A Textual Thematic Analysis: Tools to Measure the Readiness of Industry towards the Disruption Era

Pijar Suciati[1], Mareta Maulidiyanti[1] and Sri Rahayu[2]
[1]*Public Relations Studies, Vocational Education Program, Universitas Indonesia, Depok, West Java, Indonesia*
[2]*Creative Advertising Studies, Vocational Education Program, Universitas Indonesia, Depok, West Java, Indonesia*

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Abstract: This study aims to examine the many tools of readiness measurement of the various Industry to face the disruption era the industry 4.0. In order to perform this research, a qualitative textual thematic analysis was used to discover the best-combined way to measure the readiness of the industries facing the era of Artificial Intelligence and robotics. Themes were found in analysis to show the comprehensive ways in which how to measure the readiness. The results of this research are the existing models at this time can be used to measure industry readiness in dealing with industry 4.0 depending on the tendency of the researcher (tangible, intangible, or combined). Besides, the results of this study can be opened up for other researchers to develop existing models by adding elements of the dimensions of "psychology" and "environment". The finding of this research shall provide input to industries and practitioners which tools to use to analyze their readiness so that they can prepare and improve their product and services, strategy and organization, and business model to face the revolutionary industry 4.0. Future studies are needed to elaborate on the result of this study into a broader scale.

1 INTRODUCTION

Technology can be defined as "the practical application of knowledge, especially in certain fields" (Merriam-Webster, 2017). Thus, technology shows the existence of specific knowledge, as well as the practical application of that knowledge. According to this point of view, technology is often seen as an illustration of science and everyday life (Bonciu, 2017). The developing technology forces people to follow developments that are very broad in all fields and affect their lives and human lifestyles.

One of the most revolutionary technologies in the history of human life is "the Internet". Transformation of the internet is becoming more complicated because it is developing from Web 1.0 to Web 4.0. Web 1.0 restricts users from only reading content from the web, while Web 2.0 allows users to contribute to the web by creating, storing and sharing content. Web 3.0 is even more advanced by using semantics, creating better communication between humans and machines. Web 3.0 moves from the connection between data and knowledge, using keywords and tags to connect based on natural language and intrinsic meaning. This development can improve information search and data sharing. Although Web 3.0 is still under development, the era of Web 4.0 has arrived. Web 4.0 brings connections to the web anytime and anywhere, personalized services through data usage and ongoing connections with other users (Boer, Ajam, Rompay, 2019). This complex and growing web-based technology create various conveniences. One of them is making companies more sophisticated, reliable, and able to improve services to their stakeholders (Amoroso & Hunsinger, 2009). Devices with sophisticated technology attract much attention and also researchers. People began to enjoy this World Wide Web technology since the late 1990s, and cloud computing began several years ago (Saariko, Westergren, Blomquist, 2017).

Unnoticed by many people, the 4.0 Industrial Revolution began to be present in our midst. Based on the World Economic Forum (WEF), industrial revolution 4.0, it is hyper automation and connectivity based on Artificial Intelligence (A.I.), big data, robots, and the Internet of Things (IoT). A.I., Big Data, and robotics can increase productivity and increase industrial production. Robots that use A.I. can make complicated decisions

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on their own like humans. Hyper automation and hyperconnectivity are increasing not only at the national level but also globally by using information and communication technology (ICT). IoT is the core technology for creating hyperconnectivity in the Cyber-Physical Systems (CPS) that connects technology, nature, and humans (Park, 2018).

At the WEF annual Davos meeting from 2016, the problem of the fourth industrial revolution and some aspects of this new phase or cycle of industrial progress were presented by different authors. According to WEF Chair Klaus Schwab, as the originator of the term and theme of the fourth industrial revolution in the Davos debate, the phase of industrial development begins now, and is "marked by the ubiquitous and cellular internet, censors that are smaller, stronger, and cheaper, with artificial intelligence and machine learning "we can see its evolution in the world with virtual and physical systems interrelated in the making, service, and other human activities (Prisecaru, 2016).

There are opinions similar to the definitions of WEF regarding the terms "Industry 4.0." and "Fourth Industrial Revolution" (FIR), public institutions (such as the German, US, Italian, French and Hollande governments), private institutions (Economic Forum World, Hedge Funds, commercial banks), from a variety of literature. Industry 4.0 refers to the incomplete transformation of the production of goods and services produced due to the adoption of a new wave of technological innovation: collaborative interconnected robots; machine learning; Artificial intelligence; 3D printers connected to digital development software; interconnected machine simulations; integration of information flows along the value chain; multi-directional communication between the manufacturing process and the product (Internet of Things) (Caruso, 2018).

In the last ten years, the Internet of Things (IoT) has influenced organizations and companies to carry out their daily activities. This is also influenced by what is called Smart City, when the goal of IoT is to exploit information and communication technology (ICT) and support value-added services for the population, giving companies more opportunities to innovate through the use of the latest technology. (Bresciani, Ferraris, Del, 2018). For some, IoT can be very profitable, but some others feel IoT shifts the role that was previously performed by humans. With modern and instant life and technology compilation making things faster, Internet-of-Things (IoT) is now more comfortable and more accessible, allowing companies to take advantage of IoT to improve their tourism results. IoT allows physical devices to connect and exchange data through the internet by gathering strategic information, thus creating opportunities for companies to be more efficient and responsive to market changes (Lo & Campos, 2018).

Another technology used in industry 4.0 is Artificial Intelligence (A.I.), which, according to some experts, discusses any device that solves its environment and takes actions that maximize the chances of success in several purposes. These technologies include machine learning, rule-based systems, supporting natural languages, and the introduction of acceptance. After completing the rise and fall in popularity, A.I. technology is now increasingly difficult to diffuse. In the emergence of the concept of web 3.0, Internet of Things (IoT), open innovation, and large and open data, A.I. has gained momentum as a series of technologies collected in many fields of Industry, such as finance, automotive, retail, travel and media (Qian & Medaglia, 2018). This disruptive era affected the existing Industry, various industries, as mentioned earlier, they must be able to keep up with the technological developments so as not to lag behind the times. Business organizations continue to look for ways to benefit from their competitors. Most companies focus on producing as much as possible without considering the right request. Recently, businesses have begun to find more efficient ways to deal with significant turnover (Erasmus, Rothman, Eeden, 2011), namely with the technology and automation offered by the era of the disruption.

Because various industries have successfully adapted automation, government institutions have also begun to adopt various Artificial Intelligence (A.I.) technologies in various domains (e.g. Health, taxation and education); However, extensive research is needed to exploit the full potential of A.I. in the public sector and utilize various A.I. technologies to address significant problems and needs. There has been a new approach, as well as an ICT platform architecture that supports it, for the continued exploitation of certain A.I. technologies, namely chatbots, in the public sector to address critical issues: increasing communication between government and citizens (who have long been in trouble) (Androutsopoulou, Karacapilidis, Loukis, Charalabidis, 2018).

Many researchers have accepted this fact in various ways. At present, starting to become unnecessary, especially on raising awareness about what is the 4.0 trend. This trend, at some point, has been advancing rapidly in many companies, and

furthermore, the dynamics are consistent with the current high rate of change. Meanwhile, not only in technological change; they incorporate further changes, e.g., on demographics and climate. Today's question is how quickly trend 4.0 will penetrate into the daily lives of companies - and into society as a whole. Various readiness indices and maturity models can help companies to make easier, faster decisions about how they should build Industry 4.0, and at what time. Both of these shows not only the position of the company but also the position of its competitors. At present, attention is shifting to tasks related to implementing the changes needed and determining expectations in addition to the benefits associated with their deployment. For example, achieving the highest possible flexibility and increasing the availability of products and services, together with further cost reductions, decreased resource consumption, and reduced environmental impact, etc. (Basl & Petr, 2019).

The purpose of this research is to analyze and summarize the readiness index and maturity model, compare their essential characteristics, and integrate them into their groups. These groups set the selected maturity model and relative readiness index to each other, then simultaneously identify areas where there is potential for the basic model in further research. Finally, the proposed themed group is an essential guideline for the development of further analysis from fields such as psychological and environmental that are predicted to play a significant role in the level of company preparedness.

2 LITERATURE REVIEW

2.1 Industry 4.0

Hannover Expo 2011 is a new era for the German Industry because of the debut of Industry 4.0. The concept of smart factories in the future will produce smart products for the global market. Deeper horizontal and vertical integration will result from each member of the value chain, while collaboration will move to a service-based model. The physical and virtual world produces products that become intelligent and will control production. Personalization of specially made products will be produced using sophisticated mass production technology (Pongrácz, 2016).

Industry 4.0 concept has a characteristic as a fully automatic and optimal transformation of production and manufacturing environment. Production processes vertically and horizontally in the company system. Sensors, machines, and I.T. systems are interrelated in the value chain across corporate boundaries. For this purpose, the Cyber-Physical System (CPS) is the foundation for smart factories. New smart factories are still operating in a geographical environment, and the performance of these production units is related to the condition of the community and the region where they are located. Collaboration between Industry, University and Local Government is essential because human factors become essential in innovation to enter the global competition (Basl & Kopp, 2017).

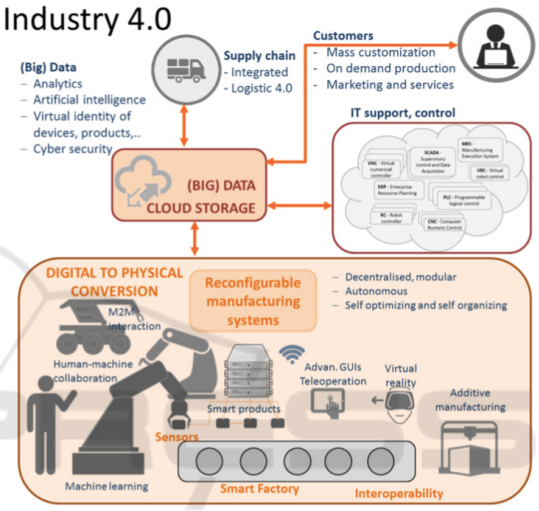

Figure 1: Industry 4.0 Smart Factory [16]

Figure 1 describes the process of how the smart factory is running. It started from big data that is converted into physical activities through the I.T. support and control. In developed countries, Industry 4.0 has been a particular concern for the past few years. In these countries, national initiatives, projects or institutions related to Industry 4.0 are being prepared or supported. For example, Germany offers a strategic initiative "Industrie 4.0". France, the "Industrie du Futur" project is being developed. Apart from a country, this trend is increasingly in demand by businesses. (Basl & Kopp, 2017).

Looking at the current condition of Industry 4.0, it is essential to know the prerequisites that must be met so that new concepts can be introduced in industrial manufacturing systems. At least the following things must be fulfilled:

1. Production stability must be guaranteed during the transition phase.
2. A gradual investment must be carried out because most industrial processes cannot bear a significant investment once.

3. Excellent protection is needed. Related to cybersecurity issues (Rojko, 2017)

The modern concept is not limited to production systems but also includes a complete chain (from suppliers to customers) and all company functions and services. It is not easy to fulfil this criterion because only a few 'concepts' of the Industry 4.0 concept can currently be applied.

2.2 Technology Maturity Index

In general, the term "maturity" refers to a "state of being complete, perfect, or ready" (The Oxford English dictionary, 1989) and implies some progress in the development of a system. Accordingly, maturing systems (e.g. biological, organizational or technological) increase their capabilities over time regarding the achievement of some desirable future state. Maturity can be captured qualitatively or quantitatively discretely or continuously (Kohlegger, Maier, Thalmann, 2009).

A maturity model is used as an instrument to conceptualize and measure the maturity of the organization or process in specific target countries. Then what is labelled synonymously is the readiness model to capture the starting point and make it possible to initialize the development process. Understanding the difference between readiness and maturity in terms of assessing readiness occurs before engaging in the maturity process. In contrast, the maturity assessment aims to capture the circumstances that occur during the maturity process, for example in energy and utility management (Ngai, Chau, Poon, To, 2013), in the field of manufacturing environmental design or lean manufacturing (Pigosso, Rozenfeld, McAloone, 2013).

In evaluating at the company level, as in individual companies, the situation is different from at the "macro" level. There is no comparison of the large number of companies involved, but regular evaluations and self-evaluations to determine the stage of the company's maturity. This causes the maturity model to dominate at this micro-level (in contrast to the macro level, where the readiness index dominates).

2.3 Readiness Index

Company will always be in a particular environment, which requires digitalization and the ability to innovate. Therefore, we can see company evaluations not only from a "micro" perspective but also from the perspective of a broader context. One of these is the individual dimension of the German RAMI 4.0 reference model for Industry 4.0, which is often mentioned by many researchers, also containing this link in itself (Studie Industrie 4.0, 2014, CSC-Stuie, Industrie 4.0, 2015). Within this "macro" view, we are viewing the whole of society or individual nations. Multiple significant readiness indexes have long existed in this respect, such as:

1. NRI (Networked Readiness Index) (BCG, 2016);
2. GII (Global Innovation Index) (Wang, Towara, Anderl, 2017);
3. GCI (Global Competitiveness Index) (Suri, Cadavid, Alferez, Dhouib, Tucci-Piergiovanni, 2018).
   And further
4. OECD scoreboard (Global Information Technology Report, 2016).
   For direct evaluations of Industry 4.0, meanwhile, this concerns:
5. The Industry 4.0 Readiness Index from Roland Berger (Dutta, Lanvin, Wunsch-Vincent, 2018).

Industry 4.0 assessment readiness at the company level is based on an independent assessment. Information is collected through internet surveys or telephone interviews. The initial survey, targeting general information about awareness, perceptions, attitudes, etc. Some of them sought more detailed information about the company, manufacturing (such as decision-making processes, smart manufacturing technology, data security) and branch-specific data (Schwab, 2018). A similar approach is also observed internationally, (OECD Science, Technology and Industry Scoreboard 2017) for the DACH region (Germany, Austria, Switzerland), and at the global level provides more descriptive information about the phenomenon (Siepen, 2015).

3 METHODOLOGY

In order to perform this research, qualitative textual thematic analysis is used to find the best-combined way to measure the readiness of the Industry is facing the era of Artificial Intelligence and robotics. After the analysis is done, the theme will be found to show the exact way in which to measure readiness. The combination method used can produce a full understanding of this topic. Starting with textual

analysis to establish a basic framework than the thematic analysis that then occurs

3.1 Textual Analysis

Textual analysis is used for content analysis because nothing can be measured. I need to see the big picture to get started. The textual analysis allows texts to be separated and then linked together (Berger, 1995). Because quantitative content analysis does not occur, this can be seen as qualitative content analysis, to some extent, namely coding. There are no statistical tests on the data carried out. The texts are seen as a whole and permitted for more precious comparisons between them (Berger, 1995).

These journals are analyzed according to their content and meaning, not their structure (Fairclough, 1992). For this study, the way journals present texts are not as important as what they say in them. The textual analysis allows researchers to examine how words are presented to the reader. Prior (2004) states that before the research begins, the angle of the text to be analyzed must be decided. For this research, the text is examined in a way to measure the readiness of the Industry to face the industrial era 4.0 (Prior, 2004). The textual analysis in this research is based on ten published research papers by a range of 5 years (2015 – 2019).

3.2 Thematic Analysis

The thematic analysis was performed after the textual analysis in 10 research journals about the Industry's readiness to face the Industry 4.0 era that using different measurement index in the range five years (2015-2019), they are:

1. A Maturity Model for Assessing Industry 4.0 Readiness and Maturity of Manufacturing Enterprises by Andreas Schumacher, Et. al (2016)
2. How to Measure Industry 4.0 Readiness of Cities by G. Nick, F. Pongrácz (2016)
3. Study of the Readiness of Czech Companies to the Industry 4.0 by Jakub Kopp, Josef Basl (2017)
4. Assessing Industry 4.0 Readiness of Enterprises by Zoltán Rajnai, István Kocsis (2018)
5. Companies on the Way to Industry 4.0 and Their Readiness by Josef Basl (2018)
6. Industry 4.0 – Are we ready? by Ślusarczyk B. (2018)
7. Rapidly Arriving Futures: Future Readiness for Industry 4.0 by A.P. Botha (2018)
8. A Metamodel for Evaluating Enterprises Readiness in the Context of Industry 4.0 by Josef Basl and Petr Doucek (2019)
9. Assessing Industry 4.0 Readiness in Manufacturing: Evidence for the European Union by Isabel Castelo-Branco, Et. al. (2019)
10. Industry 4.0 Readiness in manufacturing Companies: Challenges and Enablers Towards Increased Digitalization Carla Gonçalves Machado, Et. al. (2019)

These themes were extracted from the initial analysis. "Thematic analysis is the search for themes that emerge as important for the description of phenomena" (Fereday, Muir-Cochran, 2006, p. 3). The phenomenon encountered in this study is the dimensions and indicators that measure the readiness of new technologies to come. When conducting a thematic analysis, the researcher will read and reread the text carefully; it is essential to reveal the patterns contained in the data. This enables the emergence of appropriate analytical categories. For this study, the researcher categorized into three categories: 1) Dimensions, 2) Sub Dimension, 3) Leveling (Fereday, Muir- Cochran, 2006).

After the content is separated into several categories, the data must be combined and used to fit the sub-theme. Then from the results of the discussion, these themes will be justified from the researchers' perspective to give the reader a better understanding of what is pulled from the data that is considered necessary. All of this lead to how viral marketing is being used for cyber marketing and public relations, which was the ultimate goal (Arson, 1994). In this research, the theme is decided into 4, they are; 1) Tangible Area Domination Models, 2) Intangible Area Domination Models, 3) Combined Area Domination Models, 4) Complete Component Models.

3.3 Limitations

The weakness of textual and thematic analysis is its subjective nature. Because texts can carry many meanings, different people can interpret information in different ways. It is recognized that qualitative research cannot be generalized, and this applies to this research. For preliminary work in this field, this is acceptable. This is the beginning of future research dealing with the readiness of the Industry to face industry 4.0 (Stacks, 2002).

3.4 Analysis

The guidelines established by the coding sheet guide the researcher was putting the article into categories according to the topic. Unlike content analysis, there is no sum in trend grouping. Articles are read in a way that looks for where the data is in a predefined category. By separating articles into trends, thematic analysis is then produced. The thematic analysis looks at each broad category defined by textual analysis, then draws on more specific themes. Themes will give a better picture of what happens to readiness measurements. Propositions that are guided by analysis and repeatedly referred to ensure that the theory is related to what is being discussed. The theory is the framework for this entire thesis, which will show the importance of this research in an academic and practical perspective.

4 RESULTS AND CONCLUSIONS

From the thematic textual analysis, it can be concluded that from the 11 existing models all can be used to assess industry readiness in a predominantly substantive area, namely around products, technology, skills, data, and corporate strategy in dealing with 4.0. There is a model that is unexpectedly dominated by assessments of intangible areas such as value/culture, social, behaviour, events, etc. If further research wants a balanced combination of tangible and intangible areas, a model can be used:

1. Metamodel for Evaluating Enterprises Readiness Within Industry 4.0 (Josef Basl and Petr Doucek, 2019)
2. Industry 4.0 Maturity Model of Manufacturing Enterprises (Andreas Schumachera, Selim Erol, Wilfried Sihn, 2016)
3. Roland Berger Industry 4.0 Readiness Index (Roland Berger, 2016)

For researchers who want to use a mature and complete model (dimensions, sub-dimensions, and level indexes) can use the following model:

1. Roland Berger Industry 4.0 Readiness Index (Roland Berger, 2016)
2. Industry 4.0 Maturity Model of Manufacturing Enterprises (Andreas Schumachera, Selim Erol, Wilfried Sihn, 2016)
3. The Forrester Digital Maturity Model (Martin Gill and Shar VanBoskirk, 2016)
4. Future Readiness Index for Industry 4.0 (A.P. Botha, 2018)

Table 1: The Thematic Results Table

	Tangible Area Domination Models	Intagible Area Domination Models	Combined Area Domination Models	Complete Component Models
Industry 4.0 Readiness Models	Industri 4.0 Readiness Model of The IMPULS Foundation of VDMA (Association for Mechanical Engineering, and Informations Technology, 2015)	Future Readiness Index for Industry 4.0 (A.P. Botha, 2018)	Metamodel for Evaluating Enterprises Readiness Within Industry 4.0 (Josef Basl and Petr Doucek, 2019)	Roland Berger Industry 4.0 Readiness Index (Roland Berger, 2016)
	Smart Collaboration Index (G. Nick, F. Pongrácz, 2016)		Industry 4.0 Maturity Model of Manufacturing Enterprises (Andreas Schumachera, Selim Erol, Wilfried Sihn, 2016)	Industry 4.0 Maturity Model of Manufacturing Enterprises (Andreas Schumachera, Selim Erol, Wilfried Sihn, 2016)
	PwC Industry 4.0 Survey of 2016		Roland Berger Industry 4.0 Readiness Index (Roland Berger, 2016)	The Forrester Digital Maturity Model (Martin Gill and Shar VanBoskirk, 2016)
	The Forrester Digital Maturity Model (Martin Gill and Shar VanBoskirk, 2016)			Future Readiness Index for Industry 4.0 (A.P. Botha, 2018)
	Readiness of Czech Companies to The Industry 4.0 (Jakub Kopp, Josef Basl, 2017)			
	Industry 4.0 Readiness Online Self-Check for Businesses, developed by IW Consult and FIR at RWTH Aachen University (Carla Gonçalves Machadoa, Mats Winrothu, Dan Carlssonb, Peter Almström, Victor Centerholtb, and Maln Hallin, 2019)			
	The Questionaire ICT Usage and E-Commerce in Enterprises Statistical Classification of economics activities in the European Community (NACE) (Isabel Castelo-Branco, Frederico Cruz-Jesus, Tiago Oliveira, 2019)			

Researchers' findings in the following textual analysis are; no dimensions or sub-dimensions have been found that assess and measure the psychological and mental readiness of workers and professionals who will face the era of disruptive industry 4.0. Measurements made are about skills and abilities in managing, operating, and adapting to technology 4.0. Also, from the existing model, no one mentioned the readiness of the Industry in terms of the environment. Green I.T. is becoming a hot topic in the world, and it would be nice if the measurement model of Industry 4.0 readiness also reviews and measure the environment (recycled tech waste, green office, etc.).

The conclusion is the existing models at this time can be used to measure industry readiness in dealing with industry 4.0 depending on the tendency of the researcher (tangible, intangible, or combined). Researchers and industry players can choose models that suit their needs. In addition, the results of this study can be opened up for other researchers to develop existing models by adding elements of the dimensions of "psychology" and "environment".

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