The Requirements for Knowledge and Skills of Managers in ICT Modified Fourth Industrial Revolution[1]

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Abstract

Digitalisation and new technologies transform current world into digital one and thus leading towards changes of customer behaviour, business models, innovations, methods of operation, as well as new generation of people, so called „Digital Natives". Management of human resources should create conditions for application of Industry 4.0 principles into practice in advance, based on analysis of digitalisation impact on their own business and its strategy, adapt processes of human resource planning. In order to acquire employees with digital qualification and thinking, it will be necessary to alter their recruitment, especially with orientation on social media and mobile variations of traditional recruitment channels. This scientific article points out a change in human capital competence impacted by the fourth Industrial revolution. This scientific article eventuates into proposal of requests for skills and knowledge of managers on different levels of management determined by fourth industrial revolution.

Keywords: *manager, management, information and communication technologies, ICT skills, information literacy*

JEL Classification: M12, M15

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[1] VEGA No. 1/0388/20 IT *Management in Enterprises in Slovakia: International Standards and Norms versus Individual Business Processes – Proportion 40%.*

VEGA No. 1/0412/19 *Human Resource Management Systems in the Era of the Fourth Industrial Revolution – Proportion 30%.*

VEGA No. 1/0375/20 *New Dimension in the Development of Production Management and Logistics under the Influence of Industry 4.0 in Enterprises in Slovakia – Proportion 30%.*

Introduction

Currently we are living in a period of unprecedented change branded by term Industry 4.0. This period is distinctive for a digital transformation of the surrounding world with an obligatory interaction between people, information-communication technologies, and tangible assets. Digitalisation and new technologies transform current world into a digital one, leading to a change in customer behaviour, business models, innovations, work approach, as well as new generation of people, so called „Digital Natives“. This digital world is characterised by terms such as virtuality, mobility, big data, internet of things, representing significant means enabling this change. A mutual connection of these elements creates faster and more complex environment, which demands businesses to be more agile and capable to adapt swiftly and transform. They must be aware of what they are doing, how they are doing it and must be prepared to adapt to new methods of work.

In this scientific article we compare theoretical basis, we point out changes caused by the fourth industrial revolution in work sphere, requirements on skills and knowledge of managers in individual areas of information-communication technologies (ICT) typical for the fourth industrial revolution. At the moment, there is a lack in summary of requirements on actual digital competences of managers in scientific literature, which managers should obtain within graduate and post graduate education. Simultaneously, we present partial results of an extensive research focused on utilisation of ICT by managers and we verify research hypothesis determined by research issue. The main objective is to identify difference in intensity of ICT utilisation by managers on different levels of management. Article eventuates into proposal of requirements for competences, knowledge and skills of managers on different levels of management determined by the fourth industrial revolution.

1. Theoretical Background

An important milestone in mankind development, including economic development, are industrial revolutions (Table 1). Literary resources mention reference to three significant stages of industrial revolution (Geissbauer, Vedsø and Schrauf, 2016), and those were year 1700 connected with an invention of steam engine resulting in development of mechanisation, beginning of the 20th century related to development in utilisation of electric energy and mass production and period after the second world war, also called „computer age“, accompanied with massive informatisation of society.

Nowadays, we are in a stage four of industrial revolution accompanied with integration of information – communication technologies and information systems and their mutual communication.

T a b l e 1

Main Attributes of Individual Industrial Revolutions

Period	Energy resource	Main invention	Industry development sectors	Transportation development
I. 1760 – 1900	Coal	Steam engine	Textile, steel	Train
II. 1900 – 1960	Crude, electric power	Combustion engine	Metallurgy, automobile industry	Train, automobile
III. 1960 – 2000	Atomic power, gas	Computer, robot	Automobile industry, chemical industry	Automobile, air
IV. 2000 –	Green power	internet, 3D print, genetic engineering	High Tech	Electrical automobiles, speed trains

Source: Prisecaru (2016).

Term Industry 4.0 was first used in 2011 by the director of German national academy and technics (Acatech) Henning Kagermann to describe proposed industrially supported initiative. Industry 4.0 began to have a strong representation in Germany, intensely supported by initiatives of important industrial businesses. This initiative has been growing recently and spreading to other countries, especially USA, Japan, China, Scandinavian countries, and Great Britain with support of world economy leaders. Companies such as Siemens and GE stated that Industry 4.0 and technologies related to it have become „a key part of their identity“ (Gross, 2016).

Digitalisation of society brings extensive changes impacting production and non-production businesses, public sector, education, businesses of all sectors, way of company management as well as casual human life and they belong to common topics of discussion of political and social processes.

Industry 4.0 focuses on combination of several important innovations in information-communication technologies and digital technologies, which are able to transform almost all economy sectors (Geissbauer, Vedsø and Schrauf, 2016). Fourth industrial revolution changes everything – starting from the way we communicate to the job we perform (Schwab, 2017). It also changes means of economy functioning. In relation to Industry 4.0 and integration of information-communication technologies authors Geissbauer, Vedsø and Schrauf (2016) claim that „technologies and internet web, which initiated industrial revolution in society, have become hyper-sensible systems that are highly flexible, react not only to human orders, but they also have their own perception and direction and which follow clear algorithms.“ Stock and Seliger (2016) stress that Industry 4.0 provide wide space for sustainable development.

Economic environment has been formed by deepening globalisation, businesses has been constantly shortening life cycles of products and need to decrease expenses with a goal to remain competitive in a global environment. Because of classic businesses models remain vulnerable, businesses must rationalize their innovation processes and transform their models to models oriented at services (Shahd and Hampe, 2015). Value orientation of customers have been changing and moved attention of businesses to the higher level of adaptation and demands on flexibility. As a result, markets have become more volatile and heterogeneous. There is a growing need for collaboration, businesses form strategic alliances of their suppliers or competitors, in order to stay competitive (Fiala and Prokop, 2013). This leads towards correlation of value chains resulting in global growth in process complexity (Helmrich, 2015).

The topic of fourth industrial revolution has been currently dominating expert discursus in both theory and practice of management. Industry 4.0, which is based on massive digitalisation and mutual communication and cooperation of people, machines, devices and products significantly influences not only means how economy will produce but also means how people will work.

1.1. Change of Competence under an Impact of Industry 4.0

Knowing outside and inside environment is a key to define future competence, which represent commodity on work market in conditions of Industry 4.0. Transformation of working environment changes profiles of working positions and demands employees to be equipped with wide range of competences (Spencer and Spencer, 1993; Kagermann, Wahlster and Helbig, 2013). Over the last course of the years many authors have introduced different definitions of a term competence, while discorsus regarding this topic has not been closed yet (Prifti et al., 2017). The first definition of competence comes from McClelland (1973), who defined competence as „a personal trait or a set of habits leading to more effective or higher work performance“. According to Spencer and Spencer (1993) competences represent „skills and abilities obtained as a part of work and life experience, study or training“. Bartram, Robertson and Callinan (2002) understand competences as „a collection of behaviour assisting in achieving desired results or inputs“. In accordance with authors Meyer, Brunig and Nyhuis (2015) competence is a combination of skills, abilities, knowledge and experience of people, which are essential for execution of life and work role.

Changes in a fundamentals of work impact formation of demands on business competitive abilities and hence require reaction from systems managing people in a company in form of defining required employee competence. Physical strength or specific physiological characteristics of employees remained important only

in narrowly profiled occupations. Some of the core employee competences in the world of 4.0 include not only economic, social, environmental and political, but also technological competences (Table 2).

T a b l e 2

Key Employee Competences in the Work World of 4.0

Environment	Competence
Economic	**Ongoing globalisation** Multicultural skills, diversity tolerance, language skills, time flexibility, ability to communicate, understanding of a process **Increased need for innovations** Entrepreneurial thinking, creativity, problem solving, work under pressure, application of newest knowledge, development of technical skills, research abilities, understanding of a process **Demand on increased orientation on services** Problem solving, communications skills, ability to compromise, web creating **Growing need of cooperation and interaction** Ability to compromise and cooperate, ability to work in a team, communication abilities, web skills
Social	**Demographic changes and transforming social values** Ability to transfer knowledge, ability to accept rotation of work tasks and changes related to the job (tolerance of uncertainty), time and space flexibility, leadership skills **Growing utilisation of virtual work** Time and place flexibility, technological skills, communication abilities, understanding of IT security **Growing process complexity** Technical abilities, understanding of a process, motivation to learn, tolerance of an uncertainty, decision making, problem solving, analytical skills
Technological	**Exponential growth in technology and data utilisation** Technical skills, information and digital literacy, analytical skills, effective work with data, programming, understanding of an IT security **Growing cooperation on platforms** Ability to work in a team, communication skills in virtual environments, multimedia skills, understanding and following of an IT security, ability to cooperate
Environmental	**Climate change and lack of resources** Sustainable approach, motivation to protect an environment, creativity in development of new sustainable solutions
Political	**Standardisation** Technical skills, ability to programme, understanding of a process **Data security and personal privacy** Understanding of an IT security, acceptance and application of security standards

Source: Hecklau et al. (2016).

Basic competences of a digital work power include information, digital literacy and digital interactivity. The need for digital skills represents priority for work positions in Industry 4.0. Hence, learning and managing of these skills presents an assumption for future work performance. Employees will be forced to adapt knowledge and skills of programming, cyber security, digital networks, cloud computing, databases as well as administration of innovative technologies Industry 4.0 and new information systems (Zhang, Yu and Ly, 2015; Sackey and Bester, 2016; Hecklau et al., 2017; Piñol et al., 2017; Pinzone et al., 2017).

Naturally, digital manpower will have new requirements on management. Current managerial principles will go through significant redefinition. It is called digital leadership 4.0, which is fast, hierarchical, team oriented and cooperative with strong orientation on innovations (Oberer and Erkollar, 2018). It requires personal skills, open mind and ability to use new tools (Oberer and Erkollar, 2018). Digital leadership requires change in strategic thinking (combination of digital and business strategy), reassessment of function in business IT, business platforms, setting mind and skills with an emphasis on innovation and experimenting with digital know-how. It will be required to perform changes at workplaces towards humanisation of an environment and work flexibility (El Sawy et al., 2016). As the world heads to digital state, digital leadership must be integrally connected to new trends in digital area, such as Big Data, mobile devices, artificial intelligence or network learning (Kelly, 2018). Some authors emphasise ability of digital leaders to create condition for experimenting and support people to think different ways and motivate people to cooperation (Kane et al., 2018). In relation to the above mentioned it is very important for management to support education and innovations (Shamim et al., 2016) while education 4.0 is also characterised by support of an artificial intelligence in learning process (Ciolacu et al., 2018). Its aim is to cover six aspects in future education and those are new education formats, independence from place and time, individualised learning, globalisation, shared skills and lifelong education (Flores, Xu and Lu, 2020).

Digitalisation is often called a metatrend which encourages many economic, social, political and ecological changes. Several studies acknowledged that there is a positive corelation between investments into ICT and business economic results (Devaraj and Kohli, 2003; McAfee and Brynjolfsson, 2008; Belvedere, Grando and Bielli, 2013). Implementation of ICT into management processes assumes that managers are prepared. The main objective of this article is to identify level of demands on skills and knowledge of managers in ICT area on different levels of management in relation to development of Industry 4.0.

1.2. Requirements on Knowledge and Skills of Managers in ICT Department

Technological advancement impacts all spheres of life of society, individuals and naturally it influences life of managers. Dynamic development brings changes of different intensity, quality and quantity. Hence, businesses put pressure on managers, their knowledge, skills, abilities, in regard to an increasingly faster change in nature of their job which results in limitation of requirements and demands depending on the variety of business activities.

There is a significant impact on strategy, structure and business functioning in those ICT, which apart from radical changes assist to increase interactivity,

flexibility, performance and productivity. Correct ICT implementation is vital, as is its connection to strategic goals of business, its activities and information systems (IC) established on bases of ICT, which are essential for directing role of managers. Development of IS in a business is influenced by new information technologies (IT). Advanced IT improves IS parameters, these terms are closely related. Managers on all business levels (operations, tactical and strategic) are required to possess skills and abilities in managing ICT, IS/IT in scope and on level corresponding their managerial position.

There are following managers operating in businesses: manager of human resources, production, strategy, marketing, information systems etc. Requirements on managers differ in relation to the department in which business operates. It is essential for manager to follow latest trend of development in this sphere as well as ICT at home and abroad and would cultivate these development trends systematically, while considering real conditions of the business.

Some of the basic requirements on managers include also demands on their personal qualities, presented by their productive, cultured communication not only at a workplace but also towards business surroundings and overall high cultural level. Diapason of requirements on manager is extensive, we only single out those ones every manager should be equipped with, so they would be able to persuade their surroundings with their personal maturity they have potential to manage business and make correct decisions.

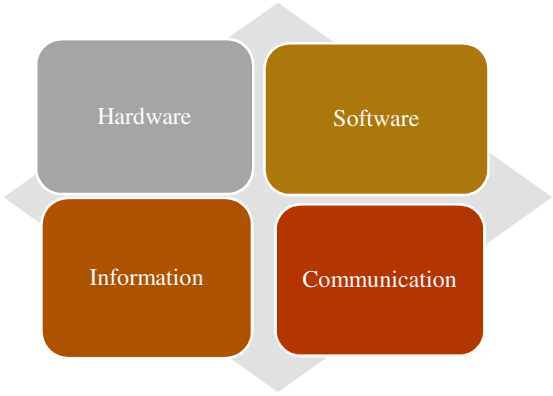
Specific requirements on managers are determined by businesses themselves based on character of their activities. The nature of manager's job changes quickly, trends are not universal and hence, managers are forced to continually improve their knowledge, abilities and skills in ICT, in order to be able to face new challenges.

Manager, which takes part on further education and expansion of their skills, should be able to adequately cover fulfilment of their tasks after finishing their education, as crudeness leads to errors of ignorance. On the other hand, abundant education might cause misunderstanding of affected managers and ineffective utilisation of efforts invested as well as waste of resources. Education and qualification are characteristics of manager, that are hard to quantify and hence, it is not simple to identify demands of business on education. Requirements on education are determined on company level and they emanate from difference between expected and real results of an organisation. It is necessary to specify educational needs on level of in-house departments and then on level of specific employees based on the assessment of their performance and difference between required and real knowledge and skills (Armstrong, 2015; Kucharčíková, Mičiak and Hitka, 2018). Such complex identification of educational needs might be

demanding, but it presents assumption for effective business education. Educational requirements assist in determining educational goals. They might be determined not only based on company goals and strategy, but also by analysing researched findings business desires to eliminate. With regards to stated, it is possible to define following educational requirements of middle managers in ICT (Figure 1).

Figure 1

Education Sectors in Information-communication Technologies



Source: Processed by the authors.

It is desirable to be educated and to be skilled, informationally literate in sphere of understanding hardware and software, work with information and ability to communicate. Information literacy (Bolek, Kokles and Korček, 2016) is defined as the ability to identify the need for information, to search for, obtain, process information available through appropriate ICT tools, evaluate it and use the obtained information as efficiently as possible. Information literacy generally includes the ability to understand information and use it in various formats from different sources presented through modern ICTs. Picture nr.1 represents a general framework, individual requirements on education, knowledge and skills in mentioned ICT sphere are specified in detail for individual work positions. We also remind that it is not sufficient to only utilise ICT tools, but it is also necessary to increase qualification and education in sphere of information security, as many security incidents are related to insufficient expert level of knowledge (Kokles and Bolek, 2013). Authors' recommendations point also to The Model of Manager Information Literacy (Bolek et al., 2018). The information literacy model presents 6 blocks. Managers' education in these blocks creates the synergy effect on managers' information literacy, which is affected by personal attributes and managers' surroundings.

In formulating requirements on managers, it is assumed that pillar for success development and business competitiveness are talented, educated people – natural leaders, equipped with competences and not only people leaning against power, ownership, wealth.

Leaders of modern businesses realise the need to fulfil managerial roles by educated managers, willing to educate further. Manager's willingness to educate is related to business' performance and competitiveness. They form such intellectual potential that is characterised by high level of education, talent and skills – knowledge, especially in understanding modern ICT and information systems.

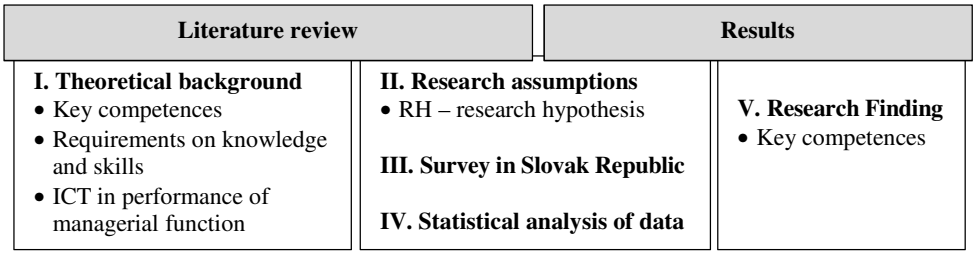
Internal environment of businesses is characterised by rapid development of information-communication technologies, which are utilised to make every deliberate business activity more effective and consecutive achievement of prosperity. Nowadays, ICT has become an inseparable part of management and demands on business manager. To maintain diversity and complexity of performed activities there must be created an integrated informational managing system able to cooperate in creating business concepts and strategic management with an aim to satisfy needs to harmonise activities of individual in-house departments. In integration of individual parts of information systems there cannot be missing quality information strategy.

2. Methodology

Progression of this scientific article is illustrated in a research model (Figure 2).

Figure 2

Research Model



Source: Author's calculations.

Within theoretical basis and based on detail analysis, anatomisation and comparation of theoretical basis by national and foreign authors, we pointed out changes caused by fourth industrial revolution in the world of labour, demands on knowledge and managerial skills in individual ICT departments, which are

typical for the fourth industrial revolution. These theoretical bases represent a fundamental basis of an actual state of knowing to resolve research problem, out of which we formulated a research assumption, and we formulated a research hypothesis with an objection to provide exact answer.

Research Assumptions

The objective of this research was to verify to what degree demands on managers on different level of ICT utilisation differ in execution of managerial role in period of fourth industrial revolution. We based our research on following assumptions:

1. Requirements on knowledge and skills of managers in ICT on different levels are differentiated,
2. Intensity of ICT utilisation in manager's work depends on level of management.

Research Hypothesis

The aim of research presented was to verify whether there is a significant dependence between level of management and intensity of ICT utilisation ($p < 0.05$), and so whether intensity of ICT utilisation by managers in the business is directly influenced by their job title. The hypotheses will be tested at the level of significance $p = 0.05$. Tested hypothesis can be formulated as follows:

H_0: There is no significant dependence between level of management where manager operates and intensity of ICT utilisation ($p = 0.05$).

H_1: There is a significant dependence between level of management where manager operates and intensity of ICT utilisation ($p = 0.05$).

Research Instrument, Data Structure and Methods

Selected research tools were questionnaire and structured and semi-structured interviews with managers of selected companies (35 respondents completed the interview). The sample structure (Table 3) according to sectors approximates the distribution of enterprises in the national economy (statistical classification of economic activities – SK NACE).

Respondents answered closed, opened and semi-opened questions from the questionnaire. In assembling questionnaire, we were coming from analysis of individual problem areas and justified construct, content and criterion validity (Gavora et al., 2010). Reliability and accuracy of the questionnaire was determined by the following factors: frequency of items, homogeneity and complexity of tasks (Field, 2009; Gavora et al., 2010). For part of intensity of individual ICT application, we applied Likert scale (on scale 0 – do not apply to 5 – apply very

often). In assessing data obtained from questionnaire research, we used a wide set of mathematic-statistics methods.

T a b l e 3

Respondent Structure of the Research Sample According to Industrial Sectors

Sector	% of respondents
A. Agriculture...	5.34
C. Industrial production	24.27
D. Electricity supply...	0.49
E. Water supply...	0.49
F. Construction	9.71
G. Wholesale and retail...	12.14
I. Accomodation and catering services...	5.34
J. Information and communication	6.31
K. Financial and insurance activities	8.25
L. Real estate activities	0.49
M. Professional, scientific and technical activities	3.88
N. Administrative and support sevices	3.40
O. Public administration and defence....	0.97
P. Education	3.40
Q. Healthcare services	2.43
R. Art, entertainment and recreation	0.49
S. Other activities	12.62
Total sum	**100.00**

Source: Author's calculations.

Results presented come from the research which was realised on the sample of 180 respondents consisting of managers on different levels of management. These were selected for the research based on casual selection. Structure of respondent sample is characterised in the following table (Table 4).

T a b l e 4

Respondent Structure According to Their Work Position and Achieved Education (in %)

Work position	Highest achieved education				Total
	High education with examination	*University I. degree*	*University II. degree*	*University III. degree*	
Operational managers	10.00	2.78	19.44	0.00	32.22
Tactical managers	6.11	1.11	33.33	2.22	42.78
Top managers	5.56	1.11	16.67	1.67	25.00
Total	**21.67**	**5.00**	**69.44**	**3.89**	**100.00**

Source: Author's calculations.

Managers of individual businesses were segmented into groups based on the level of management they operate on. Operational managers represented 32.22% of research sample, the highest share was of tactical managers (42.78%), top managers represented 25.00%. This criterion was fundamental for following statistical analysis. The most commonly achieved education amongst managers was a university education of second degree (69.44%).

Data collected from the questionnaire research were analysed in a detail. Apart from basic statistical methods of descriptive statistics, we also applied system methods to seek connections between individual problematics. Normality of data division was tested by Leven test. In further analysis of normally divided data we utilised T-test and Anova and Bonfferoni correction. For data that did not meet criterion of normality for data division we used Mann-Whitney test and Kruskal-Wallis test. We also examined effect size via Cramer's V between work position and intensity of ICT utilisation there is a medium strong dependence.

3. Research Results

In the following part we present results of the research focused on requirements on knowledge and skill of managers in work with information-communication technologies in context of requirements of the fourth industrial revolution.

Intensity of ICT utilisation by managers is defined as degree to which managers rely on ICT with their work activities. To assess intensity of ICT utilisation we selected five-step scale, where value 1 expressed non-utilisation of ICT in manager's work and value 5 expressed its often utilisation (Table 5).

T a b l e 5

Intensity of ICT Utilisation by Managers in Dependence on Work Position (in %)

Work position	**Intensity of utilisation**				
	1	**2**	**3**	**4**	**5**
Operational management	0.00	2.22	8.89	7.22	13.89
Tactical management	0.00	1.11	2.78	13.33	25.56
Top management	0.56	0.56	7.22	7.22	9.44
Total	**0.56**	**3.89**	**18.89**	**27.78**	**48.89**

Source: Author's calculations.

Based on research results we can establish that managers with no regards on level of management utilise ICT often (27.78%) to very often (48.89%) in fulfilling their work tasks, average value of intensity in ICT utilisation moved on level M = 4.21 b, STDEV = 0.92 b. From the results of analysis of angular coefficient, we deduce SKEW = –0.90, that managers state higher values of intensity in ICT utilisation. The most common value of intensity in ICT utilisation by managers at work is value 5 (Mo = 5). Up to 50% of respondents stated higher value of utilisation intensity than 4 (Me = 4).

After considering level of management (Table 6), on which managers operate, it is clear that ICT is utilised in the highest degree by tactical managers M = 4.48 b, SD = 0.74 b. Operational M = 4.02 b, SD = 1.00 b and top managers M = 3.98 b,

SD = 0.99 b indicate wider variability of ICT utilisation, marked value move in scope 3 – 5. In case of operational and tactical managers, none of respondents stated minimal value 1.00.

T a b l e 6

Intensity of ICT Utilisation by Managers in Dependence on Work Position

Work position	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean		Min	Max
				Lower Bound	*Upper Bound*		
Operational management	4.02	1.00	0.13	3.75	4.28	2.00	5.00
Tactical management	4.48	0.74	0.08	4.31	4.65	2.00	5.00
Top management	3.98	0.99	0.15	3.68	4.28	1.00	5.00
Total	**4.21**	**0.92**	**0.07**	**4.07**	**4.34**	**1.00**	**5.00**

Source: Author's calculations.

In general, we can discuss that managers on all levels of management utilise ICT in their work daily, which is confirmed by study results, published by authors Šajbidorová and Lušňáková (2013).

In accordance with them, up to 90% of managers utilise ICT daily and perceive it as a resource of information, communication means and tools for time management. Concurrently, managers perceive also negative sides of ICT (this is an opinion of 78% of respondents), listing negatives such as information oversaturation by abundant information, increased time burden in e-mail communication at the expense of personal communication.

Verification of Research Hypothesis

Verification of research hypothesis regarding relation between level of management where manager operates, and intensity of ICT utilisation was performed via Levene's test. Data did not meet criterion of normal data division (Levene statistic p = 0.022). Hence, these data were tested via non-parametrical test K Independent test Kruskal-Wallis H (Table 7).

T a b l e 7

Test of Differences in Middle Values

Test Statistics[a,b]	
	Intensity
Chi-Square	11.237**
df	2
Asymp. Sig.	**0.004**

Note: * p = 0.05, ** p = 0.01.

Source: Author's calculations.

Achieved results confirmed that intensity of ICT utilisation significantly differs depending on level of management where manager operates. Level of management has a significant impact on intensity of ICT utilisation in a business (χ = 11.237, df = 2, p = 0.004). Concurrently, we investigated effect size throughout Cramer's V r = 0.237, there is a medium strong dependence between working position and intensity of ICT utilisation.

Research Findings

Based on result assessment we establish, that hypothesis H_0 was rejected. Hypothesis H_0 is dismissed and we accept a new hypothesis H_1: There is a significant dependence between working position of a manager and intensity of ICT utilisation.

Operational managers (M = 4.02; SD = 1.00), tactical managers (M = 4.48; SD = 0.74) and top managers (M = 3.98; SD = 0.99) are significantly and statistically different (χ = 11.237, df = 2, p = 0.004) when it comes to intensity of utilising information-communication technologies. There is direct medium strong dependence between working position and intensity of ICT utilisation r = 0.237.

4. Discussion

Fourth industrial revolution has significantly modified and influenced business processes by implementing and integrating innovative, pervasive technologies into all business spheres. Current fourth revolution transformation of a business into smart one, integration of intelligent devices, support for Internet of things, utilisation of cognitive calculations, connecting cloud servers. These changes considerably change and increase requirements on skills and abilities of managers.

Based on our findings that demands of ICT utilisation are imminently impacted by level of management, where managers operate, it is crucial for businesses to understand demands of individual levels of management, because these will present determinant for processes of employee selection for these positions as well as their development processes.

Technological changes in an environment, massive growth in ICT utilisation and work with data, cooperation using platform environment generates especially requirements on key employee competences established as well as newly entering labour market of Industry 4.0 in individual areas. Requirements on key competences in sphere of demands on ICT utilisation can be formulated as follows (Table 8).

T a b l e 8

Key Competences of Employees in an Environment of World of Work 4.0 in Sphere of Demands on ICT

Requirement category	Competences in sphere of ICT utilisation	Application
Technological	Communication skills	Increased share of virtual work requires employees to use intelligent means of communication.
	Work with hardware	Knowledge and skilled work with innovative technologies. Knowledge represents their potential, restrictions as well as weaknesses. Growth in requirements on innovations, miniaturization and interoperability of these devices.
	Work with software	New innovative technologies ignited demands on creating new and upgrade of current information systems and software applications. Increasing demands on work with information systems, information and digital literacy, critical, logical thinking.
	Programming	Growth of digitalised processed creates higher need for employees with ability to programme and knowledge of software architecture.
	Culture of IT security	Virtual work on servers or platforms requires awareness of cyber security.
Methodological	Creativity	The need for systematic innovation of production systems, products as well as internal processes requires productivity.
	Decision making	Growth of autonomy and responsibility for processes increases demands for decision making skills and utilisation of tools to support decision making.
	Analytical skills	Ability to assess a complex analysis of high data volume with an assistance of software support has become a necessity.
	Research abilities	Ability to work with reliable knowledge resources and ability to learn continually in ever changing environment.
	Orientation of effectiveness	Complex issues must be resolved more effectively, e.g. analysis of growing amount of data.
Social	Communicational skills	Orientation on services requires good listening and presentation skills, there is a growing demand on communication skills in virtual environments.
	Ability to network	Work in highly globalised and connected value chain requires ability to create and care for ties on numerous levels.
Personal	Security awareness	Following strict rules for IT security, work with technologies or correct division of work time.

Source: Own processing of authors amended by study results of author Hecklaua et al. (2016).

Understanding the fact, that level of management directly influences demands on ICT utilisation encourages the need to deeper analyse needs and requirements of individual levels of management. Our findings are also only partially in accordance with findings of authors (Corso et al., 2003; Acar et al., 2005; Fuchs et al., 2010; Ongori and Migiro, 2010), who investigated an intensity of utilisation, but not the relation of working position of managers and intensity of ICT utilisation. Within discussion, in line with our research findings, structured and semi-structured interviews with respondents, we have formed requirements on competences, skills and abilities of managers on operation, tactical and top level in sphere of information-communication technologies, which are determined by the fourth industrial revolution.

Managers on the lowest hierarchical level of organisation are so called operational managers. These managers should be able to effectively utilise managerial informational systems in line with turbulent changes in requirements of developing organisation.

Work focus of an operational manager is usually single-sided, with orientation on narrow range of activities within their authority. Their role is to keep evidence of employees, prepare details for personnel activities, such as rewarding. Equally, they are responsible for keeping evidence of stock, monitoring and assessment of qualitative and quantitative parameters regarding stock and their changes, monitoring amounts of spent resources, work, energy, preparation of purchase orders and other records, which present flow of process management in an organisation. In fulfilling their role, operational managers use especially information from business informational system, which are very detailed and they are characterised by high degree of repeatability and automation.

The share of information utilised from business information system and their importance in advantage to external informational resources decreases towards higher levels of management: to medium and top. Transaction Processing Systems (TPS), utilised by operational managers integrate internal processes of an organisation to an individual entity with an aim to automate and simplify common routine tasks. Title „transaction“ system determines routine exchange related to financial state of the organisation. These systems perform daily accounting operations related to suppliers, customers, employees, their evidence, wages, stock… One of the fundamental characteristics of these systems is an interaction between users and the system, which is brief, clear and fast – in short time intervals and with an immediate response. This is a critical application and hence, it is vital to maintain continuity, integrity of data and their protection. Transaction systems include numerous different systems, which cover specific narrow sphere of organisational processes.

Supply Chain Management utilises systems aimed at quick, complex connection and strengthening of organisation. In supply chain management these systems bring optimisation of flow for individual records, coordination of activities related to purchase, production, distribution, customer satisfaction and re-transformation of linear supplier chain into adaptable system. Utilisation of these systems reduces costs of the entire process, starting from procurement up to delivery of the product to the final consumer, which can lead towards decrease of the final price.

One of the tasks of operational management is to improve and maintain relationships with customers. CRM (Customer Relationship Management) systems represent systems dealing with customer relations. Their goal is to summarize and process information regarding customers and their archiving in the database. One of advantages of preserving information in the database is that seller is able to react to customers' requirements, complaints and seamlessly assign them to appropriate segment. They record an entire sales process, from the first contact with the customer to the invoicing of products and services. Today, CRM systems belong to standard modules in majority of economic software and business informational systems because tool of sale and service support is one of the tools increasing sale effectiveness and customer satisfaction.

In accordance with organisation focus and specification in routine operational activities, management is able to utilise also other specific transactional information systems, such as: CAD, CAM – construction systems, GIS – geographic systems, RIS – reservation systems contributing towards automation of common routine activities.

Operational managers are also required to continually improve in ICT, supporting of electronic data exchange and knowledge and skills in standard office informational systems, especially wider Microsoft Office Package.

Middle level of management, in hierarchy of a management pyramid, is a tactical manager. In order to perform their managerial activities, it is required to possess abilities/skills to manage ICT corresponding this level of management and decision making.

There is necessary to have an ability of communication closely related to new ICT trends, which are directly related to informational systems of an organisation and manifest themselves by investigation, concentrating, processing and exchange of high volume of information in inner an outside environment of an organisation. From the point of requirements of tactical manager, it is necessary for organisation to demonstrate requirements of communicational process, communicational ties expressed in organisational regulations and work regulations. Manager on this level needs to overlap collected information with information

from the higher level of management – top management as well as information from the lower level of management – operational manager. Professional handling, identification of available resources in ICT utilisation represents favourable result in process of enforcing directing managerial function on this level. Middle manager partakes on controlled activities, planning, constructing motivational means, development of human resources, market analysis. Manager on this level is in between two levels of management which is not simple sometimes and it does not mitigate their decision-making process. Top manager focuses on making strategic decisions and operational manager is focused on more practical issues. Tactical manager represents a connecting link between these two levels. Based on these facts and functions requirements on managers on tactical level are formed. To support process of decision making on tactical level they use optimising and simulation processes and algorithms.

Tactical managers are expected to possess knowledge and ability of (MIS) Management Information Systems, which are specialised for certain area of entrepreneurship and decision-making. Usually these systems consist of several modules, including: Accounting, Finance, Human Resources, Acquisition, Property management, Stock control, Reporting and others. MIS partakes on implementation of organisational strategy, monitoring company surroundings, assessment, reporting, analysis… It is vital for MIS to be designed in a way to fulfil the basic concept and to harmonize with concept of the project FASMI (Fast Analysis of Shared Multidimensional Information).

On this level of management, it is vital to have knowledge of utilisation information systems to support decision making (DSS – Decision Support Systems), enabling competent managers to assemble useful information based on combination of primary data, documents. „These specific requirements of management based on demands on information quality, speed of their recovery and their orientation on market and hence, also their competitiveness, require specialised approaches to providing information, their selection, availability, processing, form and other attributes, which turn data into real information assisting decision-making“ (Látečková, Bigasová and Stabingis, 2016). Together with some necessary information, they can identify problems and find optimal, or acceptable solution to a task based on optimising and stimulation programs. At the same time, they are expected to possess knowledge of expert systems (KWS – Knowledge Word Systems) from different divisions. Managers must apply their deduction and inference skills in utilisation and coordinating data from this system. „They are mostly used in resolving tasks of diagnostic character. There are often applied technologies of an artificial intelligence and knowledge is built in the knowledge base“ (Požár, 2010). Tactical managers must be able to effectively

and efficiently utilise and support processes, applications and technologies, which are aimed at effective support of analytical, planning and decision-making processes in an organisation. These managerial information systems providing diverse managerial applications and reporting tools fall within the sphere of business intelligence applications (BI) and hence, their knowledge is imperative.

Also, managers on this level must take part on implementation and realisation of electronic data interchange (EDI) and Workflow.

Top managers should be acquainted with EIS – Executive information systems and be able to draw, dig internal, as well as external relevant information, in order to fulfil organisation's strategic objectives. Managers on this level do not deal with individual, partial information and sub-systems of information systems, but they deal with complex reports and entries from lower levels of management. „Even data entering EIS are usually transformed into the form suitable for strategic decision-making" (Požár, 2010).

Skills in OIS – Office Information Systems, which includes, for example complete Microsoft Office package, presents an important condition for success of top management. Managers must be skilled in IS/IT (information systems supported by information technologies), in sphere of managing business information with connection to all areas and levels of management and they must support EDI – Electronic Data Interchange between organisations, business institutions, financial institutions etc. It is a structured data interchange aimed at creating more efficient communication between subjects, which results in saving time, expenses, regional independence of administration and business centres, creating competitive advantage on both local and foreign markets, but especially it improves information flow (Neuburger, 1994). Within levels of management it is crucial to support workflow, in order to manage, simplify and automate business processes.

On position of top manager, there is an emphasis put especially on their personal profile, expert skills, experience from different working positions and versatility in education, knowledge, abilities, intellectual capacity on higher level, multidisciplinary approach to problem solving, responsible approach to management of an organisation and skills in controlling ICT relevant to their position. Current modern top manager is also required to be able to work in a team, which may contribute towards creating synergy of unique individualities in the organisation, communication with managers on lower levels and with all levels of other subordinates, which is supported by development and utilisation of ICT. There is also preferred ability to deal with pressure from both inside and outside environment, setting vision, as well as credibility, empathy, complexity of thinking and distribution of information.

Top manager is considered to be a carrier of knowledge, who based on their position has possibility to influence other employees within an organisation. Hence, success or failure of an organisation depends on their managing and decision-making activities.

We agree with the statement of an author Grass (2016), who in relation to digital transformation of society stresses, that transformation itself does not present danger requiring immediate radical interference. He considers it an evolution rather than revolution. Even though, it is not completely clear where will the fourth industrial revolution lead, it is necessary to prepare for upcoming changes and accept them positively. It is management of human resources and their gradual and post-gradual education that has an irreplaceable role in establishing above mentioned concepts and implementation of 4.0 into the real life. It will be responsible for creating essential tools as well as sensibilization of managers and employees to new requirement and challenges.

This research study has its limits of research. One of them is research tool itself – the questionnaire. The questionnaire survey was conducted by a random selection of enterprises in the Slovak Republic. The research sample is limited in its regional scope. The measuring instrument can also be considered as a limitation of the research, due to the fact that the respondents answered the individual questions by self-assessment, while their answers could be influenced by various factors (lack of time, their mood, imminent event when filling the questionnaire).

Conclusion

Employee competence analysis in ICT represents a resource for definition of specialised strategies forming working potential and management of employee work performance. Models defining key competences and relations between them, which enables managers to identify divergence of real and desired key competences are a significant tool for management of human resources in Industry 4.0 era.

Nowadays, it is clear that in the forthcoming future there will be a significant shift in work position profiles. Consequently, this will also change requirements on occupant of these working positions. Based on the research performed, we can establish that managers significantly differ when it comes to intensity in utilisation of information-communication technology leading to differentiation of requirements on their skills, knowledge and subsequently on their informational literacy. By now, all the studies agree with an opinion, that management of human resources will have a key role in digital transformation. It will be fundamental to adapt processes of personnel planning, find new ways in acquiring and recruiting new employees, their development, propose new work models.

Management of human resources should create conditions for application of Industry 4.0 principles into practice in advance, based on analysis of digitalisation impact on their own business and its strategy to adapt processes for human resource planning.

Followingly, it is necessary to identify critical activities and positions, whose profiles would need to be adapted. In order to acquire employees with digital qualification and thinking, it will be necessary to change the way of their recruitment, especially orienting on social websites and mobile variations of traditional recruitment canals. The need to achieve change in competences in company's employees will lead to adjusting education methods and employee development. Likewise, traditional thinking in sphere of working regimes will have to be abandoned, flexible production requires flexile employees.

It will be interesting to look back at impact of the fourth industrial revolution and its requirements on skills and knowledge of human capital impacted by corona pandemic (COVID-19). Corona crisis has invoked even stronger pressure on digital skills and knowledge of human capital, we can even state, that in some businesses it has become an accelerator for digitalisation of business processes. Future direction of research will probably focus more on upcoming fifth industrial revolution. Industry 5.0 predicts integration of human factor, human intelligence into an industrial framework and pervasion of technologies. Industry 5.0 will create new work positions marked by transformation in sense of the previous industrial revolution. Fifth industrial revolution will transfer production to the new level of speed and perfection. It will remove imperfections and inadequacies of fourth industrial revolution. Visionaries predict that businesses have already begun developing such systems in context of Industry 5.0 that are powered by renewable energy and eliminate impact on an environment. Attention focuses on ambience, ambient intelligence. Significant changes can be observed in digitalisation of business processes creating ambient business intelligence with focus on innovative pervasive technologies and integration of human factor.

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