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The Constructionalisation of Intellectual Capital Based on the Industrial Revolution 4.0: A Meta-Analysis

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The industrial revolution 4.0 has fundamentally changed the way humans think, live, and relate to one another. This era will disrupt the various human activities in numerous fields; not only in the field of technology, but also in other fields such as economics, social, and politics. The development of the industrial revolution is also inseparable in constructing the human mindset. This also influences the development of intellectual capital owned by each organisation. Intellectual capital is an intangible asset related to the knowledge embedded in an organisation. The purpose of this study is to identify an intellectual capital construction based on the development of the current 4.0 industrial revolution era. This research uses a qualitative approach combined with research design in the form of a literature study and a narrative review meta-analysis method. This study concludes that the rapid development of science and technology has significant consequences for human life, including the construction of intellectual capital in the era of the industrial revolution 4.0.

Keywords: *Industrial revolution 4.0, Intellectual capital, Intellectual capital characteristic, Intellectual capital constructionalisation.*

Introduction

The world is currently facing a fourth industrial change, known as Industry 4.0. Based on the analysis of the McKinsey Global Institute, Industry 4.0 has a very large and broad impact, especially in the employment sector, where robots and machines will eliminate many jobs in the world (Liao et al., 2017a). For this reason, according to Maynard (2015), the era of the



industrial revolution must be responded to by industry players wisely and carefully. On the one hand, this industrial era, through connectivity and digitalisation, has been able to improve the manufacturing chain efficiency and product quality (Oesterreich et al., 2016). However, the industrial revolution 4.0 will also eliminate 800 million jobs throughout the world until 2030 because it is taken over by robots (Sommer, 2015). This could be a threat to Indonesia, as a country that has a workforce and high unemployment. For this reason, the government needs to address these changes appropriately through the formulation of strategies that can increase the competitiveness of national industries while also creating wider employment opportunities.

The era of the industrial revolution 4.0 was coloured by artificial intelligence, supercomputers, genetic engineering, nanotechnology, automatic cars, and innovation (Morrar et al., 2017). These changes occur at an exponential speed which will have an impact on the economy, industry, government, and politics. In this era, more and more visible forms of the world have become a global village. The industrial revolution 4.0 has fundamentally changed the way humans think, live, and relate to one another. This era will disrupt the various human activities in various fields, not only in the field of technology, but also in other fields such as economics, social, and politics. The industrial revolution 4.0 is a stage in the development of knowledge where the boundaries between the physical, digital, and biological world become increasingly obscure (Schwab, 2016).

The development of the industrial revolution is also inseparable in constructing the human mindset. This also influences the development of intellectual capital owned by each organisation. Intellectual capital is an intangible asset related to the knowledge embedded in an organisation (Sadalia et al., 2015). In the current era of the knowledge-based economy, intellectual capital has a very important role, namely as a value driver for an organisation (Dominici, et al., 2016). Intellectual capital is now an important research study in various disciplines. Felipe (2015) defined intellectual capital as all non-monetary and non-physical resources that are fully controlled by the organisation and that contribute to the creation of organisational value.

Intellectual capital is the main "weapon" of an organisation in accommodating organisational development in the era of the industrial revolution 4.0. The formation of intellectual capital within the scope of the organisation is inseparable from the character values instilled in employees while working. One of the problems faced by employees in the era of the industrial revolution 4.0 is that the character of employees is easily contaminated by the amount of information and issues that are obtained easily, quickly, at any time, and anywhere through various electronic devices. From the historical point of view of intellectual capital in Indonesia, indirectly intellectual capital has been alluded to in PSAK No. 19 (revised 2010) concerning intangible assets.



Intangible assets are defined as non-monetary assets that can be identified and do not have a physical form and are owned to be used in producing or delivering goods or services, leased to other parties, or for administrative purposes (Enrol et al., 2016). Malik (2019) stated that intellectual capital is elusive or difficult to understand, but when intellectual capital can be found and exploited, intellectual capital will become a new resource (asset) for organisations to be able to increase competitiveness. The purpose of this study is to identify an intellectual capital construction based on the development of the current 4.0 industrial revolution era.

Literatures

Industrial Revolution 4.0

Revolution is a social and cultural change that takes place quickly and involves the basis or main points of people's lives (Liao et al., 2017b). In a revolution, the changes that occur can be planned or unplanned, and can be carried out without violence or through violence (Almada- Lobo, 2016). Meanwhile, industry 4.0 is a term that was first coined in Germany, in 2011, which was marked by a digital revolution (Morrar et al., 2017). Industry 4.0 is a digitally connected industrial process that includes various types of technology, ranging from 3D printing to robotics, which is believed to be able to increase productivity (Ning et al., 2015).

Schumacher et al. (2016) stated that industry 4.0 itself is one of the implementation projects of the "German Modern Technology Strategy 2020". This strategy is implemented through improving manufacturing sector technology, creating a consistent strategic policy framework, and setting certain priorities in the face of global competition (Vasin et al., 2018). Schwab (2016), through the Fourth Industrial Revolution, stated that the world has experienced four stages of the revolution. First, the industrial revolution 1.0 occurred in the eighteenth century through the invention of steam engines, thus enabling goods to be mass produced. Second, the industrial revolution 2.0 occurred in the nineteenth and twentieth centuries through the use of electricity, which made production costs cheap. Third, the industrial revolution 3.0 occurred around the nineteen-seventies, through the use of computerisation. Fourth, the industrial revolution 4.0 itself took place around 2010, through intelligence engineering and the internet of things as the backbone of the movement and connectivity of humans and machines.

The Theories of Legitimacy and Stakeholder

Legitimacy theory encourages organisations to make voluntary disclosures as a form of accountability for social contracts held between the organisation and the surrounding community (Lazzarini, 2015). Ivanov (2017) explained that organisations tend to disclose



information through disclosure when a special need arises to increase their legitimacy. This need arises when the physical capital of the organisation, which is usually a symbol of success in the traditional economy, is not strong enough in giving the organisation a legitimate status (Obeidat et al., 2016). The status of strong organisational legitimacy also means the belief that the organisation operates by what is expected by stakeholders, namely operations that improve organisational performance (Mkumbuzi, 2015).

Stakeholder theory states that organisations are expected to carry out activities that are considered important by stakeholders and report back these activities to stakeholders (Peterlin et al., 2015). This theory states that all stakeholders have the right to be provided with information about the activities of organisations influencing them (for example, through pollution, sponsorships, and security initiatives), even when they choose not to use that information and even when they cannot directly play a role which is constructive in the survival of the organisation (Stonkiene et al., 2016).

In the context of explaining the concept of intellectual capital, the theory of legitimacy and stakeholders is seen from both its fields, both the ethical (moral) and managerial fields. The field of ethics argues that all stakeholders have the right to be treated fairly by the organisation, and managers must manage the organisation for the benefit of all stakeholders (Ivanov, 2017). When managers can manage the organisation to its full potential, especially in the effort to create value for an organisation, it means that managers have fulfilled the ethical aspects of this theory. From the managerial field, intellectual capital relates to value creation, which in this context, is to utilise all the potential possessed by the organisation: human capital, capital structure, and relational capital (Felipe, 2015).

Intellectual Capital

Intellectual capital is defined as a combination of intangible resources and organisational activities in changing the quantity of material, financial, and human resources in a system that can create value (Lanza et al., 2015). Heclau et al. (2016) stated that intellectual capital is the process of creating value for an organisation from various combinations of knowledge resources in the form of members, customers, processes, or technology. Not only that, intellectual capital refers to intangible or invisible capital related to human knowledge and experience and the technology used. Intellectual capital has the potential to advance organisations and society (Xie et al., 2016).

According to Neeliah et al. (2016), intellectual capital consists of three main components. First, human capital as a source of useful knowledge, skills, and competencies in an organisation. Human capital will increase if the organisation can use the knowledge possessed by members of its organisation. Second, structural capital is the ability of an



organisation to meet the organisation's routine processes and structures that support members' efforts to produce optimal intellectual performance and overall organisational performance. Third, relational capital is a component of intellectual capital that provides real value. This element is a harmonious relationship that is owned by the organisation with its partners, both from reliable and quality suppliers, from loyal customers and satisfied with the services of the organisation concerned, and derived from the organisation's relationship with the government and surrounding communities.

Method

Research Approach and Design

This study uses a qualitative approach combined with a research design in the form of a literature study and a meta-analysis method of narrative review. Meta-analysis is the most recent development technique to help researchers find consistency or inconsistencies in cross-checking results from similar research results.

Setting

A simple meta-analysis research can be described as an analysis of an analysis. In other words, in a meta-analysis, it can be carried out in many analyses of several research results on a chosen topic, comprehensively (Green, 2005). The instrument in this study used the human instrument. After the focus of the research becomes clear, according to King et al. (2006), a simple research instrument can be developed, which is expected to complement the data and compare data that has been found previously. The population in this study are all written documents regarding intellectual capital research and the industrial revolution 4.0.

Collection Data and Analysis Data

The data collection techniques will use documentation techniques taken by a convenience sampling of several international journal articles from 15 journals, as previous research samples. This is because the data or information to be obtained from the sample is determined based on its suitability with the theme of this study. The analysis of the data used is the analysis of quantitative data with percentages and analysis of qualitative data for the results of narrative studies (narrative review), of the studies found.



Result and Discussion

The Framework Identification of Intellectual Capital

Intellectual capital consists of three basic components, namely human capital, structural capital, and relational capital. Human capital is the amount of explicit knowledge. Human capital is a source of innovation and improvisation, but this component is difficult to measure and becomes a source of knowledge, such as skills and competencies in an organisation (Neeliah et al., 2016). Human capital describes an organisation in producing the best solutions based on the knowledge that the organisation has. Human capital will increase if an organisation can manage the capabilities of its members.

Structural capital is the ability of an organisation to produce optimal intellectual performance and overall organisational performance through ongoing organisational processes and structures which can support the efforts of its members (Liao et al., 2017a). This component is a collection of economic, political, and institutional relationships that are developed and enforced between academic, non-academic, profit organisations, non-profit organisations, local governments, and society in general (Lazzarini, 2015). Malik (2019) explained that the component of relational capital is a component which provides a real value. Relational capital shows the relationship of an organisation with its stakeholders and can be seen from various parts outside the environment that can add value to an organisation (Mkumbuzi, 2015).

Intellectual capital can be seen as knowledge in the formation, intellectual property, and experience that can be used to create wealth (Sadalia et al., 2015). Intellectual capital includes all the knowledge of members, organisations and their ability to create added value and lead to a sustainable competitive advantage. Vasin, et al. (2018) explained that intellectual capital has been identified as a set of intangibles (resources, abilities, and competencies) that drive organisational performance and value creation.

The intellectual capital dimension consists of knowledge related to members (human capital), knowledge related to customers (customer capital or relational capital), and knowledge related to the organisation (structural or organisational capital), that will form an intellectual capital for the organisation. Human capital can be categorised as personal attributes, including intelligence and skill or expertise. Some personal factors that are often researched are emotional stability, openness, experience, and understanding.

Ivanov et al. (2016) mention several studies on human capital related to personal factors in organisational behaviour. Structural capital contributes to human capital by transferring processes and knowledge through training, but all can run smoothly if the human factor or its



members are willing to learn new things. Customer capital or relational capital (external capital) is a network that is related to the organisation and is created by mutual understanding between consumer needs and producer consistency.

The Constructionalisation of Intellectual Capital Based on Industrial Revolution 4.0

The global economy is currently at the cusp of major changes that are proportional to the appearance of the first industrial revolution or the development of the production assembly, or even the discovery of microchips. Advances in technology have enabled automation to occur in almost all fields. Meanwhile, the ownership of smart devices in various parts of the world leads to an unimaginable level of interrelation with one another. Among the challenges facing the world today, perhaps the greatest is how to shape the Industrial Revolution 4.0, which began at the beginning of this century. Qin et al. (2016) state that the industry 4.0 is characterised by the emergence of functions of artificial intelligence, mobile supercomputing, intelligent robots, neuro-technological brain enhancements, big data that requires cybersecurity capabilities, biotechnology development, and genetic editing. This digital production network is decentralised, acts independently, and can control operations efficiently and respond to changes in the environment and strategic goals (Ivanov et al., 2016). The Industry 4.0 has created an unprecedented increase in routine task automation. Wherein, the important role of human capital and intellectual capital as the main foundation of an organisation in gaining a competitive advantage is due to changes in the environment that creates new challenges for organisations (Agoll, 2018, pp.41–58). There are eight competitive challenges faced by organisations in the present and the future, as follows:



Table 1: Competitive Challenges of Industrial Revolution 4.0

No.	Competitive Challenges	Information
1.	Globalisation of Globalisation	Globalisation is a state of diversity, ambiguity and complexity or unlimited unification of the world. In the context of this challenge, companies must be able to improve their ability to learn and work together, manage differences, ambiguity, and complexity. An important role in the function of global human resource management is the ability to increase adaptation and coordination. Consequently, a long-term strategy is needed in anticipating and responding to changes in the organisation to be more competitive.
2.	Competence and Intellectual Capital	Competence and intellectual capital require organisations to be required to obtain human resources who have expertise, perspectives and experience in managing global transformation.
3.	Profitability Through Cost and Growth	Every organisation is required to obtain profitability through efficiency or savings in production costs, human resource costs, and other expenses. On the other hand, to increase revenue growth by attracting consumers and always being innovative in creating new products.
4.	Technology	The existence of technology has resulted in a faster production process and a smaller world. This challenge requires managers to be able to make the technology offered easy to use and useful.
5.	Capability and Change	Focus on capability involves tangible capabilities, such as technology that is possessed and intangible, such as ability to change, be flexible, have self-confidence and achievement, motivation, etc.
6.	Value Chain for Business Competitiveness and Human Resource Service	Customer responsive value chain.
7.	Turnround Is Not Transformation	Transformation that emphasises fundamental change. These environmental changes require companies to always improve performance or productivity.

Source: Ulrich in Malik, 2019



Based on the table, it indicates that new technologies and approaches that combine the physical, digital, and biological world in a fundamental way will change humanity. There are many opinions that the health sector and biotechnology greatly benefit from this transformation, and the extent to which this transformation will have a positive impact depends on how we navigate the risks and opportunities that arise along the way (Liao, 2017a). Today, we are on the threshold of a technological revolution that will fundamentally change the way we live, work, and relate to one another (Lazzarini, 2015). In terms of scale, scope and complexity, the transformations that are happening are different from what humans have experienced before (Lanza et al., 2015).

Along with the development of life, science has also developed. Obeidat et al. (2016) states that the development of science, especially management, has brought a difference in offering solutions for organisations to achieve success through achieving a competitive advantage where intellectual capital itself is an interesting topic to be investigated, given its increasingly vital role in organisations today. According to the traditional view, assets that are valuable to organisations are in the form of physical assets such as land, labour, and capital, and these assets are considered as determinants of the organisation's financial performance. Organisations engaged in software, finance, pharmacy, and hospitality, rely heavily on intellectual capital for profit, while organisations engaged in production and manufacturing combine intellectual capital with physical assets to increase the competitive advantage of the organisation (Sadalia et al., 2015).

Intellectual capital which includes valuable organisational resources and capabilities that are difficult to replicate and are irreplaceable, can produce competitive advantages and superior performance compared to organisations that do not use it (Peterlin et al., 2015). The disclosure of intellectual capital is the provision of information about intellectual capital owned by an organisation, consisting of several parts: members, customers, information technology, processes, research and development, and the statement of strategy with the aim of increasing the internal effectiveness of the organisation's operations (Felipe, 2015). The disclosure of intellectual capital in a financial statement is a way to reveal that the report describes the activities of a credible, integrated, and "true and fair" organisation (Dominici, et al., 2016).

There are at least two types of competencies needed to be adaptive to changes in the era of industrial revolution 4.0. Namely, personal competencies and interpersonal competencies, as a form of construction of intellectual capital (Enrol et al., 2016). Furthermore, Enrol et al. (2016) explained that personal competencies can be seen as the ability to develop cognitive abilities and value systems that may be owned by someone. Meanwhile, interpersonal competencies are embedded in individuals as social creatures with their environment, where



there is the ability to communicate, work together and build social connections, and social structures with other individuals and groups.

At the organisational level, to be able to compete in a globalised world and be adaptive to changes in the industrial era 4.0, organisations must have intellectual capital capable of creating organisational values that contain at least four characteristics according to Malik (2019), including: First, valuable resources that enable organisations to implement strategies to improve efficiency and effectiveness. Second, scarce resources, where the organisation has resources that are not owned by other organisations and if the strategy is implemented, the organisation will gain a competitive advantage. Third, unique resources that are not easy to imitate (imperfectly imitable resources), so that other organisations that seek to imitate need to pay expensively. Fourth, is substitutability, where other organisations that do not have resources can imitate their effects by replacing them with resources.

Morrar et al. (2017) identified the challenges in Industry 4.0 as follows: 1.) information technology security issues; 2.) reliability and stability of production machines; 3.) lack of adequate skills; 4.) reluctance to change by stakeholders; and 5.) lost a lot of work because it turned into automation. More specifically, Heclau et al., (2016) explained the challenges of Industry 4.0 as follows:

Table 2: Challenges Constructionalisation of Intellectual Capital on Industrial Revolution 4.0

No.	Challenges Construction	Components	Information
1.	Economic Challenges	Continuing globalisation	Intercultural skills
			Language ability
			Time flexibility
			Network skills
			Understanding the process
		Increased need for innovation	Entrepreneurial thinking
			Creativity
			Solution to problem
			Work under pressure
			Current knowledge
			Technical skills
			Research skills
			Understanding the process



		Requests for higher service orientation	Conflict resolution Communication skills Ability to compromise Networking skills
		Growing the need for collaboration	Able to compromise and cooperate Ability to work in teams Communication skills Networking skills
2.	Technical Challenges	Technological development and exponential data usage	Technical skills Analytical ability Efficiency in working with data Coding skills The ability to understand IT security Obedience
		Grow collaborative work	Able to work in teams Virtual communication capabilities Media skills Understanding of IT security Ability to behave cooperatively
3.	Social Challenges	Changes in demographics and social values	The ability to transfer knowledge Acceptance of work task rotation and related work changes (tolerance for ambiguity) Time and place flexibility Leadership skills
		Increased virtual work	Time and place flexibility Technology skills Media skills Understanding of IT security
		Growth of process complexity	Technical skills Understanding the process Motivation to learn Tolerance of ambiguity Decision-making Problem solving Analytical skills
4.	Political and Rules Challenges	Standardisation	Technical skills Coding skills Understanding the process



		Data security and privacy	Understanding of technology security information
			Obedience
5.	Environmental Challenges	Climate change and scarcity of resources	Continuous mindset
			Motivation to protect the environment
			Creativity to develop new sustainability solutions

Source: Heclau, et al., 2016

In Industry 4.0, the successes and failures of most organisations are highly dependent on how they manage their intellectual capital, which is caused by the industrial revolution 4.0 providing space for human interaction with machines (Schumacher et al., 2016). According to Almada-Lobo (2016), the features of the industrial revolution 4.0 require workers who are not only creative and innovative, but also have the knowledge and technical abilities that are appropriate to the environment to build intellectual capital in human resources that are in line with current and future demands. Human resource competency identification is also needed, such as skills, knowledge, attitudes, and motivation.

In the industrial revolution 4.0, workers are also needed who are deeply rooted in human interaction with machines, technology interfaces, and have a good understanding of networking systems combined with intellectual capital. Furthermore, accompanied with human resource competencies with certain characteristics, it will, in turn, be able to create superior human resources, that are creative and innovative, as well as adaptive to change, so that they are able to compete globally in this Industry 4.0 era.

Conclusion

Based on the results of the research that has been described, it can be concluded that the rapid development of science and technology has significant consequences for human life, including the construction of intellectual capital in the era of the industrial revolution 4.0. Many conveniences and innovations are obtained with the support of digital technology. Services are faster and more efficient and have a wider range of connections with online systems. To face the challenges outlined above, now we need to find human resources that can compete in all multidimensional fields. The construction of intellectual capital in the Industrial 4.0 era is needed. In order to play this role, the researcher needs to examine various previous research journals, and then conclude the findings of the constructionalisation on the intellectual capital dimensions that are in accordance with the development of the industrial revolution era 4.0, as follows:

1. Structural capital in competitive organisational competence, in which the organisation's management, in taking human resource policies, must first understand the organisational



structure and know the financial capabilities before being able to calculate the costs and benefits for each alternative human resource policy, along with the consequences of the social and ethical impacts of its implementation.

2. Human capital on professional and technical knowledge, wherein the implementation of human resource management must be professional, have technical knowledge such as placement, member development, appreciation, organisational design, communication, and performance appraisal so that implementation is as expected.
3. Relational capital on the ability to manage change where organisational management must have the ability to manage change from diagnosing problems, implementing and evaluating changes and being able to improve the quality of human resources in accordance with the changes made.
4. Integration competence is a combination of human capital, structural capital, and relational capital, where organisational management must be able to integrate workforce competence to be able to work with quality, effectively and efficiently.



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