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Industrial Revolution 4.0 Technology Application Capability: A Portrait of Higher Education Institutions' Readiness in West Java Province, Indonesia

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***Abstract*—The digital industrial revolution 4.0 refers to the development of information technology that is disruptive to the way of how organizations operate. This study aims to examine the extent to which universities in West Java - Indonesia are preparing themselves to face the digital industrial revolution 4.0. The readiness of the higher education institutions is reviewed from the aspects of lecturers, study programs, and curriculum. The survey instrument was developed from literature which discussed the topic of Industrial Revolution 4.0 technology on education and business. The snowballing method and an online survey using the Google form were used as the sampling method, form was distributed via WhatsApp groups and as many as 386 respondents were received. The results of the study show that lecturers are aware of the effect of RI 4.0 on education in study programs, but the majority of lecturers have not integrated the Industrial revolution 4.0 material into the curriculum or courses of their study programs. This study has implications for preparing strategies that must be followed by stakeholders so that study programs and graduates remain relevant to business and industry.**

Keywords— Technology, Industrial Revolution 4.0, Higher Education Institutions

I. INTRODUCTION

The industrial revolution (IR) 4.0 is taking place rapidly and has a broad impact on all processes within the organization [1]. IR 4.0 technology is dramatically changing the way organizations run their business and impacting all types of industries and jobs [2]. Organizations in almost all industries are now implementing artificial intelligence (AI) solutions to solve a variety of cases, from maintenance of industrial assets to machine learning for various tasks [3]. As cyber-physical systems become more integrated into business, the involvement of AI in all lines of business, hence the required skills by employees will definitely change and cause companies to change their job qualifications.

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For context in Indonesia, the application of information technology is also growing rapidly. Industry growth in Indonesia is being driven by use of digital business processes, which involve many 4.0 technologies such as cloud-computing, artificial intelligence, data analytics, and blockchain [4]. Indonesia also targets to become the largest digital economy in Southeast Asia. International Data Corporation (IDC) of Indonesia reports that there has been a trend of increasing investment in recent years in the latest technologies such as cloud, data analytics, and data center management, and predicts that information technology trends will have an impact on the digital transformation of companies in Indonesia [5]. The Ministry of Industry of the Republic of Indonesia in 2018 has also compiled a road map "Making Indonesia 4.0" in which Industry 4.0 technology is expected to increase the competitiveness of Indonesian industry so that Indonesia can become the top 10 of world economic powers based on GDP in 2030 [6].

The seriousness of the Indonesian's government in facing digital transformation must also be aligned with the readiness of higher education institutions to produce the graduates which are required in the digital era. Higher education institution in Indonesia must strive to prepare students to compete in the employment market. To keep up with the times, the old educational paradigm must be reviewed. It is very important to adjust the education system to become education 4.0 which is in accordance with the development needs of the new society [7]. Education 4.0 is a learning approach associated with the fourth industrial revolution that aims to transform education in the future through cutting-edge technology and automation [8]. Smart technology, artificial intelligence, and robotics are part of the industrial revolution 4.0 and are greatly affecting the daily life of the business and the industrial world [9]. Therefore, if higher education institutions crave in producing graduates that match industry needs, then then institutions must prepare their graduates to face a world where cyber-physical systems are everywhere.

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Institutions must integrate their teaching and operations with technological advancement to prepare future graduates.

Education 4.0 emphasizes adapting to change, thus for institutions of higher learning, it involves determining what future graduates will require [8]. Graduates ought to be able to grasp the competencies needed by quickly evolving technologies. The education system must be able to keep up with business and this requires changes in the learning process. Learnings must combine artificial intelligence and machine learning so as to keep students up to date with the demands of the industrial revolution 4.0 [7].

The main problem of this study is the question of the readiness of tertiary institutions from the aspects of lecturers, study programs and curriculum in preparing graduates who are competitive according to development needs in the Republic of Indonesia 4.0 era. To understand the extent to which study programs have anticipated the potential impact of the Industrial Revolution 4.0, this study aims to examine the extent to which universities in West Java - Indonesia have prepared themselves to face the digital industrial revolution 4.0. The readiness of higher education institutions is reviewed from the aspects of lecturers, study programs, and curriculum. It is important to conduct this study as it provides a portrait of the readiness of higher education institutions in Indonesia at this time, and serves as a basis for giving the best for the future of education in Indonesia, especially for future graduates. This study is very important because it can further reflect the future of higher education in Indonesia, the future of graduates and the future of all those involved in higher education. This study has implications for preparing strategies that must be followed by stakeholders so that study programs and graduates remain relevant to the world of business.

II. Industrial Revolution 4.0 Technology

The Industrial Revolution 4.0 refers to technological developments from the previous industrial era which began using mechanical production of water and steam (RI 1.0), then technological developments using electric powered assembly lines and mass production (RI 2.0), then developing in automation, computers, and electronics (RI 3.0) and today developing technology leads to cyber physical systems, internet of things and smart technologies (RI 4.0) [13]. Technological developments in the RI 4.0 era are disruptive, changing the way organizations do business and greatly impacting all aspects of human life [12].

There are various opinions regarding the technology that is included in the IR 4.0 technology category. Reference [2] stated that IoT, big data, artificial intelligence, and 3D printing are technologies that are included in the context of IR 4.0. Reference [1] created four groups of IR 4.0 technology, namely data, computing power and connectivity; analytics and intelligence; human-machine interaction and advanced production methods. Of the various IR 4.0 technology, the following is an explanation of some of the most frequently mentioned IR 4.0 technology in various literatures that discuss the topic of Industrial Revolution (IR) 4.0 technology for education and business, namely the Internet of Things, data analytics, business process automation, artificial intelligence, and cloud computing.

Internet of Things is all the things that are connected to the internet network and when a product or service is connected to the internet, it will change many things the way companies operate. Data Analytics refers to extracting raw data using specialized computing systems that transform, organize, and design data to draw conclusions and identify patterns. Data analytics enables management to make decisions based on data and would drastically change the way organizations manage their business eventually [10]. Business process automation (BPA) refers to the software that is used to automate business processes in organizations and its capabilities will increase along with the development of artificial intelligence [11]. Artificial intelligence refers to the techniques used to develop computer-based systems that could act like humans in terms of analytical and decision-making abilities [12]. Cloud computing is defined as a model that enables ubiquitous, easy-to-use and demand-based self-service network access to a shared pool of configurable computing resources (e.g. servers, networks, applications) that are made available quickly with minimal management effort [13].

III. Results and Discussions

A. Respondents Demographic Aspects

Data was collected by distributing online questionnaires from February to March 2023. A total of 386 lecturers from various universities in West Java, Indonesia gave comments on the extent to which higher education institutions in Indonesia have prepared themselves to face the digital industrial revolution 4.0. In terms of gender, a fairly balanced number was obtained, namely 55.05% female respondents and 44.95% male respondents. In terms of age, the majority of respondents were in the age range of 30 – 50 years, namely 58.8%, followed by a balanced number for the age range of under 30 years and over 60 years, namely 20.3% and 20.9% respectively.

From the level of education, the majority of respondents had Master's degree, namely 62.4%, followed by 35.85% had Doctoral degree, and the remaining 1.75% had Bachelor's degree. Regarding teaching experience, 65.3% of respondents have had teaching experience of more than 10 years. In terms of positions in the institutions, the majority of respondents are lecturers, namely 78.15%, and the rest are managers in study programs and faculties, namely 21.85%.

Looking at the institutional background, as much as 68% of the respondents came from private universities, and 32% came from state universities. The source of the respondents' institutions was spread across six major cities in West Java, namely Bekasi (12.3%), Bandung (46.2%), Depok (15.3%), Bogor (11.7%), Tasikmalaya (7.53%), and Cirebon (6.97%).

There were 11 programs study from the 386 respondents, namely Management (21.24%), Accounting (19.6%), Informatics Engineering (10.8%), Industrial Engineering (10.6%), Information Systems (8.29%), Law (7.25%), Psychology (6.99%), Computer Systems (5.18%), Civil Engineering (3.88%), Electrical Engineering (3.10%), Medicine (3.07%).

B. Readiness of Higher Education Institutions Viewed from the Lecturers Aspects

The following is the lecturer's response about the extent to which higher education institutions in Indonesia have

prepared themselves to face the digital industrial revolution 4.0 shows in Fig. 1.

Of the 386 lecturers who were the respondents in this survey, it is found that 46.45% of the lecturers have the knowledge and 8.10% of the lecturers are very knowledgeable about the digital industrial revolution 4.0. This finding is quite delightful considering that lecturers play a very important role in ensuring that the study program curriculum is relevant to the needs of the industrial world which is entering the industrial revolution 4.0. The results also show that there are 12.2% of lecturers who are not knowledgeable or even very ignorant about the industrial revolution 4.0. This fact is of course very worrying considering that technological change is rapid and demands a fast response from lecturers as one of the spearheads in preparing graduates who are in accordance with the demands of the industrial revolution 4.0.

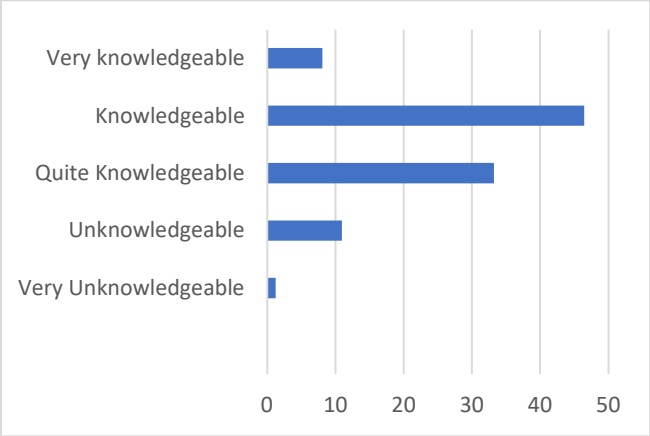

Fig. 1. Level of Knowledge of the Industrial Revolution 4.0 (Percentage of Total Respondents)

Respondents were also requested to provide feedback about the effect of the industrial revolution 4.0 on study programs and curriculum shows in Fig. 2. The majority of respondents (77.95%) thought that the industrial revolution 4.0 has an effect on the study program/curriculum. Though it's unfortunate as there are still a number of 6.1% of respondents who think that the industrial revolution 4.0 has no effect on the study program / curriculum. The big impact of the industrial revolution on all business processes within companies certainly affected the way organizations operate and eventually the way human resources in managing the companies. Therefore, it is the responsibility of the study program to produce graduates that are aligned with industry needs, which is reflected in the study program curriculum.

Fig. 3 shows the results of the responses to the question "I am able to integrate industrial revolution 4.0 technology in courses". More than half of the respondents, namely 52.55%, responded agree and strongly agree, while 13.2% of respondents answered that they disagreed and strongly disagreed. This result needs to be an important concern for study programs, especially lecturers who were unable to integrate industrial revolution 4.0 technology in their courses.

Respondents were also requested to provide feedback to the question "I am able to prepare graduates who can utilize the digital industrial revolution 4.0 technology effectively, understand its capabilities, impacts, risks and opportunities". Fig. 4 shows that as many as 53.55% of respondents responded agree and strongly agree, that they are able to prepare graduates so that graduates are ready to work in the era of the industrial revolution 4.0. Serious attention is needed for study programs and industries is that there are still 12.2% of respondents who have not been able to prepare graduates who are able to utilize industrial revolution 4.0 technology.

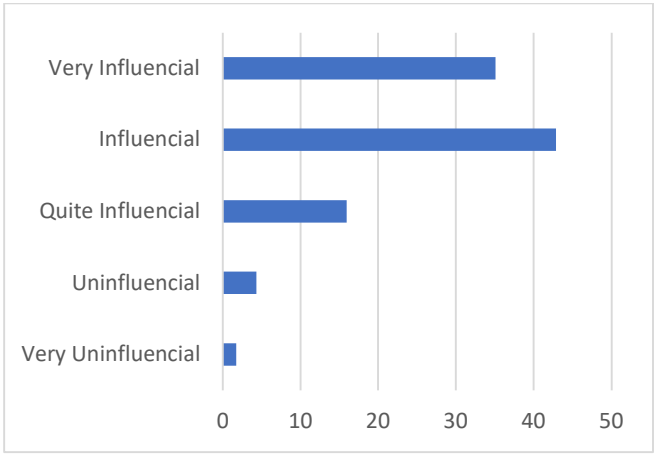

Fig. 2. The effect of the 4.0 Industrial Revolution on Study Programs / Curriculum (Percentage of Total Respondents)

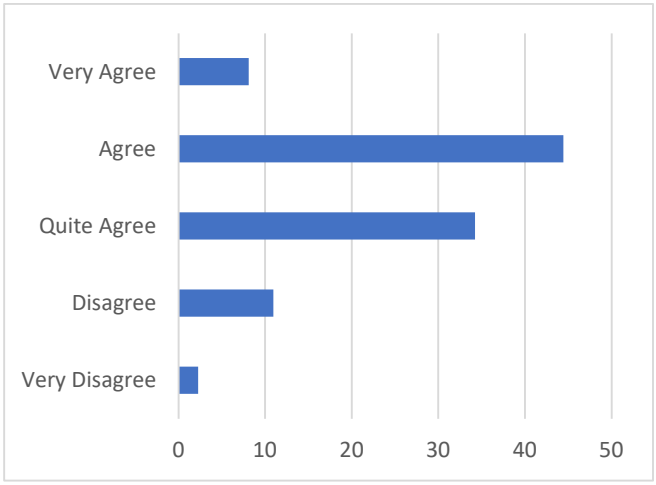

Fig. 3. The Capability of Lecturers to Integrate Industrial Revolution 4.0 Technology in courses (Percentage of Total Respondents)

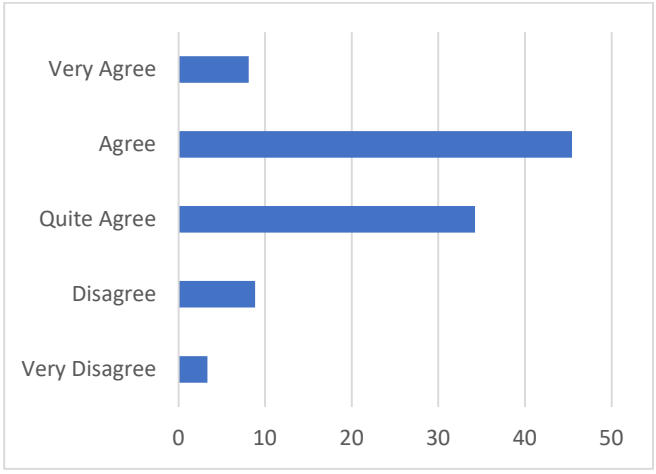

Fig. 4. Lecturers' Ability in Preparing Graduates Who Are Able to Utilize Industrial Revolution 4.0 Technology (Percentage of Total Respondents)

Fig. 5 shows the results of the responses to the question "I have received an adequate training for new 4.0 technology materials". As many as 56.05% of respondents stated that they had received adequate training regarding the new 4.0 technology materials. However, there were still quite a number of respondents (24.9%) who answered that they had not received adequate training regarding the new IR 4.0 technology material. Study programs and institution need to pay great attention to the issue of training for lecturers, teaching strategies, and teaching methods related to new technology 4.0 materials.

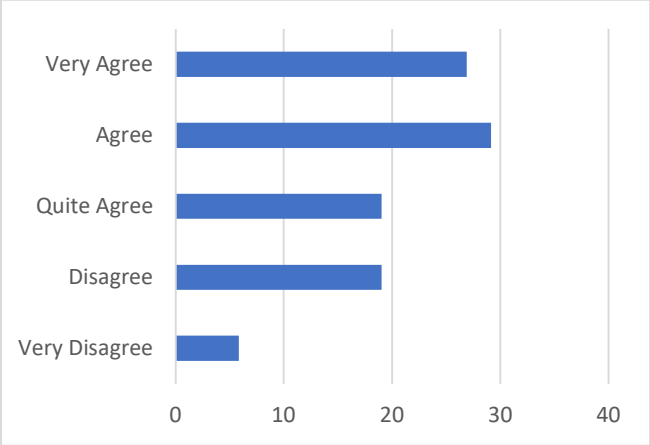

Fig. 5. Lecturers Receive an Adequate Training for the New IR 4.0 Technology Materials (Percentage of Total Respondents)

C. *Higher Education Institutions Readiness Viewed from Study Program Aspects*

Fig. 6 shows that the study program has utilized a new curriculum that has been reviewed in a relatively recent time. This can be seen from the responses of respondents, as much as 41.35% of the curriculum currently used is the curriculum that was reviewed one year ago, and as many as 44.45% of respondents answered that the curriculum of the study program had been reviewed within the last three years. There were still as many as 14.2% of respondents who answered that the current curriculum had not been updated, in other words, study programs were still using the old curriculum which had not been updated about three to five years ago.

This survey has also asked respondents about what activities or efforts were made by the study program in dealing with the industrial revolution 4.0 shows in Fig. 7. Most respondents (36.6%) answered that study programs integrate the latest information technology materials into the related courses. Next, 29.8% responded that the study program held workshops and seminars to review the curriculum. Furthermore, the study program has also increased training related to the industrial revolution 4.0 technology material (18.65%), adding new courses related to the information technology (10.95%) and 4% of respondents answered that the study program did not make any efforts in dealing with the industrial revolution 4.0.

D. *Higher Education Institutions' Readiness Viewed from Curriculum Aspect*

In the curriculum aspect, respondents were asked to respond to the following statement "The curriculum for my study program has fully integrated industrial revolution 4.0 technology" shows in Fig. 8. 32% stated agree and strongly agree, while most others (68%) stated somehow agree, disagree, and strongly disagree. These results also provide an illustration that the study program is not quite ready to face the industrial revolution 4.0. Even though various activities have been conducted and efforts have also been made to update the curriculum, new material related to the information technology of industrial revolution 4.0 has not been sufficiently integrated into the existing curriculum.

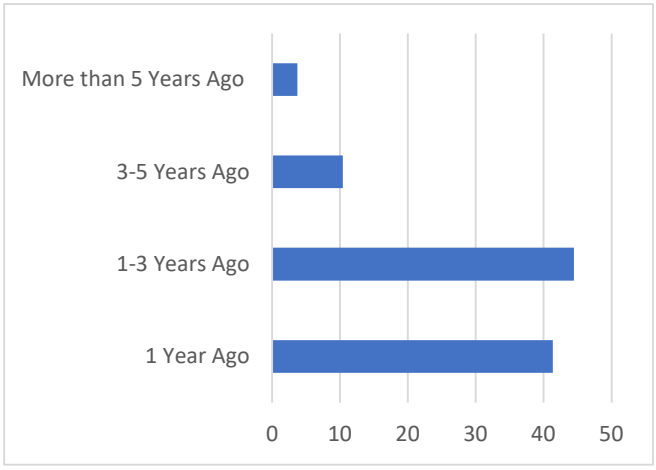

Fig. 6. The Last Time when Study Program Reviewed Curriculum (Percentage of Total Respondents)

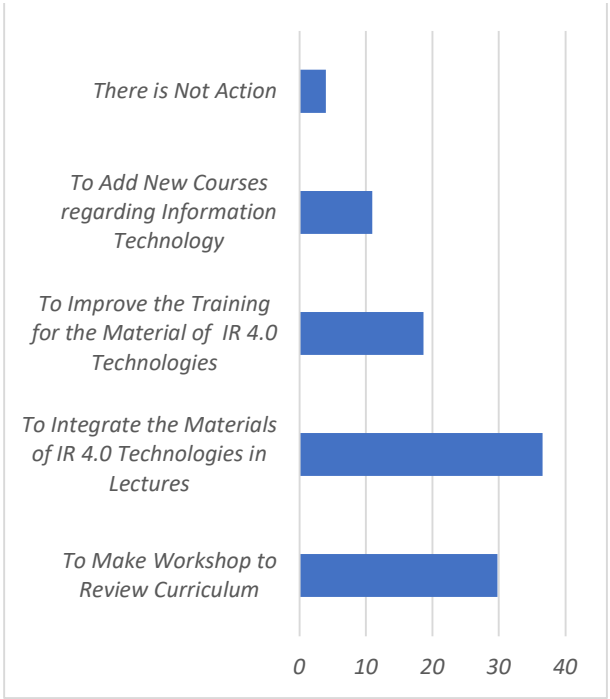

Fig. 7. Study Program Activities in Facing IR 4.0 (Percentage of Total Respondents)

In the last part of the questionnaire, respondents were asked to provide responses regarding the statement "Graduates of my study program has demonstrated the capability to effectively utilize the information technology for the digital industry revolution 4.0, understand its capabilities, impacts, risks, and opportunities" shows in Fig. 9. As many as 39.35% of respondents stated agree and disagree, while the majority (60.65%) stated somehow agree, disagree, and strongly disagree.

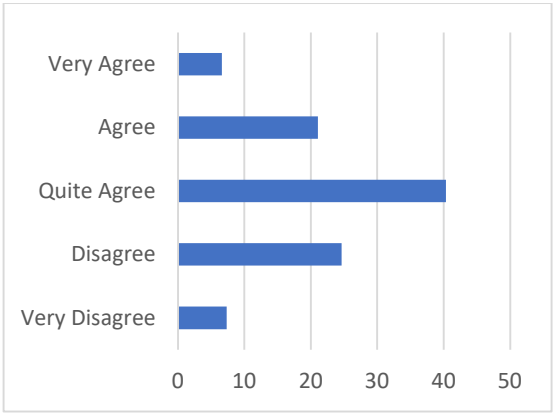

Fig. 8. Study Program Curriculum Has Fully Integrated the Information Technology of Industrial Revolution 4.0 (Percentage of Total Respondents)

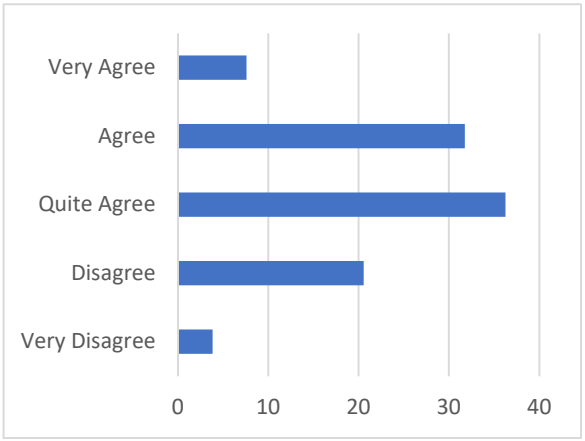

Fig. 9. Graduates' capability to Utilize Information Technology of IR 4.0 (Percentage of Total Respondents)

IV. Conclusions, Limitations, Suggestions, and Contributions

The industrial revolution 4.0 has had a broad impact on the way organizations conduct their business processes. This happens not only in developed countries but also in developing countries like Indonesia, which are not immune from the latest trends in information technology advances. The results of the study show that the lecturers at higher education institutions in West Java-Indonesia have realized the effect of the industrial revolution 4.0, but the integration of new material related to the IR 4.0 technology into courses is still not as expected and is a problem that requires attention. The results of the study show that there is still a gap between the need for the ability to utilize digital information technology 4.0 and the abilities of current graduates.

This study discusses the responses of lecturers in many study programs and does not focus on specific study programs, so the results do not provide an in-depth picture regarding the readiness of certain study programs in enabling graduates to use Industrial Revolution 4.0 Technology. Based on these limitations, some suggestions for further examining this discussion in the future are first, to conduct a survey of the capability to utilize Industrial Revolution 4.0 Technology specifically for certain study programs; second, to conduct a survey of courses in certain study programs that contain information technology topics or material to receive a better understanding on the readiness of the study programs' curriculum; third, reviewing the preparation of lecturers in certain study programs in preparing graduates who can meet the requirements of the 4.0 industrial revolution era; Fourth, mapping the IR 4.0 technology material in certain study programs; fifth, mapping the extent of student skills related to IR 4.0 technology; sixth, to examine the teaching methods that are suitable for certain study programs according to the requirements of the IR 4.0 Era.

This study contributes in describing the readiness profile of lecturers, curriculum, and study programs in the IR 4.0 era and provides awareness of the needs to prepare strategies so that graduates' abilities remain relevant to the business and industrial world. The handling needs to be focused on access/preparation of lecturers, support for study program managers and institutions, as well as increasing students' awareness of learning digital 4.0 technology materials.

The results also contribute to many stakeholders because they can open communication and synergy between users, industry, the private sector, the government, and all higher education actors, namely faculties, study programs, lecturers and students. All of these parties need to continue to work together to meet the demands of the RI 4.0 era.

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