Slavko Arsovski¹ Zora Arsovski Marija Zahar Djordjevic

> Research paper DOI – 10.24874/QF.25.118



A NEW ROLE OF SMART QUALITY 4.0, 5.0 AND 6.0 ON INDUSTRY 4.0 / 5.0 / 6.0 AND SOCIETY 6.0

Abstract: A concept of quality is developed in previos centuries dominantly related to quality of products and then quality of industrial organizations. In this period is defined and used concepts of Industry 1.0, Industry 2.0, Industry 3.0, Industry 4.0, Industry 5.0 and now Industry 6.0. This transformation of industry is fellowed concept of quality from Quality 1.0 to Quality 6.0.

In the paper is presented this way and challenges of the transformation and especialy now role of smart quality for Industry 4.0/5.0 and Smart and Intelligent Quality for Industry 6.0 and Super Intelligent Society 6.0

Keywords: Industry 6.0, *Quality* 6.0, *Super Intelligent Society* 6.0

1. Introduction

An accelerated changes in Smart and Intelligent Technologies (SIT) changed all social processes including Industrial. In first phases a process of changing started from Industry 1.0 to Industry 2.0 and Industry 4.0 based on "clasical technologies for achievement dominantly production goals. development With starting fast digitalization in in 21.th century is generated basis for using the new concept Industry 4.0 and correspondent concept Quality 4.0 or Smart Quality.

In last ten yearst is developed concepts Industry 5.0 and Quality 5.0 with added introduction of Intelligent Technologies and Systems (ITS). In last five years is developed a new concept of society – Smart (Intelligent Society 4.0/5.0) and Super Intelligent Society (Society 6.0). The last concept needs a new concept of Quality 6.0.

Purpose of the article is to explain relationships among Industry 6.0, Quality 6.0 and Society 6.0 and challenges in proces of transition from stages 4.0, 5.0 and 6.0. Goal of the paper is to find relationship between Smart and Intelligent Quality and Society 6.0.

Methodology used in the research is based in methods of analises of paradigmes, modeling complex systems, integration based on goal achievement, leadership and management for effective and efficient transition and integration of SIQS (Smart and Intelligent Quality Systems) and Industry 6.0 and Society 6.0.

The article is organized on following way. After introduction, in second part is presented literature review related to SIQS, Industry 6.0 and Society 6.0. In third part is presented model of their interaction and in fourth part expected results based on own research and literature sources.

In fifth part is presented conclusions.

2. Literature review

According the described methodology autors analyzed in first step literature related to

¹ Corresponding author: Slavko Arsovski Email: <u>cqm@kg.ac.rs</u>

quality science and analysis of paradigmes evolution. In second step is analized area of smart prosperity and smart society. In third step is analyzed literature related to expetations for next period carractirized with accelerated using virtual environment in super smart and intelligent society.

In area of quality is used a lot of uppraches in last hundred year with begining from quality gurues and industry. For this article all of its described and upgraded with new management, social and technological approaches (Arsovski 2016; Arsovski, 2023a) with articles about transition from Quality 4.0 to Quality 5.0 (Arsovski, 2023b) with including aspects of sustainability, spirituality and intelligent leadership.

In its references are described: (1) quality as interdisciplinary, multidisciplinary, and transdisciplinary science with new extended model of quality appropriate for broader quality systems as in society, with a lot of influenced entities and variables, (2) resolving a quality dilema and problem of achieving of accurate level of quality described as quality squaring, and (3) model of transition of Quality 4.0 into Quality 5.0 and related industrial concepts Industry 4.0 and Industry 5.0.

The key research problem is transition from Quality 5.0/Industry 5.0 to Quality 6.0 and Industry 6.0 connected with Society 6.0.

Smajdorova (2024) analized Quality 5.0 as evolutive stage from Industry 4.0/5.0 and Quality 4.0/5.0 which consits from:

- 1. total quality,
- 2. life cycle quality,
- 3. digital transformation,
- 4. sustainability,
- 5. innovation and cooperation, and
- 6. quality based on data analisis,

with using folloving technologies:

- 1. concious machines and autonomous quality system,
- 2. quantum quality analysis,
- 3. holographic quality visualization and

4. neuro-quality interfaces based on brain-comuter interfaces.

Almusaed et al. (2023) analyzed context of Industry 6.0 in Architecture, Engineering and Construction (AEC). In their research are two related circles, i.e.: (1) circle form Industry 1.0 to Industry 6.0 and vice versa, and (2) circle of society form Society 1.0 to Society 6.0 and nice verse. Using these concept they developed transformation of construction throuug Industry 6.0 with technology integration, sustainability and collaborative innovation.

Lykov et al. (2024) analized Industry 6.0 dryven by generative AI and Swarm of heterogenous robots. In their research is used product manufacturing driven by generative AI and generative AI component via ApenAI API and LLM (Large Language Model).

Chourasia et al. (2022) analyzed benefits and challenges of sustainability aspect of Industry 6.0. in their research last stage of industry evolution is Industry 6.0 with following content:

- product personalization,
- automatic robotic industry controled by quantum rador,
- customer driven,
- virtualization,
- anti-fragile manufacturing,
- digital twins,
- dinamic supply chain,
- dynamic inter and intra connectivity across organizations,
- system integration,
- service dominant logic and
- green sustainability.

Benefits of Industry 6.0 are support of hyper-connected industries with achieving higher danamic value networks with higher level of green sustainability.

Singh et al. (2024) emphasized technologies based on 6G and Japan 6G Strategic Plan an using smart and intelligent technologies.

Annanpera et al. (2021) analyzed way from crisis to transition, defined Industry 6.0,

analyzed the Finish situation with industry future and how to go in future. In their research are included role of science and technology minister responsible for holistic agenda in area of integration virtual Industry 6.0 and university, smart specialization strategies, join test factory, and digital transformations accelerator for Finish industry.

Žižek et al. (2021) analyzed social respond on Industry 6.0 accordin Japan concept of Society 6.0. In their research is pointed out concept of Well-Being Society as core component of sustainable socially responsible Society 6.0. The dimensions and components of the "Well-Being Society 6.0" model are:

- organisations with human factors,
- economic system,
- political system,
- legal system,
- ecological system,

- social system,
- health system,
- technological system, and
- values, culture, norms, etics.

At the end of circle they defined upgraded sustainability Leadership Model in conection to "Well-Being Society 6.0" with:

- 1. social sustainability,
- 2. economic sustainability,
- 3. environmental sustainability,
- 4. procedural sustainability, and

personal sustainability.

3. Model of integration Quality 6.0 and Industry 6.0

Based on previos own research and other results presented in references author defined base model of integration Quality 6.0 and Industry 6.0 in Society 6.0 (figure 1).



Figure 1. Base model of integration smart and intelligent systems into SSIS 6.0

In this model is conected: (1) smart citizens, (2) smart Industry 4.0, (3) intelligent Industry 5.0, Industry 6.0 with SSIS 6.0 as process of human development and achieving the highest human and other social and ecological goals. In this process parallel and supporting is evolution of quality from versions 1,2,3,4,5 and 6. In the first entity in this model is are Smart Citizen. For development and introduction Smart Citizen in Quality 1.0, 2.0 and 3.0 is defined by relation R4 and in Industry 4.0 in defined by relation R1. On other side there are relations R7 as impact on Society 6.0 and oposite relations R5 and R6 on entity 1 and 2. In present society exist bath previos concepts (Smart Citizens, Smart Industry 4.0 and first stages of Society 6.0, described as Society 1.0, 2.0 and 3.0. Between Smart Industry 4.0 and Intelligent Industry 5.0 is relation R2 and all previos relations R5, R6, R1, R9, R10. On this way is developed and intraduced with Quality 5.0 through relations R11 and R12 with Quality 5.0 and relations R13 and R14 with Society 5.0. At the end od this process of evolutions of quality, industry and society is are Quality 6.0, Industry 6.0 and Society 6.0 connected with relations R3, R15, R16, R17, and R18.

Each entity and relation has very complex structure and dinamic carracter. So relation R1 consist from direct impact of Smart Citizen and their knowledge, Smart Specialization, Smart Community and Smart Supply Chain on Smart Industry 4.0. On other side, Smart Industry 4.0 is also very complex and dinamic with introduction a lot of new smart technologies, as robotics, IoT, smart digitalized processes and other.

Intelligent Industry 5.0 depend of previos industry concepts and quality concepts, as well as requests of Super Smart and Intelligent Society (SSIS) through relation R12 and R13.

Industry 6.0 is in the middle of evolution of quality concepts from Q1, Q2, Q3, Q4 and Q5 and Society concepts from S1, S2, S3, S4 and S5.

Using Technique of Nominal Groups (TNG) is assessed level of each entity (figure 2).



Figure 2. Level of introduction of Smart and Intelligent Solutions

Each level of entitics 1, 2, 3, 4 and 5 is presented as average value among individual assessment of members of Nominal Group (based on 15 questionvics).

Presented base model is possible to modeling using Artificial Neural Network technique (ANN) or with higle number of assessment using statistical methods. Also, is possible to use System Dynamics approach for modeling relationships among entities described in figure 2 and other variables as sustainability, resilience, agility and prosperity.

In figures 3 and 4 are presented model of interaction based on approach of Systems Dynamics (Sterman).

In figure 3 is presented model of developed Society 6.0 using System Dynamic approach. For it are identified following interconnected loops:

- Smart, Spiritual and Intelligent Leadership (SSIL),
- Smart and Intelligent Technologies (SIT),
- Smart, Intelligent and Spiritual Citizens (SISC),
- Smart Government (SG),
- Smart and Intelligent Industry (SII),
- Smart and Intelligent Quality (SIQ),
- Smart and Intelligent Society (SIS),
- Smart and Intelligent Sustainability, Agility and Resilience (SISAR), and

• Smart and Intelligent Prosperity (SIP).

Each component loop has own structure and is connected to other via Smart, Spiritual, Intelligent Leadership and directed with dominant related loops. For research presented in the article is emphasized relationships among SSIL, SII and SIQ (figure 4).

For deeper analysis of each component (or loop) is necessory to identity process components, its relationships and dynamics in present and future circumstances, it is motive for further research.



Figure 3. Global map of System Dynamics from Smart, Spiritual and Intelligent Leadership to SIT to Industry 6.0, Quality 6.0 and Society 6.0



Figure 4. Interconnection of loops among components related to Industry 6.0, Quality 6.0 and Smart and Intelligent Society via Smart, Spiritual and Intelligent Jeadership

The first step and key process is achieving smart citizens according their needs, cooperation, knowledge, impact on smart community, smart cities, smart governements, smart nations and smart civilizations. They also designed and improved quality and industry evolution, and vice versa from SSIS and industry and quality achieved own personal, family and national goals.

This model is very complex and partialy is desribed in research of the authors. Using Smart and Intelligent Technologies, Smart Leadership and Inter-government support this process could be modelled and simulated. This process is now in "mixing" situation with existing all quality models (1,2,3,4,5 and 6) and industry models (1,2,3,4,5 and 6) with different models of Society 6.0. It is motive for future scientific research and upgrading our knowledge, intelligence, and prosperity of civilization.

4. Expected results of integration Quality 6.0 in Industry 6.0

Expected results of integration Quality 6.0 and Industry 6.0 in Society 6.0 are:

- 1. higher level of development of both concepts,
- 2. higher implementation and uprading existing SIT into Quality and Industry concepts,
- 3. higher sustainability of society,
- 4. higher resilience of society,
- 5. higher development and agility of SIT and social processes,
- 6. higher level of eco-cyber environment,

- 7. higher level of achieving of Milenium Goals,
- 8. higher level of quality of life of citizens,
- 9. higher interconnection and support to civilization goals, and
- 10. achieving a super intelligent, smart, resilient, sustainable society with higher spirituality and humanmachine interaction.

5. Conclusions

The new role of Smart Quality (Quality 5.0/6.0) in Industry 5.0/6.0 has impact on

Society 6.0. Presented base model of its integration is very complex and is necesary to modeling each entity in this model with intra relationships in entities and extra relationships related to other relationships. This model is verydynamic because high speed of technological development, social and eco-cyber environment and possible limitations of ours civilizations. For it is necessory to extend concert of quality to achieve peace and civilization development. It is next very broad and deep area of our research.

References:

- Almusaed, A., Yitmen, I., & Almssad, A. (2023). Reviewing and integrating aec practices into industry 6.0: Strategies for smart and sustainable future-built environments. *Sustainability*, 15(18), 13464.
- Annanpera E. et al. (2021). From Industry X to Industry 6.0: Antifragile Manufacturing for People, Planet, and Profit with Pasion. Business Finland, AIF, Helsinki.
- Arsovski S. (2016). *Nauka o kvalitetu (in inglish Quality Science)*. Centar za kvalitet, Fakultet inženjerskih nauka, Kragujevac.
- Arsovski S. (2023a). Kvadratura kvaliteta (in inglish Quality Squaring). Centar za kvalitet, Fakultet inženjerskih nauka, Kragujevac.
- Arsovski S. (2023b). The Sustainable Transition from Quality 4.0 to Quality 5.0: A Role of Sustainable, Spiritual and Intelligent Leadership in Creation of Capital for Future. Quality Festival 2023, pp. 3-19.
- Chourasia, S., Tyagi, A., Pandey, S. M., Walia, R. S., & Murtaza, Q. (2022). Sustainability of Industry 6.0 in global perspective: Benefits and challenges. *Mapan*, 37(2), 443-452.
- Lykov, A., Cabrera, M. A., Konenkov, M., Serpiva, V., Gbagbe, K. F., Alabbas, A., ... & Tsetserukou, D. (2024). Industry 6.0: New generation of industry driven by generative AI and swarm of heterogeneous robots. *arXiv preprint arXiv:2409.10106*.
- Singh, R., Tyagi, A. K., & Arumugam, S. K. (2024). Imagining the sustainable future with Industry 6.0: A smarter pathway for modern society and manufacturing industries. In *Machine Learning Algorithms Using Scikit and TensorFlow Environments* (pp. 318-331). IGI Global Scientific Publishing.
- Smajdorova, T. (2024). Journey to Quality 6.0: Evolution of quality management across industrial revolutions. *Trends in Computer Science and Information Technology*, 9(2), 063-070.
- Žižek, S. Š., Mulej, M., & Potočnik, A. (2021). The sustainable socially responsible society: Well-being society 6.0. *Sustainability*, *13*(16), 9186.

Slavko Arsovski Faculty of Engineering, University of Kragujevac, Kragujevac, Serbia <u>cqm@kg.ac.rs</u> ORCID 0000-0002-1443-1157

Zora Arsovski Faculty of Economics, University of Kragujevac, Kragujevac, Serbia ORCID 0000-0003-4985-6988

Marija Zahar Djordjevic

University of Kragujevac, Faculty of Engineering Sciences Kragujevac, Republic of Serbia <u>maja_199@yahoo.com</u> ORCID 0000-0003-4905-2728