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Research Model of the Degree of Technological Humanism in Manufacturing Companies in the Transformation towards Industry 5.0

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Abstract: Adopting the concept of Industry 4.0 enables manufacturing companies to gain advantages from digital production management, though issues have been identified related to human resources, management and organisation. Problem areas concern workplace ergonomics to the general wellbeing and satisfaction of workers, and social responsibility. Industry 5.0 promotes progress based on human-machine collaboration and sustainable, human-centred value creation. The research model of the degree of technological humanism, which aims to ensure that technological progress improves human wellbeing in manufacturing companies in the transformation towards Industry 5.0, is a demanding area that has not been sufficiently researched or unambiguously defined so far. The presented model can facilitate the digital transition of manufacturing companies towards Industry 5.0, as it contains the components necessary for the transformation of organisational processes, thereby enhancing and accelerating the implementation of smart manufacturing.

Keywords: ergonomics; social responsibility; technological humanism; transformation towards Industry 5.0

1 INTRODUCTION

Companies today are facing conditions of high volatility and business uncertainty, which can hinder economic growth, and so organisations need to address a number of interconnected organisational changes. This is particularly true for manufacturing companies, and their possible courses of action can be challenging, resulting in problems or opportunities, depending on the approach taken. The current age of industry demands a deep integration of mature technologies and up-and-coming technologies, and the accompanying demands reflect not only on the fusion of information and communication technologies, but also on the convergence of information and operational technologies [1]. The industry sector is also facing increasing pressures to improve its agility and flexibility to better adapt to the highly dynamic production demands [2].

Digital production management has become the imperative for manufacturing companies, and digital transformation affects all areas of value creation [3]. The implementation of smart factory concepts and Industry 4.0 concepts increases company performance [4], including business agility [5], organisational efficiency, efficacy and profitability [6]. Adopting the Industry 4.0 concepts enables companies to gain an advantage from digital production management, though over time issues have been identified relating to human resources, management and organisation. Newer research has shown that hurdles within the company are more important and relevant for the adoption of digital production management than external and operational ones [7]. It has been identified that a hurdle such as a lack of technical skills and expertise is directly related to organisational culture and organisational factors, such as employee leadership, skills and expertise, and not purely technological factors. Accordingly, the greatest challenge for Industry 4.0 is not technology but people, since this concept has a strong impact on employees [8]. For that reason, focus should be placed on the entire organisation as a social-technical system, with consideration of the many interactions between people, technology, business and organisation, since digitalisation and people are still less than ideally synchronised [4], and people are a part of the entire production system [9]. This indicates the need to include a human element in the fundamental concept, which is the integration of human creativity throughout the industrial process [10] and caring for the emotional intelligence of employees as the organisation implementation of automation processes [11]. This is engrained within the new concept Industry 5.0, as an update to Industry 4.0.

2 INDUSTRY 5.0 AND TECHNOLOGICAL HUMANISM

The fundamental area for implementation of the concept Industry 4.0 includes production, logistics, operational management, and business organisation [12-16]. The new concept Industry 5.0 was designed to complement the digital development of industrial systems with purposeful and efficient cooperation between humans, machines and systems in a digital environment [17]. Industry 5.0 thus changes the paradigm and brings solutions that reduce the emphasis on technology, instead placing the focus on the holistic, sustainable creation of human-centric values [18, 19]. Industry 5.0 helps people and machines work together to improve the efficacy of industrial production [18, 17], and represents a tool for enabling sustainable and resilient industry [20], with synergy between humans and technology. With ongoing improvements to technology, humans have had to adjust in order to build a better society, while adopting industrial innovations [10], and Industry 5.0 brings benefits for both workers and society [18], bringing significant progress in quality in relation to the last industrial revolution. This can be considered a response to the demands of the new industrial paradigm that is human-centric, and includes structural, organisational, management, philosophical and cultural aspects, as well as those based on knowledge [21].

Technological humanism is a new concept that arose following the exceptionally rapid penetration of new technologies into all segments of human life and work. Industry 5.0 implements this concept into business and production processes and relationships. It recognises that

technology has not supported transformation towards a globally sustainable society by providing tools that are aligned with the logic of pan-humanism, anthropo-relational humanism, and digital humanism in all social and business relationships [22]. Digital humanism describes, analyses and influences the complex interrelations between technology and humans, with the aim of creating a better society, with the complete abidance of universal human rights [23] and it should be interpreted as an interest for understanding the development of digitalisation, with the aim of influencing it technically, socially and politically [24]. In 2016, the Japanese government recognised the technical, social and political dimensions of technological humanism, when it presented the new concept Society 5.0 as an ideal Japan would strive to achieve, in which there is a high degree of convergence between the cyberspace (virtual space) and physical space (real space) [10]. Society 5.0 stands for a new type of society in which innovations in science and technology take a prominent place, in balance with social phenomena and problems that need to be solved, while ensuring economic development [25]. Industry 5.0, as defined by the European Commission, shares many properties with the Society 5.0 concept [26]. Technological humanism therefore is one of the most important new trends in the labour world, in which technology is in service of humans and their development, wellbeing, and fulfilment [27]. In the industrial sphere, technology in service of people has the purpose and goal of promoting social integration and human development, while the purpose of the company is to promote the alliance of all social agents in creating shared values [28]. The benefits of adopting the concepts of Industry 5.0 therefore enable a transition towards a "smart social factory" [18].

3 RESEARCH MODEL FOR DETERMINING THE DEGREE OF TECHNOLOGICAL HUMANISM IN THE TRANSFORMATION TOWARDS INDUSTRY 5.0

Technological humanism is complex in nature and has multiple dimensions. The technical dimension includes the consideration of various disciplines such as philosophy, social sciences, law and economics, and as such as a transdisciplinary concept with social, political and cultural implications of creating and using advanced forms of technology, and testing both the creation of benefits and potential threats [24]. To build a research model to examine the degree of technological humanism within production companies in their transformation towards Industry 5.0, it was first necessary to identify those components of Industry 5.0 in relation with the concept of technological humanism that enable and stimulate the necessary transformational processes for the implementation of smart production.

3.1 Employee Understanding and Knowledge Management

Strategic management of intellectual capital, innovativeness and creativity, technology and information together form the fundamental dimension that has become a trend in organisations, and forms the space for resolving challenges and improving competitiveness in the increasingly complex global context [29]. Today's business conditions place new goals before organisations, impacting their systems, managing information and knowledge, and the human sector. Industry 5.0 is revolutionising production systems around the world by eliminating redundant tasks for workers, and instead enabling development of innovative human potential [18]. Within this concept, people are asked to develop skills and new competencies, both the necessary soft skills and acquiring advanced technical skills that can pose a problem for workers [30]. The development of the human potential of a company should include the process of systematic improvement of knowledge and expertise within the organisation to improve its overall impact, while supporting the degree of understanding and education on the factors that could have an impact on both company operations and on themselves. Company employees who are efficiently informed and appropriately trained in new technologies are able to use them efficiently, which benefits the quality and speed of functioning of the organisation. This enables workers to understand that Industry 5.0 was designed to create strong cooperation, and not competition, between humans and machines [17], which was the greatest problem with previous industrial revolutions. The harmony between the organisation's knowledge management and implementation of Industry 5.0 enables the company to become more agile, effective and sustainable [29], while life-long learning should be a strategic goal of the organisation [31]. In that sense, the management of knowledge and employee understanding are identified as the first component needed to enable the transformation of organisational processes towards smart production and Industry 5.0.

3.2 Organisational and Operational Management

Transformation processes that enable the successful implementation of Industry 5.0 strongly depend on the effectiveness of a company's organisational and operational management. In order to adopt Industry 5.0, it is necessary to create conditions of a high level of interaction between machines and their operators, and the role of the business organisation in adequate decision-making [18]. Workers need to understand new technology to property handle intelligent machines and robot systems, which requires a change in the structure of the labour force, and places increasing demands on employees [32]. Physical and redundant tasks are becoming automated, so the fundamental goal of smart production is for humans and machines to be properly paired so as to increased efficacy of the process of using human brain power and creativity by integrating work processes and intelligent systems [33]. Due to the revolution in industry and society, it is expected that many work posts will be terminated, leading to unemployment and possible severe social issues [34]. The World Economic Forum has assessed that by 2025, 50% of all workers will require requalification due to the adoption of new technologies [35]. There is a need for the employment of highly qualified employees who are open to change and teamwork and are able to transfer knowledge [32], calling for the education of new employees and requalification of existing employees to use new technologies. This presents an upward spiral in

which new jobs require new or newly retrained workers, thus creating the new concept Operator 5.0 [36]. It is evident that under such conditions, the company needs to strategically define its organisational and operational management. Digital strategies need to be developed that are focused on the interrelations between digital technology and people at various organisational levels in the processes that shape, transfer, implement, host and support the strategy [37]. Industry 5.0 evidently has a strong impact on work positions, and penetrates deep into every pore of organisational and operational management, setting new rules and patterns for future success. For that reason, organisational and operational management with considerations of the significance of the effects of Industry 5.0 on work posts is the second component of the transformational process aimed at achieving effective and smart production.

3.3 Organisation of an Ergonomic Workplace

The next step is to consider the workplace itself in its ideal form as posited by Industry 5.0, and accordingly to consider the ergonomics of the workplace with the aim of meeting the required conditions. Unlike previous revolutions, the paradigm of Industry 5.0 includes human health and safety as key factors in production systems [38], and following digitalisation, the role of the human operator within it requires changes in ergonomic principles [39]. Ergonomics is a science developed in response to the demands of the industrial revolution [40] and production companies need to treat it appropriately as it has a strong effect on business and production processes and their quality, including its effects on the workers themselves. This is a multidisciplinary science of three fundamental branches that include physics, cognitive and organisational aspects to achieve its goals, by applying other sciences such as physiology, anatomy, engineering, psychology, management and business system design [40]. Industry 5.0 has a tendency towards maximally reducing the physical engagement of workers, in particular problems of a physiological and anatomical nature. The specific effect of digitalisation on people is in its psychological effect and possible disturbances, which is a subject of wide discussion not only in the business world, but also within life in society overall. These disturbances have been defined as Cyber-syndrome, and include physical, social and emotional disturbances that have an effect on humans due to their excessive interactions with cyberspace [40]. Within the concept of Industry 5.0, human interaction with cyberspace is highly intensive and will only increase with the development of new technologies. For this reason, a special subsystem of ergonomics, called Cybergonomics, has been created. Its aim is to optimise security, productivity and health of individuals, and when applied properly, can facilitate Industry 5.0 in achieving its goal of protecting humans from the detrimental effects of new technologies and ensuring the necessary rules and adaptations for better interaction of the labour force and high technology [40]. Adopting advanced technology that requires more time and effort from workers [18] creates a challenge for the activities of organisational ergonomics, which in Industry 5.0 should create a resilient and sustainable business and production system that is human-centric, including the necessary organisational structures, policies and processes. The focus is not only on the need to reexamine existing work posts, but for innovations in those areas and directing the development of human-centric business solutions with new innovations [41]. Organisation of workplace ergonomics in line with the postulates of Industry 5.0 is therefore the third identified component within the company's transformation processes in its transition towards smart production.

3.4 Human Resource Management and Labour Psychology

The processes arising from Industry 5.0 and its influences on the workplace including its organisation and ergonomics certainly affect workplace satisfaction. The company is both a business and a social system, and it is necessary to consider the importance of human health and wellbeing in both these aspects, which is the subject of consideration in human resource management and labour psychology. Since Industry 5.0 places worker wellbeing at the forefront in production processes, new technologies should ensure wellbeing even outside the domain of business and economic growth, so as to become a resilient provider of overall prosperity [42]. Organisational management processes have the demanding task of fulfilling this aim. Companies need to recognise what technology can do for people, and focus on how to adapt technology to the requirements of workers, and not vice versa [18], and to strategically define an appropriate organisational system that enables it. Its efficacy is under the strong influence of workplace factors that affect worker satisfaction and motivation, and possible physical and mental stress at work [43]. An additional goal of digital transformation included in Industry 5.0 is to ensure that people lead purposeful and creative lives [21]. Reducing the need for physical work under conditions of digitalisation and automation enables people to improve their creativity, share ideas, and gain completely new knowledge and abilities for which there was no time or opportunity in the past. With this, technology is shifted from focusing only on improving productivity to creating happy and engaged employees [44]. Accordingly, human resource management must fulfil the conditions from the four main groups that are predictors of a happy and engaged employee: a well-defined role, development of skills and career management, social relations, and support of superiors that include the social factor [45]. Improving the capability of supervision and control in the company, based on the increasing accessibility of data, affects privacy and intimacy of workers and in that sense, it is important that technology deals with the issues of employee autonomy and privacy [18]. Achieving satisfaction at work within the systematic management of human resources and labour psychology within the organisation is therefore the fourth identified component of a successful transition to smart production.

3.5 Managing the Quality Profile of Human Resources

Once the requirements that Industry 5.0 sets for a company are known, the necessary processes and workplace organisation including optimal ergonomics and factors oriented towards achieving employee work satisfaction, the

final component is management of the quality profile of employees by human resources, i.e., managing the creation and retention of a high-quality work force. Investing in people is an important determinant of Industry 5.0 as it enables employee retention. Within it, and with the further development of technology, the concept of quality in doing one's work changes in meaning over time. For that reason, companies are faced with the challenge of continuously having a high-quality work force under changing conditions, and these changes are now occurring faster than ever. On the one hand, workers require ongoing training and professional development so that they can develop their careers, making this a key phase in the future quality of the work force [31], while on the other hand, there is the inevitability of the need to replace workers that do not meet the required conditions. If certain workers are not open to change and do not possess the desire for new learning or requalification, the company is forced to hire a new work force. In this, it is important to note that new generations have different values and priorities, which means the company is also required to constantly adapt to the changing conditions on the labour market. Retaining a high-quality workforce requires financial instruments and may raise issues about employee care, visible through the optimal ergonomics of the workplace and a positive influence on their overall work satisfaction. Further, the feeling of belonging to a group and respecting the values of the work performed in the organisation are aspects that can influence organisational culture [46], and worker satisfaction. It can also achieve their explicit inclusion in the design and functioning of business processes [47], which in turn ensures their productivity and efficacy. Worker motivation is a key component of Industry 5.0 [48], and companies need to recognise employee interests in new knowledge and developing their job skills. Only once these and other requirements set by the current business environment are met, can companies expect to retain a high-quality work force and increase the company's attractiveness as a place to work, in line with the values and priorities of new generations.

3.6 Research Components and Model

Based on the above theoretical assumptions, the new research model has been designed to examine the degree of technological humanism with manufacturing companies in their transformation towards Industry 5.0 that contains the following components:

1) Information And Knowledge Management – accessibility and distribution of new information and knowledge
2) Workplace Organisation Management – how positions are organised and processes aligned with the identified elements of change
3) Workplace Ergonomics Management – ergonomics in work positions is aligned with the necessary changes in workplace organisation
4) Workforce Wellbeing Management – achieving worker satisfaction in changing working conditions
5) Long-Term Work Quality Management – ensuring lasting work quality by retaining existing and attracting new high-quality workers.

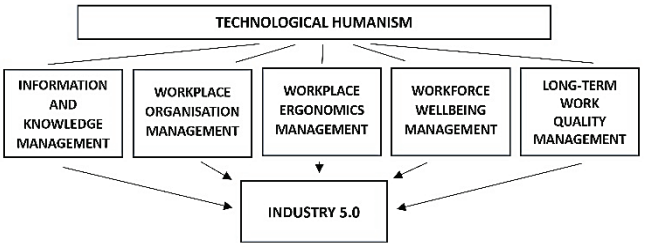

Figure 1 Graphic representation of the new model.

4 CASE STUDY OF RESEARCHING THE DEGREE OF TECHNOLOGICAL HUMANISM

In accordance with the newly created model, a case study was conducted on a sample of employees in two Croatian manufacturing companies to identify the degree of employee knowledge and awareness of Industry 5.0 and its influences on the company and on them personally. The research covered the five components of Industry 5.0 relating to the role of technological humanism, in line with the developed model. Both surveyed companies are small companies with annual revenues in the range of EUR 2–7 million. An additional goal of the case study was to determine whether there is a statistically significant difference in employee perceptions in relation to their work positions, and further to obtain their opinion on how the company could better organise the necessary educational and training processes.

The case study included all company employees, and their work positions were considered in six categories:

1) Auxiliary staff
2) Operational non-production worker
3) Operational production worker
4) Non-production department head
5) Production department head
6) Top management.

The survey questions 1-5 are presented below, and they followed the model components (1-5):

1) To what extent are you familiar with the potential that new technologies can offer the company you work in?
2) In your opinion, to what extent can the application of new technologies affect your work position?
3) In your opinion, to what extent can the application of new technologies affect or could affect the improvement of the ergonomics of your workplace?
4) In your opinion, to what extent can new technologies affect or could affect improvement of your satisfaction at work?
5) In your opinion, to what extent can new technologies affect or could affect your decision to be a long-term employee in your company?

For each question, nine areas addressing the technological aspects of Industry 5.0 were listed:

a) Digital collection of data during production and analysis
b) Automation of production and assembly
c) Use of autonomous robots

d) Automated warehousing systems
e) Real-time digital supervision of machine and device functioning
f) Automated needs planning for raw materials and other materials
g) Business decisions based on digitalised data
h) Use of artificial intelligence (AI) in production, organisation and management
i) Information support for measuring worker performance.

Employees were asked to give answers to the questions based on a five-point Likert scale. Statistical analysis of results was performed to identify possible correlations between factors that influence significant differences. The analysis of these associations was conducted by observing the mean values of responses to the areas a) to i). In total, 60 properly-filled out responses were obtained, with 77% of the total number of employees in the first company and 82% of the total number in the second. Responses from both companies were pooled into a single sample and examined on the basis of work position categories.

Tabs. 1 to 6 give an overview of the descriptive statistics results pertaining to the relationship of the classification determinants relating the type of work position (1-6) and the components of the research model (1-5). Statistically significant values are shown in bold.

Table 1 Total statistical data work position category

Variable	All Groups - Descriptive Statistics							
	Mean	Median	Mode	Freq.of Mode	Minimum	Maximu	Std.Dev.	Skewnes
Component 1	2,50	2,44	Multiple	7	1,00	4,67	0,84	0,51
Component 2	2,84	2,67	2,67	9	1,33	5,00	0,79	0,69
Component 3	2,89	2,89	3,00	8	1,11	4,78	0,82	0,48
Component 4	3,02	2,89	2,78	8	1,22	5,00	0,85	0,51
Component 5	2,95	2,78	Multiple	6	1,00	5,00	0,86	0,48

Table 2 Kruskal-Wallis test results for model component 1

Component 1	Multiple Comparisons p values (2-tailed); Component 1 Independent (grouping) variable: Work position classification Kruskal-Wallis test: H (5, N= 60) =8,453742 p =,1329					
	1	2	3	4	5	6
1		1,00	1,00	1,00	1,00	0,33
2	1,00		1,00	1,00	1,00	0,11
3	1,00	1,00		1,00	1,00	0,16
4	1,00	1,00	1,00		1,00	1,00
5	1,00	1,00	1,00	1,00		1,00
6	0,33	0,11	0,16	1,00	1,00	

Table 3 Kruskal-Wallis test results for model component 2

Component 2	Multiple Comparisons p values (2-tailed); Component 2 Independent (grouping) variable: Work position classification Kruskal-Wallis test: H (5, N= 60) =18,16744 p =,0027					
	1	2	3	4	5	6
1		0,28	0,69	1,00	1,00	1,00
2	0,28		1,00	0,27	1,00	**0,01**
3	0,69	1,00		0,64	1,00	**0,03**
4	1,00	0,27	0,64		1,00	1,00
5	1,00	1,00	1,00	1,00		0,54
6	1,00	**0,01**	**0,03**	1,00	0,54	

It is evident in model components 2, 3 and 4 there was a statistically significant difference in the responses with regard to the position (work category) of survey respondents. Specifically, work category 6, top management, showed significantly difference perceptions in relations to categories 2 and 3 (operational non-production and production workers).

Table 4 Kruskal-Wallis test results for model component 3

Component 3	Multiple Comparisons p values (2-tailed); Component 3 Independent (grouping) variable: Work position classification Kruskal-Wallis test: H (5, N= 60) =16,60810 p =,0053					
	1	2	3	4	5	6
1		0,33	1,00	1,00	1,00	1,00
2	0,33		1,00	1,00	0,12	**0,01**
3	1,00	1,00		1,00	1,00	0,08
4	1,00	1,00	1,00		1,00	1,00
5	1,00	0,12	1,00	1,00		1,00
6	1,00	**0,01**	0,08	1,00	1,00	

Table 5 Kruskal-Wallis test results for model component 4

Component 4	Multiple Comparisons p values (2-tailed); Component 4 Independent (grouping) variable: Work position classification Kruskal-Wallis test: H (5, N= 60) =13,58608 p =,0185					
	1	2	3	4	5	6
1		1,00	1,00	1,00	1,00	1,00
2	1,00		1,00	1,00	1,00	0,06
3	1,00	1,00		1,00	1,00	**0,04**
4	1,00	1,00	1,00		1,00	1,00
5	1,00	1,00	1,00	1,00		1,00
6	1,00	0,06	**0,04**	1,00	1,00	

Table 6 Kruskal-Wallis test results for model component 5

Component 5	Multiple Comparisons p values (2-tailed); Component 5 Independent (grouping) variable: Work position classification Kruskal-Wallis test: H (5, N= 60) =15,29599 p =,0092					
	1	2	3	4	5	6
1		0,57	1,00	1,00	1,00	1,00
2	0,57		1,00	0,86	0,09	0,15
3	1,00	1,00		1,00	0,25	0,43
4	1,00	0,86	1,00		1,00	1,00
5	1,00	0,09	0,25	1,00		1,00
6	1,00	0,15	0,43	1,00	1,00	

Figs. 2 to 4 illustrate the results of the case study for the identified significant differences between the model components 2, 3 and 4.

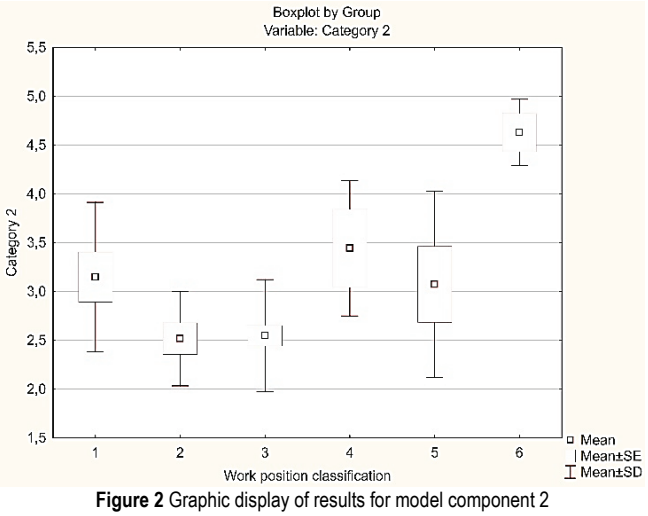

Figure 2 Graphic display of results for model component 2

The case study results indicate significant differences between work positions concerning knowledge and opinions concerning the processes surrounding the transformation of

production companies towards Industry 5.0 within the aspect of technological humanism. Particularly in production companies, there is a wide spectrum of employees in different work positions and with varying qualifications and education levels. The results of the case study showed differences in the knowledge, opinion and position on transformation towards Industry 5.0, with statistical significance in one category, top management. This is important since top management is responsible for decision-making and defined policies and company transformation processes towards Industry 5.0. The results of the case study indicate the need to conduct further educational processes and training adapted to the various employee categories, and that more attention should be focused on the development and implementation of specific knowledge transfer programmes, instead of a universal approach to the entire organisation.

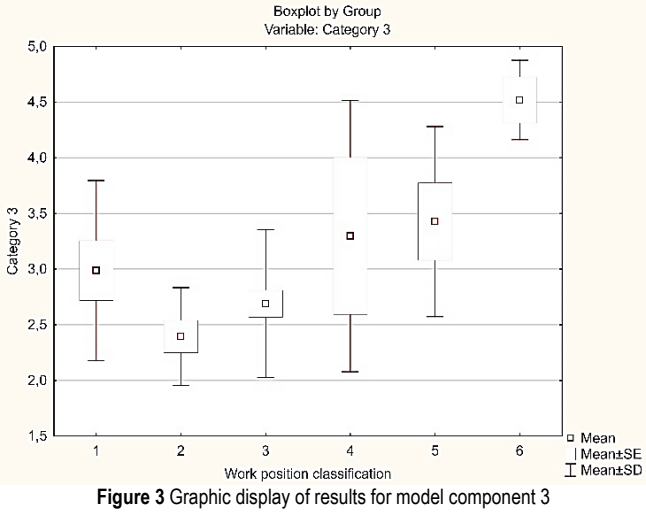

Figure 3 Graphic display of results for model component 3

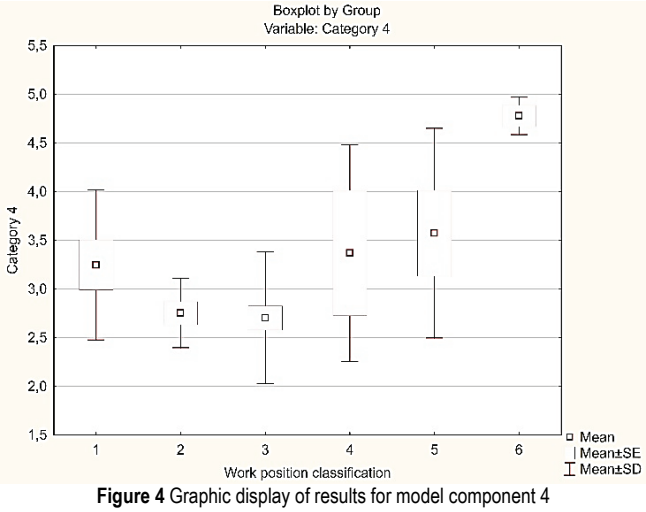

Figure 4 Graphic display of results for model component 4

5 CONCLUSION

Technological humanism is an important component in the transformation of traditional factories into smart ones, with the aim of securing both economic and social benefits. Previous concepts within Industry 4.0 have since been upgraded with the addition of a more human approach to the implementation of digital technologies that are developing at exceptional speeds and penetrating into all spheres of business and society. In that accelerated process, it is easy to neglect the importance of people who are the target group using these means, and instead concentrating on achieving only rapid implementation of new technologies and maximum economic effect. This can function in the short-term, though bringing negative consequences in the mid- and long-term. Technological humanism therefore is a concept that should serve as a guide for the successful transformation of manufacturing companies towards Industry 5.0, with long-term benefits.

This paper presents the new research model to examine the degree of technological humanism within a manufacturing company in transformation towards Industry 5.0, that through its components represents a template that such companies could follow to successfully organise their own business processes and strategic management at all levels. Its components include information and knowledge management, workplace organisation, workplace ergonomics, workforce wellbeing, and long-term work quality, which together form a basis for strategic definition and setting the appropriate organisational systems necessary for successful transformation of manufacturing companies towards Industry 5.0.

The conducted case study showed the differing perceptions of all structures of employees within the categories of technological humanism within Industry 5.0. Top management showed significantly difference perceptions in relations to operational non-production and production workers. The presented results are significant because they enable the creation of appropriate measures that are applicable to different categories of employees in the real sector of production. Primarily there is a need to clearly define the company policy and strategy of the new technologies implementation while informing all employees. In order for the process of transition towards Industry 5.0 to be successful, open communication and highly functional knowledge management that respects all categories of employees is essential. Here it is necessary to take into account that an approach according to employee age and education level is applied. At all organizational levels, it is necessary to promote openness to changes through effective change management. The corresponding activities should include a positive approach with focus on new opportunities, pointing out benefits for workers. There are new and specific tasks for HR management that should be considered to people with different skills and competencies, other than top management. HR departments should consider very seriously that the emergence of new technologies results in the emergence of new job profiles, and some of the existing jobs will disappear. One of the necessary measures that companies should take, especially for workers with a lower level of education and job profile, is the use of positive principles of work psychology. Employees often show big resistance to changes that can result on the lack of knowledge but also human fear of the new. Establishing an

organizational culture that promotes constant learning and adaptation to changes is suggested. The task of top management is to foster employee motivation, and educate but also listen to employees.

In manufacturing companies, the aim therefore is to establish changes that are based on knowledge in relation to the work position classification, thereby enabling a successful process of appropriate education and learning that involves all company employees in line with their specific classification characteristics. This can enable the implementation of the smart factory concepts and transformation to Industry 5.0 to positively affect the entire organisation, and lead to business and social progress. These results therefore highlight the significance of technological humanism in today's world of rapid technological development.

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