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## Analyzing the Impact of COVID-19 Outbreaks on MIS Students: A Qualitative Approach

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### ABSTRACT

During the breakout of coronavirus disease (COVID-19), many schools worldwide have enforced a policy of distance education. The Taiwanese students also experienced long hours of learning by using smart technologies for the first time. MIS education is a career preparation for IT professionals who use smart technology in organizations. IT professionals with MIS education backgrounds may have important roles when facing COVID-19. Moreover, many MIS students will become IT professionals and join the workforce for combatting the pandemic using smart technologies with their background of MIS education. This study intends to construct theories that depict the relevance among MIS education, IT professionals, and smart technologies in the confrontation of the COVID-19 pandemic. By using in-depth interviews with MIS students and recent MIS graduates, the possible impacts of COVID-19 outbreaks are analyzed. The results could provide reflective insights for MIS education providers, human resource units, IT firms, and organizations confronting COVID-19 outbreaks.

*Keywords:* Management information system, education, IT professional, COVID-19, metaphor.

### INTRODUCTION

The year 2020 was a difficult time for the whole world. Since the start of 2020, the world has been facing the epidemic of coronavirus disease (COVID-19). To prevent infectiousness, many countries have restricted transportation, grounded airlines, closed public facilities, blocked traffics, sealed cities, and quarantined residents, making the provision of goods and services extremely difficult (Whitelaw *et al.*, 2020). During this abnormal period, electronic governments and businesses taking advantage of digital technologies provide emergency relief to the people and organizations in need at home or worldwide under this disastrous situation (Tuli *et al.*, 2020).

IT professionals are key actors in the utilization of digital technologies. They are people with IT skills to help the confrontation of contingencies for governments, enterprises, and other organizations. Therefore, IT professionals could be an important linkage resource between digital technologies and the COVID-19 confrontation. Furthermore, many IT professionals have an educational background in management information systems (MIS). Their professional careers start with the knowledge obtained from MIS education. Thus, MIS students (i.e., the future IT professionals) are also relevant in the connection between digital technologies and the confrontation with COVID-19.

Each year, many students who graduated from university MIS (or similar) education programs join the workforce of IT professionals and play a pivotal role in the utilization of digital technologies to serve in various sectors of organizations. With this educational background in the MIS discipline, they are expected to be confident and perform their duties with satisfying results. However, the real world is always full of various challenges. Starting from the year 2020, MIS graduates are facing one more challenge that is not seen in human history: the outbreak of COVID-19.

Moreover, the COVID-19 outbreak triggered many schools worldwide to enforce a policy of distance education. The Taiwanese students also experienced long hours of learning by remote technology for the first time. This policy also caused many Taiwanese students studying abroad to come back to Taiwan temporarily. Most of them chose to come back to their family and friends to avoid facing the pandemic alone. This experience of disruption in life may have a long-term impact on their perceptions of learning and future career.

However, despite these possible connections, the research on the impact of COVID-19 outbreaks on MIS students so far is very scant. Therefore, the objective of this research is to investigate and clarify the possible impacts. This study aims to analyze the impact of COVID-19 outbreaks on MIS students and deliver possible implications to MIS educators and IT managers.

The paper explains first the research setting for this study. Following that, the process of data collection and the results of data analysis are elaborated. Finally, discussion, implications, and conclusions with suggestions are provided.

### METHOD

#### Research Setting and Data Collection

This study intends to construct a theoretical framework that depicts the relevance among MIS education, IT professionals, and smart technologies in the confrontation of the COVID-19 pandemic. A grounded theory approach for data analysis is chosen

because of its specific objective of building a theoretical framework from qualitative data and interpretative analysis (Corbin & Strauss, 1990).

Data for this study were collected through formal interviews, informal dialog, and archived data. Data collection activities were started in the middle of April 2021 and took about thirty days to complete. Table 1 exhibits data collection methods.

Table 1: Data collection.

Data source	Data collection process
Formal interviews	<ul style="list-style-type: none"> <li>● Six formal interviews, each took about eighty minutes</li> <li>● Seventeen follow up video conferences for data clarification</li> <li>● Interviewees include MIS students and recent graduates</li> <li>● We have ruled out the students from our affiliated school</li> </ul>
Informal dialog	<ul style="list-style-type: none"> <li>● Five conversations with two MIS professors, one of which has been a department chair</li> <li>● Three conversations with a corporate CIO and an MIS team</li> <li>● Four conversations with a senior VP of a recruitment website</li> </ul>
Archived data	<ul style="list-style-type: none"> <li>● MIS education program descriptions on the university websites</li> <li>● Recruiting advertisements for IT professionals</li> <li>● Attending two public, corporate conferences held by IT companies</li> <li>● Discussion of life and social experience on social media</li> <li>● News and commentaries about COVID-19 outbreaks and social phenomena</li> </ul>

Source: This study.

### Recruiting Procedure

This study used purposive sampling with a snowballing method to recruit participants. In the sampling, we have ruled out students of our affiliated school. Data collection by interviews was conducted in April of 2021. Totally six interviewees with diverse backgrounds from different universities in Taiwan and USA participated in this study. At the time of the interviews, some of them were senior MIS students, some of them were master-level MIS students, and the others were recent graduates from MIS programs and worked for less than two years. The participants are as shown in Table 2. They were interviewed separately. Each interview lasted about eighty minutes.

Table 2: Participants description.

Case name	Status at the time of this study	Affiliated school location
Student Chen	<ul style="list-style-type: none"> <li>● Senior undergraduate MIS student</li> <li>● Studied accounting before transferring to MIS</li> <li>● Part-time work in pharmacy sector for one year</li> </ul>	Northern Taiwan
Student Fang	<ul style="list-style-type: none"> <li>● Senior undergraduate MIS student</li> <li>● Assisting a project about cloud security and social media privacy</li> <li>● Summer practicum at a medical equipment manufacturer</li> <li>● Summer practicum at an online retailer</li> </ul>	California, USA
Student Guo	<ul style="list-style-type: none"> <li>● First-year master level MIS graduate student</li> <li>● Two years of working experience in the finance sector</li> <li>● Part-time working experience at a gym</li> <li>● Self-study of herbal medicine</li> </ul>	Northern Taiwan
Student Lin	<ul style="list-style-type: none"> <li>● Second-year master level MIS graduate student</li> <li>● Working on a thesis about comparing agile development model and waterfall model</li> <li>● One year of working experience in the media sector</li> <li>● Part-time volunteer service in the healthcare sector</li> </ul>	Texas, USA
Student Wu	<ul style="list-style-type: none"> <li>● Graduated from undergraduate MIS program</li> <li>● Working for two years in the MIS unit of the manufacturing sector</li> <li>● Traveled to China and Korea several times for work assignments during the COVID-19 outbreak</li> </ul>	Northern Taiwan
Student Yeh	<ul style="list-style-type: none"> <li>● Graduated from master MIS program</li> <li>● Master project of using neural network and data mining to analyze supply chain data</li> <li>● Working for one year in the MIS unit of the retail sector</li> <li>● Six months of civil service in a hospital on an outer island of Taiwan</li> </ul>	California, USA

Source: This study.

### Interview Process

Semi-structured interviews were conducted with the sampled MIS students. Data were recorded through a semi-structured guideline as a starting point, followed by open-ended and unstructured interviews. The semi-structured interview guideline is listed in Table 3.

During the interviews, the interviewees were invited to freely express their thoughts about their MIS education, becoming an IT professional, the current COVID-19 situations, and any other related thinking.

From April to May 2021, six formal interviews were conducted, each taking about eighty minutes. The languages used in the interview were Chinese and English. The locations of the interviews were mainly in northern Taiwan.

Table 3: Semi-structured interview guideline.

Sequence	Topics
1. Opening	
1	Introduction
2. Learning aspect	
2.1	Reasons of studying MIS
2.2	General perception about MIS education
2.3	Additional thoughts
3. Working aspect	
3.1	Interest of becoming an IT professional
3.2	General perception about IT professional
3.3	Additional thoughts
4. COVID-19 aspect	
4.1	General perception about COVID-19
4.2	Impacts of COVID-19 to MIS education
4.3	Impacts of COVID-19 to IT professional
4.4	Additional thoughts
5. Ending	
5.1	Acknowledgement and other suggestions

Source: This study.

### Data Analysis

The data of this study were analyzed after the data collection stage. The interview files were transcribed from notes to text to form the significant statements as the data for analysis in this study. Data clarification was made by contacting the interviewees when there were ambiguous or missing contexts. After reading the transcribed text, the researcher extracted the meanings of perceptions and experiences of the interviewed students. Iterative meanings were collected, analyzed, coded, and organized into themes.

## RESULTS

Data from the individual interviews were analyzed and classified into three themes: MIS education as an adaptable incubator, IT professional as an agile integrator, and COVID-19 epidemic as an anguishing intruder.

### MIS Education as an Adaptable Incubator

Excerpts of the interview results of MIS students' perceptions about MIS education were analyzed, as shown in Table 4. Three attributes were identified for students' perceptions about MIS education: adaptable content, continuous learning, and intellectual preparation.

Table 4: MIS students' perception of MIS education.

Interview excerpt	Coding	Theme
MIS education, to me, is fundamental learning of IT and its application. The knowledge is updated very quickly, so we have to keep learning by ourselves anytime and anywhere we can.	Intellectual preparation Continuous learning	An adaptable incubator
I think of my MIS education as training to become a knowledgeable person of information technology and management who is adaptable to new trends.	Intellectual preparation Adaptable content	
Maybe it is because of the fast-changing pace of this discipline. I feel it is like a life-long learning task. We have to continue learning by ourselves even after graduation. The goal is to prepare ourselves for challenging IT tasks. Learning in the clouds is quite popular now. You can find many free courses and training programs on YouTube and other websites. It is your own responsibility to keep learning.	Adaptable content Continuous learning Intellectual preparation	

After the COVID-19 outbreak, most of the time, we use distance learning and take courses online. At first, I was not used to studying this way, but now I have gotten used to it and think it's quite convenient. I can use my mobile phone to participate in courses. Thanks to smart technologies.	Continuous learning	
The school teaches you the foundation of knowledge. It is like opening the door for you. Then you have to go further by yourself. Because new AI and deep learning knowledge are coming up so fast, we need to visit our library and websites very often and keep learning whenever we have time.	Continuous learning Adaptable content	
Fortunately, we have a pretty good digital library in our school. I think it saves me much of the time to find the innovative status of IT-related topics. For example, our professors would ask us to log into the school library and search for the recent development of IoT and blockchain.	Adaptable content	

Source: This study.

This theme refers to students' experiences and viewpoints about the content and value of their MIS education.

### IT Professional as an Agile Integrator

Excerpts of the interview results of MIS students' perceptions about IT professionals were analyzed, as shown in Table 5. Attributes identified in this topic include digital infrastructure, agile servicing, and technology integration.

Table 5: MIS students' perception of IT professionals.

Interview excerpt	Coding	Theme
IT and IT professionals are seldom regarded as a leading role. It is the infrastructure. It is much like a supportive role. However, it is a necessary supportive role for all the other services.	Digital infrastructure Technology integration	An agile integrator
Manufacturing, finance, retail, healthcare, and even government all require the infrastructure provided by IT. I think of IT professionals as enabling integrators of information systems. Without them, IT is just a piece of hardware.	Digital infrastructure Technology integration	
My understanding about IT professionals is that they often work under very tight schedules because all the others would be based on them to function. IT is like infrastructure to everything.	Digital infrastructure Agile servicing	
It seems to me that they (IT professionals) don't need to have deep knowledge of every kind of technology, but they need to know how to quickly put things together to work. Smart technologies are advancing very fast, and they have to keep up with the technologies and practice them.	Technology integration Agile servicing	
In this profession, we need to deliver innovative services efficiently under time constraints and changing requirements. The user preferences and demands are constantly changing, so we usually work with learning-by-doing to quickly respond to the changing world. So for the COVID-19 situations, we need to work around the needs of our clients because their situations have also changed suddenly. We need to think and act ahead of our clients.	Agile servicing	
During the COVID-19 pandemic, our professors invited some graduates now in the healthcare industry to our class and shared how they helped mitigate the situation with the integration of smart technologies.	Technology integration	

Source: This study.

This theme refers to students' understanding of IT professionals from classroom knowledge and previous experiences to the practicum or part-time works by the observation and practice in the workplace settings.

### COVID-19 Epidemic as an Anguishing Intruder

Excerpts of the interview results of MIS students' perceptions about the COVID-19 epidemic were analyzed, as shown in Table 6. The identified attributes in this topic were: lifestyle disruption, pervasive anxiety, and public uncertainty.

Table 6: MIS students' perception of COVID-19 epidemic.

Interview excerpt	Coding	Theme
People were wondering how long it (COVID-19) would last, how much food supply is left, and where to get a mask. My parents run a small retail store in the south (of Taiwan). During the pandemic, they really worried about the supply of merchandise and the stop of customers.	Public uncertainty Pervasive anxiety	An anguishing intruder
Most of us have to stay home or stay in the dorm. Most of our courses were switched to distance learning. We were not allowed to have indoor meetings and activities.	Lifestyle disruption	
The virus can continue to evolve and mutate. They seem to be unstoppable. So far, no real cure is available. We were advised to avoid physical contact with our family members, classmates, and friends. This is really annoying.	Pervasive anxiety Lifestyle disruption	
There are lots of fake news and false messages of the pandemic situations around. This is often amplified by social media. I think social media need to be used more carefully in times like this. So, I think COVID-19 breakout is not just the spread of physical viruses but also the spread of cyber viruses.	Public uncertainty Pervasive anxiety	
COVID-19 breakout makes me pause my usual activities and think about life, our environment, and our community. I wonder if there is something I can do to help. You have to respect human lives. You have to respect the environment. You have to respect the ecology. These are what COVID-19 taught us.	Lifestyle disruption Pervasive anxiety	
During this period, we rely on various information systems and services to cope with the situation. Online shopping, distance learning, remote conferencing, and work at home have become common for almost everyone. This scenario makes me feel like living in a world of virtual reality.	Lifestyle disruption	

Source: This study.

This theme refers to students' cognition and experiences about the COVID-19 outbreaks. They narrated their encountering with the disastrous pandemic and the disruption and change of their lives.

### Summary of Findings

Table 7 exhibits a summary of the findings. In our coding process, metaphors were adopted as a media of scientific communications. Recent research in cognitive science has demonstrated that metaphors can shape the way people think and initiate scientific research ideas through novel comparisons between natural phenomena and everyday experiences (Taylor & Dewsbury, 2018; Thibodeau *et al.*, 2017). Metaphors are also commonly adopted in MIS studies. For example, "cloud" computing, "waterfall" model, and data "warehouse" are all metaphors for understanding abstract concepts of information technologies.

Table 7: Summary of MIS students' perceptions.

Theme	Perception	Components
MIS education	As an adaptable incubator	<ul style="list-style-type: none"> <li>● Adaptable content</li> <li>● Continuous learning</li> <li>● Intellectual preparation</li> </ul>
IT Professional	As an agile integrator	<ul style="list-style-type: none"> <li>● Agile servicing</li> <li>● Digital infrastructure</li> <li>● Technology integration</li> </ul>
COVID-19 epidemic	As an anguishing intruder	<ul style="list-style-type: none"> <li>● Lifestyle disruption</li> <li>● Pervasive anxiety</li> <li>● Public uncertainty</li> </ul>

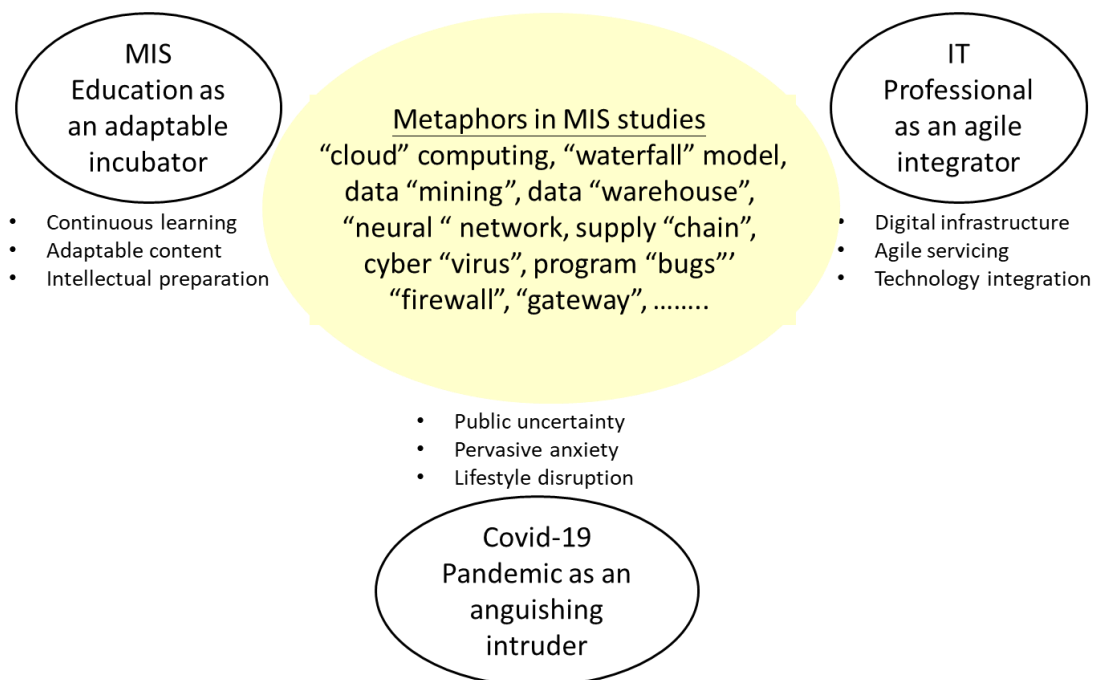
Source: This study.

## DISCUSSION

The results can be further discussed toward five focal points: meanings of the metaphors, linkage of the perceptions, remedy of the pandemic impacts, the role of smart technologies, and the possible transitions. These focal points are illustrated as follows.

### Understanding the Metaphors

As displayed in Figure 1, metaphors are widely used in MIS study and the IT profession to convey abstract concepts by familiar things in life. In our analysis of data, the students' perceptions of MIS education, IT professional, and COVID-19 outbreak were also expressed with metaphors such as "an adaptable incubator," "an agile integrator," and "an anguishing intruder." We presented these metaphors to various MIS students, IT professionals, and scholars (listed as informal dialog in Table 3) and obtained positive responses. They also suggested that in many scenarios of communicating with IT professionals, using metaphors is more profound and inspiring. The three metaphors we adopted, incubator, integrator, and intruder, also fit the IT culture and lingo.

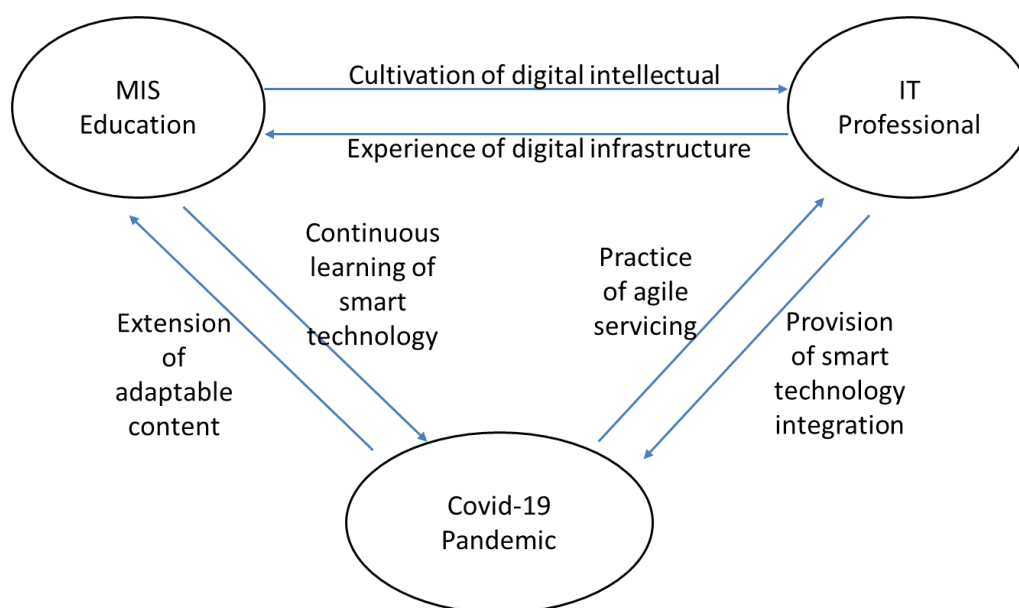


Source: This study.

Figure 1: Understanding the metaphors.

**Linking the Perceptions**

Figure 2 shows a conceptual framework linking the students' perceptions of MIS education, IT professionals, and the COVID-19 outbreak. These linkages were constructed in the coding process by relating the attributes of the perceptions in Tables 6-8. For example, MIS education is an incubator for cultivating the digital intellectual of IT professionals, while IT professionals provide experiences of the work on digital infrastructure. Also, the COVID-19 pandemic is expected to extend the adaptable content of MIS education and stimulate effective practices of IT professionals.

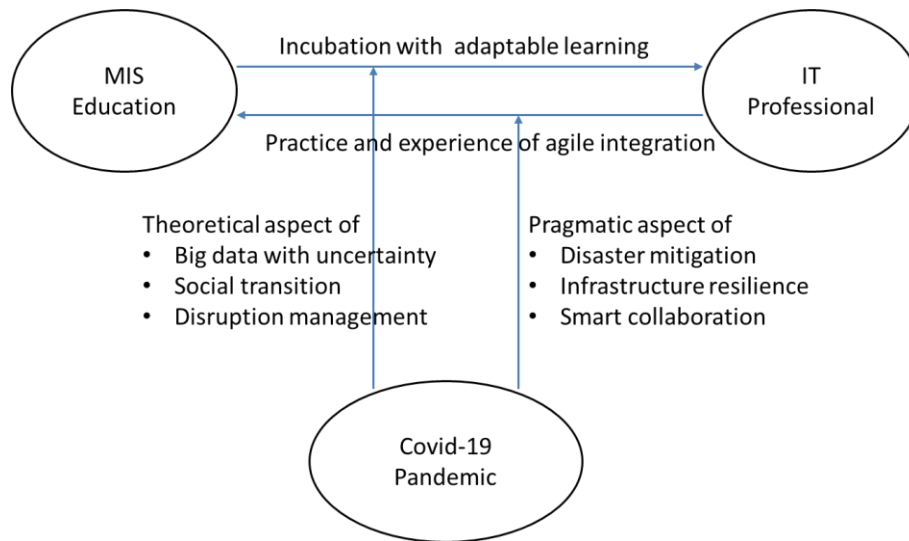


Source: This study.

Figure 2: Linking the perceptions.

### Remedying the Intruder

Figure 3 displays a framework that elaborates the challenges of the COVID-19 outbreak on the connections between MIS education and IT professionals and the stimulation of topics for MIS learning and IT practices.



Source: This study.

Figure 3: Remedying the intruder.

COVID-19 outbreaks have caused lifestyle disruption, pervasive anxiety, and public uncertainty. For MIS education, these dimensions could activate the study, such as big data with uncertainty, social transition, and disruption management. For IT professionals, these dimensions should intensify the practices of infrastructure resilience, disaster mitigation, and smart collaboration. Since the pandemic will not vanish soon, this research and practice will also continue.

Furthermore, the experience of facing COVID-19 is highly personalized and diversified. Everyone may be dealing with different problems and coping with different situations. The decision-making is required to adjust dynamically with the fast-changing environment. Therefore, making individual life transitions facing COVID-19 becomes a challenging problem.

## IMPLICATIONS

### Implications for MIS Educators and Researchers

MIS students perceive MIS education as an adaptable incubator. This implies they are aware of the fast-changing pace of the IT field and the multi-discipline nature of management. They understand the importance of continuous learning for knowledge upgrades. The content of the education needs to be adaptable to environmental changes and contingent situations. MIS education is to prepare the students toward caring intellectuals of IT and management.

The outbreak of COVID-19 incurs public uncertainty, pervasive anxiety, and lifestyle disruption. These disastrous effects will last for years. However, the pandemic also invoked great attention from IT-related academics and stimulated the reflective thinking of MIS researchers. As the relevance between the COVID-19 outbreak and MIS education programs increases, the pandemic situations will expand the knowledge domain and research area of MIS. Case studies and scenario analyses are a starting point for MIS students. The analytics of social pandemic big data is a topic combining theory and application (Bossé & Solaiman, 2018). In particular, the students are aware of the concepts of ethics and social responsibility. They expressed their volition to help with the resolution of the situation. Therefore, MIS educators may consider enhancing the discussion of topics such as big data with uncertainty (Bossé & Solaiman, 2018; Hariri *et al.*, 2019; Weng, 2020a), social transition (Haimson, 2018; Haimson *et al.*, 2021), and disruption management (Giuntella *et al.*, 2021; Zheng *et al.*, 2021).

### Implications for IT Professionals and Managers

Our results indicated that MIS students perceive IT professionals as agile integrators. In the interview dialogues, IT professionals are perceived as enablers of digital infrastructure. On top of this infrastructure, they can efficiently develop and deploy various services used by government units, manufacturers, retailers, healthcare providers, and other sectors. They are the integrators of innovative technologies for corporate and personal users (Weng & Lin, 2015). The practice and experience of IT professionals are valuable reference models of careers for MIS students. Moreover, in recent years various industry sectors are gradually upgrading into new paradigms, such as Industry 4.0 for manufacturing (Lasi *et al.*, 2014), Fintech for finance, smart healthcare (Wang *et al.*, 2018), smart retail (Weng, 2020b), and smart tourism (Koo *et al.*, 2017), among others. These industrial upgrades require the services of IT professionals to provide smart technology-empowered solutions. However, the outbreak of COVID-19 presents an unforeseen challenge to all of these industries.



For IT professionals and managers, the COVID-19 outbreak provides alerting reflection on the IT community. Whenever there is an ecological, economic, or social catastrophe, digital infrastructure becomes a critical supportive resource to continue human activities. The future practices of IT will need to strengthen competencies in contingency handling, disaster prevention, and mitigation (Ardito *et al.*, 2021; Bundy *et al.*, 2017; Reuter *et al.*, 2018), change management, and critical digital infrastructure protection (Assaf, 2008). Moreover, since IT-enabled remote collaboration will be the frequent working mode under pandemic situations, IT professionals also need to develop efficient mechanisms for productive collaboration (Weng, 2021).

### CONCLUSIONS

Our goal is to investigate how MIS students perceive the meanings and connections among their MIS education, IT professionals, and COVID-19 confrontation. A cohesive linkage among theoretical knowledge, technical skills, professional competencies, and situational problem solving is critical for MIS students' success in future careers, especially in this unusual time of the disastrous pandemic. Providing quality transition paths of practice and experience for MIS students is vital to the development of commitment and competent IT professionals facing real-world challenges. We hope these findings will not only help MIS educators fully understand the educational effectiveness of current MIS education programs but also provide recommendations for managers of organizations in their efforts to recruit and train newly graduated IT workforce.

Furthermore, although this study reported meaningful implications regarding MIS students' perceptions of MIS education, IT professionals, and COVID-19 outbreak, the validity of a proposition could not be firmly established on the basis of a single qualitative study. Further studies on this topic with other research methods and participants are recommended. Such research will help accumulate more empirical evidence for assessing and validating the results of this study.

### REFERENCES

- Ardito, L., Coccia, M., & Messeni Petruzzelli, A. (2021). Technological exaptation and crisis management: Evidence from COVID-19 outbreaks. *R&d Management*, 51(4), 381-392. doi:10.1111/radm.12455. doi:10.1111/radm.12455
- Assaf, D. (2008). Models of critical information infrastructure protection. *International Journal of Critical Infrastructure Protection*, 1, 6-14. <https://doi.org/10.1016/j.ijcip.2008.08.004>
- Bossé, É., & Solaiman, B. (2018). Fusion of information and analytics: a discussion on potential methods to cope with uncertainty in complex environments (big data and IoT). *International Journal of Digital Signals and Smart Systems*, 2(4), 279-316. doi: 10.1504/ijds.2018.10023080
- Bundy, J., Pfarrer, M. D., Short, C. E., & Coombs, W. T. (2017). Crises and crisis management: Integration, interpretation, and research development. *Journal of Management*, 43(6), 1661-1692. <https://doi.org/10.1177/0149206316680030>
- Corbin, J., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology*, 19(6), 418-427. doi: 10.1007/BF00988593
- Giuntella, O., Hyde, K., Saccardo, S., & Sadoff, S. (2021). Lifestyle and mental health disruptions during COVID-19. *Proceedings of the National Academy of Sciences*, 118(9), e2016632118. <https://doi.org/10.1073/pnas.2016632118>
- Haimson, O. (2018). Social Media as Social Transition Machinery. *Proceedings of the ACM on Human-Computer Interaction*, 2(CSCW), 2, 1-21. doi: 10.1145/3274332
- Haimson, O. L., Carter, A. J., Corvite, S., Wheeler, B., Wang, L., Liu, T., & Lige, A. (2021). The major life events taxonomy: Social readjustment, social media information sharing, and online network separation during times of life transition. *Journal of the Association for Information Science and Technology*, 72(7), 933-947. <https://doi.org/10.1002/asi.24455>
- Hariri, R. H., Fredericks, E. M., & Bowers, K. M. (2019). Uncertainty in big data analytics: survey, opportunities, and challenges. *Journal of Big Data*, 6(1), 1-16. doi: 10.1186/s40537-019-0206-3
- Koo, C., Park, J., & Lee, J.-N. (2017). Smart tourism: Traveler, business, and organizational perspectives. *Information & Management*, 54(6), 683-686. <https://doi.org/10.1016/j.im.2017.04.005>
- Lasi, H., Fettke, P., Kemper, H.-G., Feld, T., & Hoffmann, M. (2014). Industry 4.0. *Business & Information Systems Engineering*, 6(4), 239-242. doi: 10.1007/s12599-014-0334-4
- Reuter, C., Hughes, A. L., & Kaufhold, M.-A. (2018). Social Media in Crisis Management: An Evaluation and Analysis of Crisis Informatics Research. *International Journal of Human-Computer Interaction*, 34(4), 280-294. doi: 10.1080/10447318.2018.1427832
- Taylor, C., & Dewsbury, B. M. (2018). On the Problem and Promise of Metaphor Use in Science and Science Communication. *Journal of Microbiology and Biology Education*, 19(1), 19.11.46. doi: 10.1128/jmbe.v19i1.1538
- Thibodeau, P. H., Hendricks, R. K., & Boroditsky, L. (2017). How linguistic metaphor scaffolds reasoning. *Trends in cognitive sciences*, 21(11), 852-863. doi: 10.1016/j.tics.2017.07.001
- Tuli, S., Tuli, S., Tuli, R., & Gill, S. S. (2020). Predicting the growth and trend of COVID-19 pandemic using machine learning and cloud computing. *Internet of Things*, 11, 100222. doi:10.1016/j.iot.2020.100222
- Wang, Y., Kung, L., Wang, W. Y. C., & Cegielski, C. G. (2018). An integrated big data analytics-enabled transformation model: Application to health care. *Information & Management*, 55(1), 64-79. <https://doi.org/10.1016/j.im.2017.04.001>
- Weng, W.H. (2020). Impacts of competitive uncertainty on supply chain competence and big data analytics utilization: An information processing View. In Proceedings of The 20th International Conference on Electronic Business (pp. 181- 190). ICEB'20, Hong Kong SAR, China, December 5-8.

- Weng, W. H. (2020). Internet of things utilization in marketing for competitive advantage: an organizational capability perspective. In *Proceedings of The 20th International Conference on Electronic Business* (pp. 200- 209). ICEB'20, Hong Kong SAR, China, December 5-8.
- Weng, W. H. (2021). Examining impact factors for the sustainability of information systems: A relational perspective. In *2021 IEEE International Conference on Social Sciences and Intelligent Management (SSIM)* (pp. 1-4). IEEE, Taichung, Taiwan, August.
- Weng, W. H., & Lin, W. T. (2015). A mobile computing technology foresight study with scenario planning approach. *International Journal of Electronic Commerce Studies*, 6(2), 223-232. doi: 10.7903/ijecs.1242
- Whitelaw, S., Mamas, M. A., Topol, E., & Van Spall, H. G. C. (2020). Applications of digital technology in COVID-19 pandemic planning and response. *The Lancet Digital Health*, 2(8), e435-e440. [https://doi.org/10.1016/S2589-7500\(20\)30142-4](https://doi.org/10.1016/S2589-7500(20)30142-4)
- Zheng, R., Shou, B., & Yang, J. (2021). Supply disruption management under consumer panic buying and social learning effects. *Omega*, 101, 102238. doi: 10.1016/j.omega.2020.102238