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E-WASTE HANDLING IN DKI JAKARTA PRIVATE HIGHER EDUCATION INSTITUTION

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ABSTRACT

The growth of electronically usage has given rise to a new environmental challenge, known as electronic waste. The negative impact that is caused from the waste of electrical and electronic equipment (WEEE), has forced many institutions to take some serious action. In the other hand the dependencies toward electronic devices are getting higher, especially in the education area. This paper discusses the E-Waste handling in the area of private higher education institution. Private higher education institution gives significantly contribution to the increasing of the electronic waste. The use of technology has grown rapidly caused by the growth of the student's intake as well as the need to provide them with the latest technology. However, E-Waste model has been developed and still under reviewed continuously.

Keywords: *E-Waste, Electronic Waste, Green Computing, Green IT*

1. INTRODUCTION

Many devices, especially the old ones, built during the early phase of the electronic revolution, contain toxic materials that are potentially harmful; disposing them safely poses a major problem. Due to continued advancements in technology that already mentioned earlier, leads to an accumulation of much e-waste. Most of these devices end up in landfills or get exported to developing countries for recycling [3]. Most developing countries lack the waste removal infrastructure and technical capacities necessary to ensure the safe disposal of hazardous waste [6].

Indonesia, as the world's 16th largest country in terms of land area, has been receiving electronic waste from many developed countries. This happens, due to the lack of awareness, illegal waste and falsely claimed of "basic materials" waste. The flow of e-Waste into Indonesia had lowered the age of landfills and caused health problems among scavengers. Quoted from DyahParamita (Indonesian Center for Environment Law), said that Indonesia should make electronic waste definitions to prevent the flow of electronic waste into the country [4].

Private higher education institution also gives significantly contribution to the increasing of the electronic waste. The use of technology has grown rapidly caused by the growth of the student's intake as well as the need to provide them with the latest technology. As a matter of fact, as an education institution, it is its obligation to manage the electronic waste as well as to educate people about how to recycle, reuse and dispose electronics. Electronic waste is a global problem that is requiring a global solution [6]. However, every private higher education are handling equal problem, which caused by the huge amount of operational cost. In order to support its students as well as its employees, university needs to provide information system and information technology peripherals. Therefore, most of them use the low-cost information technology equipment, which may

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not environmentally friendly and it gives contribute to hazardous waste.

In terms of the necessity for exploring this research area, Hevner&Chatterjee have categorized Green technologies for climate as one of the trend that creates a surge in the need for design researchers [12]. A carbon footprint that may cause from the waste of the electronic relates to the amount of greenhouse gases produced in people day-to-day lives. A carbon footprint is made up of the sum of two parts, the primary footprint and the secondary footprint. The secondary footprint is defined as an amount of the indirect CO_2 emissions from the whole life cycle of electronic product that people use [12].

Therefore, this paper discusses the e-waste handling in Private Higher Education Institution, especially in the DKI Jakarta as the capital city of Indonesia. There are 331 private higher education institutions in DKI Jakarta area based on Kopertis III data [14]. However, only 32 of them are using information system and information technology (IT) as their day-to-day academic operational, which became our respondents. Few of them were analyzed and we are still collecting the rest. Data collection that has been processed in this paper will be finalized for future presentation. By the end of this year, all data will be processed and analyzed.

2. LITERATURE REVIEW

2.1 The Green IT Governance Model for Private Higher Education Institution in DKI Jakarta

The green IT governance model for Private Higher Education Institutions in DKI Jakarta uses push and pulls paradigms. Push model was adopted from the Material Resource Planning (MRP) system in manufacturing industry. Push model uses calculation and production schedule for every level, based on sales forecast. During the production process, sub-assemblies are pushed to the following level without perceiving the requirement of them. In IT context, future technology will be based on push technology [10].

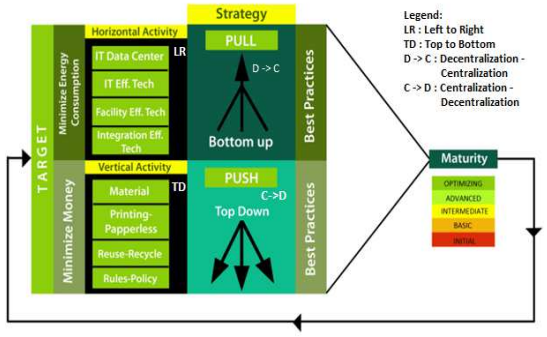

Fig.1. The Green IT Governance Model for Private Higher Education Institution in DKI Jakarta

Based on our previous research, private higher education institutions in DKI Jakarta area need to enhance its procurement and usage of information system and information technology. This model emphasizes on the importance of sustainable improvement, so that both horizontal and vertical activities can be done simultaneously (Figure 1). Horizontal activity focuses on the minimization of energy consumption in the data center, while vertical activity put more effort on reducing the operational cost in private higher education institution.

This paper elaborates the push model (vertical activity) (Figure 2) in green IT governance model for Private Higher Education Institutions in DKI Jakarta. Managing e-Waste is influenced by several processes in the vertical activity. Vertical activity depends on material elements, which are: printing-paperless, reuse-recycle and rules-policy (figure 1). University may transform its materials (table 1) into green material by reducing the amount of paper they used, continuously reusing and recycling its IT equipment and establishing rules and policy for green IT purpose Top-down (centralization-decentralization) strategy is being used towards this paradigm. Meanwhile, pull model (horizontal activity), will be our following research topic.

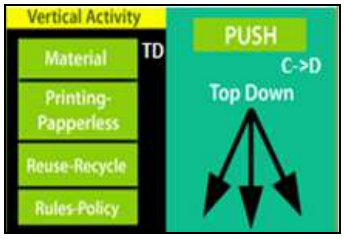

Fig.2.Push Model

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Table 1.Materialcomponents [13]

Material Components		
Computer	Laptop	Paper
E-Waste	Regulations	Printer
Monitor	Vendor	Scanner
Gadget	Fax	Cell phones

2.2 Capability Maturity Level for E-Waste Handling

In furtherance of identifying and enhancing the implementation of green IT for Private Higher Education Institutions in DKI Jakarta area, they need to evaluate current green IT performances. By using capability maturity model framework, it is possible for them to know the level of maturity of e-waste handlingthat already achieved by each institution (figure 3).

Fig.3.*E-Waste Handling Capability Maturity Level [10]*

In the initial level, education institution has inadequate knowledge toward e-waste handling. E-waste policy has insufficient found or none. E-waste is not being applied yet into university's life cycle system. Basic level captures e-waste strategy in the minimum level. The awareness of e-waste is increasing. However the accountability of it is not yet defined. Few policies are made, but none of them are being applied consistently. The intermediate stage emphasizes the association between its e-waste strategies with e-waste plan. Private Higher Education Institutions establish priority level toward e-waste handling. They develop the ability and expertise to advance each individual in the institution to contribute in this sustainable program.

Meanwhile, in the advanced level, sustainability has become major component in the business-planning and IT life cycle. Education institution realizes that managing e-waste has been giving significant contribution. Various e-waste policies are designed to achieve best practice for each individual in its institution.

In the optimizing level, education institution not only applies e-waste handling in its internal environment but also toward its partners. Institution is being awarded as sustainability leader in the e-waste handling area and becomes role model for other education institutions.

2.3 The Impact of Electronic Waste (e-Waste)

The waste of electrical and electronic equipment also known as WEEE, represents a serious problem, not just in terms of how its treatment and disposal is ultimately managed, but also in the broader context of sustainability and the waste of valuable and finite resources [5]. An electronic product may contain more than 1,000 different substances, some of which can be harmful to human and environmental health [2].

2.4 E-Waste Prevention

Every organization is responsible in purchasing new electronic equipment that has been design with environmental attributes. There are number standardizations in order to pursuit green IT. Key among them are EPEAT (Electronic Product Environmental Assessment Tool), RoHS (Restriction of Hazardous Substances Design), the ISO 14001 core set standards for designing and implementing an effective environmental management system and the EN 16001 Energy Management System.

In terms of government policy, European Union launched the Eco-Label (Flower Label). It standard mandates that an environmental impact analysis be conducted on products or services throughout their life cycle. United Kingdom developed greening of government ICT (Information Communication Technology) strategy. It is the a green ICT scorecard that evaluated constituent department, agencies and so on, using 32 indicators, including 19 ICT – related metrics. Japan established Green IT Promotion Council. The council consists of members from academia, industry (nationally and internationally) and government or the public sector [11].

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2.5 Managing The Waste Stream of Electronic Product

Godbole (2011), proposed the management of waste stream of electronic product that is presented in figure 4. It is developed from the waste disposal hierarchy or the '3Rs' of waste disposal – Reduce, Reuse, Recycle (figure 4). The important point is that the emphasis should be toward're-use' as much as possible and 'disposal' should be used as the last option [2].

Reuse is to send the computer for reuse to some other place like an educational institution. However, there are some following guidelines before sending the device for reuse: (1) make sure that the receiving organization does need the device being sent and can reuse it, (2) copy the information that has been stored in the device to a backup device or another device and (3) wipe off personal or sensitive information in the device using tools specific for this purpose like Symantec's WipeInfo [3].

Fig.4.*Managing The Waste Stream Of Electronic Products [2]*

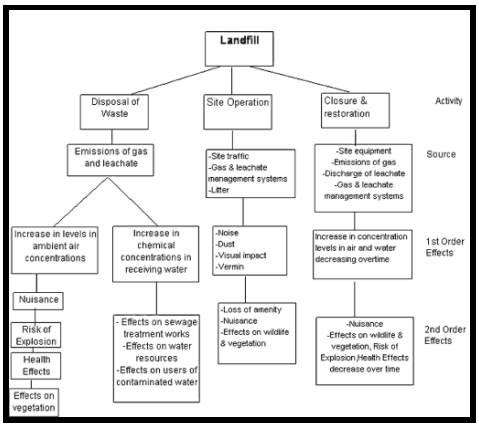
The next best option is to recycle. In the process of recycling, most of the original device's materials are reused as raw materials for a new device, thus resulting in less waste. Materials like gold, silver, copper and plastic can be recovered and reused [3]. Kellner (2009), found the importance to disassembly in the recycling industry. Disassembly defined as the need to remove materials and components for re-use and or remanufacture [9]. Figure 5shows the end-of-life destination flowchart.

In terms of dispose stage, according to educators' guide up to 75 percent of unused computers are stored in the closets, basements and offices of the original owners. Fifty percent of computers being recycled are still in good working order and could be reused. Furthermore, 85 percent of computers that are "thrown in the garbage" end up in a landfill [2].

Fig.5.**End-of-life destination flowchart illustrate [9]**

Currently, the only way to deal with waste of electrical and electronic equipment contaminated with liquid crystal displays is by disposing of them in waste incinerator or in landfill. Liquid crystal displays are dominantly found in the flat-panel display market and typical applications such as notebook computers, desktop monitors, electronic organizers, mobile phones, pocket calculators, digital cameras, audio video equipment and other household appliances [8]. The dumping of waste in the ground, called as landfill also created risk to human health from vermin and flies. Figure 6 depicts the impacts and effect of landfill on the environment.

Landfill also gives many downsides to the disposal approach. It is included disease, health risks, environmental contamination and the danger of explosion from untapped landfill gas (methane). However, landfill is the cheapest method of waste disposal and around 80% of waste in the United Kingdom (UK) is still disposed of to landfill [7]. The difference between landfill and incineration is that incineration consumes large amounts of energy and can generate volatile products such as dioxins, while landfilling is known to be hazardous toground water [8].



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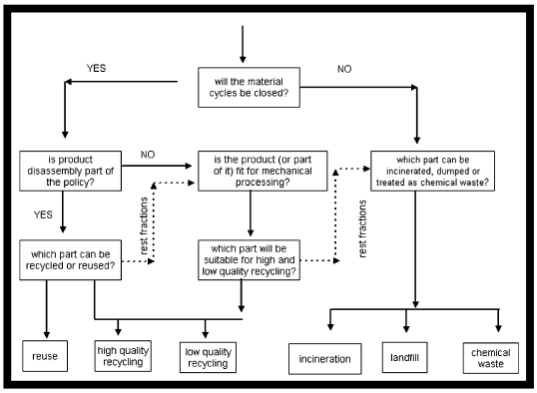

Fig.6.*Impacts And Effects Of Landfill On The Environment [7]*

2.6 E-Waste Policy Framework

E-Waste policy framework (figure 7), is created by those who understand the e-Waste issues. It is best for industry to initiate policy information collectively, but with the involvement of users/consumers. Godbole (2009) formulated the framework that has address all issues ranging from production and trade to final disposal, including technology transfer for the recycling of electronic waste. There is also a need to address the loop holes in the prevailing legal frame work to ensure that e-Waste from developed countries are not reaching developing/poor countries for disposal [2].

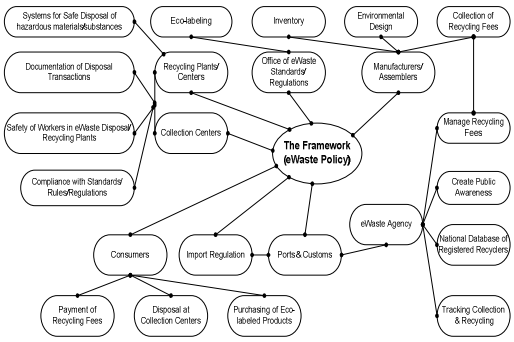

Fig.7.*E-Waste Policy Framework [2]*

3. E-Waste Handling in Private Higher Education Institution

3.1 E-Waste Evaluation in DKI Jakarta Private Higher Education Institution

In order to evaluate the electronic waste handling in the area of DKI Jakarta private higher education institutions, a set of questionnaires were distributed. Questions were categorized into 5(five) sub topics and each of question scores into 1 to 5 scale (very poor, poor, fair, good and very good).

The first sub topic covers prevention and avoiding activities that the university has done towards electronic waste. The second topic discusses activities that deal with reducing or minimizing the carbon emission. Questions focus on the implementation of paperless, e-learning, Energy Star certification and others. Reuse or repairing and cannibalism program are the third sub topic in the questionnaire. In this section, university needs to use the recycle paper for printing purpose, utilize computer parts that still in the good condition (cannibalism) and also recycle old computer. The fourth sub topic deals with the disposal of the waste of the electronic, while the last one focuses on the incineration.

As shown in table 2, in terms of prevention and avoiding activities toward e-waste (Sub topic I), most universities scored fair to good. The total average of 3.61 tends to be in the "good" result. This result means that most universities do suitable prevention and avoiding activities for their electronic waste. They only buy upgradable computer equipment, socializing the green ICT and the global warming and follow the regulation which relates to green computing. Meanwhile, the reducing or minimizing the amount of carbon emission has scored higher than the first. They put so much effort on reducing the amount of carbon emission through the use of Energy Star certified product, paperless policy, e-learning and telecommuting implementation. The third sub topic scored slightly lower than the previous sub topics. The total average of 3.25 means that reuse or recovery and recycle program has been implemented fairly. Moreover, in terms of the disposal activities (sub topic VI), universities tend to dispose their electronic waste in fairly manner. Although few of them gives poor result. The last sub topic earned the lowest result compare to other component. The incineration for electronic waste has been done in poorly to fairly way, although there is one university who claimed to do it in a "very good" way.

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Table 2.E-Waste Evaluation In DKI Jakarta Private Higher Education Institutions

University	Sub Topic I	Sub Topic II	Sub Topic III	Sub Topic VI	Sub Topic V	Total Avrg.
Uni A	4	4.6	3.9	3.7	4.5	**4.07**
Uni B	3.6	3.6	3.4	3.3	3	**3.45**
Uni C	3.1	3.2	3	2.2	2.5	**2.85**
Uni D	3.7	4.8	3.6	3.8	3	**3.93**
Uni E	2.7	3.6	2.7	2.3	2.5	**2.80**
Uni F	3.4	3.4	2	2.4	2	**2.76**
Uni G	4.8	4.6	4.2	3.9	3	**4.31**
Total Avrg.	**3.61**	**3.97**	**3.25**	**3.08**	**2.93**	

In terms of the level of maturity based on figure 3, most universities tend to be in the intermediate level. The intermediate stage emphasizes the association between its e-waste strategies with e-waste plan. Private Higher Education Institutions establish priority level toward e-waste handling. They develop the ability and expertise to advance each individual in the institution to contribute in this sustainable program.

3.2 The Proposed E-Waste Model

Based on various theories from several studies and the result from data collection, the E-Waste model for private higher education institutions has been proposed. There are 6(six) methods offered in this model (avoid/preventive, reduce/minimization, reuse/repairing/cannibalism, disposal, incineration and landfill).

The green indicators are best or favored option for electronic waste handling method, while the red indications are becoming the worst or last option for electronic waste handling method. However, based on the evaluation result, universities tend to practice avoid/preventive, reduce/minimization and reuse/repairing/cannibalism for their electronic waste. It is proven to be environmentally friendly by maximizing the use of materials (table 1).

Meanwhile, disposal, incineration and landfill are poorly to fairly implemented in the university. As it is shown in figure 8, the toxin and hazard have become the outcome of the processes. Therefore, many universities tend to avoid this method due to the high risk of the impact.

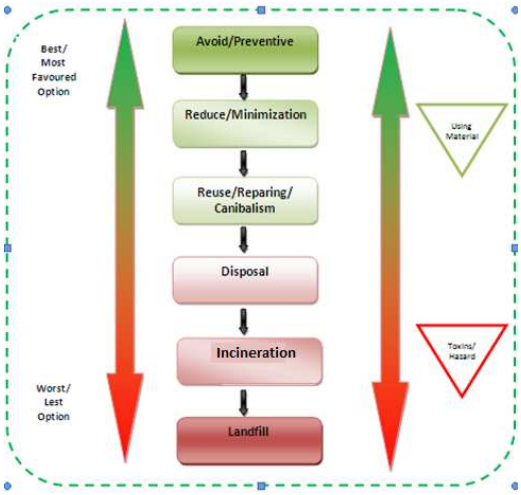

Fig.8. E-Waste Model For Private Higher Education Institution

3.2.1 Avoid or Preventive

The main principle of avoid or preventive is to prevent or to keep something from happening, use alternative, raise awareness and build academic skill for basic knowledge of electronic waste. The characteristics of avoid or preventive act are included: (1) University need to make sure while buying any electronic products. It has to be something that university is needed and closest to the specification that university looking for. (2) Buying an electronic device that has the capacity of changing with the technology and upgradable. (3) Choose products that are made of materials with less toxicity, greater recycled content and higher efficiency. (4) Hazardous materials (mercury, PVC, Arsenic, Lead, BFR, Phthalate, etc) should not be used during the manufacturing process of electronics. (5) Buying from companies who support the recycling and reuse of electronics and take corporate responsibility dealing with e-waste seriously. (6) If electronic gadget is outdated, consider an upgrade – not buying the new one. (7) Purchasing refurbished products are encouraged.

3.2.2 Reduce or Minimize

The main principle of reduce or minimize means to use less or make less of any electronic devices. Universities need to avoid unnecessary waste generation by buying less, buying in bulk, buying quality and buying concentrates. They also may reduce the energy consumption by using power

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supply efficiently, lowering power components and using power management software. The characteristics of reduce or minimize act are included: (1) University need to use less energy and process less pollution (2) Conserve energy by supporting renewable energy. (3) Using green technology or practice by improving energy efficiency within the establishment, reducing greenhouse gas emissions through methods other than renewable energy generation and energy efficiency, reducing the creation of waste materials, conserving natural resources. (4) Use as small as possible packaging for product shipment. (5) Upgrading to energy efficient appliances (Energy star label). (6) Taking a good care the electronic devices as long as possible. (7) All electronic devices should be accompanied by an instruction manual for instruction dealing with good use of the product and easy fix-it-user guide. (8) Turn electrical equipment off when not in use (Reduce phantom Watts).

3.2.3 Reuse or Repairing or Cannibalism

The main principle of reuse or repairing or cannibalism is to increases the lifespan of investments and spares a business the cost of buying new products. The idea behind recycling is to reduce energy usage, reduce volume of landfills, reduce air and water pollution, reduce greenhouse gas emissions and preserve natural resources for future use. The characteristics of reuse or repairing or cannibalism are included: (1) Reuse of electronics should be encouraged with little repairing needed. (2) Donate or sell the product to somebody who can use it if did not want to keep it. The types of electronics recycling: computers, mobile phones, televisions, computer parts, toner cartridges, monitors, iPods, DVD Players and VCRs, telephones, cables/wires, printers, portable electronics, home entertainment, calculators and small electronic devices.

3.2.4 Disposal

The main principle of disposal is to collect, transport, and dispose of garbage, sewage and other waste products. Waste consists of two general types: municipal and hazardous. Municipal waste is refuse from households and small business while hazardous waste includes chemical, infectious or otherwise toxic waste. The waste must be evaluated to determine the characteristics of the waste and whether the waste is regulated or managed as hazardous. The characteristics of electronic waste are included: (1) Non-hazardous waste can be identified from regular solid waste, paper, soda cans etc. (2) Hazardous biological waste can contain or contaminate with a radioactive isotope. (3) Hazardous biological waste : waste containing or contaminated with an infectious or potentially infectious agent, a biological toxin, an animal carcass, a genetically modified organism, recombinant DNA. Etc. (4) Hazardous chemical waste: products which are chemical in nature (cleaning agents, paint, motor oil, and pharmaceutics), products that contain chemicals (fluorescent lamps, thermometers) or materials contaminated with chemicals (e.g. contaminated soil or rags). (5) Otherwise regulated waste (e.g., asbestos, car batteries, electronics, and construction debris).

3.2.5 Incineration

The main principle of incineration is to cut down on the amount of trash. There are two main ways to dispose of waste: by burning it (incineration) or by placing it in a lined pit (land filling). The type of waste determines how it is disposed of. The characteristics of incineration are included: (1) Type disposal method in which municipal solid waste are burned at high temperatures so as to convert them into residue and gaseous products. (2) Reduce the volume of solid waste to 20 to 30 percent of the original volume.

3.2.6 Landfill

The main principle of landfill is the disposal of waste into or onto land. Land filling is the last step in a hierarchy of waste management. The purpose of landfill is to bury the trash in such a way that it will be isolated from groundwater, will be kept dray and will not be in contact with air. The characteristics of landfill are included: (1) Bottom liner – the bottom liner separates and prevents the buried waste from coming in contact with underlying natural soils and ground water. (2) Cells (old and new) – this is the area in a landfill that has been constructed and approved for disposal of waste. (3) Leach ate collection system – the bottom of each landfill is typically designed so that the bottom surface of the landfill is sloped to a low point, called a sump. (4) Storm water drainage – this is an engineered system designed to control

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water runoff during rain or storm events. (5) Methane collection system – bacteria in the landfill break down the trash in the absence of oxygen. (6) Cover – waste that is placed in a cell is required to be covered daily with either six inches of compacted soil or an alternative daily cover. (7) Groundwater monitoring stations – these stations are set up to directly access and test the groundwater around the landfill for presence of leach ate chemicals.

4. CONCLUSION

In order to support its students, lectures, employees, university in conducting day-to-day operational, university needs to provide the information system and information technology equipment accordingly. Meanwhile, many private higher education institutions are burdened with the high amount of operational cost. Therefore, choosing the economical peripheral for supporting its operational is commonly adopted by them. However, buying the low-cost equipment is not a good option, in terms of the future negative impact on the hazardous waste. As a place for creating many future leaders, an education institution need to manage the electronic waste as well as to educate people about how to avoid, reduce, recycle, reuse and dispose electronics waste. During the data collection process, several private higher education institutions gave "fair and good" results. However, these results have to be increased in order to achieve an eco-friendly education environment.

There are some significant barriers during this research. Some institutions are still afraid to reveal its information regarding the waste management or they are not really sure with what they are doing in terms of managing their waste. Therefore, the process of data collection is still continuing and we plan to conduct an internal socialization towards the e-waste model for private higher education institution in DKI Jakarta. As it mentions above, there are only 32 private higher education institution in DKI Jakarta area that already computerizing its academic operational among all 331 private higher education institutions.

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