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THE INTERPRETATION OF INDUSTRY 4.0 BY HUNGARIAN TECHNOLOGY-ORIENTED STARTUPS

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ABSTRACT

Technology-oriented startups are valued participants of the economy in the 21st century. By inventing and bringing new technologies to the market, this sector supports not only the growth of competitiveness in the corporate sector but that of the standard of living as well. These companies reinterpret the meaning of enterprise by building new functional business strategies, collaborations and business models. As of changing production sequences, conditions of business activity will change together. In the near future, not only the activity of organisations but of technology and business platforms, networks shall be controlled and developed along the value production chain. As attitude to customers will undergo serious changes, the meaning of team working will also be reinterpreted. The carrier of changes will be the Industry 4.0 framework. Due to this, information technology will not exclusively support business but establish new business value by utilizing companies' tools and resources. The aim of this paper is to present by a recent survey the attitude of Hungarian technology-oriented startups to the changing business environment in the era of Industry 4.0 which can already be observed in many sectors. The author of this paper believes that technology-oriented startups may take serious role in Europe to fight against low wage countries in the world.

Keywords: **Startups, Industry 4.0, Hungary, Business scaling.**

JEL Classification: **L16, L52, O14, O25.**

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1. Introduction

Industry 4.0 has been a system of approach influencing the development of the corporate sector for nearly a decade. While its significance is well known by most corporate managers, the effect on companies in different sectors shall be inevitably diverse. The phenomenon is especially important for technology-oriented startups (recently also referred to as early stage companies) since their development may result in positive effects in economy and in society. Before studying the effect of Industry 4.0 on early stage companies, we summarize how it is interpreted and perceived in the literature.

Industry 4.0 has been a phenomenon placing companies in the focus of the economy (Nagy 2017, Nagy 2019) as opposed to the 4th industrial revolution incorporating a wider effect and meaning. The 3rd industrial revolution unleashing the development of informatics and electronics industry in the 1970s as well as the "dotcom" crises at the end of the 1990s fueled by the spread of the internet has brought a fertile ground to the birth of new industries and technologies, finally resulting in the 4th industrial revolution and Industry 4.0 strategies of governments.

The rise of performance of traditional industries and rationalization of business processes are existing demands, the concept of Industry 4.0 is not restricted to production and connecting devices into networks (Hofmann and Rüsch, 2017). The internet has been a driving force of business processes, communication among people, machines is also not restricted to industrial digitalization (Brettel et al. 2014).

2. Industry 4.0 in the literature

The essence of Industry 4.0 is to integrate a company's capacities for value production along the entire value chain (Heynitz et al. 2016, Baldassarre et al. 2017). The aim of changes is interpreted as an effort for cooperation in operation and processing of huge quantities of data and information (Xie et al 2016) while the essence of Industry 4.0 is considered as real-time, intelligent, horizontal and vertical building of networks establishing the dynamic management of complex systems (Müller et al. 2017). According to Hermann, Industry 4.0 involves new technologies and concepts for the management of the value chain (Hermann et al 2016), however, it is considered as a wide and intensive use of information and communication technologies (Kovacs 2017a, Kovacs 2017b). An important antecedent for this had been the vanishing of border lines between informatics and telecommunication after the 3rd industrial revolution (Szalavetz 2016) which enabled the spread of communication technologies in the civil, business and government sector. These changes have changed the fundamental structure and operation of organizations and their

connection to other partners. Digitalization is so responsible for changes in companies' business models (Prause 2015), while Industry 4.0 will bring completely new economic models for the industry (Peressotti 2016: pp. 44).

Industry 4.0 initiates changes of how companies work (Porter et al. 2014). The use of smart components will bring a new "technology stack" and so the essence of operation can not be restricted to the process of production. The most important change is that former products will become physical components that will be extended by smart components (e.g. sensors, chips, data storage units, devices, embedded systems) and connectivity components (ports, antennae, protocols) (Porter et al. 2015). The "technology stack" established by these components will provide a gateway for data exchange between product and the user and integrates data from business systems, external sources, and other related products. This involves cloud services, security systems as well as enterprise resource planning systems.

The use of new data storage devices make companies transform the value production process inside the company. It is not the internet itself what makes smart connected products fundamentally different but the "changing nature of things" (Porter et al. 2014). This is meant by how the capacities and functions of these devices are extended and how data is collected. The spread of internet in the early 1990s was also revolutionary because it supported the crescendo of coordination and integration along the value chain geographically without changing the product. Current interpretation of Industry 4.0 will, however, make changes in the product in order to raise productivity.

The rich flow of data and information will be coupled with conscious communication along the value chain resulting in a value production by new functions and competencies. Flow of data will support monitoring during operation, detection of changes in environment, which allows companies to adapt to user's preferences establishing the real value. Customer value can take varies forms:

- First, it can be interpreted in stable operation, higher efficacy or forecast of relevant business information.
- Second, the flow of data vests participants with a control function. Value is transmitted to users by switching on/off of a function.
- Third, comprehensive gathering of data will raise performance, optimize operation in many dimensions.
- Finally, "monitoring, control and optimization capabilities combine to allow smart, connected products to achieve a previously unattainable level of autonomy" (Porter et al. 2014). This will support not only autonomous decisions, but self-diagnosis by intelligent behavior of hardware and software components.

2.1. The transformation of value production within companies

Before Industry 4.0, managers combined internally generated company data with consumer information. Non real time data collection was decentralized and used separately in ad-hoc ways without having sufficient information about the operation of the product (Porter et al. 2015). During the era of Industry 4.0 gathering of data occurs in real time followed by integration and analysis. The aims of harmonized operation are earmarked by descriptive analysis, diagnostics predictive analysis or prescriptive analysis. Becoming a focus in the operation by data, inter-organizational connections is changed. Former discrete management is replaced by mass management of data bringing value production in the focus from product development, sales and user experiences. This new attitude makes physical components of the product to be less important since value is not transmitted not by external characteristics. The carrier of value can also be a software embedded to the product which can be modified during the entire cycle of the product. Jeff Immelt, former CEO of General Electric said that "every industrial company will become a software company." This concept makes us rethink what a product will look like in physical terms, what components shall be produced internally or bought from a supplier and how to rebuild our internal data systems. Using and embedding of intelligent softwares is not a decision we can get around in the era of Industry 4.0.

These changes affect the learning process of organizations as well. Previously, knowledge was much more a result of individual learning having tighter connection to members of the organization. In the era of Industry 4.0, however, learning is performed within forms of networks and knowledge is usually shared by the members of the network (Szabó et al. 2019). The networking of learning process can be traced not only among affiliates and their headquarters but also among business organizations or inter-organizational units of different industries. This can help to dissolve lack of specific knowledge, reform the organization and achieve higher performance as well.

Changes are not only embodied in the appreciation of sales and market segmentation but in a deeper understanding of consumer's needs and satisfaction. Companies may get to know what functions they really appreciate, what they consider to be customer value and what other demands are not yet met yet by the product. Industry 4.0 is inevitably appreciating after sales activities of companies which puts again emphasis on the rich flow, integration and analysis of data. These changes will affect all fundamentals of companies, however, they had already been met by companies in the ICT sector years ago (Porter et al. 2015).

Table 1. The effect of Industry 4.0 on companies' operation

Type of changes	Content of changes
Shorter development cycles	Instead of periodic releases of new products, smaller changes in hardware and software components with upgrades and enhancements.
Product-as-a-service business models	Product based business models are replaced by service-based business models, turning the product into an operating, rather than capital, expense. Tracking the use becomes crucial.
Focus on customer success	By shifting to service-based business models, customers' high level of satisfaction must be maintained after sale as well.
Products part of broader systems	Successful products become part of a comprehensive system supporting for the quest of new functions, content and also new forms of collaborations in the ecosystem in order to create new uses for their products.
Analytics as a competitive advantage	Efficient marketing for customers becomes a strategic goal while border lines among industries are fading.

Source: Own work by Porter et al. 2015

At least 3 new types of inter-organizational units will be developed by companies in the era of Industry 4.0. Unified data organizations are supposed to serve security, authority and technology demands from other functional units. Development-operation units shall satisfy needs for targeted data processing while customer success management units integrating into companies' current working processes will achieve high level of customer satisfaction by the entire life cycle of the extended usage of the product.

The ownership of the huge amount of data established by parties along the value chain shall be clarified in legal terms. General standards clarifying all aspects will be born only on the long run, meanwhile terms of conditions regarding the exclusive or common usage of both public and private data shall be set before each sale.

2.2. Determinants of incentives for Industry 4.0

Industry 4.0 requires transformation and conformity of companies. Advanced technological solutions place customer value in the focus resulting in the amalgamation of different organizational structures by constant transformation and conformity[1]. Due to this, traditional company departments vanish, suppliers become strategic partners fading the lines between industries and companies. Cross-sectoral alliances will also become stronger which brings "hybrid" products to markets.

Signs of changes will first be perceived in industries with shorter investment cycles, high amount of investments in production units and rich flow and record of data regarding spare

[1] The process is explained by evolution and convergence by Heynitz et al. (2016)

parts for production. This is typical in automotive industry, medical device sector, housing industry, electronic industry, transportation and business logistics (PWC 2016).

Industry 4.0 approach goes far beyond cost reductions offered by automation and revenue growth potentials (PWC 2016). The essence of customer value production is not covered by the integration of algorithms and sensors but the digitalization and integration of vertical and horizontal value chains, service production, business models and the optimization of customer interactions. The rise of numbers of Industry 4.0 companies is to be expected in other business sectors as well as competition becomes stronger and lines between industries and companies are fading. The grasp of the Industry 4.0 approach namely requires strategic thinking and corporate responsibility. Most companies can define the starting point of Industry 4.0 according to their own business vision, roads to success are marked by decision on technology paths, conformity with technology trends which are little known in most industries. The breakthrough requires the following steps from the management of the company (PWC 2018a):

1. Establishing digital strategy of companies. Based on interviews with 1155 manufacturing executives in 26 countries, 2/3 of companies doesn't have a vision or strategy to support digital transformation and culture.
2. Revolutionizing the quality of operational decision making by artificial intelligence. Only 9% of total advanced companies of Industry 4.0 are using artificial intelligence.
3. Training of staff for the use of advanced technologies, e.g. managing, processing and analysing "big data". According to the survey, only 27% of employees have the required qualifications for the digital future – creativity and innovation, general curiosity, adaptive budgeting, rapid decision making and problem-solving orientation.

The pace of Industry 4.0 – thus, the transformation of companies, industries, products and services – will be globally different. Support of digital transformation, constant evaluation of mid-term facts are important preconditions for this (Adamik et al. 2018), however, the most important determinants will be the matching of new competitive advantages and individual competences for which currently applied techniques are not satisfactory[2]

2.3. The focus of early stage companies on Industry 4.0

Technology-oriented startups are important driving forces of innovation next to multinational companies with significant R&D capacities (Makra 2009, pp. 176). Their economic role can be interpreted in establishing new workplaces, accelerating innovation and technology and

[2] OECD Structural Business Statistics (ISIC Rev. 4) database reveal sectoral production, customer value generation and use of digital tools (OECD 2018a, OECD 2018b, OECD 2018c, OECD 2018d), however, these competitiveness indexes explain cross-sectoral effects only to some extent (Baldassare et al. 2017).

supporting economic growth and change of economic structures. The major competitive advantage of these companies is their innovation capacity that helps them develop and bring new products to markets. These companies are not creating homogenous groups together since usually they differ from one another in major characteristics as well. Transferring of knowledge and technology with partner organizations is a common feature for them (Makra 2009, pp. 178). Their role in employment is growing with time.

The reason why young technology companies play a key role in technological changes lies in the so-called creative destruction phenomenon. Concentrating on customers' demand that have not been satisfied or finding a "niche" role next to a market leading company makes them stay alive and spread the use of new technologies later on. The have a "provoking role" by developing new technological pathways and a "technology transfer role" by adjusting and bringing innovative technologies to customers. Both their existence and development are dependent in the conditions of the external ecosystem established by grant programs, closeness to universities, research institutes or incubators, ownership structure, and attitude, age and number of founders (Almus et al. 1999).

Early stage companies are transitory organization established to develop new reproducible scalable business models (Blank 2013). These companies have high growth and risk potential and ambiguous business targets: they incorporate a promise for huge returns while they are experimenting with new ideas, products, business models and markets (Government of Hungary 2016, pp. 22.). According to Vecsenyi (2011), startups are fragile micro enterprises whose founders have a vision for becoming a big company.

Technology oriented early stage companies are important participants of the Industry 4.0 ecosystem because of their orientation to technical and scientific achievements. Their operation has many similarities:

- founders have usually a strong vision for the future, e.g. for raising effectiveness of business operation, developing and introducing new business models, standards (PWC 2018b)
- these companies provide existing companies with new solutions and technologies
- they contribute however less to the integration of horizontal and vertical value chains opposed to traditional companies
- they are prone to adapt to existing customer standards as well as to change these habits fast and dramatically
- they are not selling final products which makes them uncertain to meet customers' satisfaction (Vecsenyi 2011)
- these ventures are forwarders of the transformation of existing economic arrays, termination and establishment of workplaces.

Ecosystems supporting technology oriented early stage companies are already receiving supports from the environment. By this, early stage companies' community have been vivid both in Western and Eastern Europe after 2015

A recent survey among 30 start-up executives in Belgium revealed that according to 57% of respondents, maturity of technology was key in launching their business while 27% of respondents said that they have started their businesses from a combination of a market need together with the inspiration that emerging technologies could potentially provide a better solution. Only 17% of them declared that an actual market need made them begin to search for the right technology to support the solution (PWC 2018b). 83% of respondents stated that their solution will improve overall operational performance of partner companies while 70% of them confirmed that their products will reduce operational costs. A report of the European Commission (2018) including 700 startups revealed however, that startups' financial performance does not improve over time (European Commission 2018, pp. 4.). Even if many startups are founded in the EU, international market penetration is low although 2/3 of them provide digital services.

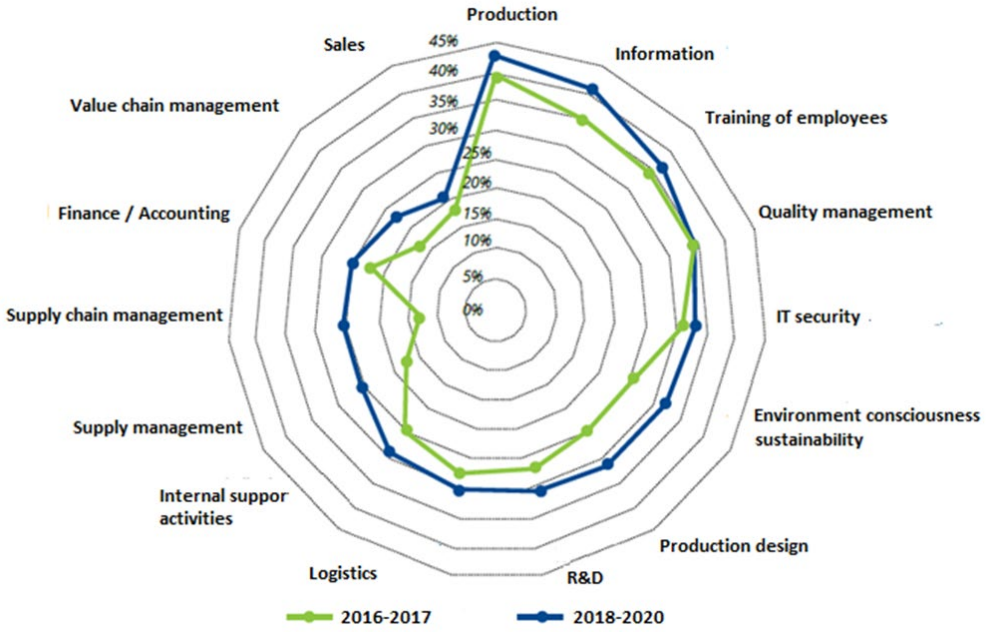
Horvath (2019 et. al) revealed in a recent paper that multinational companies have higher driving forces and lower barriers to Industry 4.0 than SMEs, however both sector face significant business potentials. It is however interesting that suppliers mostly highlight technological side, while users rather the management aspects of Industry 4.0. Resistance to changes may come not only from employees but from middle managers. Industry 4.0 means a lot more than simply a fear of losing jobs: it has an effect of disrupting the social environment of a company.

2.4. The Industry 4.0 in Hungary

A recent survey of the Institute for Computer Science and Control has revealed that Hungarian companies are facing an evolution of cloud based services. Unfortunately, companies use cloud services to data storage instead of data processing which is a significant soil of Industry 4.0 solutions. The survey has also revealed that companies are willing to invest significantly more in Industry 4.0 areas.

Most Industry 4.0 solutions are due to R&D collaborations between companies and academic research institutes. It is however regretful that more than 50% of Hungarian SMEs did not have any collaboration with universities in the last 5 years and 38% of companies declared to have one new collaboration in every year with a research institute. The study revealed that 44% of companies regularly share data with its suppliers and clients which is again a fertile soil for Industry 4.0 collaborations. The fact that 65% of companies use new data and information mainly to quality management, production

optimization and technology development suggests that Hungarian companies currently don't have an Industry 4.0 strategy. We argue that managers have a general interpretation about Industry 4.0, but they lack of high quality competencies to reorganize business.



Source: Computer Science and Control, 2017

Figure 1. Current trends in Industry 4.0 investments in Hungary

3. Target and methodology of the survey. Evaluation of Industry 4.0 by Hungarian early stage starts

Founder of early stage startups have usually a clear vision by knowing global trends, innovation in technology and science affecting their operational environment. Only few early stage startups operate currently in Hungary with short business record what makes comprehensive surveys to be hard. Changes regarding organization form, owners and business visions are common, however, this sector also does have similarities and differences in attitudes to environment like traditional companies. The starting-point of this research was initiated by the hypothesis that early stage startups have a general knowledge of Industry 4.0, however, determinants supporting and limiting Industry 4.0 perceived by this sector is not known yet opposed to traditional companies. There is little evidence in

literature (Bertelsmann Stiftung 2015) that Industry 4.0 requires companies to increase their size and optimize their operation what makes executives decide on new methods and techniques for scaling business processes.

To answer these questions, an anonym survey among founders of 10 Hungarian startups[3] having formerly received informal venture capital had been performed[4]. Among the responding companies, 3 companies have been operating in the ICT sector, 6 companies in health care and life sciences and 1 company in the biotech sector since 2017. Beside the startups, 10 SME company was also involved in the survey in order to analyse differences in attitudes regarding Industry 4.0[5]. Results of the survey is summarized in the next chapter.

4. Results. Similarities and differences in the interpretation of Industry 4.0 between early stage and traditional companies

The major obstacle of Industry 4.0 is capital intensive investments considered both by early stage and traditional companies. Executives of the latter, however, consider the immature style of Industry 4.0's system of target and tools to be also an important factor. Early stage companies' executives believe to more extent that Industry 4.0 will address companies' weak points more effectively. Early stage companies, however, argue that there is a lack of decent management skillsets and competences to perform these organizational changes. They also consider data security of new systems to be riskier.

Early stage companies expect significant transformation in business models and intra-organizational relationships by digitalization. Respondents have attributed high scores to value production by the use of 'smart' devices. Executives of traditional companies with business record considered transformation of business models to be much more important than that of early stage companies. Both respondent groups have evaluated the change of nature of intra-organizational relationships with high scores, however, it was scored lower by executives of traditional companies. Respondents have agreed to some extent that transformation of business models will result in new forms of revenues (e.g. royalty and license fees). A better solution of local social problems by Industry 4.0 is not expected by either respondent group.

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[3] The size of average informal venture capital investment fluctuated from HUF 30 million to HUF 200 million resulting in investors' equity share between 8% and 24%.

[4] Respondents were asked for a score on a scale from 1 to 10 whether they completely disagreed or completely agreed with the statement.

[5] The average business year of SMEs was 13.9 years. Among the responding companies, 2 companies have been operating in the ICT sector, 2 companies in health care and life sciences, 1 company in the biotech, 1 company in garbage recycling sector, 2 companies in industrial automatization, 1 company in financial services and 1 company in food supply sector. The annual turnover of 2017 fluctuated between HUF 73 million and HUF 1443 million.

Table 2. Major obstacles of introduction of Industry 4.0 solutions by companies

	Average score	
	Early stage companies	Traditional SMEs
Immature style of Industry 4.0's system of target and tools	6.6	7.2
Long term gains cannot be evaluated properly by companies as opposed to short term gains and business risks	6	6.7
Decent management skillsets and competencies are lacking to perform organizational changes within the organization	6.3	6.9
Decent management skillsets and competencies are lacking to perform organizational changes in the training and business consultancy sector	6	6.4
Lack of competitors' commitment on Industry 4.0 makes no constraint on the company to manage changes required	6.5	6.6
Introduction of Industry 4.0 reveals organizational weaknesses that makes managers feel unpleasant	6.9	5.7
Because of constant changes of markets, required comprehensive changes can be performed only slowly	5	5.9
The use of "smart" devices subject companies to security attacks (cyber-attacks, misuse of data, etc.)	6.2	5.4
Industry 4.0 requires capital intensive investments	7.4	8.0
Companies cannot sell extra amount of products produced by digitalization/automatization	5.2	4.2

Source: own survey

Table 3. The effect of digitalization on the operation of companies

	Average score	
	Early stage companies	Traditional SMEs
Business model of companies following a pathway for Industry 4.0 undergo major transformation in the next 5 years as opposed to companies not following the trends	8.9	8.8
Strategic goals of companies will become more clear and strong	5.9	6.9
Business models will undergo significant transformation	8.8	9.2
Intra-organizational relationships will improve significantly	9.6	8.4
The problem of lack of skilled work force will be solved	4.5	4.1
Companies will be able to choose their customers and suppliers more consciously	7.1	7.1
Administrative costs will decrease significantly raising competitiveness	8	6.7
Administrative costs will increase, extra administration will however increase efficiency in marketing and production	4.6	5.1
Short term financing of companies become safer opposed to other companies	5.4	4.3
Revenues from intellectual products (e.g. royalty and license fees) will increase significantly	6.5	5.6
Companies will perform better solutions to local social problems	6.1	4.0
Early stage companies will have better access to information, financial, human resources in order to compensate handicaps in competition	8.4	7.1
The use of 'smart' devices providing customer value by new products will spread	9.3	8.8

Source: own survey

Although Industry 4.0 will transform the operation of companies basically, none of the respondent groups gave definite answers whether this process will make corporate strategic goals to be stronger. It is now clear that the success of digitalization is dependent on the new cognitive skills, creativity and advanced social and emotional skills of employees (McKinsey 2018). New technologies will not cease but redefine scope of activities (Szalavetz 2016) and so creative tasks will be performed by well-trained employees. Executives of early stage companies see higher potential in reduction of administration than traditional companies' executives.

5. Business scaling from the viewpoint of early stage technology-oriented startups

Digitalization – offering possibilities for growth – also makes companies confront with serious challenges by the necessity of business scaling. Scaling incorporates all tasks and decisions to be performed by an organization in order to increase its size including the transformation of processes with employees, workplaces, customers, business turnover, costs, etc. without endangering the stability of the operation. Scaling of business is thus a crucial point setting possible successes by Industry 4.0. Transformation of processes are indispensables for a business success in all administrative functions of a company.

There are several well-known ways of supporting business scaling in organizations in international studies. Digitalization and Industry 4.0 requires companies to measure and analyse performance for each and every employee. Employees having worked in the same position formerly will have definitely different tasks in the future which calls for an elevation in motivation systems and redesign of functional links between operative and strategic levels of the company. Introduction of an Industry 4.0 approach will require constant external and internal trainings, consultations and the establishment of a supporting back-office system. Although many executives are aware of the advantages and challenges of Industry 4.0, little is known about how executives and founders see the business scaling in the early stage and traditional business sectors. The survey aimed to reveal the determinants for this.

Our survey revealed that there are significant differences in attitudes regarding the interpretation of Industry 4.0 between early stage and traditional companies. In case of the use of customized performance measurement systems we have experienced an unexpected contradiction which requires further investigation. The balanced scorecard approach – known as a means for establishing links between operative and strategic levels – received

lower scores by early stage companies which is probably explained by the smaller size of their organization enabling to perform operation by a simpler manner. Early stage companies put more emphasis on gaining new knowledge by networks of business partners, while traditional companies prefer internal trainings to it. A background for supporting management decisions has received very high scores from early stage companies which can be explained by several facts. First, early stage companies lack of well-functioning management or enterprise resource planning (ERP) systems so they perceive systems as a target of corporate development serving their needs for gathering and processing of data. Second, administrative service units had already been established in most traditional SMEs why they consider the development of these systems to be of less important. It is important to mention that traditional SMEs already use ERP systems, however, these systems can be used to support management decision making once they have been customized to the operation of the company.

Table 4. Determinants of business scaling by type of companies in Hungary

	Average score – early stage companies	Average score – traditional SMEs
Establishing new methods for measuring performance of individual employees	6	8.5
Operating a customized motivation system	8.7	7.9
Operating by balanced scorecard principles (BSC)	5.6	7.0
Targeted internal trainings	7.6	8.2
Targeted trainings by professional consultants	7.1	6.3
Establishing of collaborations or network of business partners	8	6.8
Introducing a back-office system to support management decisions	9.1	7.4

Source: own survey

6. Conclusions

Industry 4.0 will transform operation of both early stage and traditional companies. Our survey has revealed many similarities and differences how these group of companies approach the organizational effects of Industry 4.0. Similarities of opinions regarding trends and effects is very important for companies in different sectors to form new networks of collaboration in Industry 4.0 and development by sharing their knowledge. Our research has also revealed that enhancement of Industry 4.0 is also considered different in terms of the importance of organizational resources by companies in different sectors.

The effectiveness of business scaling performed by technology-oriented startups is currently not evaluated in Hungary. The changing business and technology environments induced by Industry 4.0 force these companies to exit to international niche markets (Kozma-Sass 2019). This requires a strong and deep cooperation among startups from other countries as well and change from personal scaling strategies to network connections. The author of this paper believes that international market activity of technology-oriented startups shall be interpreted together with Industry 4.0 strategic goals.

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