

Modelling the Utilization of Digital Technology in Education During the COVID-19 Pandemic Through an Expert-Based Analytic Tool

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ABSTRACT

The coronavirus disease (COVID-19) pandemic has threatened the capability of academic institutions to continuously deliver quality education despite the worldwide lockdown implemented to curb the transmission of the dreaded disease. As a result, institutions are forced to take advantage of supplementary digital technology to support online learning. Recognizing that an expert-based approach is deemed necessary to carefully execute the decision-making process of utilizing digital technology, this paper provides a new perspective of assessing the constructs of digital technology utilization with the use of fuzzy decision-making trial and evaluation laboratory (DEMATEL). Among the constructs considered, burnout (BO), technostress (TS), goal incongruence (GI), and reflexivity (RE) are found to be effects of other causal constructs. These findings offer crucial insights into the evolving literature of COVID-19 on education, particularly on informing the design of initiatives and measures to support the use of digital technologies as may be necessary.

KEYWORDS

Continuance Intention, COVID-19 Pandemic, DEMATEL, Digital Education, Educational Technology, Fuzzy Set Theory

1. INTRODUCTION

The coronavirus disease (COVID-19) lockdowns across the world have compelled economies to confront crucial challenges, inevitably disturbing the pedagogical sphere, with adverse consequences

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for teachers, who have had to work remotely from their workplaces (e.g., schools and universities; see Hasan & Bao, 2020). Although governments intended to slowly restart the economy after a short lockdown period, it was found that suspending physical classes at schools was a crucial measure in curbing coronavirus transmissions and stopping healthcare facilities from being overwhelmed (Ocampo & Yamagishi, 2020). Given such drastic conditions, other viable means to sustain the functioning of crucial infrastructures (e.g., education) were explored in ways unprecedented in recent history. Consequently, distance education gathered momentum as the only immediate solution for supporting suppressed activities, and communication technologies became crucial means of sustaining various community functions, including schools and all areas of work. In the education sector, these instant and undoubtedly startling transformations may have caused a range of challenges to the success of both teachers and students (Rapanta et al., 2020).

The massive shift from traditional offline teaching to online mode has brought some challenges to higher education institutions (HEIs) in delivering quality education (Sahu, 2020; Bao, 2020). Some of these challenges include student performance assessment (Al-Amin et al., 2020), hands-on experience, and other activities which can only be performed by being physically within the campus (e.g., laboratory work, visits to the library, tutoring, remedial teaching, and research and collaboration; see Mishra et al., 2020), distance, scale, and personalized teaching and learning (Dhawan, 2020), among others. In developing economies, HEIs have experienced policy paralysis in education around planning, management, and organization due to their poor technical infrastructure, academic incompetency, and lack of resources (Thomas, 2020). Moreover, technology, culture, practices, skills and competencies, individual values, and attitudes are also considered barriers to the digital transformation of HEIs (Vial, 2019). As of this writing, most HEIs, if not all, are still closed in 177 countries, a condition that has affected more than one billion students globally, or 72.4% of total enrolled learners (UNESCO, 2020). With these closures, the COVID-19 crisis has increased virtual mobility and collaborative online learning in HEIs to 60% (Mbyinoni et al., 2020). Thus, because of sudden shifts in operations, HEIs are confronted with stressful circumstances in responding to the COVID-19 crisis while pushing through the academic year (Marinoni et al., 2020). For one thing, online courses require intricate lesson plan design, teaching materials (e.g., audio-visual materials), and technical support teams (Bao, 2020), for which many HEIs, particularly those in developing countries, lack the required training and infrastructure. Those in academe have been abruptly confronted with concerns about the lack of online teaching practice and training, slow internet speed, WIFI coverage, interface design, quality content, system use, and students' adoption of systems, and technical infrastructure in rural areas, among others (Azhari & Ming, 2015; Shahzad et al., 2020). Given these conditions, academics need to be trained in the learning management systems and/or other digital platforms provided by the HEIs through a plethora of lectures, webinars, and tutorials to effectively use these tools (Donitsa-Schmidt & Ramot, 2020).

Digital transformation created significant changes by combining information, communication, and connection of technologies (Vial, 2019). In the context of HEIs, digital transformation must embrace all digital processes needed to provide them with the right opportunities to optimize the use of digital technologies (Kopp et al., 2019). To effectively cope with the challenges in teaching-learning processes during the COVID-19 pandemic, HEIs must equip teachers and students with the necessary knowledge and tools (Donitsa-Schmidt and Ramot, 2020). Even before the outset of the pandemic, the online education market had grown and was projected to increase by 16.4% annually from 2016 to 2023. With the growth of the Internet, it is projected that teaching-learning models in higher education will continually evolve over the next 10 to 15 years (Shahzad et al., 2020). However, having been forced to undergo such a drastic shift, academics tend to have an adverse response to the abrupt and compulsory use of digital technology. During times of pandemic, learning can be effectively delivered if academics can continually teach productively. Thus, HEIs may foster the motivation of academics to sustain digital education (and that motivation may be external or intrinsic, cognitive or affective, positive or negative; see Panisoara et al., 2020). There may be factors that affect

academics' willingness to continue digital education technology during a crisis, which is marked by varied emotions and uncertainty in their environment (Panisoara et al., 2020). The digital education technology environment brought about by crisis conditions differs significantly from a naturally evolved and carefully planned environment that embraces digital education.

1.2 The Impact of the Pandemic on HEIs

There is extensive literature on COVID-19 in the context of HEIs. Notable works include that of Shahzad et al. (2020), who proposed a framework to determine e-learning portal success. They examined the impact of information, system, and service quality on user satisfaction and the impact of the e-learning system used on the e-learning portal's success. Mishra et al. (2020) highlighted the perception of teachers and students of the online teaching-learning process during the COVID-19 pandemic. They addressed the need for online teaching-learning amid the pandemic and the ways HEIs can use existing resources to shift from offline to online education with online tools. Other works in this category include studies of online teaching strategies (Mishra et al., 2020; Bao, 2020; Shahzad et al., 2020; Neuwirth et al., 2020), students' perceptions (Chandra, 2020; Aristovnik et al., 2020; Hebebe et al., 2020), challenges and opportunities (Donitsa-Schmidt & Ramot, 2020; Neuwirth et al., 2020; Mishra et al., 2020; Adedoyin & Soykan, 2020; Brammer & Clark, 2020), education responses (Azorín, 2020; Crawford et al., 2020; Assunção & Gago, 2020; Quezada et al., 2020; Zhu & Liu, 2020), digital readiness (Händel et al., 2020; Zalite & Zvirbule, 2020), online assessment (Joshi et al., 2020; García-Peñalvo et al., 2021), digital transformation (Iivari et al., 2020), and mobile learning (Naciri et al., 2020). The list keeps evolving dramatically as new insights and a better understanding of various domains become available. Overall, these studies have analyzed how stakeholders, including the teachers and students who are primarily affected by the shift in the educational system in HEIs, can cope with such a change.

Some works focused on how readily teachers and students adopted digital education technology; they found that cognitive and affective factors were critical in absorbing the adverse effects of the unexpected exponential increase in the use of technology in the teaching-learning process. Because digital education technology has become a primary tool to support education in HEIs during the pandemic, an examination of the factors affecting adoption of digital education technology has become even more important. For instance, König et al. (2020) reported that the information and communication technology tools, digital competence, and digital learning opportunities of teachers contribute to the adoption of digital education technology during COVID-19. Tandon (2020) developed a theoretical model emphasizing online teaching adoption factors during the COVID-19 outbreak, affirming that performance expectancy and facilitating conditions positively impact behavioral intention and attitude. In addition, effort expectancy failed to drive teachers' adoption of online teaching, and social influence had a significant relationship with behavioral intention but had an insignificant relationship with attitude. Ho et al. (2020) proposed a research model comprising five exogenous variables that affected students' acceptance of e-learning during the pandemic. These variables included computer self-efficacy, interpersonal influence, external influence, system interactivity, and content feature, integrated among three endogenous variables: perceived ease of use, perceived usefulness, and attitude toward the use of e-learning system.

As better perspectives on the phenomenon come forward, the evolving literature is starting to embrace the integration of feelings or emotions (i.e., positive or negative) into the continuing usage of digital educational technology during unstable circumstances such as COVID-19 (Al-Marroof et al., 2020; Panisoara et al., 2020). For instance, Al-Marroof et al. (2020) explored the effect of fear on students' and teachers' technology adoption during the COVID-19 pandemic. They found out that fears (i.e., fear due to a family lockdown situation, fear of education failure, and fear of losing social relationships) significantly impacted perceived ease of use, perceived usefulness, and subjective norm. On the other hand, Panisoara et al. (2020) explored motivation and continuance intention for digital education technology. They proposed a model derived from self-determination theory, job demands-

resources model, and technology acceptance model (TAM) to describe the overarching relationships of teachers' cognitive and affective constructs with teachers' continued exposure to digital platforms in carrying out the teaching-learning process. These constructs were used in describing teachers' continued intention to use digital education technology. The constructs included technological pedagogical knowledge self-efficacy, intrinsic motivation, extrinsic work motivation, occupational stress (i.e., BO and TS), and continuance intention. Using these constructs, the researchers were able to empirically assess the relationships between emotional and motivational factors and the continuous use of digital education technology during COVID-19. The impressive results offered crucial insights into how motivational factors relate to occupational stress in the constant adoption of digital education in a disruptive environment.

1.3. Gaps in the Literature

Among the research works which focused on integrating the construct of feelings or emotions into the continuing usage of digital educational technology amid the pandemic, the work of Panisoara et al. (2020) has opened interesting avenues for further study. Despite the integrative model of Wei et al. (2010), a few reservations could be observed. First, although popular, the use of structural equation modelling (SEM—adopted by Panisoara et al., 2020) as a means for causal relationship analysis sometimes, if not often, results in some fallacies due to model modification, as discussed by Wei et al. (2010). Wei et al. explained that models in SEM were often modified for better fitness, given most observations that the “data may be inconsistent with the initially hypothesized model.” Such scenarios may lead researchers to model trimming via critical ratios or modification indices (Wei et al., 2010). Chin (1998) provided some details to expose this problem. It was observed that most initial models under consideration were rejected, forcing the researchers to continuously change and re-estimate the model until it fit the data. Arbuckle and Wothke (1999) and Sellin (1990) criticized such a practice of modification and argued that relevant ratios and indices must not be treated as definitive guides. Without any theoretical support, Wei et al. (2010) provided a list of fallacies that may affect model results and insights. This line of argument on the drawbacks of using SEM was well amplified by Jeng and Tzeng (2012).

Second, empirical investigations via SEM involve a large number of samples, and most established models—e.g., TAM, Unified Theory of Acceptance and Use of Technology (UTAUT)—for evaluating technology systems (e.g., digital educational technologies) require that these samples completely understand these systems (Jeng & Tzeng, 2012). Such prerequisites are not often met, resulting in empirical models that insufficiently analyze causal relationships via SEM (Jeng & Tzeng, 2012). Third, Hsieh et al. (2012), citing the decomposed theory of planned behavior (DTPB) as an example, claimed that the assumption of independence of variables often induces incomplete representation of relationships. According to Hsieh et al. (2012), most models (e.g., DTPB) evaluate only the effects of variables, leaving the cause-and-effect relationships among variables out of the analysis. The model proposed by Panisoara et al. (2020) may suffer from such a limitation. To initiate an argument, consider two constructs: technological pedagogical knowledge self-efficacy and continuance intention. In the hypothesized model of Panisoara et al. (2020), the former has a significant positive effect on continuance intention. However, it is reasonable to assert that over time, with the continuous intention of use and the actual use of educational technologies, technological pedagogical knowledge will possibly gain additional momentum. This kind of feedback causal loop fails to be represented by Panisoara et al. (2020). Finally, with an intention to model only the continuance intention of use, the identification of crucial constructs for adopting digital educational technologies was not explored. By carefully analyzing the crucial constructs associated with adopting digital educational technologies, a more refined guideline can be provided to the stakeholders such that the eventual adoption (or nonadoption) can be clearly outlined.

Furthermore, the constructs identified by Panisoara et al. (2020) (i.e., technological pedagogical knowledge self-efficacy, intrinsic motivation, extrinsic motivation, BO, TS, continuance intention) can

be extended to include other constructs that are deemed necessary to evaluate the overall adoption of digital educational technologies. Extending the list of initial constructs allows a more comprehensive view of the problem area to be explored and makes it possible to draw better insights. Such constructs include incentives (Bhattacharjee, 2001), goal incongruence (Alter, 2015), accessibility (Aguilera-Hermida, 2020), and reflexivity (Kahn et al., 2017).

Given the preceding arguments and research gaps, the main departure of this work is to advance the methodological process of evaluating the model of Panisoara et al. (2020) by way of an expert-opinion-oriented analytical approach—the decision-making trial and evaluation laboratory (DEMATEL). Developed in the 1970s by the Geneva Research Centre of the Battelle Memorial Institute (Gabus & Fontela, 1972), DEMATEL handles a complex system of elements connected by causal relationships, borrowing its efficacy from the principles of graph theory and linear algebra (Gabus & Fontela, 1973). It highlights (1) determining the causal relationships among elements in a network (e.g., constructs in a set of constructs) and (2) clustering these elements into the net cause and net effect groups. DEMATEL is a practical and useful tool for visualizing the structure of complex causal relationships of elements and organizing them into an intelligible structural model (Wei et al., 2010). With DEMATEL the constructs associated with the adoption of digital educational technology can be better understood, and stakeholders are more directed to address constructs that are particular to the nature of this area of study.

The use of DEMATEL in solving practical problems has been widespread for the last two decades. In the education sector, applications of DEMATEL are limited; they include strategic management (Özdemir & Tüysüz, 2017), performance evaluation (Supeekit et al., 2016; Zhang et al., 2021), and e-learning (Muhammad & Cavus, 2017; Jeong & González-Gómez, 2020). Note that this list is not intended to be comprehensive. Some COVID-19-related applications of DEMATEL have already been introduced in the current literature, except for education applications (see Kashyap & Raghuvanshi, 2020; Dizbay & Öztürkoglu, 2020; Maqbool & Khan, 2020; Altuntas & Gok, 2020; Ocampo & Yamagishi, 2020). On the basis of the arguments of Wei et al. (2020) regarding the drawbacks of SEM in causal modelling, various attempts were reported on the use of the DEMATEL approach in evaluating some popular models, including TAM (Chang & Chen, 2018; Chen, 2018; Nguyen et al., 2020), UTAUT (Jeng & Tzeng, 2012; Liao & Chen, 2020), DTPB (Ullah et al., 2021; Hsieh et al., 2018), among others. Sheng-Li et al. (2018) provided a thorough review of the methodologies and applications of DEMATEL during the last decade.

As an expert-oriented analytic tool, DEMATEL contains inherent uncertainty, particularly in the judgment elicitations of human experts within its framework. In handling this uncertainty so that crucial information was dealt with, the current study adopted the generalization of the fuzzy set theory developed by Zadeh (1965). Here, the fuzzy set theory introduces a membership function that has been extensively applied in various contexts, along with other extensions, such as in the insurance industry (Shi et al., 2019), green supply chain (Lin et al., 2018), the management of sustainable solid waste (Abdullah et al., 2019), location selection (Karaşan & Kahraman, 2019), knowledge transfer (Khan et al., 2021), enterprise resource planning (Tooranloo et al., 2018), recycling (Gan & Luo, 2017), and a recently reported policy analysis for COVID-19 lockdown measures (Ocampo & Yamagishi, 2020). Note again that this list is not intended to be comprehensive.

Given the efficacy of DEMATEL in modelling causal relationships, this study advances beyond the proposed model of Panisoara et al. (2020) by offering a different methodological perspective, an expert-based analytic causal modelling approach based on fuzzy DEMATEL. Additionally, the constructs presented by Panisoara et al. (2020) are extended to include other relevant constructs that can also affect the overall adoption of digital educational technology amid the pandemic. In this work, the six constructs (namely, technological pedagogical knowledge self-efficacy, intrinsic motivation, extrinsic motivation, BO, TS, and continuance intention) identified by Panisoara et al. (2020) were adopted in constructing a structural model using fuzzy DEMATEL. In contrast to SEM, the proposed methodology provides the following innovations: (1) it uncovers hidden causal relationships among

constructs; (2) aside from the direct effects of one construct on another, it takes into consideration the indirect effects among constructs, which would then generate total relations; (3) it identifies critical constructs for decision-making; (4) it provides a better understanding of complicated and intertwined problems, instrumental in an exploratory mode of analysis; and (5) it addresses technical problems (e.g., those concerning digital education technologies) with limited sample sizes. This work advances the evolving literature of COVID-19 on education by providing a structural model based on expert analysis of the continuance intention of academics in higher education to use digital education technologies.

The remainder of this paper is arranged as follows: Section 2 presents a brief background of fuzzy set theory and DEMATEL. The proposed methodology is described in Section 3. Section 4 details the results and the findings. The paper ends with a conclusion and discussion of future work in Section 5.

2. PRELIMINARIES

2.1. Fuzzy Set Theory

In traditional multicriteria decision-making (MCDM) methods, the concept of fuzzy set theory has been widely applied to incorporate the vagueness of human perception in decision making, especially when constructs considered are subjective in the first place (Kuo, 2011). When this concept is used, decision makers' subjective judgment during evaluation is captured more effectively and developed better. We refer the readers to the original work of Zadeh (1965) for a full discussion of fuzzy set theory.

The basic and useful concepts of fuzzy set theory are presented as follows.

Let X be a universal set and let $A \subseteq X$. Suppose that A is a standard fuzzy set such that there exists a membership function $\mu_A(x)$ and $\mu_A(x): X \rightarrow [0,1]$. The set of a 2-tuple $A = \{x, \mu_A(x) : x \in [0,1]\}$ is considered as a fuzzy set where x is a member of A and $\mu_A(x)$ is the membership function of $x \in A$. Furthermore, the triangular fuzzy number being $A = (l, m, u)$ is a triplet, and the membership function of such triplet follows the expression in Equation (1):

$$\mu_A(x) = \begin{cases} 0 & x < l \\ (x-l)/(m-l) & l \leq x \leq m \\ (u-l)/(u-m) & m \leq x \leq u \\ 0 & x > u \end{cases} \quad (1)$$

Then the universe of discourse, X , can be defined such that $l, m, r \in \mathbb{R}, \mu_A(x) \rightarrow [0,1]$.

2.2. The DEMATEL Method

Developed by the Battelle Memorial Institute of Geneva for a Science and Human Affairs Program in the 1970s, the DEMATEL method is a tool based on graph theory that considers a system as a graph, where elements or concepts and the causal relationships among these elements are represented as vertices and edges, respectively. It achieves two objectives: (1) to determine the total causal relationships among elements based on direct and indirect relations and (2) to categorize these elements into the net cause and net effect groups. In DEMATEL, elements take on both cause and effect roles, and the final categorization assigns each element a superior role, either cause or effect. These objectives of the DEMATEL enable a better understanding of the elements or concepts under consideration, which are often intertwined in convoluted problems (Gabus & Fontela, 1972; Gabus & Fontela, 1973).

The computational algorithm of DEMATEL is briefly described in the following steps (Bongo & Ocampo, 2016):

1. **Generate the direct-relation matrix.** A group of experts is tasked with assessing the influence of various parameters. For comparing criteria, a scale of 0 to 4 is employed, from “no influence,” “low influence,” “medium influence,” “high influence,” and “very high influence”, respectively. The results of evaluating the influence of i^{th} criterion on the j^{th} criterion, $\forall i = 1, 2, 3, \dots, j-1, j+1, \dots, n$, form an initial direct-relation matrix of the k^{th} decision-maker, which is denoted by $Z^k = (z_{ij}^k)_{n \times n}$. It is represented by the following expression in Equation (2):

$$Z^k = \begin{bmatrix} z_{11}^k & \cdots & z_{1j}^k & \cdots & z_{1n}^k \\ \vdots & & \vdots & & \vdots \\ z_{i1}^k & \cdots & z_{ij}^k & \cdots & z_{in}^k \\ \vdots & & \vdots & & \vdots \\ z_{n1}^k & \cdots & z_{nj}^k & \cdots & z_{nn}^k \end{bmatrix}, k = 1, 2, \dots, K \quad (2)$$

2. **Aggregate initial direct-relation matrices** Z^k using Equation (3) where $\beta_k \rightarrow [0, 1], \beta_k \neq 0$ is the importance weight of the k^{th} decision-maker where $\sum_{k=1}^K \beta_k = 1$. Z is known as the average matrix.

$$Z = (z_{ij})_{n \times n} = \beta_1 Z^1 + \beta_2 Z^2 + \dots + \beta_m Z^m \quad (3)$$

3. **Normalize the average matrix.** Equation (4) through Equation (6) can be used to calculate the normalized direct-relation matrix, where all primary diagonal members are equal to zero.

$$Y = \frac{1}{g} Z \quad (4)$$

$$g = \max \left(\max_{1 \leq i \leq n} \sum_{j=1}^n |z_{ij}|, \max_{1 \leq j \leq n} \sum_{i=1}^n |z_{ij}| \right), i, j \in \{1, 2, 3, \dots, n\}, \quad (5)$$

$$\lim_{i \rightarrow \infty} Y^i = [0]_{n \times n} \text{ where } Y = [Y_{ij}]_{n \times n}, 0 \leq y_{ij} < 1. \quad (6)$$

4. **Obtain the total relation matrix.** After obtaining the normalized direct-relation matrix, a steady decline in the indirect effects of problems along the powers of Y , e.g. $Y^1, Y^2, \dots, Y^\infty$ guarantees convergent solutions to the matrix inversion. The total-relation matrix $T = (t_{ij})_{n \times n}$ can be derived by using Equation (7), where I is denoted as the identity.

$$T = Y + Y^2 + Y^3 + \dots = \sum_{i=1}^{\infty} Y^i = Y(I - Y)^{-1} \quad (7)$$

5. **Compute the values of influence and relation.** Levels of influence on others and levels of interactions with others are defined as illustrated in Equation (8) through Equation (9) using the values of D and R , where D is the sum of columns and R is the sum of rows in a matrix, as shown in Equation (10). Some criteria have positive values and consequently significantly impact other criteria. These criteria are known as dispatchers, while others have negative values and are thus influenced substantially by other criteria. These are called receivers. The value $D + R$ indicates the degree of relationship between each criterion and other criteria. Criteria having greater values of $D + R$ have stronger relationships with other criteria, while those having smaller values of $D + R$ have lesser relationships with others.

$$T = [t_{ij}]_{n \times n}, i, j \in \{1, 2, 3, \dots, n\}, \quad (8)$$

$$D = \left[\sum_{j=1}^n t_{ij} \right]_{n \times 1} = [t_i]_{n \times 1} \quad (9)$$

$$R = \left[\sum_{i=1}^n t_{ij} \right]_{1 \times n} = [t_j]_{1 \times n} \quad (10)$$

6. **Set a threshold value to obtain the influence-relation map.** The decision maker must specify a threshold value for the influence level in order to obtain an adequate influence-relation map. Only those elements with a matrix influence level larger than the threshold value can be selected and translated into the influence-relation map. The threshold value can also be calculated using Equation (11). The influence-relation map is acquired by mapping the dataset of $(D + R, D - R)$ where the horizontal axis is $D + R$ and the vertical axis is $D - R$.

$$\alpha = \frac{\sum_{i=1}^n \sum_{j=1}^n [t_{ij}]}{N} \quad (11)$$

where N is the number of elements in matrix T .

3. METHODOLOGY

The proposed fuzzy DEMATEL approach for modelling the utilization of digital education technology is described in the following steps:

1. **Identify the constructs that comprise the model.** The proposed constructs that best describe the intention to use digital educational technology during the COVID-19 pandemic were obtained from Panisoara et al. (2020). In summary, Table 1 presents the constructs, along with the codes for the brevity of the presentation and corresponding brief descriptions. These include technological pedagogical knowledge self-efficacy (TPK-SE), intrinsic motivation (IM), extrinsic motivation (EM), burnout (BO), technostress (TS), continuance intention (CI), incentives (IN), goal incongruence (GI), accessibility (AC), reflexivity (RE).
2. **Set up the initial direct-relation matrices in linguistic variables.** An expert group of 10 academics with extensive background and experience in using digital educational technologies elicited judgments on the causal relationships among constructs. These academics were all working as teachers under the Philippine Department of Education, ranging from Teacher II ($N = 3$) to Teacher III ($N = 7$) positions. The average length of experience holding academic positions was 8.80 years. These academics had been working in a work-from-home arrangement since the COVID-19 pandemic started, engaging in the use of online learning and flexible learning systems. Also, they were involved in research in various areas (e.g., education, technology management, business management, information and communication technology, management science, and tourism).

Table 1. Constructs on utilizing digital education technology

Code	Construct	Description	References
TPK-SE	Technological pedagogical knowledge self-efficacy	teachers' belief in their ability to execute their domain-general knowledge of how educational technology can be applied to support students' learning during teaching	Fernet et al. (2012); Roca and Gagne (2014); Abdullah and Ward (2016); Ghita (2019); Koehler and Mishra (2009); Scherer et al. (2018)
IM	Intrinsic motivation	a determinant of action in which a person becomes involved due to their interest	Ryan and Deci (2000); Deci and Ryan (2010)
EM	Extrinsic motivation	a determinant of action in which a person performs an action to fulfill social expectations and to avoid sanctions or to comply with external control	Schmuck et al. (2000); Fernet et al. (2008)
BO	Burnout	the syndrome of emotional exhaustion, depersonalization, and reduction of personal achievement that can occur among people who "work with people" of any kind	Maslach and Jackson (1981); Droogenbroeck et al. (1981); Colomeischi (2015)
TS	Technostress	the condition of improper adaptation caused by the failure of people to cope with technology and the changes in requirements related to the use of technology, which generate psychological and physical stress	Brod (1984); Jena (2015)
CI	Continuance intention	the post-acceptance behavior in which people regard the use of technology as an important educational and cognitive choice	Kim (2010); Hooi and Choi (2017)
IN	Incentives	monetary or non-monetary rewards that may have a positive influence on e-learning continuance intentions	Bhattacharjee (2001)
GI	Goal incongruence	the degree to which the goals of principal and agents differ	Alter (2015)
AC	Accessibility	the ease with which a student can access reliable internet and use of cloud applications and mobility, defined as the students' ability to use devices without any time or place restriction	Aguilera-Hermida (2020)
RE	Reflexivity	the ordinary mental capacity to consider oneself in relation to one's social setting	Kahn et al. (2017)

Note that this work takes a position from Yin's analytic generalization point of view (1994). Analytic generalization, as described by Yin (1994), is considered an approach whose purpose is to support, contest, extend, refine, or elaborate theoretical propositions, in contrast to the more familiar statistical generalization, which generally describes the population from a well-defined randomly generated sample. Since analytic generalization addresses theoretical propositions, it makes the findings of this work generalizable from theoretical perspectives (Ocampo & Promentilla, 2016; Medalla et al., 2020). Analytic generalization has a strong alignment to purposive sampling as the dominant data acquisition technique; therefore from the perspective of analytic generalization, a small group of decision makers (i.e., the five experts in this study) is sufficient to generate crucial insights that describe the utilization of digital education technologies. It is noteworthy that the findings may not necessarily resonate with all academics; these experts contribute to providing a better theoretical understanding of the topic. This method of choice is consistent with the DEMATEL-based works of Ancheta et al. (2018), Bongo et al. (2018), Bongo and Ocampo (2018), Ocampo et al. (2018a, b), Medalla et al. (2020), Ocampo et al. (2020), and Ocampo and Yamagishi (2020), among others. The members of this expert group were asked to individually generate initial direct-relation matrices using the evaluation scale (i.e., in linguistic variables) as shown in Table 2 (in linguistic scale) and Table 3 (in initial direct-relation matrix).

3. **Defuzzify individual initial direct-relation matrices of experts.** At this point, the initial direct-relation matrices that correspond to the individual judgment made by experts were defuzzified using the signed distance method to generate crisp data points with respect to each set of fuzzy numbers. The formula for the signed distance method was as follows. The defuzzified initial direct matrix is presented in Table 4.

$$d(\tilde{A}, 0) = \frac{l + 2m + u}{4}$$

4. **Aggregate the judgment of experts.** Here, the direct-influence matrices were aggregated as in Table 5 (in fuzzy numbers) and Table 6 (in crisp values) in order to get a unified evaluation with respect to one criterion for another.
5. **Normalize the average matrix.** Using Equation (4) through (6), the normalized direct-relation matrix was computed. Table 7 shows the results after normalizing the aggregated matrix.
6. **Analyze results.** The normalized average matrix was further evaluated to obtain the r and s vectors, which were later used to identify the category of criteria. Table 8 presents the vectors and the classification of each criterion.

4. RESULTS AND DISCUSSION

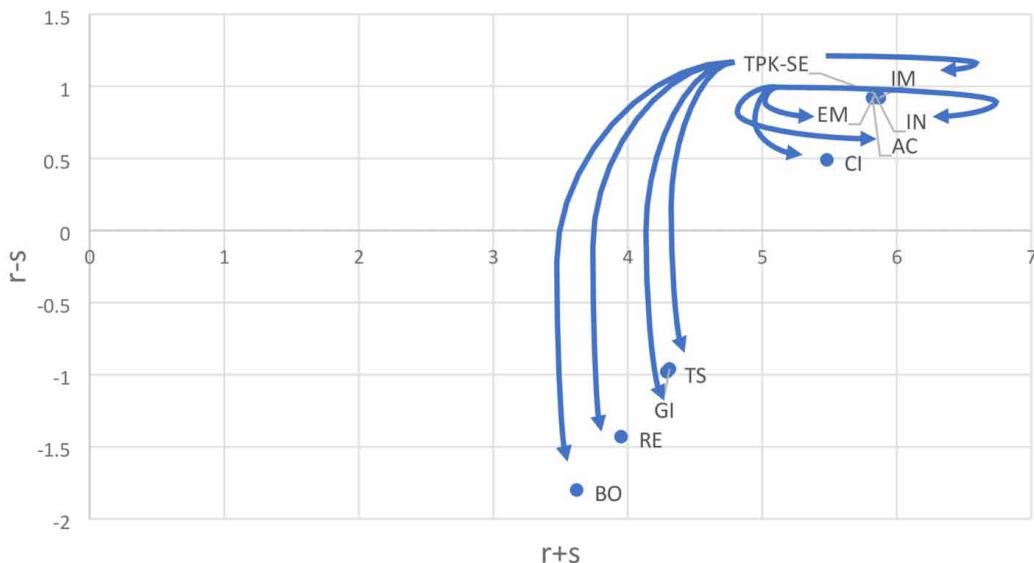
The implementation of fuzzy DEMATEL to analyze the constructs presented by Panisoara et al. (2020) brought together relevant insights that can be used to understand the domain at a closer level. Following the proposed fuzzy DEMATEL methodology, Table 2 presents a sample initial direct-relation matrix in linguistic variables assessed by one expert. These linguistic scale ratings were then converted into their corresponding fuzzy numbers, as shown in Table 3. In addition, the initial direct-relation matrix was converted into crisp values for better analysis and ease of computation (see Table 4). Once the initial direct-relation matrix of each expert was completed, it was then aggregated, as seen in Table 5, and further translated into crisp values, as seen in Table 6. Lastly, Table 7 presents the normalized direct-influence matrix, and Table 8 shows the relations among constructs. The values in Table 2 through Table 6 still do not provide a meaningful implication. However, these are necessary to produce the results shown in Table 7 through Table 8.

Notice that in Table 7, where this matrix is presented, there are cells that are highlighted which represent significant influence on and from criteria. For instance, TPK-SE can be found to have a significant influence on all other criteria, which further supports its being a causal criterion (e.g., the second row of Table 7). On the other hand, since no highlighted cells are evident in the row under BO, this means that this construct does not have any significant influence on any of the constructs (e.g., fifth row of Table 7). These results serve as very important insights to decision makers in the move to attend to criteria that have a significant impact on others. Such information is particularly useful for prioritization—that is, ensuring that resources are properly allocated only to constructs that significantly influence others.

The influential relations map in Figure 1 was developed from the results generated in Table 8 to give a visual representation of the vector values in $r + s$ and $r - s$. This figure is discussed in light of the findings of Panisoara et al. (2020) and the relevant literature. Note that for brevity purposes, the influential relations map was prepared for TPK-SE only, in order to illustrate the significant relations among constructs as specified in Table 6. It was found that TPK-SE has a significant causal relation to CI, which supports the finding of Panisoara et al. (2020). This implies that when teachers or academics have a higher degree of belief in their ability to deliver instruction through digital modes, continuance intention to subscribe to such modes would also be higher. Figure 1 also shows that intrinsic motivation is causally related to continuance intention, supporting Panisoara et al. (2020). Also, extrinsic motivation is associated with continuance intention, which implies that rewards and penalties imposed by universities effectively encourage CI. However, the insight regarding extrinsic motivation was not supported by Panisoara et al. (2020).

In terms of the affective factors (e.g., EM's causing BO and TS), this finding is consistent with many studies in the domain literature. For instance, Chang et al. (2015) also found that as EM increases, academic BO among students also increases. Other applications outside the education sector also support the finding that EM significantly affects BO (Margaretha, 2019; Kim, 2018). With universities closing gates, academics have been compelled to abruptly shift to adopt digital education technologies in the teaching-learning process, even though some of them have lacked the necessary skills and training for such use. This requirement, coupled with other, sometimes drastic

Figure 1. Influential map of TPK-SE to other constructs



measures taken by universities, have directly resulted in BO and TS. This insight is also supported by Panisoara et al. (2020). Intrinsic motivation (IM), on the other hand, does not significantly cause burnout, as supported by most literature. As illustrations parallel of this finding, the works of Pedersen et al. (2021), Khan et al. (2020), and Lyndon et al. (2017), to name a few, further point out that IM is negatively associated with BO in the context of general practitioners, medical students, and employees, respectively. In short, IM does not significantly cause BO. It is worth emphasizing that even in various research works involving different cohorts, the same realization is derived—that is, IM is not a factor that leads to BO. In fact, Alotiby (2022) highlighted that with sheer and sound IM, students can be better protected from BO. Overall, while there is a plethora of studies in the literature proving that IM is negatively associated with BO, the variation found within these works should be taken with caution and not generalized to all cases, specifically among students. Furthermore, it is imperative to note that students experience BO differently because of other mediating factors such as self-efficacy, learning profile, academic engagement, and other stressors (Asikainen et al., 2020; Salmela-Aro & Read, 2017; Maslach & Leiter, 2016; Rahmati, 2015).

However, IN induces TS. This result implies that despite strong interest in the use of digital technology, sustained exposure to digital platforms causes fatigue and stress, particularly in the presence of poor infrastructures (e.g., poor WIFI connection and defective computer sets). Such a finding is consistent with Panisoara et al. (2020). Finally, parallel to the insights of Panisoara et al. (2020), along with other findings in the literature, TPK-SE is causally associated with IM, an association that is indicated by a feedback loop. This implies that as long as academics' IM in continually using digital education technologies is in place, TPK-SE can be observed, as they will seek and access ways to get acquainted with technology and improve themselves for such use. It is also noteworthy to describe the path from TPK-SE to TS by means of IM. Thus, as TPK-SE increases IM, it impacts TS as fatigue and stress from the continued use of digital platforms become significant. Another interesting insight into this finding is the fact that since TS is a multidimensional and transactional approach to stress, a number of aspects within it further strengthen the role of IM in causing TS. Vallone et al. (2023) summarized these dimensions as being techno-overload, work-home conflict, pace of change, techno-ease, techno-reliability, and techno-sociality. Out of these dimensions, techno-ease, techno-reliability, and techno-sociality are found to have a significant correlation to IM. This work has satisfactorily partitioned the dimensions of TS, an accomplishment which is very useful in the analysis of the overall role of IM to TS; however, the approach used may still be improved. As a reminder, TS is measured in the work of Vallone et al. (2023) through a TS scale (Ayyagari et al., 2011) which uses a Likert-scale point system. The subjectivity of the scale system used may not fully reflect the subjectivity of TS as a complicated concept. Therefore, more sophisticated approaches, such as the use of fuzzy set theory (Zadeh, 1965), can be used to generate more reliable and reflective results.

Figure 1 also shows that TPK-SE, IM, and EM belong to the net cause group, which implies that they are considered the primary motivating constructs in the use of digital educational technologies. Attaining them is crucial to the successful implementation of the teaching-learning process through digital platforms. These constructs in the net cause group have a more influential impact than influenced impact. On the other hand, BO, TS, and CI are in the net effect group. They tend to be influenced by other TPK-SE, IM, and EM, as their values are negative, which implies that the influential impact of these constructs is lower than their influenced impact. These findings are almost straightforward in a practical sense, as BO, TS, and CI are resulting constructs with TPK-SE, IM, and EM for readily apparent reasons.

Ultimately, identifying the critical constructs requires simultaneous consideration of both vectors. In achieving this, we refer to Figure 1 and place all constructs into four distinct categories: minor key constructs (low prominence, high relation), key constructs (high prominence, high relation), indirect constructs (high prominence, low relation), and independent constructs (low prominence, low relation). On the basis of Figure 1, the minor key construct comprises EM. The key constructs include IM and TPK-

SE. The indirect construct category is composed of CI. The independent constructs consist of BO and TS. We would highlight the key constructs category and identify the most crucial constructs. The rank order of the key constructs is as follows: IM > TPK-SE. Thus, universities and stakeholders must concentrate their resources on investing in initiatives to increase the intrinsic motivations of academics. Such finding is consistent with Kuvaas et al. (2017), who offered crucial insights into this domain. Moreover, seminars, training, and workshops must be facilitated to improve academics' TPK-SE in the use of digital educational technologies. Useful concepts of TPK that universities and academic institutions may consider in informing the design of initiatives and measures were discussed extensively by Cengiz (2015), Pringle et al. (2015), Koh et al. (2015), Koh and Chai (2016), Kuvaas et al. (2017), and Willermark (2018).

5. CONCLUSION AND FUTURE WORKS

As the suspension of physical classes at schools is still an important measure in curbing COVID-19 cases, universities are still compelled to instantly shift the teaching-learning process to digital platforms on a massive scale. Together with amplifying factors such as poor technical infrastructure, academic incompetency, and lack of resources, particularly in developing economies, this sudden shift induces a stressful environment for academics in carrying out teaching duties, not to mention their other roles in their organizations. The current literature was quick to catch up with reports and contribute a better understanding of the various facets of education affected by the COVID-19 pandemic. An important highlight focused on understanding the continuance intention to use digital educational technologies, which may include both cognitive and affective factors. The important contribution of Panisoara et al. (2020), which offers a model based on five constructs, became the motivation for this work. Despite providing crucial insights into the problem domain, the work of Panisoara et al. (2020), with SEM as their mode of analysis, entails a few drawbacks, which include (1) possible fallacies brought about by model modifications, (2) huge sample size and technical knowledge requirements, (3) assumption of independence of variables, and (4) identification of priority constructs for decision making.

This work offers corrections for these drawbacks by adopting a fuzzy DEMATEL approach in modelling the use of digital education technologies in the face of the COVID-19 pandemic. In this study, the causal relationships of the six constructs of Panisoara et al. (technological pedagogical knowledge self-efficacy, intrinsic motivation, extrinsic motivation, burnout, technostress, and continuance intention) were evaluated. Results suggest that TPK-SE, IM, and EM have a significant

Table 2. Sample initial direct-relation matrix in linguistic variables

	TPK-SE	IM	EM	BO	TS	CI	IN	GI	AC	RE
TPK-SE	NI	NI	NI	VHI	VHI	VHI	VHI	VHI	VHI	VHI
IM	VHI	VHI	VHI	NI	NI	NI	VHI	VHI	VHI	VHI
EM	VHI	VHI	VHI	VHI	VHI	VHI	NI	NI	NI	VHI
BO	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
TS	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI
CI	VHI	VHI	VHI	VHI	VHI	VHI	VHI	VHI	VHI	VHI
IN	VHI	VHI	VHI	VHI	VHI	VHI	VHI	VHI	VHI	VHI
GI	VLI	VLI	VLI	VLI	VLI	VLI	VLI	VLI	VLI	VLI
AC	VHI	VHI	VHI	VHI	VHI	VHI	VHI	VHI	VHI	VHI
RE	VLI	VLI	VLI	VLI	VLI	VLI	VLI	VLI	VLI	VLI

Table 3. Sample initial direct-relation matrix in fuzzy numbers

	TPK-SE			IM			EM			BO			TS			CI			IN			GI			AC			RE		
TPK-SE	0.0	0.1	0.3	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0			
IM	0.7	0.9	1.0	0.0	0.1	0.3	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0			
EM	0.7	0.9	1.0	0.7	0.9	1.0	0.0	0.1	0.3	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0			
BO	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3			
TS	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3			
CI	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.0	0.1	0.3	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0			
IN	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.0	0.1	0.3	0.7	0.9	1.0	0.7	0.9	1.0			
GI	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.0	0.1	0.3	0.5	0.1	0.3			
AC	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0			
RE	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.0	0.1	0.3			

Table 4. The initial direct-relation matrix crisp values

	TPK-SE	IM	EM	BO	TS	CI	IN	GI	AC	RE
TPK-SE	0.0	0.1	0.3	0.7	0.9	1.0	0.7	0.9	1.0	0.7
IM	0.7	0.9	1.0	0.0	0.1	0.3	0.7	0.9	1.0	0.7
EM	0.7	0.9	1.0	0.7	0.9	1.0	0.0	0.1	0.3	0.7
BO	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3	0.0
TS	0.0	0.1	0.3	0.0	0.1	0.3	0.0	0.1	0.3	0.0
CI	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7
IN	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7
GI	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1
AC	0.7	0.9	1.0	0.7	0.9	1.0	0.7	0.9	1.0	0.7
RE	0.1	0.3	0.5	0.1	0.3	0.5	0.1	0.3	0.5	0.1

causal impact on continuance intention. They are consistent with the findings of Panisoara et al. (2020), except in the case of EM, which does not support continuance intention. On the other hand, EM causes both BO and TS, a finding that supports the recent finding of Panisoara et al. (2020). IM does not significantly cause BO, but induces TS. Furthermore, TPK-SE has feedback-loop causal relationships with IM, and with this loop, TPK-SE impacts TS because of the fatigue and stress associated with sustained use of digital platforms. In summary, most relationships revealed by Panisoara et al. (2020) are supported by the findings of this work. Results also indicate that BO, TS, and CI are effects of TPK-SE, IM, and EM constructs. Finally, IM and (TPK-SE) are the most crucial factors in resource allocation decisions and policy formulations in furthering the use of digital educational technologies amidst the pandemic. These findings were not explored by Panisoara et al. (2020). With these insights, this work reveals that fuzzy DEMATEL has considerable potential in modelling studies in education, which are scarce in the domain literature.

Nevertheless, the findings of this work have some limitations. First, the limited number of experts may be a ground for future research. With an expanded number of experts, future works may explore the same model along with the proposed approach to test the validity of the findings. Second, the proposed approach could be used in any extended model, which may capture some salient constructs in the use of digital educational technologies. Third, other DEMATEL extensions could be explored as a methodological extension to analyze further any continuance intention model. Fourth, the use of different modelling techniques (e.g., system dynamics modeling and interpretative structural modeling) could also be used to evaluate the hypothesized model of Panisoara et al. (2020). Finally, a resulting construct prioritization problem may be carried out in future research, along with the use of multiattribute decision-making techniques.

DECLARATION OF INTERESTS

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Table 5. Aggregated direct-relation matrix

	TPK-SE			IM			EM			BO			TS			CI			IN			GI			AC			RE		
TPK-SE	0.00	0.10	0.30	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00
IM	0.70	0.90	1.00	0.00	0.10	0.30	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00
EM	0.70	0.90	1.00	0.70	0.90	1.00	0.00	0.10	0.30	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00
BO	0.00	0.22	0.43	0.00	0.24	0.46	0.00	0.22	0.43	0.00	0.10	0.30	0.00	0.22	0.43	0.00	0.22	0.43	0.00	0.22	0.43	0.00	0.22	0.43	0.00	0.22	0.43	0.00	0.22	0.43
TS	0.00	0.47	0.68	0.00	0.47	0.68	0.00	0.47	0.68	0.00	0.47	0.68	0.00	0.10	0.30	0.00	0.47	0.68	0.00	0.47	0.68	0.00	0.47	0.68	0.00	0.47	0.68	0.00	0.47	0.68
CI	0.55	0.75	0.93	0.57	0.77	0.94	0.55	0.75	0.93	0.55	0.75	0.93	0.57	0.77	0.94	0.00	0.10	0.30	0.57	0.77	0.94	0.57	0.77	0.94	0.57	0.77	0.94	0.57	0.77	0.94
IN	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00	0.00	0.10	0.30	0.70	0.90	1.00	0.70	0.90	1.00	0.70	0.90	1.00
GI	0.19	0.41	0.61	0.21	0.43	0.63	0.19	0.41	0.61	0.19	0.41	0.61	0.19	0.41	0.61	0.19	0.41	0.61	0.19	0.41	0.61	0.00	0.10	0.30	0.19	0.41	0.61	0.19	0.41	0.61
AC	0.70	0.90	1.00	0.68	0.88	0.99	0.70	0.90	1.00	0.68	0.88	0.99	0.68	0.88	0.99	0.70	0.90	1.00	0.70	0.90	1.00	0.68	0.88	0.99	0.00	0.10	0.30	0.70	0.90	1.00
RE	0.10	0.30	0.50	0.12	0.33	0.54	0.10	0.30	0.50	0.10	0.30	0.50	0.10	0.30	0.50	0.10	0.30	0.50	0.10	0.30	0.50	0.10	0.30	0.50	0.10	0.30	0.50	0.00	0.10	0.30

Table 6. The aggregated direct-relation matrix crisp values

	TPK-SE	IM	EM	BO	TS	CI	IN	GI	AC	RE
TPK-SE	0.13	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
IM	0.88	0.13	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
EM	0.88	0.88	0.13	0.88	0.88	0.88	0.88	0.88	0.88	0.88
BO	0.22	0.24	0.22	0.13	0.22	0.22	0.22	0.22	0.22	0.22
TS	0.40	0.40	0.40	0.40	0.13	0.40	0.40	0.40	0.40	0.40
CI	0.75	0.76	0.75	0.75	0.76	0.13	0.76	0.76	0.76	0.76
IN	0.88	0.88	0.88	0.88	0.88	0.88	0.13	0.88	0.88	0.88
GI	0.41	0.43	0.41	0.41	0.41	0.41	0.41	0.13	0.41	0.41
AC	0.88	0.86	0.88	0.86	0.86	0.88	0.88	0.86	0.13	0.88
RE	0.30	0.33	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.13

Table 7. Normalized direct-influence matrix G

	TPK-SE	IM	EM	BO	TS	CI	IN	GI	AC	RE
TPK-SE	0	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
IM	0.11	0	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
EM	0.11	0.11	0	0.11	0.11	0.11	0.11	0.11	0.11	0.11
BO	0.03	0.03	0.03	0	0.03	0.03	0.03	0.03	0.03	0.03
TS	0.05	0.05	0.05	0.05	0	0.05	0.05	0.05	0.05	0.05
CI	0.09	0.1	0.09	0.09	0.1	0	0.1	0.1	0.1	0.1
IN	0.11	0.11	0.11	0.11	0.11	0.11	0	0.11	0.11	0.11
GI	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0	0.05	0.05
AC	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0	0.11
RE	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0

Table 8. Relations among constructs

	r	s	$r + s$	$r - s$	class
TPK-SE	3.39	2.44	5.84	0.95	causal
IM	3.39	2.47	5.87	0.92	causal
EM	3.39	2.44	5.84	0.95	causal
BO	0.91	2.71	3.62	-1.80	effect
TS	1.65	2.64	4.29	-0.98	effect
CI	2.98	2.49	5.48	0.49	causal
IN	3.39	2.45	5.84	0.94	causal
GI	1.67	2.64	4.31	-0.96	effect
AC	3.37	2.45	5.82	0.92	causal
RE	1.26	2.69	3.95	-1.43	effect

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