
Industry 4.0: the transformation of management systems and influence tools

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Abstract: The article focuses on management system transformation, considering changes caused by the technological renewal of enterprises due to the standards of Industry 4.0. The aim of the article is to explore how enterprise management systems change in response to Industry 4.0 technologies and to identify effective management influence tools within the 'smart' ecosystem. Method of scientific systematisation was applied to categorise key aspects of management tools transformation in Industry 4.0, namely technological, human, organisational and behavioural aspects. Results cover changes across corporate, functional and individual levels. The source of empirical data was semi-structured in-depth expert interviews with managers of selected enterprises in Ukraine and Bulgaria that are in the process of transition to a 'smart' ecosystem. All data was analysed using qualitative content analysis. The main findings reveal targeted aspects of management system transformation in Industry 4.0 to be done in the early stage. Originality of the article is among the first to give specific examples of management system transformation in Industry 4.0 aimed to accelerate overcoming of existing implementation barriers.

Keywords: Industry 4.0; management; management system; influence tools; digitalisation; transformation; technologies; behaviour.

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1 Introduction

As of today, breakthrough technologies permeate every sphere of human activity and significantly influence its development. Digitisation and automation of production, rationalisation of processes, logistics and service within the value chain are identified as main development indicators in the era of Fourth Industrial Revolution, better known as Industry 4.0. This concept was primarily formulated by the government of Germany as a response to holding competitive market enlargement due to the intensive use of innovations (Kagermann et al., 2013; Lasi et al., 2014). Today it is perceived not only as up to date, but rather as mandatory for the further effective functioning in any industry (Singh et al., 2019). However, the number of companies that successfully develop and implement ecosystems of 'smart' enterprises or embed similar transformations in strategic planning still is not high (Margherita and Braccini, 2021). This is primarily due to the organisational culture barriers, an outdated type of managerial thinking, lack of a sufficient motivation level to implement change (both inside and outside the company), insufficient awareness of content, principles and complexity, lack of experienced specialists to operate in a 'smart' ecosystem (Castagnoli et al., 2022). At the same time, there are other limitations, but most of them, in our opinion, can be solved by a correct, consistent and high-quality transformation of management systems.

Companies that have already successfully embedded Industry 4.0 technology did not fully deploy their potential (no more than 60% of the available capabilities) according to the conclusions of McKinsey Institute researchers (McKinsey & Company, 2015; De Boer et al., 2020; Georgia, 2021; McKinsey & Company, 2022). Most successful cases focus on implementing the latest technologies in existing production processes, obtaining benefits from increased productivity and cost reduction, improving value chains and analysing data sets during decisions making (Schumacher et al., 2016; Vaidya and Ambad, 2019; Zhou et al., 2019). But often, in planning and implementing projects of technological transformations an issue of a significant complexity of management processes and Industry 4.0 ecosystems is overlooked. Management systems deals with flexibility in data processing and information exchange received from an increased number of sources (IoT sensors, machine learning and artificial intelligence algorithms), establishing joint work within 'smart' ecosystems, forming teams capable to interact effectively while being geographically distributed (Castagnoli et al., 2020).

Owing the analysis of scientific publications in Fourth Industrial Revolution it is noted that along with an in-depth concept content of its key elements a lack of quality systematic studies highlighting changes caused by its practical implementation still exists. Among available publications by authors studying Industry 4.0 transformations major research interests are technological aspects of concept (Porter and Heppelmann, 2015; Yang and Gu, 2021), advantages achieved by improving production and management processes, logistics chains, strategic and operational changes (Piccarozzi et al., 2018; Prabowo and Rusdiansyah, 2021). Other provided results reveal an opportunity to control and monitor products quality at all creation stages, reduce financial risks, get an ability to reach a wider consumers range (Toro et al., 2015; Rennung et al., 2016; Saucedo et al., 2018; Xu et al., 2021). Reasonably for management system breakthrough technologies allow extremely effective issues prevention before these cause losses or lead to resource overspending directed to elimination (Soomro et al., 2019; Wang et al., 2019; Zhao et al., 2020). In addition, breakthrough technologies are improving decision-making processes, turning management activities into pre-emptive rather than reactive ones. However, available literature lacks substantiation of management system change. Key instruments of managerial influence are not clearly stated, corporate practice has provided general and mostly aggregated recommendations that are difficult to be applied.

For these reasons following research questions are formulated: how does an enterprise management system be transformed in response to the Industry 4.0 technologies application? What management influence tools will be effective within the 'smart' ecosystem and able to accelerate overcoming of existing implementation barriers? Additionally, there might be an appropriate response in the context of a qualitative change in management processes and flexibility acquisition in management influence tools (from the standpoint of different aspects). For example, application of behavioural design principles, which is aimed at eliminating outdated habits by the 'soft' pushing method. The paper is structured as follows: the second section gives an overview of the theoretical backgrounds; the Section 3 explains the empirical research utilised in this study. The Section 4 summarises conclusions based on the analysis.

2 Theoretical backgrounds

2.1 Management in Industry 4.0

There are different approaches to define concept of Fourth Industrial Revolution. Almost every scientific research has an attempt to form a generalised vision or an author's interpretation. Conceptually, 'Industry 4.0' term can be called general for a set of technological transformations in production, organisation, management and other processes occurring within value chain (Kagermann et al., 2013; Su and Yang, 2018). These changes are, on the one hand, caused by transition to higher levels of process automation and digitisation, cyber-physical systems formation, big data processing technologies usage, etc., and on the other, value content rethinking and value chain restructuring (Singh et al., 2019).

Most authors agree that managers are faced with problem of mastering specifics technologies, realising, adjusting and applying its capabilities both personally and on the scale of organisational ecosystem. Common management approaches within a multivariate and constantly updated environment does not work effectively, nor at all (Margherita and Braccini, 2021). Thus, to achieve a management system interacting effectively with technological environment of the Fourth Industrial Revolution ecosystem theoretical knowledge basis and practical approaches to build up new management systems should be well structured.

Scientific research of Industry 4.0 concept implementation concentrates mainly on its technological component. It is mostly outlined advantages of applying these technologies or their functional elements, instruments, methods (Porter and Heppelmann, 2015). As for the management science field, researchers seek to understand what challenges management system faces due to production methods restructuring (Qin et al., 2016; Ivanov et al., 2019), business models transformation (Grabowska and Saniuk, 2022), strategic development (García and García, 2019) and HR management (Bonekamp and Sure, 2015; Azwar et al., 2020; Gunathunge and Lakmal, 2021), same as sustainability and social innovation (Iqra et al., 2021). Highlighted literature shows that a complete restructuring of management systems must take place to obtain maximum efficiency during enterprise transformation within Industry 4.0 framework (Schumacher et al., 2016; Piccarozzi et al. 2018; Vaidya and Ambad, 2019). Yet, there is no clear vision of management system transformation in Industry 4.0. All previous attempts differ in terms of complexity, as each individual enterprise case is unique.

In our opinion, transformation of management reality in Industry 4.0 is much deeper especially in the context of managerial influence, where not only tools and methods change, but relationships content and nature. It is common to understand managerial influence tools as techniques or methods that managers use to influence behaviour of their employees or colleagues in the workplace. These tools can include various strategies such as positive reinforcement, coaching, feedback, goal setting, persuasion, negotiation and authority which is different in Industry 4.0 ecosystem. For study purposes it is necessary to determine key changes in management influence tools, and their optimal combination. Let us outline key aspects of management system transformations due to Industry 4.0 concept below.

Focus on technological innovations in the list of goals of Fourth Industrial Revolution (custom production capabilities development, automatic and flexible production chain adaptation, product movement tracking, technological interrelationships facilitating,

production optimisation achieved by ‘smart’ technologies, asymmetric business models) constitutes *technological aspect* of management system transformation. Mentioned technologies allows new types of products and services to be offered within one value chain (Shafiq et al., 2016); strategic and operational planning process adopt new environment same as resource accumulation and distribution approaches (Veile et al., 2020); employees acquired qualitatively new skills and competencies through the corporate training system (Azwar et al., 2020); security systems exceed or became much more complex.

Additionally, concept of Industry 4.0 is called human-centred, while the only goal that directly indicates role of human in improving technological processes is outlined in Human-Machine Interaction (HMI) paradigm (Gorecky et al., 2014). Its main idea is that industrial IoT is a key component for individual production sites and even a complex production process to interact outside human factor. Telecommunication systems exchange information considering production processes, while a person is assigned as a coordinator and manager, who promptly reacts to the data flow and takes appropriate optimised decisions (Bonekamp and Sure, 2015). The freed-up time can be directed to personal development and creativity, as well as ‘lifework’ balance maintained, one’s own potential preserved and restored (Di Nardo et al., 2020). So, quality of the human factor acquires an exceptionally high level of knowledge and skills and properly formed communication system, along with expand of executive responsibility when monotonous processes are automated. This finding is discussed as *human aspect* of management transformation in Industry 4.0.

Another type of changes discussed in scientific literature is organisational level of management system which generally differs in ensuring simultaneous vertical and horizontal integration of business processes (Davies et al., 2017). All value chain elements are becoming interconnected. Process of data exchange is now easier and faster allowing more flexible and optimised decisions to be taken. It also provides an opportunity to create innovative products and services, quickly receive feedback and adjust value proposition without significant overspending of resources. Interaction between divisions within organisational structure is so close that certain departments form a synergistic collaboration with clarity loss in functional responsibilities. Therefore, *organisational aspect* is described as flexible restructure considering requirements of various stakeholders and cross-functional interaction, loss of vertical authority distribution and authority significance, renewal/recreation of a new corporate culture.

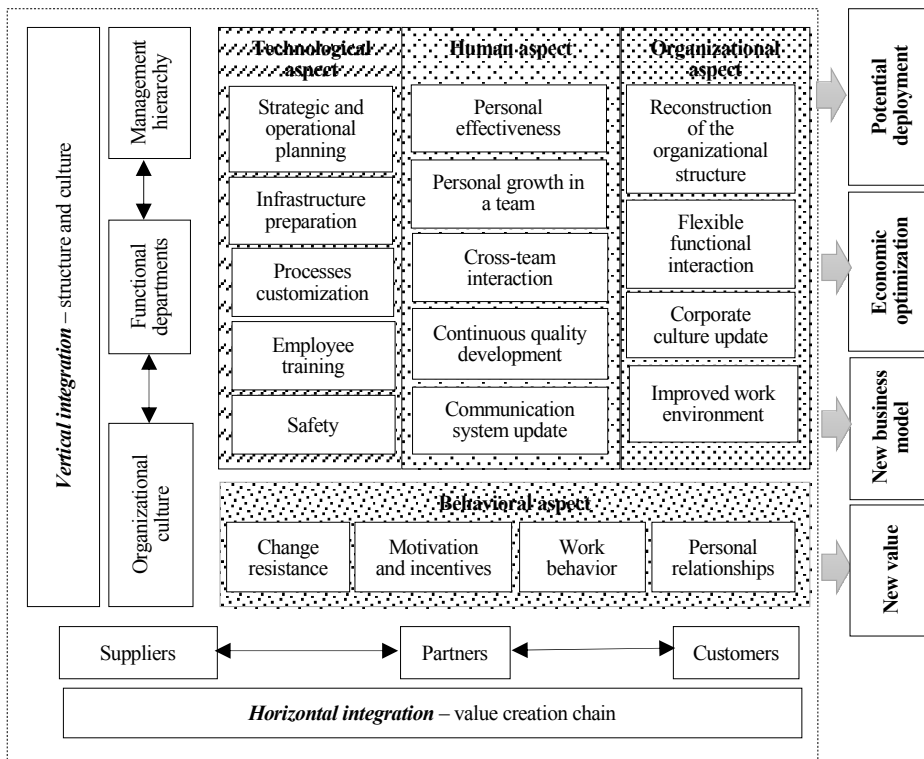
Outlined aspects are interdependent, they rightly note influence of ‘technology-human’, ‘technology-organisation’, ‘organisation-human’ type according to Veile et al. (2020).

However, it is also possible to discuss *behavioural aspect* which is not clearly defined in up-to-date research. In a certain sense, management transformation in Industry 4.0 is reduced to ensure changes in human behaviour (Koh, 2020). Primer management system challenge from the standpoint of behaviour transformation is to prepare change implementation and overcome change resistance. Depending on how this process is planned and implemented success of further transformations will be determined. In addition, motives content and corresponding incentives list is modified (Tan and Rajah, 2019). Requirement for job security and organisational justice assurances increase same as job content satisfaction. Manager must adapt flexibly their management style to the employee behaviour shift, encouraging proactivity, strengthening interpersonal relations, forming a soft type of corporate culture and deepening team interaction (Shaulska et al.,

2021). These actions can be described as *managerial influence tools* or methods of achieving management goals in the new ecosystem.

In a certain sense, Industry 4.0 can be called a set of economic optimisation algorithms, which allows reducing excessive costs, instead of using potential and opportunities as efficiently as possible. Thus, key result of management system is to create simultaneously new value, to form a new (asymmetric) business model, to achieve economic optimisation and to maximise released potential opportunities. Figure 1 shows main changes in management system in Industry 4.0 ecosystem due to described determinants and aims.

Figure 1 Technological, human, organisational and behavioural aspects of management systems transformation in Industry 4.0



Source: Compiled by authors.

It can be stated that changes may occur at the general corporate, functional and individual level and be considered from technological, human, organisational and behavioural aspects. For better understanding let us define every aspect deeply.

2.2 Considering technological aspect

Regardless of whether this is digital double creation during transition to ‘smart’ production, AI systems configuration, or robotic elements installation, etc., its implementation requires a planning stage and preparation of existing management

systems for a corresponding update (Iqra, 2021). Goals and objectives, personal KPIs, leadership and backlog metrics are aligned with each element of horizontal and vertical integration, so business cycles can be shortened and reorganised. However, this does not mean abandoning usual planning processes but only characterised by addition of a rapid testing stage (goals, tasks, solutions) to determine the most effective proposals. In the same way every other element of management cycle can be optimised without harming the process itself, but with the aim of preventing resource overspending and maximum employment of created system capabilities. Each technology type applied requires an appropriate technological support infrastructure (Thoben et al., 2017). Management is becoming like process of a new product design (Castagnoli et al., 2022). In response to consumer demand or a new idea each added element is checked for compliance before the mass spreading start, and each decision is pre-optimised if necessary. There is an individualised set of processes for specific production tasks in real-time conditions and directed information flows. Focus remains on applying those approaches that already work at individual level and can be spread throughout network. Safety component refers reviewing work-safety approaches in new operational environment (Bei, 2020). New standards, regulatory documents, rules to prevent data loss or leakage outside information system and improper use must be established.

2.3 Considering human aspect

Effectiveness of new technologies' implementation relies on quality of knowledge and competencies. Accordingly, this aspect of management consists of providing all stages of updated technological process with required quality employees in collaboration with HR department. Work conditions, environment and job content changing, same as workforce quality requirements strengthening human role and its management modification. Unproductive, complex, monotonous tasks are now performed by machines and employees' working hours are used to activate creativity, problem solving ability, effective decision-making (Margherita and Braccini, 2021). Manager's task is to create comfortable conditions for knowledge and experience exchange, review employees' powers, introduce flexible work schedules, set up remote teamwork. Achieving personal efficiency and personal growth in a team is possible in an environment with no fierce competition, freely available training programs tied to target indicators and motivational component (Bezgin et al., 2022). Acquired knowledge and skills must be immediately implemented in practice, and therefore considered in personalised metrics and achievements, rewards, incentives system (Zahariev et al., 2021). To allow appropriate conditions there might be applied soft corporate culture, encouraged autonomous interaction between team members, eliminated organisational injustice, team tasks set and made it impossible for a single specialist to perform a joint task. This approach promotes cross-cultural interaction. But encouraging cross-functional team communication management system must also be ready for change. Widespread is joint meetings practice, task performing according to employees' abilities, rather than functional duties, cross-functional specialisation (Chang and Yeh, 2018). Orientation at value chain participants encourages continuous development, aimed at real-time updating and service quality increasing. High priority is given to social competencies, ability to interact and exchange information, learn from mistakes, considered in personal development plans.

2.4 Considering organisational aspect

An effective organisation is based on a renewed corporate culture formation, which establishes new values of interpersonal interaction within vertical and horizontal communication system. Requirement to interact simultaneously within value chain through a digital communication system (where data is constantly updated) cannot be ensured in a bureaucratic (hierarchical) organisational culture (Mohelska and Sokolova, 2018). Unity, teamwork, loyalty and mutual respect as characteristics of a supportive (clan) corporate culture are more effective to form an extensive network of horizontal integration. As well as vertical integration, allowing to gently overcome constraints and entrenched relationships of previous predominantly hierarchical environment. However, supportive corporate culture is not fully able to ensure implementation of continuous development principles and encourage creativity, freedom, orientation to changes and improvement, defined as priorities of a human-centred approach in Industry 4.0. Innovative (adhocratic) organisational culture provides such opportunities. Thus, management system efforts should be directed to form or renew an existing culture of two types, or their combination. Along with the transformation of corporate culture, managerial influence tools also change. Influence based on traditional power, orientation to efficiency indicators, stability, control and fierce competition, respectively, became powerless within the concept of Industry 4.0. Personal power, personalised achievement, expertise and awareness come to the fore, as well as charisma, leadership and cognitive abilities (emotional intelligence, empathy). Such changes are well described in ‘quiet management revolution’ phenomena studies (Tom, 2022).

2.5 Considering behavioural aspect

Complex and large-scale transformations caused by Industry 4.0 technologies application receive a different level of perception and awareness why employees should adapt. The better pre-configuration and preparation for interaction in updated environment is done, the easier this transition will be and the less employee resistance to change and innovations found. Regardless of how significant benefits and efficiency gains of new technologies are employees must adapt to these innovations to perceive them completely. When employees not only positively perceive change, but quickly master and begin to apply its functionality outside standard procedures, they perform proactive behaviour. It is achieved when employees have no doubt about their convenience. Real change is not measured by increase in productivity and optimal resource utilisation, but by difference in worldview, habits and cooperation (Koh, 2020). Instruments of managerial influence here are provision of opportunities for individual development and professional growth, comfortable technologies’ utilisation, new corporate culture perception, behavioural design application (preventing previous habitual practices recurrence). Best managerial behaviour expected to be is human-oriented leadership, expert power, personal influence and cognitive abilities. It is important to cover all components of change process as fully as possible, clearly define stages, and adhere implementation in close team cooperation and constant feedback monitoring. Resistance could be decreased by a common vision of transformations, coordination of individual, team, and organisational goals for its implementation, free access to knowledge and skills and provision of necessary resources along with actual and demanded incentives (organisational justice, employment guarantees, tolerance and job process content and individual target results).

Interdependence of each determinant summarised in Table 1.

Table 1 Changes in management processes in Industry 4.0

<i>Change aspect</i>	<i>Level of changes</i>		
	<i>Corporate</i>	<i>Functional</i>	<i>Individual</i>
Technological	Strategic vision and decisions, regulatory policy, security standards, bureaucracy level, assessment of transformation readiness, technological infrastructure model, technological projects budgeting	Operational management, customisation of automotive processes, resources optimisation, data flow stabilisation, joint use of technologies, data standards, income and expenses balancing	Methods and approaches to accept new technologies, optimisation of personal goals, tasks and its implementation time, standards perception, 'machine-human' communication, awareness of transformation value
Human	Corporate training system, talent and creativity support, quality of competencies and skills, communication standards within the value chain	Strong inter-team connections, cross-functional communications set up, flexible training programs, joint projects, levelling competition, mentoring	Personalised change in the quality of knowledge, skills, competencies, metrics and performance indicators, creative tasks, learning by doing, mistakes perception
Organisational	Soft corporate culture, holistic organisational structure, cross-functional nature of interaction between departments, 'lifework' standards, comfortable work conditions	Decentralisation of decision-making, results control system, value chain design, functional flexibility settings, delegation of authority	Managerial power (personal, cognitive) and forms of influence (expertise, charisma, persuasion, emotional intelligence), ability to work remotely, flexible schedule
Behavioural	Updated motivation system, organisational injustice overcoming, focus on customer expectations, central role of stakeholders, behavioural design	Work behaviour optimisation, people-oriented leadership, habit of cross-functional cooperation	Worldview and habits modernisation, overcoming conservatism and personal obstacles to accept change, proactive approach, behaviour configuration

Source: compiled by authors.

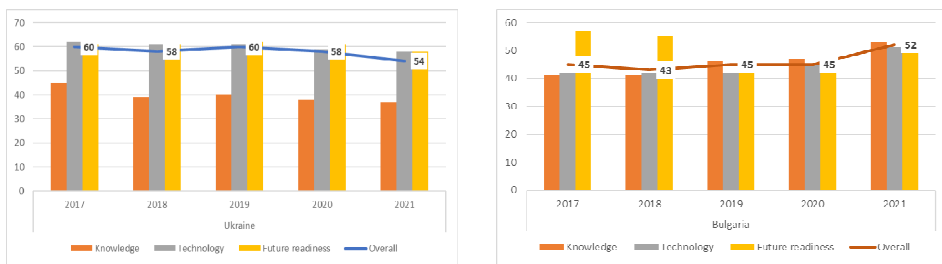
3 Empirical results

After summarising the key aspects of management system components and influence tools transformation we proceed to determine its most effective combination in practice.

Industry 4.0 global market capitalisation is growing by an average of 17.5% annually (GMD Research, 2021) and in general list of countries actively implementing breakthrough digital technologies (64 countries), leading positions are traditionally occupied by USA, South Korea, Sweden, Denmark, Singapore, Switzerland, Netherlands

(IMD, 2022). Unfortunately, Ukraine is not among leaders in the list of Industry 4.0 innovators, but over past 5 years it has strengthened position by 6 points (from 60 to 54th place). This happened mainly due to awareness of digital technologies’ advantages, clear government position to transparent processes of innovative development, and creation of technological hubs in large cities (Kyiv, Kharkiv, Lviv, etc.). It was also supported by strengthening interaction between interested stakeholders (entrepreneurs, government, technological solutions providers, educational, scientific and technical institutions), Big Data control, management systems flexibility. The most typical limitations are intellectual property issues, financial system crises (low opportunities to credit technological projects), Internet coverage, employment in scientific and technological sphere (Yuri and Oles , 2019; IMD, 2022). Bulgaria is close to Ukraine in terms of infrastructural environment which in recent years has lost 7 points in rating caused by a reduction in involvement of external specialists with high-quality knowledge and skills, total number of personnel training programs at enterprises, limitations of migration policy, low level of management system flexibility (Stefanov et al., 2021; IMD, 2022) (see Figure 2).

Figure 2 Readiness to perceive Industry 4.0 transformations in dynamics, 2017–2021 (Ukraine and Bulgaria) (see online version for colours)



Source: Compiled by IMD world digital competitiveness ranking 2021.

According to IMD in both countries important influencing factor is management system flexibility. In Ukraine there is a softening of management mechanisms and a reduction in overall amount of resistance to change. While Bulgarian enterprises continue to struggle with a high level of bureaucratisation of corporate cultures, spread of traditional management methods, failures in project adaptation, etc. (Zaharieva et al., 2022).

To determine nature of this influence and understand types of processes that need to be strengthened empirical research of management systems and influence tools transformation features at Ukrainian and Bulgarian enterprises were conducted. The main idea of this research is to find out which determinants support intensified processes of breakthrough digital technologies implementation. Main results are given in Table 2.

Table 2 The results of an expert assessment of changes in management system components and influence tools in Industry 4.0

<i>Change in management system components and influence tools</i>	<i>Industry</i>									<i>Total</i>
	<i>I1</i>	<i>I2</i>	<i>I3</i>	<i>I4</i>	<i>I5</i>	<i>I6</i>	<i>I7</i>	<i>I8</i>	<i>I9</i>	
1 Technological aspect										
1.1 Presence of a strategic vision for management system transformation	3	3	2	3	2	3	3	3	3	25
1.2 Clear regulatory policy and security system standards	3	3	1	2	3	2	3	3	2	22
1.3 Reduction of bureaucracy	2	2	3	3	2	2	3	2	3	22
1.4 Ready to change at top management level	3	3	2	3	3	2	2	2	3	23
1.5 Qualitative model of technological infrastructure development	3	2	2	2	2	1	3	2	2	19
1.6 Fair budgeting and financing	2	2	3	2	2	1	2	2	2	18
1.7 Set up automation processes	2	1	1	2	3	1	3	2	3	18
1.8 Economic optimisation of resources	3	3	2	2	2	2	2	3	3	22
1.9 Data flow stabilisation and its availability	2	2	2	3	2	1	3	2	3	20
1.10 Established standards for technology sharing	2	2	2	2	2	3	2	2	1	18
1.11 Personal optimisation of goals, tasks, and time for its implementation	3	2	3	3	2	3	3	2	2	23
2 Human aspect										
2.1 Effective system of corporate training	3	1	3	3	2	2	2	2	2	20
2.2 Talent and creativity support policy	2	2	2	2	2	2	3	2	3	20
2.3 Established communication standards within the value chain	3	2	3	1	3	2	3	2	2	21
2.4 Strong inter-team relations	2	2	3	1	2	2	3	1	3	19
2.5 Cross-functional communications set up	2	2	3	2	2	2	3	2	2	20
2.6 Joint projects	3	2	2	2	2	2	3	2	1	19
2.7 Flexible training programs, mentoring	3	1	3	2	3	2	3	2	3	22
2.8 Personalised change in quality of knowledge, skills, competencies, metrics and performance indicators	2	1	3	3	2	3	3	3	3	23
2.9 Increased level of creativity in operations and tasks	3	2	2	2	2	2	3	2	3	21
2.10 Learning by doing	3	3	3	3	2	2	3	2	3	24

Table 2 The results of an expert assessment of changes in management system components and influence tools in Industry 4.0 (continued)

Change in management system components and influence tools	Industry									Total
	I1	I2	I3	I4	I5	I6	I7	I8	I9	
3. Organisational aspect										
3.1 Support soft corporate culture	3	2	3	3	2	2	3	3	3	25
3.2 Holistic approach to build organisational structure	2	1	2	2	2	2	3	2	2	18
3.3 Cross-functional nature of interactions	3	2	3	2	2	3	3	3	2	23
3.4 Implementation of 'lifework' standards, comfortable work conditions	3	2	2	2	3	2	3	3	3	23
3.5 Decentralisation of decision-making	3	2	3	2	1	2	2	2	2	19
3.6 Functional flexibility, authority delegation	3	2	2	2	3	3	3	3	2	23
3.7 Personalisation of managerial influence	3	3	3	2	3	3	3	3	3	26
3.8 Development of effective remote workability	2	1	1	1	2	1	3	3	2	16
4. Behavioural aspect										
4.1 Human-centred motivation system	3	3	3	3	3	3	3	3	3	27
4.2 Overcoming organisational injustice	3	2	3	2	3	2	2	2	3	22
4.3 Customers' expectations, central role of stakeholders in decision-making	3	2	3	2	3	2	3	2	3	23
4.4 Behavioural design principles	3	2	3	3	2	3	2	3	3	24
4.5 Work behaviour optimisation	2	2	3	2	3	2	2	2	3	21
4.6 Formation of cross-functional cooperation habit	2	1	2	2	2	1	3	1	1	15
4.7 Worldview and habits modernisation	2	2	3	3	3	2	2	2	2	21
4.8 Overcoming conservatism and personal obstacles to change perception	3	3	3	2	2	2	3	3	3	24

Source: Compiled based on research results.

The survey covered representatives of main industries where digital transformations are taking place in both countries marked for convenience as follows: manufacturing (I1), energy, oil, gas (I2), retail (I3), agro-industrial complex (I4), finance (I5), construction (I6), IT and telecom (I7), pharmaceuticals (I8), transport and logistics (I9). Assessment of determinant significance established within following limits: 1 – high impact, 2 – medium impact and 1 – low impact. Experts in this research were representatives of all management levels and employees at the enterprises hosting Industry 4.0 technologies –

76 persons in common (46 in Ukraine and 30 in Bulgaria). To range presented determinants research was conducted in form of survey evaluation.

The survey showed that behavioural aspect has the most important influence in management system changes. Human, organisational and technology determinants were evaluated as little less, but almost same significant.

As expected, human-centred motivation system and personal performance indicators imbedded might have the most positive impact. Clear vision of management system transformation, awareness of change structure, high-quality knowledge availability, investments in training and development system were also highly appreciated. It is also outlined as strong and significant such determinants as a conscious shift to people-oriented leadership from the upper levels of management system, manager to be served as a behaviour example, promotion of flexible corporate culture and mitigation of cross-functional communication barriers. In addition, great importance was given to the readiness and speeding up of digital transformation project implementation. Another interesting result was application of behavioural design principles such as adoption of a special management decision. As revealed during the research those actions helped to turn outdated approaches by employees into inconvenient processes. Thus, changing usual way of personnel effort for searching and issuing orders in a logistics company allowed to improve habit of employees performing tasks manually. Employees began to use special monitors more frequent, analyse information from sensors more effective and therefore spend less time processing orders. As a result, labour productivity here increased about 15%.

Among obstacles and limitations revealed hierarchical management structures preservation, strict administrative influence and traditional powers availability, forced nature of digital transformation project implementation, focus on technologies rather than values, pursuit of perfection as opposed to good but sustainable results. In that view, some management teams noted their inability to build a sufficiently high-quality management system that corresponds to the new operating environment. This step is mostly important to be applied at the first stage of Industry 4.0 transformation in manufacturing, agro-industrial, finance, IT & telecom industry, same as construction, transport & logistics.

4 Conclusions

According to research results it was determined that in response to Industry 4.0 concept a complex management systems transformation is taking place, and this phenomenon requires a detailed analysis and assessment. Management system change considered from the point of view of technological impact on strategic and operational activities, internal environment, awareness of persona role and importance, and how does organisational structure react to integration processes, as well as the provision of a qualitatively new behavioural response. At the same time, they occur simultaneously at both horizontal (functional) and vertical (hierarchical) levels of management and are also focused on considering individual needs as fully as possible. Management influence tools are becoming more and more personalised and human-centred (people-oriented leadership, expert power, personal influence, cognitive abilities, soft types of organisational cultures).

Owing to the timely and qualitative change in management approaches it is possible to achieve higher levels of success in digital transformations projects and business models restructuring. In addition, the fastest possible fulfilment of change necessity and inevitability by CEO support will allow management system to get early to those levels where technological transformation projects will be more effective and profitable.

Conducted empirical research made it possible to determine which managerial influence tools were effective within the 'smart' ecosystems functioning at innovative companies of Ukraine and Bulgaria. Innovative component here presented at the early forming stage, so rapid changes in management approaches are extremely relevant as they are aimed at creating favourable conditions to percept technological changes. It can be stated that *managerial implications* are (in order of importance):

- 1) *Behavioural aspect*: based on the results it is recommended that 'smart' enterprise should start by implementing a transparent motivation system that eliminates organisational injustice and provides job security, while also changing the content of work. The company should also consider applying behavioural design principles, methods of overcoming conservatism and personal behavioural barriers, focusing on stakeholders' expectations within the value creation chain. Cross-functional cooperation habit to be formed can be achieved by transforming management and leadership behaviour at all organisational levels and should be enshrined in management standards.
- 2) *Technological aspect*: main recommendations are concentrated around establishing a clear vision for the transformation of management system and implementation of structural approach to strategic and operational changes. It is also essential to ensure commitment and positive perception of change at the top-level management and the rest of the organisation, to prioritise preparation quality and implementation speed of digital transformation projects, optimise individual goal setting, task allocation and time management. Reduction of bureaucracy should be achieved by new organisational design which is aimed to increase productivity by cutting unproductive elements of the system. Economic optimisation of resources might be settled based on improved decision-making system and data flow optimisation.
- 3) *Human aspect*: to be successful on in Industry 4.0 transformations company should focus on the following human aspects: personalised change in quality of knowledge, skills, competencies, metrics, and performance indicators, learning-by-doing ecosystem, flexible training programs and mentoring provided. It is important to ensure the availability of high-quality knowledge and personalised development programs considering needs of each employee individually. It is also worth investing in the training system and promoting reduction of barriers to cross-functional communication. To improve effectiveness of training, learning-by-doing method can be used. All above measures will help to improve quality of work and ensure successful adaptation to Industry 4.0 change.
- 4) *Organisational aspect*: transition to people-oriented leadership should begin with the personal example and personal influence of the leader. It is advisable to promote formation of a flexible corporate culture that will ensure company adaptation to change and increase efficiency of cooperation between employees. Setting up functional flexibility and delegation of authority will help increase work efficiency and reduce workload on management. Cross-functional interaction between

departments will ensure rapid and effective problem solving and reduce the likelihood of conflicts. Introduction of ‘lifework’ standards will help balance employees’ labour and personal time and reduce the risk of burnout at the first stages of transformation.

Main *limitations* are found in processing detailed data from theoretical analysis. It is still insufficient to overcome the risk of bias in assessment and data collection. In addition, the focus on Ukrainian and Bulgarian enterprises that are at the beginning stage of implementing Industry 4.0 technologies in their practices requires considering cultural and historical peculiarities of development. However, selected objects of empirical analysis meet the purpose of this study. Therefore, results cannot be directly applied to enterprises that are at later stages of implementing Industry 4.0. But above mechanisms and managerial influence tools can accelerate overcoming of existing barriers to the changes’ perception. This can make a great starting contribution to rapid implementation of technological projects and help to accept more complete utilisation of Industry 4.0 technologies potential. Further research should be focused on studying the issues of management systems improvement on successful cases provided by Industry 4.0 leaders, to compare results and identify the most favourable mechanisms of managerial influence at each stage of digital transformations.

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