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Confirmatory Factor Analysis on Technology Leadership Measurement

[1]Nor Asikin Mohamad, [2]Mua'azam Mohamad

[1]Universiti Utara Malaysia, Sintok, Kedah, norasikin2010@gmail.com
[2]Universiti Utara Malaysia, Sintok, Kedah, muaazam@uum.edu.my

Abstract

Measurement of Technology Leadership is widely used to measure the technology leadership practice by many researchers. This measurement were developed based on the frame of National Standards Technology for Administrator (NETS-A) 2009 by International Society of Technology Education. Technology leadership measurement consists of five dimensions namely visionary leadership, The Learning Culture of the Digital Age, Excellence in Professional Practice, Systemic Improvements and Digital Citizenship. The objectives of this study were (i) to evaluate the measurement of Technology Leadership by CFA, (ii) to know the reliability of the model, and (iii) to prove the validity of the model. The results showed that the resulting model from measurement of Technology Leadership using CFA. The findings also show items and the number of items resulting from the CFA. The resulting model will help next researchers especially in studies related to technology leadership. The study revealed that school leaders should enhance existing technology leadership practices in order to lead schools to compete with the outside world.

Keywords: Measurement of Technology leadership, Visionary leadership, Confirmatory Factor Analysis, Digital Citizenship.

INTRODUCTION

Technology Leadership assessment items are based on the 2009 International Society for Technology in Education's (ISTE) National Educational Technology Standards for Administrators (NETS-A). In 2001, the International Educational Technology Association (ISTE) took over the task of developing educational technology standards. ISTE is launching a project called the National Educational Technology Standards (NETS) for the purpose of developing a list of nationally recognized and recognized standards. ISTE began with the development of technology literacy standards for undergraduate students, the National Education Technology Standards for Students (NETS-S), and technology standards for teachers using the National Educational Technology Standards for Teachers (NETS-T). This standard is used as a national model for schools to ensure technology-savvy students and teachers.

In turn, ISTE strives to develop technology standards for leaders, known as the NETS-A (ISTE, 2009). The rationale for the NETS-A is that leaders must be able to support students and teachers and maintain the necessary conditions to ensure the optimum benefits of technology are provided "(Knezek, 2009).

The consensus document is known as the National Educational Technology Standards for Administrators, NETS-A. Standards and performance related indicators require that school administrators play a role in technology planning and create a clear vision for integrating technology in all aspects of education (Rogers, 2011). The NETS-A is a

national consensus among stakeholders that best demonstrate effective technology leadership (Miller, 2008).

The ISTE NETS-A Standards were developed by the Technology Administrator for Collaborative School Administrators (TSSA). TSSA's collaborative team includes representatives from national leadership organizations such as the United States Association of School Administrators (AASA), the National Association of Primary Schools (NAESP), the National Secondary School Association (NASSP), and the National Association of School Boards (NSBA). The TSSA released its official consensus document for school administrators in November 2001 (Rogers, 2011; ISTE, 2009).

A year after the development of the TSSA, International Cooperation, Educational Technology (ISTE) standards published its National Educational Technology. NETS-A Standards for Administrators (International Association for Educational Technology-ISTE, 2002). Given the central role of ISTE in the development of TSSA, the Cooperation Standards, ISTE adopted the TSSA Cooperation work and built on it by developing a list of key requirements for implementing NETS for Administrators (ISTE, 2002). NETS is an initiative of the Information Technology Association in Education (ISTE) and funded by NASA in consultation with the U.S. Department of Education, Milken Educational Technology Exchange, and Apple Computers. The NETS-A was developed through extensive perspective input and feedback from practitioners and technologists in the field of technology.

The NETS-A standards issued by ISTE are important in establishing identities for technology professionals and in determining the key roles and responsibilities of school leaders in developing 21st century schools in America (Redish, 2008). Leadership in technology integration and implementation requires that school leaders have a wealth of knowledge and skills; NETS-A standards for leaders provide this comprehensive list.

The basic assumption of the NETS-A standard is that administrators should be knowledgeable users of information and technology tools familiar to information age professionals. Although interest in NETS-A has emerged since the release, and some professional development. Activities have been developed, some research studies including standards. According to Creighton (2003), this standard enables us to move from simply acknowledging the importance of administrators in determining the important needs that administrators need to know and do in order to fulfill their responsibilities as leaders in effective use of technology in schools.

The ISTE NETS-A 2002 is organized into six subsections: leadership and Vision; learning and teaching; productivity and professional practice; support, management, and operations; assessment and evaluation; and social, legal, and ethical issues. For each of the six subscales, performance indicators were added to further explain the theme (ISTE, 2009). To address the rapid changes in technology, teaching, and the learning environment, ISTE recently led a collaborative, international effort to refresh NETS for administrators. Refreshing standards have been influenced by "the emergence of the digital learning landscape" and "the decline in national leadership in innovation" (Stager, 2007, p. 30). The standards update reflects the broad role of technology and the need to prepare students for 21st century reality (Schrum et al., 2011). The NETS-A 2009 reflects the skills and knowledge that administrators and school leaders need to lead and maintain a culture that supports digital learning, builds a vision for technology infusion, and transforms the teaching landscape (Knezek, 2009).

In 2009 NETS-A reflected on the opinions of those involved. Sykora (2009) points out that standards include "the need for shared leadership and culture in which transformative leaders are among their stakeholders rather than their own, the value of administrators promoting digital work professionals, and support for a culture of change and risk taking".

In section 3, NETS- (2019), education leaders is organize into five subsections. First, equity and citizenship advocate leaders use technology to increase equity, inclusion, and digital citizenship practices. Next, visionary planner where leaders engage others in establishing a vision, strategic plan and ongoing evaluation cycle for transforming learning with technology. Then, empowering leader, leaders create a culture where teachers and learners are empowered to use technology in innovative ways to enrich teaching and learning. Systems Designer need leaders to build teams and systems to implement, sustain and continually improve the use of technology to support learning. Lastly, connected learner where leaders model and promote continuous professional learning for themselves and others.

The Gap of the Study

Technology leadership is essential for the effective use of technology (Anderson & Dexter, 2005). Thus, school leaders who have technology leadership have a significant impact on the effectiveness of the use of technology by teachers in teaching and facilitators. According to Sheninger (2014), there are still school leaders who are reluctant and misunderstand the use of digital technologies, such as the role of social media and the advantages of using digital devices. Some principals do not master ICT and digital technology competencies. In fact, the rapid development in technology and its widespread use in schools has led to a re-evaluation of the roles and responsibilities of school leaders.

This phenomenon illustrates that the level of technological leadership of school leaders is still at a low and unsatisfactory performance (Kor et al., 2016; Ugur & Koc, 2019). These findings prove that there are still gaps that need to be explored to study the level of technological leadership in different contexts of respondents. Most past studies have linked technology leadership to ICT culture, leader competence, and even technology acceptance (Leong et al., 2016; Ugur & Koc, 2019; Yorulmaz & Can, 2016). Even so, there are still school leaders who do not understand the function of technology leadership to encourage teachers to integrate ICT effectively (Alkrdem, 2014).

Literature Review

Technology Leadership

Technology leadership is about change using digital devices in the field of educational management. This transformation process requires leaders to intensify their efforts to mobilize, implement and absorb the use of digital devices as a medium of teaching and learning through strategic planning aligned with the vision of the school (International Society for Technology in Education (ISTE), 2009, 2021). Technology leadership defined as a leader's ethical practice in facilitating learning and improving school performance through the creation, use and management of technology resources and processes involving appropriate technology (Mwawasi, 2014). Technology leadership also refers to the ability and influence of leaders to develop the potential and capacity of organizational members, teachers and students as they evolve through the production of innovations that can enhance school excellence and effectiveness (Moktar, 2011). Technology leadership is a combination of strategies and techniques that are common to leadership but requires particular attention to technology, especially in relation to access to equipment, technological updates and sensitivity to professional development (Juraime, F., &Hamzah, M. I. M., 2017).

School leaders need to act as technology leaders in facing a variety of complex responsibilities to ensure that technology is available and safe to be used by schoolchildren and teachers in order to improve the quality of teaching and learning. Therefore, leaders need to be involved in the use of technology so that they can master 21st century technology and encourage the use of it among teachers and staff. School leaders today must strive to fill any gaps in their technological knowledge and skills in order to provide direction and guidance to lead digital development in their school and

spread this practice to the school learning environment (Aksal, 2015).

Therefore, school leaders should understand the importance of ICT integration and provide a conducive learning environment for students. In fact, top leaders should delegate power to other leaders so as to encourage the use of technology among school leaders and to collaborate with experts and external organizations in their quest to gain support in a networking process. All school leaders should play the role of technology leaders in an effort to build an innovative learning culture.

School leaders play an integral role as technology leaders (Anderson & Dexter 2005; Dikkers, Hughes & McLeod 2005; Fletcher, 2009; Gerard, Bowyer & Linn 2008; ISTE 2007; McLeod 2008; Slenning 2000). Therefore, they have to comply with every dimension and item outlined by the International Technology Education Association which has developed the National Education Technology Standard for Administrators (NETS-A (2009)). The standard has outlined 5 dimensions of technology leadership as follows;

Dimension of Technology Leadership

Visionary Leadership

Visionary leadership shows that school leaders are involved in changes that maximize learning goals using digital resources. They are involved in the ongoing process of developing, implementing, and delivering strategic plans that implement technology in line with their shared vision. School leaders support the implementation of applied technology vision and strategic plans.

The Learning Culture of the Digital Age

The Digital Age Learning Culture means that school leaders are always on the lookout for innovations in teaching that focus on continuous improvement in digital learning. They also maximize frequent and effective use of technology for learning. School leaders provide a learning environment with technology and learning resources to meet the diverse needs of all students. They maintain effective practices in technology and cultural studies across the curriculum. School leaders participate in community learning that fosters digital innovation, creativity and collaboration.

Excellence in Professional Practice

Excellence in Professional Practice requires school leaders to devote time, resources and access to ensure continued professional growth in technology expertise and integration. They participate in community-based learning that stimulates and supports teachers in teaching and using technology. School leaders demonstrate collaboration or collaborative and effective communication among stakeholders, using digital tools. They are also up to date on educational research and emerging trends in the use of effective technologies and promoting new technologies that have the potential to enhance student learning.

Systemic Improvements

Systemic or holistic improvements indicate that school leaders should adhere to changes aimed at maximizing learning achievement and goals through the use of technology and mass media resources. They work together to enhance assessment, collect and analyze data, interpret data and share insights to enhance staff performance and student learning. School leaders are competent staff in the use of technology to advance academic and operational goals. They utilize strategic partnerships to support comprehensive improvement. School leaders create and maintain a robust technology infrastructure including integrated and manageable technology systems to support management, operations, teaching and learning.

Digital Citizenship

As digital citizens, school leaders ensure access to appropriate digital tools and resources to meet the needs of all students. They encourage, demonstrate safe, legal and ethical use of digital information and technology. School leaders also encourage and demonstrate responsibility for social interactions related to the use of technology and information. They engage in the development of a shared cultural

understanding and engagement in global issues through the use of current communication and collaboration tools.

Previous Studies Related Technology Leadership Measurement

The study conducted by Richardson, J. W., & McLeod, S. (2011) on Technology Leadership in Native American School has adopted the measurement of the Technology Leadership based on the National Educational Technology Standards for Administrators (NETS-A).

Alkrdem M. (2014) study about Technological Leadership Behavior Of High School Headteachers In Asir Region, Saudi Arabia ,The questionnaire used in the study was developed by the researcher based on the areas of NETS-A standards that define the knowledge and skills that school headteachers need to become effective leaders in the use of educational technologies in their schools. Five experts from the fields of educational technologies, educational management and statistics were asked for their views about the questionnaire. Then, the pilot study of the questionnaire was conducted. Following the suggestions of experts and the preliminary applications, certain corrections and changes were made on the data collection tool, and the questionnaire was made ready for use for data collection.

A study by Juraime, F., & Hamzah, M. I. M. (2017). Principal Technology Leadership and Its Relationship To Academic Achievements In Schools In Malaysia. In the study, Juraime et. al., also adopted NETS-A by International Society Technology of Education as assessment measurement. N. Hafiza Hamzah; M. Khalid M. Nasir; Jamalullail Abdul Wahab (2021) study about the effects of principals' digital leadership also adopted the measurement of the Technology Leadership based on the National Educational Technology Standards for School leaders as assessment measurement.

Purpose of the Study

This study aims to determine the validity and reliability of the proposed level of technology leadership model to enhance teacher competence. The technology leadership model comprises five sub constructs, namely Visionary Leadership, The Learning Culture of the Digital Age, Excellence in Professional Practice, Systemic Improvements and Digital Citizenship and as the underlying primary dimension of technology leadership construct. To address the research objective, the study used a model of technology leadership synthesized from (ISTE, 2009). Based on the above objective, the research question is as follows:

RQ1. Is the measurement model for the technology leadership level of school teacher leaders valid and reliable?

Thus, based on the conceptual framework (Figure1), research objective and research question the following hypotheses were formulated:

H1. The models for the level of technology leadership model of school teacher leaders are valid and reliable.

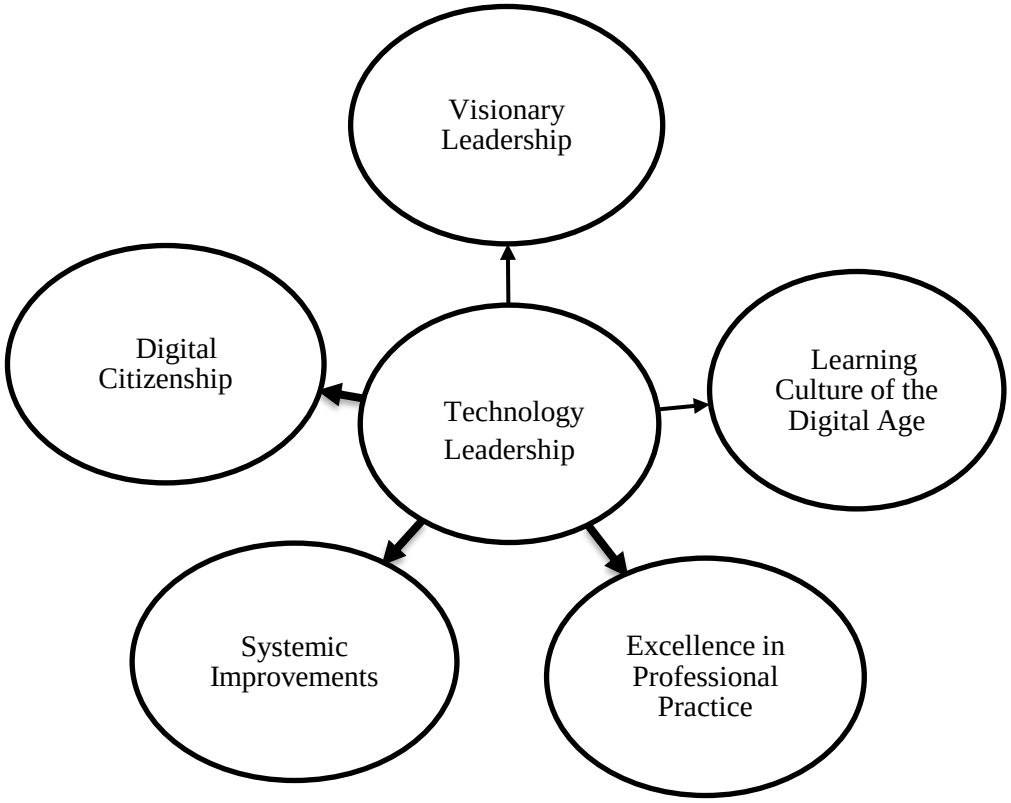

Figure 1: *Model of Technology Leadership (International Society for Technology in Education. ISTE,(2009). National Educational Technology Standard for Administrators (NETS.A)*

The question of Technology Leadership was based on The Transformative Leadership Theory introduced by Kenneth Leithwood & Doris Jantzi (2006) and the model of Technology Leadership (ISTE, 2009). The questionnaire was selected based on its ability to met the criteria for measuring technology leadership, easy to understand, concise, and had good validity and reliability.

Research Methodology

Research design

This research is a quantitative study. It applies a cross-sectional study approach in which respondents answered the questionnaire distributed. The selection of the respondents was based on a simple random sampling aimed at ensuring that each of the secondary school leaders in the state of Kelantan had the same opportunity to participate in this study.

Population and Sampling

The study involved a total of 345 school leaders consisting of senior assistants, senior teachers and subject coordinators from six core subjects for secondary schools. A sample of 345 people was used because it was large enough to represent a total population of 2262 school leaders (Krejcie & Morgan, 1970). Therefore, the distribution of the number of samples representing each school was done using a proportion ratio based on the number of samples that were determined.

Research Instrument

This study uses a technology leadership questionnaire adapted from the National Educational Technology Standard for Administrators NETS-A (2009), which is the framework of the International Society Technology Education (ISTE). The questionnaire consists of two (2) parts, A and B. Part A contains background of the respondents, Part B is technology leadership

questionnaire consisting of five dimensions of Visionary Leadership, Culture Digital Age Learning, Excellence in Professional Practice, Systemic Improvement and Digital citizenship. To measure the technology leadership, 5 point Likert scale was used. Starting with the number 1 represents "strongly disagree", number 2 represents " disagree", number 3 represents "somewhat agree", number 4 represents "agree", and 5 representing "strongly agree",

Cronbach Alpha

Based on Table 1, Cronbach's alpha (α) of each item indicater instruments has validity and reliability. By using SPSS analysis, all items showed high Cronbach's alpha. Therefore, most of the research on technology leadership will apply to all items in NETS-A (2009) to measure technology leadership. Although SPSS analysis has shown good validity and reliability of measurement, but this study wanted to see weather the same results would be obtained if the Comfirmatory Factor Analysis (CFA) analysis conducted on the data.

Before the real study, the pilot test was carried out among selected secondary schools at Bachok and Kota Baharu district. A total of 122 teachers represent the test. The results of the pilot test revealed that the value of Cronbach Alpha which is referred to as a measure of "internal consistency" reliability (Bonett & Wright, 2015) shows overall alpha value is more than 0.7 which is good considering that 0.70 is the cut-off value for being acceptable (Nunnaly, 1978). Table 2 shows in detail the results of the pilot test according to the construct.

Table 1: *Dimensions, numbers of questions and numbers of the items of Technology Leadership from National Education Technology for Administrator (NETS-A, 2009) By International Society of Technology Education (ISTE)*

Dimension	Number of Items	Cronbach Alpha (α)
Visionary Leadership	3	.773
Digital Learning Culture	5	.876
Excellence in Professional Practice	4	.829
Systemic Improvement	5	.885
Digital Citizenship	5	.880
Technology Leadership	22	**.879**

Data analysis

The quantitative method research data were analysed using the Analysis of Moments Structures (AMOS version 21.0). The study employed SPSS for analyzing descriptives of the respondents and the response score of the measuring items. SPSS was also employed to run exploratory factor analysis to perform an exploratory analysis to reduce and manage the number of many items that belong and have overlapping measurement characteristic. Meanwhile, AMOS software was use to handle the confirmatory factor analysis (CFA) to validate the measurement model of aconstruct and to test the stated hypothesis in the path model. The statical method employed in testing the path model was SEM. SEM is second-generation method of statistical analysis developed to cater for limitations in the tradisional ordinary least square regression especially when dealing with latent constructs ia a model (Reis, Schader, Milne, & Stephens, 2003; Renzulli & Reis, 1998; VanTassel-Baska & Brown, 2007). Its showed overall Cronbach Alpha for Technology Leadership (α) 0.92. Meanwhile Cronbach Alpha coefficient values between 0.6 and 1.0 indicates that a measurement instrument that is good and suitable for use in study (Zaidatul et al., 2003). Cronbach Alpha (α) of each item is as follows.

Findings

Measurement Model

First, we developed a latent construct for technology leadership. They are visionary leadership, digital learning culture, excellent in professional practice, systemic improvement and digital leadership to assess the fitness level of the measurement model involved so that the quality of the model could be improved. To do so, the fitness level can be improved by deleting items that carry lower factor loading. There are many rules of thumb to consider in the deletion of items when performing CFA such as 0.40, 0.50 and 0.60 factor loadings. In this study, we retain items beyond the threshold level of 0.60 of factor loadings as counseled in a previous study (Hair, Black, Babin, & Anderson, 2010; Lowry & Gaskin, 2014; Zainudin, 2015). Generally, the lower factor loading can impair the assessment of convergent validity such as average variance extracted (AVE) because the lower factor loading will capture lower variance that is explained by the respective latent constructs (Fornell & Bookstein, 1982; Fornell & Larcker, 1981; Hair et al., 2013; Zainudin, 2015).

Initially, the total of items in our model was 22 items before executing the CFA procedure. After specifying the measurement model in order to ensure the model achieved the fitness level, only 18 items (81.8%) were retained.

Structural Equation Modeling

Structural Equation Modelling is deemed as one of the prominent causal analysis since it is being practice in many fields. Because structural equation modeling able to analyze the interrelationship of multiple variables, moderator and indirect effect stimutaneously (Zainudin, 2019; Hoyle, 1995; Mahadzirah et al., 2019). In causal analysis, there are two families of structural equation modeling that is actually dependent on the research characteristics which is confirmatory or exploratory approach. One hand is considering as Covariance based structural equation modeling (CBSEM) that is prior to confirmatory approach. Another hand is considering as Variance based structural equation modeling (VBSEM) that is prior to exploratory approach (Hair et al., 2011). In accordance to Ringle (2015), confirmatory approach can be concerned if the analyst has acomprehensive theory that is compatible with the real data. In contrast, VBSEM is appropriate if the analyst have a few theories that using available data sets to guess the random value. In other words, VBSEM in a relevant approach if the analyst interest to operate the misspecified model or for explorative purpose (Lohmoller, 1989; Hair et al.2013; Dijkstra & Henser, 2015; Nasyat et al., 2019).

As this study is to prone on the confirmatory sense, we handle the hyphothesized models using CBSEM. Moreover, the assumption stipulated in CBSEM was satisfied in terms of data distribution and sample size requirement (more than 200 obsevations; Afthanorhan et al., 2019a). In CBSEM, measurement and structural model must be independently assessed so that the path coefficient of structural model are proper solution (McDonald & Ho, 2002; Afthanorhan et al., 2019b). Means that, measurement model must be considering at the first place to determine the fitness level of each constructs involved in the model. In measurement model perspectives, Confirmatory Factor Analysis (CFA) must be quantified to remove the meaningless items so that the fitness level of measurement model can be satisfied. To do so, the analyst have to attribute the type of modeling based on the literature required whether in the form of first order or second order construct. The sub-constructs of technology leadership are visionary leadership, digital learning culture, excellence in professional practice, systemic improvement and digital citizenship are being necessity to measure the main construct of Technology Leadership. To add, the utility of second order or multidimensional construct actually allowing the analyst to explain more regarding on the main construct behavior as implemented in the current study (Hulin, 1991; Ones & Viswesvaran, 1996) reproductions of similar nature translations.

The author examined technology leadership level based on five dimensions. The result of this procedure indicates that all items have a high factor load that exceeds the value of 0.6. Therefore, the author decided to maintain all the items in the measurement model. Next, the figure below presented the final model for the Technology Leadership construct.

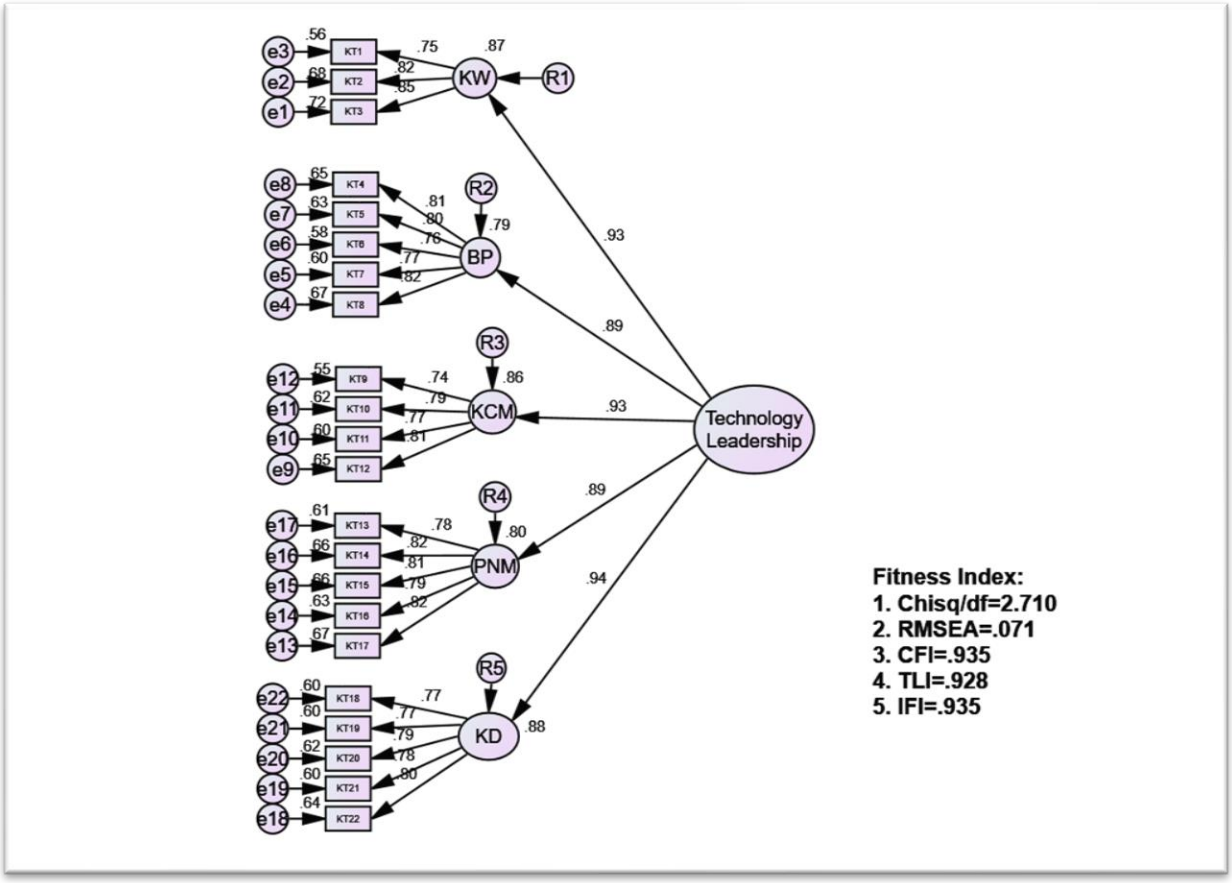

Figure 4.1: *Final Model for Technology Leadership Construct*

Furthermore, the assessment indicates that this measurement model satisfied all fitness indexes as summarized in the following table. Explicitly, the result for Chisq/df = 2.710 < 5.0, RMSEA = 0.071 < 0.08, CFI = 0.935 > 0.90, TLI = 0.928 > 0.90, and IFI = 0.935 > 0.90 asdepicted in Table 4.2. Thus, the Technology Leadership model is valid.

Table 4.2: *The Summary of Fitness for Technology Leadership Measurement Model*

Name of category	Name of index	Index value	Comments
Absolute fit	RMSEA	0.071	The required level is achieved
Incremental fit	CFI	0.935	The required level is achieved
	TLI	0.928	The required level is achieved
	IFI	0.935	The required level is achieved
Parsimonious fit	Chisq/df	2.710	The required level is achieved

Discussion

Implications and Contributions

From the theoretical standpoint and theory building, this study has contributed towards the work on technology leadership. This article of study set out to identify, examine, and build a technology leadership model for leaders. The objectives of the study was given and the findings of technology leadership model could be highlighted and can be use by researchers who study technology leadership, especially in the future. The resulting model of technology leadership measurement contribute to add to the literature either in the country as well as

broad and model of technology leadership measurement can strengthen technology leadership measurement of existing.

The findings of this study might help the Ministry of education, district offices, and schools to know about the importance of technology leadership among school leaders. It is suggested that policymakers should develop professional development programs to foster technology leadership skills among school leaders so that they are more effective and efficient especially in technology-related school management. Professional development courses in technology leadership for school leaders should aim to enhance their technology leadership level. In addition, school leaders need to be encouraged to participate in technology-related management. Close collaboration with technology expert teachers will help school leaders understand and master technology leadership. School leaders' skills in technology should be considered as one of the criteria for selection as school leaders.

In addition, the findings of this study can serve as a guide to the Ministry of Education in order to set the appropriate program to always encourage and motivate the principal and the teachers of the school to inculcate the culture of control and use of ICT in schools. This will produce competent leaders in all aspects in line with the government's aspiration to produce leaders who can withstand the present and future globalization era. The study of technology leadership among school leaders can add value and long-term impact to leadership and management practices especially to improve school leadership levels. It is hoped that future leaders will be able to compete in the world of information technology education without borders.

Conclusion

This study examines the technology leadership practices of secondary school leaders based on five dimensions of technology leadership outlined by the National Educational Technology Standard-Administrators (NET-S A 2009), which are visionary leadership; digital learning culture; excellence in professional practice; comprehensive improvements and digital citizenship. The standards have been presented by the International Society for Technology In Education, ISTE (2009).

Technology plays a very important role in schools around the world. School leaders should use technology in several aspects of their daily activities. This study confirms that school leaders are heading towards the fourth wave of the Smart School Plan (2011-2020), which is a unifying and stabilizing phase in reference to the ICT policy in Education for Malaysia (Ministry of Education Malaysia, 2010) where leadership practices and use of technology is very important in education. The Malaysian Ministry of Education (MOE) has produced the ICT Transformation Plan 2019-2023, which was launched to support the digital education agenda in Malaysia (Ministry of Education Malaysia, 2019). There is a great need for leadership in technology in order to ensure that technology is meaningful and contributes to improvement in education. Accordingly, the study revealed that school leaders should enhance existing technology leadership practices in order to lead schools to compete with the outside world.

Limitations and Suggestions for Further Research

There were three limitations have been identified that provide the extent of opportunities for future research in this scope study. First, the respondents of the sampling used in this study were limited to school leaders in Kelantan state only. Second, to measure the technology leadership, this study used 5 point Likert scale. For next study, better use 7 or 10 likert scale for better result. Third, the last limitation of this study is that the 345 sample size is relatively suitable from statistical viewpoints but should be extended to a larger sample size for solid generalisation of the findings of the study. Further studies can be conducted to look at the level of practice in technology leadership of school leaders from other demographic factors such as based on

1)the qualification of leader 2) academic field and 3)location of school. Thus, to confirm the five factor model for this study, qualitative evaluation of the model should be carried out, and it will be the next phase of exploration in this area of study. According to MacCallum, Wegener, Uchino and Fabriga (1993) there may be other alternative models that use different sub-constructs with similarities to the same data. Thus, future studies are encouraged to test the existence of other alternative models and to compare them with the original model to help make improvements to the original model.

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