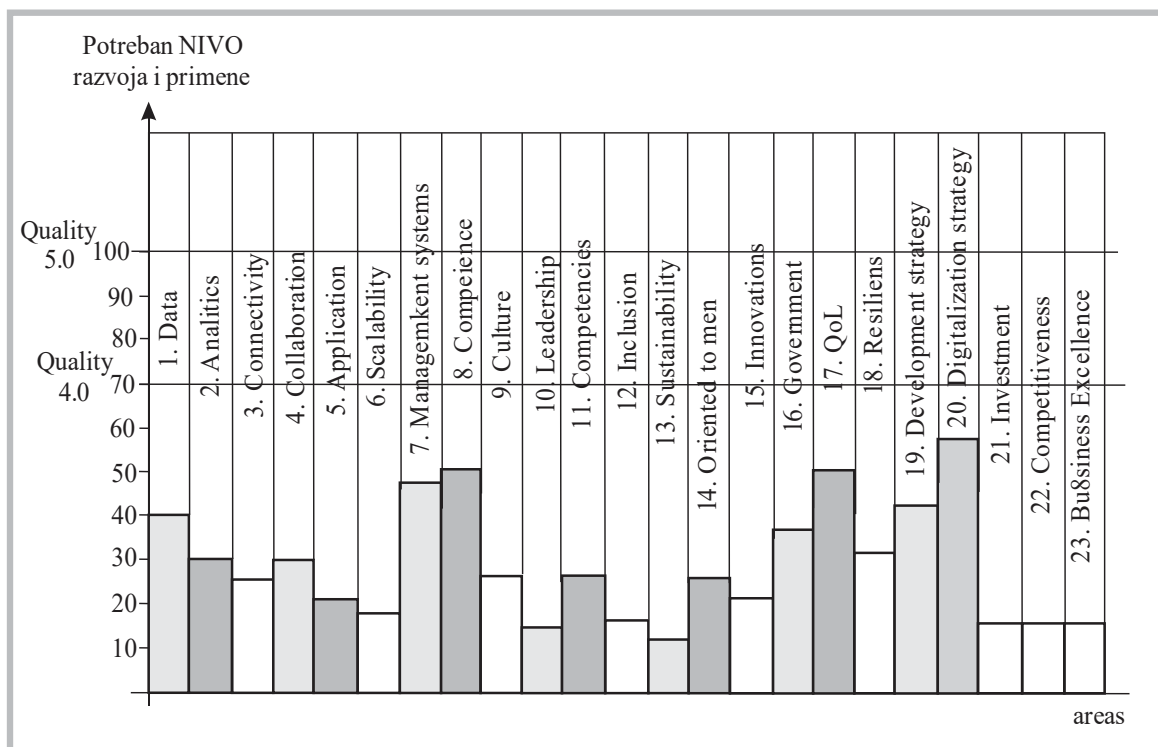According to figure 8 the level of guality in Serbia is between low and middle.

Figure 8. Level of development and introducing elements of Quality 4.0/5.0 in Serbia

This assessment is provided using Delphy method with 15 experts. The average level in Serbia is aproximatly cca 30% i.e. mixed Quality 2.0, Quality 3.0 and in save cases Quality 4.0. Based on Japan's vision 2050 the process to „Platinum Society" 2050 with Quality 5.0 consumes a lot of time (cca 30 years) and it is very expensive.
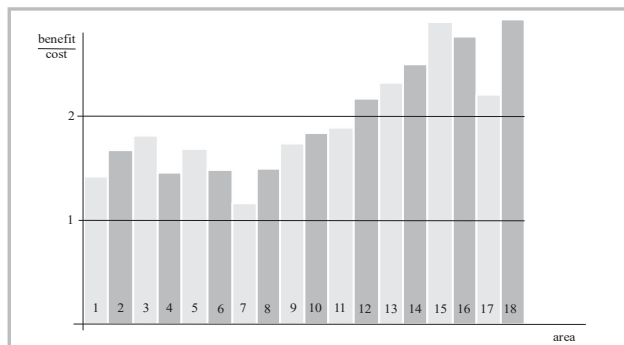

Figure 9. Results of benefit/cost analysis (CBA)

Each component of smart society needs very high investment in purpose to achieve level near assessment

10. For transition society to „Platinum Society 2050" and Quality 5.0 is necessary in first step to develop vision and strategy for this giga projects which need more than bilions of dollars, depend on priorityes and constraints for each state. In this moment with respecting cost/benefit analysis is possible to find priorities with best ratio and invest in it (figure 9).

The Quality 5.0 concept is closed with Smart Society (Platinum Society) which also needs huge investment in all 27 areas (Arsovski S., 2020, Smart region of Eastern Serbia, ALPEN TEKIJA, Kragujevac, in Serbia). Dinamics of introducing new development solutions related to Quality 5.0 and Platinum Society in Serbia is presented in figure 10, as first aproximation.

In this aproximation for Quality 5.0 according priorities is needs to invest in quality in all 27 components of smart society in Serbia.

For this study is not included risks in this long period, especialy related to natural, ecological, political, health, and other hazards.
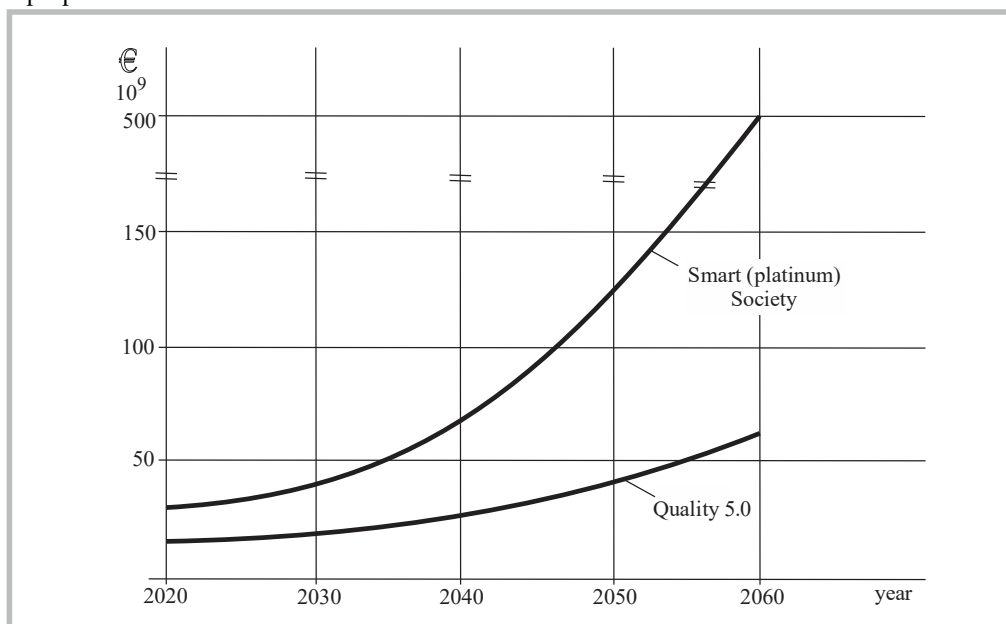

Figure 10. Investment in Quality 5.0 and Platinum Society in Serbia

5. CONCLUSION

A Quality 5.0 concept is now reality but it is partly developed and introduced. Specially for Serbia, it is problem because relative small level of quality and constraints in investments, knowledge and generally human factor.

Author proposes strategy according Japan's long range strategy, with close collaboration all stakeholders, esspecialy government, investitors, local government, business sector, universities et others.

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