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A Confirmatory Factor Analysis of STEM Education Administrative Model for Extra-large Size Secondary Schools

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Abstract

This research intended to investigate factors and associated indicators of STEM educational administration for extra-large size secondary schools. The researchers conceptualized the factors and indicators by examining related documents and cross-examining with 11 experts to confirm them. A quantitative research design using questionnaire to collect data from 480 respondents consisted of 15 school administrators and 465 teachers. The results indicated that goodness of fit for the identified factors and indicators were compliance with empirical data: $\chi^2 = 77.869$, $df = 63$, $\chi^2/df = 1.236$, *p-value* $= 0.098$, $RMSEA = 0.022$, $SRMR = 0.022$, $CFI = 0.998$, $TLI = 0.995$.

Introduction

STEM education is defined as an interdisciplinary approach to learning that integrates concepts and principles from science, technology, engineering, and mathematics. This educational approach emphasizes real-world applications, hands-on learning experiences, problem-solving, and critical thinking skills (Petrosino et al., 2020). STEM education is encouraging to implement in Thailand basic education aiming to prepare students for the demands of the

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modern workforce, where proficiency in STEM subjects is increasingly valued across various industries since 2012 (Office of the Secretariat of the Education Council, 2017). Therefore, designing a STEM education administrative model for secondary education in Thailand involves structuring the framework to ensure effective implementation and coordination of STEM programs across schools. In other words, Thailand can foster a culture of innovation, critical thinking, and problem-solving skills among secondary school students if school administrators can implement the developed administrative model that encompassing six factors and 18 indicators in their administration. Thus, preparing those secondary school students for success in the 21st-century workforce and driving socioeconomic development in the country is a necessity.

The first key factor of STEM educational administration is setting STEM educational policies that involving guidelines, regulations, and strategies development to promote and support STEM education initiatives at the institutional level (Yamada, 2018). For example, school administrators set clear and measurable goals for STEM education to align them with national educational objectives, workforce development priorities, and economic goals. This is followed by engaging a wide range of stakeholders, including educators, policymakers, industry representatives, parents, students, and community leaders, in the policy development process. The second key factor is teacher development in STEM education. School administrators have to provide ongoing professional development opportunities, workshops, and resources to support teachers in enhancing their content knowledge, pedagogical skills, and use of technology in the classroom (Mumcu et al., 2023). Mumcu et al.'s found that teachers need professional development program that can strengthen their collaboration with colleagues, contributes to pedagogical design skills in integrated STEM lesson planning and integrating STEM disciplines, hence improves their understanding of integrated STEM.

The third factor is development of an integrated learning curriculum. According to Kelley et al. (2016), school administrators have to develop standards and guidelines for STEM curriculum development to ensure an integrated learning curriculum is aligned with national educational standards and international best practices. As a result, school administrators must encourage the integration of interdisciplinary STEM concepts into existing curricula and provide support for secondary schools to develop and implement STEM-focused instructional materials and activities (Kelley et al., 2016). Creation of a STEM educational cooperation network is another important factor to administer STEM education in secondary school. Creation of a STEM educational cooperation network refers to establishment of partnerships and collaborations among various stakeholders, including educational institutions, government agencies, industry partners, non-profit organizations, and community groups, to promote STEM education initiatives and address common challenges (Santangelo et al., 2021). Santangelo et al. (2021) emphasized the importance of STEM educational cooperation network to support STEM education initiatives by encouraging industry engagement through mentorship programs, internship opportunities, and collaborative research projects to provide students with real-world exposure to STEM careers and opportunities.

Supervision and evaluation of STEM education is another crucial factor to be considered for ensuring quality and effectiveness in teaching and learning (Promboon et al., 2018). According to Promboon et al. (2018), effective supervision and evaluation of STEM education involve a comprehensive approach that focuses on curriculum, instruction, assessment, resources, collaboration, continuous improvement, and equity. Therefore, school administrators who are playing roles as supervisors can contribute to the enhancement of STEM teaching and learning outcomes by providing support and feedback to their teachers. The final factor of STEM educational administration is innovative leadership. Geesa et al. (2021) defined innovative leadership in STEM educational administration involves applying creative and forward-thinking approaches to improve teaching and learning in science, technology, engineering, and mathematics fields. They further explained that STEM educational administrators can inspire creativity, foster a passion for learning, and prepare students to succeed in an increasingly complex and dynamic world.

The researchers conceptualized the key factors and their associated indicators of STEM educational administration to develop an assessment model. This was followed by cross-examining by 11 academic specialists to confirm the identified factors and indicators in preliminary study. Following this line of reasoning, this research intends to develop a STEM education administrative that can assist extra-large size secondary school administrators to integrate concepts from science, technology, engineering, and mathematics into cohesive learning experiences. This assessment model emphasizes the interconnectedness of these subjects and encourages students to apply knowledge across disciplines (Petrosino et al., 2020). Extra-large secondary schools in Thailand have a significant student population, potentially ranging from several hundred to a few thousand students. The large student body allows for diverse perspectives, collaboration, and resource sharing. These schools would offer a comprehensive and specialized curriculum focused on science, technology, engineering, and mathematics. The curriculum would likely include advanced coursework in STEM subjects, as well as opportunities for hands-on learning, research projects, and internships (Office of the Secretariat of the Education Council, 2017).

Materials and Methods

Research Design

The researchers utilized a mixed-mode research design by incorporating document analysis, expert interviews, and a questionnaire survey. The strength of employing both qualitative and quantitative methods of data collection is to gain a holistic understanding of our research topic and produce robust results with practical implications (Larvakas, 2008). Therefore, the research procedure was comprised of two stages. In the first stage, the researchers conceptualized STEM educational administration factors and indicators. This was followed by conducting a survey to test the structural construction between experimental examination and the hypothetical theory of quantitative relationships concerning experimental data in the final stage. The relationships are epitomized by path coefficients or deterioration between the STEM educational administration factors and their indicators. Figure 1 demonstrates the research procedure.

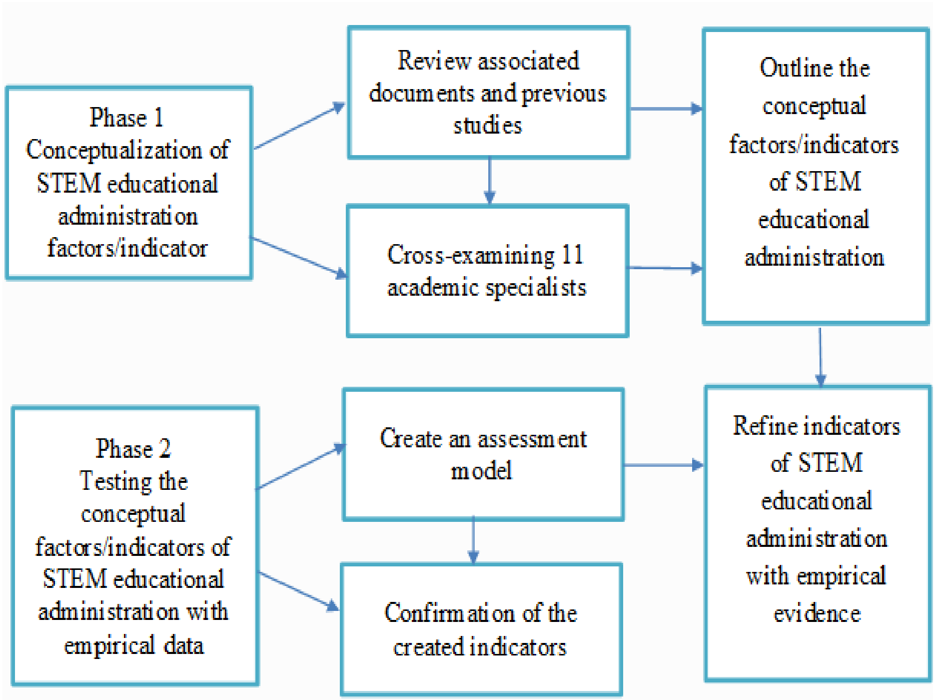

Figure 1: Research Framework.

Population and Sampling

The researchers employed stratified random sampling as a method used to ensure that sample represented two subgroups, namely 715 school administrators and 21,900 teachers, made a total population of 22,615 who were working at extra-large size secondary schools in the northeast region of Thailand. Then, the researchers used Krejcie and Morgan's (1970) sample size formula to determine the sample size needed in proportion to their presence in the population for a research. Each member of each subgroup of the population has an equal chance of being chosen and each combination of individuals has the same probability of being selected.

The Krejcie and Morgan's (1970) sample size formula is based on the population size and desired level of precision (margin of error) for estimating a population parameter, such as a proportion of mean. The researchers employed Becker and Ismail's (2016) rule of thumb to formulate an adequate sample size (N). The identified sample size was recognized as the presence of classified practice in reaching an adequate probability of the requisite findings include model convergence, statistical precision and statistical power for particular confirmatory factor analysis (CFA) with empirical data. The sample size was obtained per parameter in the ratio of 20:1. Since there were 24 parameters, the required sample size was 480 respondents. Owing to the sub-group were school administrators and teachers, the researchers selected school administrators and teachers by proportionate from 745 secondary extra-large size schools, making up a total of 480 samples consisting of 15 school administrators and 465 teachers. The survey was directed to evaluate the factors and indicators of the STEM education administrative model.

Research Instrument

The researchers employed two kinds of instruments, namely interview questions protocol and closed ended questionnaire as two resources of data collection. The 11 experts in the first phase were requested to respond to the six open questions which allowed them to express their opinions regarding the identified factors and indicators. The researchers aimed to accumulate substantial comments from the 11 experts by using open questions which seemed to be worked better in permitting them to intricate their comments in detail.

In the final phase, the researchers utilized an online survey questionnaire consisting of 35 closed questions as a method to collect quantitative data. The closed question structure was employed by limiting responses that fit into pre-determined sets of factors and indicators from the results of the first phase. A continuous five-point Likert scale was used to evaluate the strength of perception. This questionnaire was comprised of seven sections and intended to collect information pertaining to respondents' perceptions of STEM educational administration. Section A collects respondents' demographic backgrounds, namely gender, age, working experience, highest academic degree, and position. Section B to G was specifically designed to gauge data about STEM educational administration consists of six factors with a total of 30 questions.

Data Analysis

Content analysis is a research method used to systematically analyze the content of qualitative data from both sources, namely document analysis and experts' interviews (Gay et al., 2011). In the context of expert interview analysis, content analysis can be a valuable tool for extracting meaningful insights from the interviews. Structural Equation Modeling (SEM) were used to analyze quantitative data. The SEM is an appropriate method to analyze the structural relationship between measured variables and latent constructs because it syndicates factor loading examination and path analysis or multiple regression examination (Gay et al., 2011). Moreover, SEM can estimate the multiple and interrelated dependence in a single analysis, namely endogenous and exogenous variables. In this research, the endogenous variable refers to the STEM educational administration of school administrators and exogenous variables are the conceptualized factors and indicators from the first phase. Consequently, researchers utilized SEM methods to assess how meticulously a hypothetical model fits empirical data to examine the assessment model. The assessment model signifies the hypothesis that denotes how identified factors and indicators join together in corresponding to the hypothesis. Hence, researchers utilized a confirmatory factor analysis (CFA) to examine test the measurement model for its goodness-of-fit.

As mentioned by McDonald and Ho (2002), absolute fit indices mean how appropriately an assessment model fits the empirical data and verifies which projected model has the greatest fit. In this line of reasoning, researchers employed the Comparative fit index (CFI), the Chi-Square statistic (χ^2), the Tucker-Lewis index (TLI), the Standardised root mean square residual (SRMR), the Root mean square error of approximation (RMSEA), and the Goodness-of-fit statistic (GFI), to analyze the maximum-likelihood estimation and multiple indices of model fit as the variance-covariance matrix.

Results and Discussion

Identification of STEM Educational Administration Factors and Indicators

The results of document analysis in the first phase identified six key factors of STEM educational administration: (i) Setting STEM educational policies (PF); (ii) Teacher development in STEM education (TD); (iii) Development of an integrated learning curriculum (IL); (iv) Creation of a STEM educational cooperation network (CN); (v) Supervision and evaluation of STEM education (SE), and (vi) Innovative leadership (IL). Moreover, there were 18 STEM educational administration indicators which derived from the six key factors with regards to fit the Thai context. Table 1 display the details of the key factors and their indicators of STEM educational administration.

Table 1: Identification of Factors, Indicators, and their Behavioural Elements of STEM Educational Administration.

Factors	Indicators	Behavioural Elements
Setting STEM educational policies (PF)[3 indicators]	Setting objectives of STEM educational policies (PF1)	Administrators set objectives of STEM educational policies collaboratively (PF1.1)
	Setting goals and guidelines of STEM educational policies (PF2)	Administrators set goals of STEM educational policies collaboratively (PF2.1)
		Administrators establish STEM educational policy guidelines together (PF2.2)
	Supervising, monitoring, and evaluating of STEM educational policies (PF3)	Administrators supervise, monitor and evaluate STEM educational policies (PF3.1)
Teacher development in STEM education (TD)[3 indicators]	STEM education knowledge training (TD1)	Administrators encourage teachers to participate in STEM education training either online or onsite (TD1.1)
	Creating a professional learning community (TD2)	Administrators create professional learning communities for STEM teachers (TD2.1)
	Motivation (TD3)	Administrators create incentives for STEM education learning management such as giving praise, certificates, and rewards.

Factors	Indicators	Behavioural Elements
Development of an integrated learning curriculum (IL) [3 indicators]	Determining objectives of integrated curriculum (IL1)	Administrators determine aims of STEM integrated curriculum to match each grade level appropriately (IL1.1)
	Integrated curriculum design (IL2)	Administrators design an integrated curriculum focusing on student centred (IL2.1)
	Integrated curriculum evaluation (IL3)	Administrators evaluate the use of integrated curriculum for improvement (IL3.1)
Creation of a STEM educational cooperation network (CN)[3 indicators]	Cooperation between network partners (CN1)	Administrators create cooperation among STEM educational cooperation partners in both public and private sectors nationally and internationally (CN1.1)
	Creating a platform for knowledge exchange (CN2)	Administrators create platforms to exchange STEM education knowledge among schools, universities, and various agencies (CN2.1)
	Publication of best practice results (CN3)	Administrators publish the results of best practice in STEM education systematically (CN3.1)
Supervision and evaluation of STEM education (SE)[3 indicators]	Administering supervisory planning on STEM education (SE1)	Administrators plan for administering supervision of STEM education collaboratively (SE1.1)
	Administering supervisory process on STEM education (SE2)	Administrators establish a STEM education supervisory process to match school context appropriately (SE2.1)
	Evaluating STEM education supervision (SE3)	Administrators evaluate STEM education supervision using various methods (SE3.1)
Innovative leadership (IL)[3 indicators]	Vision of change (IL1)	Administrators have a vision to deal with change development of schools in the future (IL1.1)
	Creative and innovative thinking (IL2)	Administrators have initiative and creativity to create innovations in promoting STEM education administration (IL2.1)
	Creating an organizational atmosphere of innovation (IL3)	Administrators create a conducive and innovative organizational atmosphere in STEM teaching and learning activities (IL3.1)

All 11 specialists agreed to determine a cut-off point as a mean score of more than 3.00, and less than 20 percent as the coefficient of scattering, to create those indicators on the foundation of prevailing studies related to the STEM educational administration. The results of the first phase are displayed in Table 2 below.

Table 2: Identification of Indicators for STEM Education Administration.

Factors	Indicators	Mean	Std. Dev	CV
Setting STEM educational policies (PF)	Setting objectives of STEM educational policies (PF1)	4.51	0.65	14.58
	Setting goals and guidelines of STEM educational policies (PF2)	4.42	0.64	14.50
	Supervising, monitoring, and evaluating of STEM educational policies (PF3)	4.47	0.60	13.44
Teacher development in STEM education (TD)	STEM education knowledge training (TD1)	4.18	0.68	16.31
	Creating a professional learning community (TD2)	4.22	0.68	16.24
	Motivation (TD3)	4.54	0.60	13.37
Development of an integrated learning curriculum (IL)	Determining objectives of integrated curriculum (IL1)	4.38	0.64	14.65
	Integrated curriculum design (IL2)	4.25	0.74	17.60
	Integrated curriculum evaluation (IL3)	4.49	0.59	13.16
Creation of a STEM educational cooperation network (CN)	Cooperation between network partners (CN1)	4.41	0.62	14.13
	Creating a platform for knowledge exchange (CN2)	4.46	0.64	14.44
	Publication of best practice results (CN3)	4.47	0.62	13.98
Supervision and evaluation of STEM education (SE)	Administering supervisory planning on STEM education (SE1)	4.47	0.66	14.92
	Administering supervisory process on STEM education (SE2)	4.45	0.67	15.18
	Evaluating STEM education supervision (SE3)	4.43	0.68	15.49
Innovative leadership (IL)	Vision of change (IL1)	4.49	0.61	13.79
	Creative and innovative thinking (IL2)	4.44	0.63	14.18
	Creating an organizational atmosphere of innovation (IL3)	4.33	0.78	18.10

Demographic Data of Respondents

A total of 480 distributed questionnaires were successfully collected from extra-large secondary schools in northeast region of Thailand, giving a response rate of 100 percent. The majority of respondents are females (68.5%). The demographic data showed that researchers obtained a comprehensive and representative sample in terms of their age and work experience as a good practice when conducting surveys to gather quantitative data. An equal distribution of respondents in terms of their age, namely 84 (17.5%), 221 (46.0%) 123 (25.6%), and 52 (10.9%) of respondents' age between 21 to 30 years old, 31 to 40 years old, 41 to 50 years old and 51 to 60 years old respectively. On the other hand, results indicated an equal distribution of respondents in terms of respondents' work experience too such as 132 (27.5%) of respondents' work experience was less than six years; 110 (22.9%) of respondents' work experience was between six to 10 years; 86 (17.9%) of respondents' work experience was between 11 to 15 years; 73 (15.2%) of respondents' work experience was between 16 to 20 years; 48 (10.0%) of respondents' work experience was between 21 to 25 years, and 31 (6.5%) of respondents' work experience was more than 26 years.

In addition, a total of 480 respondents consisted of 15 (3.1%) school administrators and 465 (96.9%) teachers with a majority of them possessing a master's degree as the highest academic level (254, 52.9%). This was followed by 193 (40.2%) of respondents have bachelor's degree. Only 33 (6.9%) of respondents were awarded a doctoral degree as the highest academic level. This demographic data of respondents helps the researchers to capture diverse perspectives and insights across different demographic groups. Table 3 demonstrates the demographic data of respondents.

Table 3: Profile of Respondents.

Background	Frequency (N= 480)	Percentage (%)
Gender-Male-FemaleTotal	151329480	31.5 68.5 100
Age-21 to 30 years old-31 to 40 years old-41 to 50 years old-51 to 60 years oldTotal	8422112352480	17.546.025.610.9100
Work experience-<6 years-6 to 10 years-11 to 15 years-16 to 20 years-21 to 25 years->26 yearsTotal	13211086734831480	27.522.917.915.210.06.5100
Position-School administrators-TeachersTotal	15465480	3.196.9100
Academic qualification-Bachelor's degree-Master's degree-Doctoral degree	19325433480	40.252.96.9100

Intercorrelation Between Stem Educational Administration Indicators

A STEM education administrative model was then developed by the researchers which representing the identified six factors and 18 indicators through arranging them in a logical manner to reflect their interrelationships. Hence, this model would provide a comprehensive and structured overview of the ethical considerations relevant to STEM educational administration within the researchers' selected scope. The results of Pearson correlation coefficients were used to assess the linear relationships between pairs of 18 indicators.

Table 4 elucidates the results of intercorrelation between the 18 indicators of STEM educational administration indicating that there were positive correlations for all relationships between pairs of 18 indicators. This implies that as one indicator increases, the other tends to increase too. In addition, the magnitude of the correlation coefficients ranged from 0.426 to 0.805 revealing the strengths of the relationships from moderate to strong, with values closer to 1 representing a stronger correlation and all the relationships are statistically significant at 0.01 level. Consequently, results also showed that the relationship between administering supervisory planning on STEM education (SE1) and publication of best practice results (CN3) ($r = .805$; $r<.01$) was the highest magnitude of the correlation coefficient. However, the lowest magnitude of the correlation coefficient was STEM education knowledge training (TD1) and integrated curriculum design (IL2) ($r = .426$; $p<0.01$), as illustrated in Table 4.

Table 4: Intercorrelations Results of Identifying Indicators of STEM Educational Administration.

	PF1	**PF2**	**PF3**	**TD1**	**TD2**	**TD3**	**IL1**	**IL2**	**IL3**	**CN1**	**CN2**	**CN3**	**SE1**	**SE2**	**SE3**	**IL1**	**IL2**	**IL3**
PF1	1.00	.760**	.538**	.436**	.500**	.608**	.638**	.538**	.533**	.531**	.534**	.510**	.513**	.541**	.619**	.642**	.605**	.604**
PF2		1.00	.584**	.525**	.557**	.690**	.762**	.665**	.565**	.571**	.551**	.520**	.524**	.540**	.666**	.704**	.655**	.695**
PF3			1.00	.570**	.486**	.584**	.606**	.484**	.641**	.578**	.602**	.638**	.601**	.582**	.438**	.500**	.514**	.489**
TD1				1.00	.670**	.464**	.516**	.426**	.530**	.509**	.480**	.481**	.507**	.502**	.435**	.444**	.501**	.455**
TD2					1.00	.556**	.567**	.520**	.520**	.541**	.468**	.459**	.504**	.497**	.458**	.494**	.534**	.508**
TD3						1.00	.662**	.604**	.566**	.544**	.570**	.532**	.548**	.534**	.645**	.630**	.633**	.630**
IL1							1.00	.669**	.580**	.578**	.550**	.554**	.579**	.566**	.569**	.674**	.605**	.663**
IL2								1.00	.510**	.496**	.492**	.458**	.472**	.442**	.574**	.625**	.573**	.658**
IL3									1.00	.691**	.683**	.659**	.694**	.644**	.467**	.512**	.567**	.511**
CN1										1.00	.680**	.628**	.621**	.564**	.476**	.487**	.513**	.515**
CN2											1.00	.737**	.732**	.698**	.495**	.542**	.532**	.505**
CN3												1.00	.805**	.676**	.487**	.478**	.523**	.485**
SE1													1.00	.751**	.508**	.501**	.562**	.547**
SE2														1.00	.535**	.555**	.562**	.573**
SE3															1.00	.666**	.649**	.696**

IL1	1.00	.712**	.765**
IL2		1.00	.718**
IL3			1.00

**Correlation Coefficient is Significant at the 0.01 Level (2-Tailed).

The Goodness of Fit of the STEM Educational Administration Factors and Indicators with Empirical Data

The researchers projected to accomplish estimates of the parameters of the STEM education administrative model, the validity of the identified factors and their factor loading of the STEM educational administration. In particular, factor loading means the 'relative importance' of the identified indicators that collectively form a specifically identified factor in the STEM education administrative model of extra-large size secondary school administrators that had been considered. The co-variance with the STEM educational administration factors ranged from 71.30 to 98.40 percent. As shown in the following Table 5, the factor loading of all the STEM educational administration factors are ranged from 0.844 to 0.992 and is statistically significant at 0.01. The factor with the highest factor loading value was development of an integrated learning curriculum. This was followed by teacher development in STEM education, supervision and evaluation of STEM education, setting STEM educational policies, and innovative leadership. The factor that has the least capacity factor loading value was creation of a STEM educational cooperation network. Consequently, the researchers concluded that all the identified factors are found to be important constructs of STEM educational administration for extra-large size secondary school administrators in northeast region of Thailand.

Table 5: The Results of CFA for Key Factors and Indicators of STEM Educational Administration.

Factors and their indicators	**Factor Loading**			**R^2**
	β	**S.E.**	t	
Setting STEM educational policies (PF)	0.965	0.017	56.202	0.931
Setting objectives of STEM educational policies (PF1)	0.526	0.028	19.079	0.637

Factors and their indicators	Factor Loading			R^2
	β	S.E.	t	
Setting goals and guidelines of STEM educational policies (PF2)	0.566	0.025	22.326	0.777
Supervising, monitoring, and evaluating of STEM educational policies (PF3)	0.409	0.025	16.295	0.467
Teacher development in STEM education (TD)	0.985	0.020	49.469	0.970
STEM education knowledge training (TD1)	0.439	0.030	14.613	0.415
Creating a professional learning community (TD2)	0.465	0.029	16.050	0.461
Motivation (TD3)	0.496	0.025	20.105	0.667
Development of an integrated learning curriculum (IL)	0.992	0.010	96.913	0.984
Determining objectives of integrated curriculum (IL1)	0.544	0.024	22.305	0.715
Integrated curriculum design (IL2)	0.575	0.030	19.425	0.591
Integrated curriculum evaluation (IL3)	0.411	0.024	17.003	0.486
Creation of a STEM educational cooperation network (CN)	0.844	0.024	34.730	0.713
Cooperation between network partners (CN1)	0.495	0.026	19.006	0.635
Creating a platform for knowledge exchange (CN2)	0.513	0.029	17.655	0.633
Publication of best practice results (CN3)	0.486	0.026	18.498	0.605
Supervision and evaluation of STEM education (SE)	0.981	0.019	52.386	0.962
Administering supervisory planning on STEM education (SE1)	0.465	0.029	16.196	0.487
Administering supervisory process on STEM education (SE2)	0.467	0.028	16.460	0.479
Evaluating STEM education supervision (SE3)	0.537	0.028	18.864	0.612

Factors and their indicators	Factor Loading			R^2
	β	S.E.	t	
Innovative leadership (IL)	0.916	0.014	67.771	0.839
Vision of change (IL1)	0.538	0.023	23.379	0.755
Creative and innovative thinking (IL2)	0.527	0.024	22.027	0.700
Creating an organizational atmosphere of innovation (IL3)	0.675	0.029	23.104	0.743

The STEM education administrative assessment model whether is acceptable or not in SEM depends on the fit indices, highlighted by Ullman (2001). The results of goodness of fit indicated that the STEM education administrative model fits between the obtained values of collected data and the expected values as follows: χ^2 =77.869, df = 63, p-value = 0.098, CFI = 0.998, TLI = 0.995, RMSEA = 0.022, and SRMR = 0.022. After referring to the following experts' rules of thumb and their recommended cut-off values, the researchers concluded that the associated real values are fitting to the expected values in the STEM education administrative model. Table 6 presents the details of goodness of fit indexes and their interpretations.

Table 6: Interpretation of Goodness of Fit for STEM education administrative Model.

Goodness of Fit Index	Real Values	Rules of Thumb or Cut-off Values	Specialist	Interpretation
χ^2/df	1.236	<2 <5	Ullman (2001) Schumacker and Lomax (2004)	Pass
CFI	0.998	≥ 0.95	Hu and Bentler (1999)	Pass
TLI	0.995	≥ 0.95	Hu and Bentler (1999)	Pass
RMSEA	0.022	<0.06<0.07	Hu and Bentler (1999) Steiger (2007)	Pass
SRMR	0.022	<0.05	Byrne (1998)	Pass

Based on the above discussion, researchers concluded the STEM education administrative model was compliance with the empirical data. Hence the researchers established precise and significant paths of the STEM education administrative model as illustrated in Figure 2.

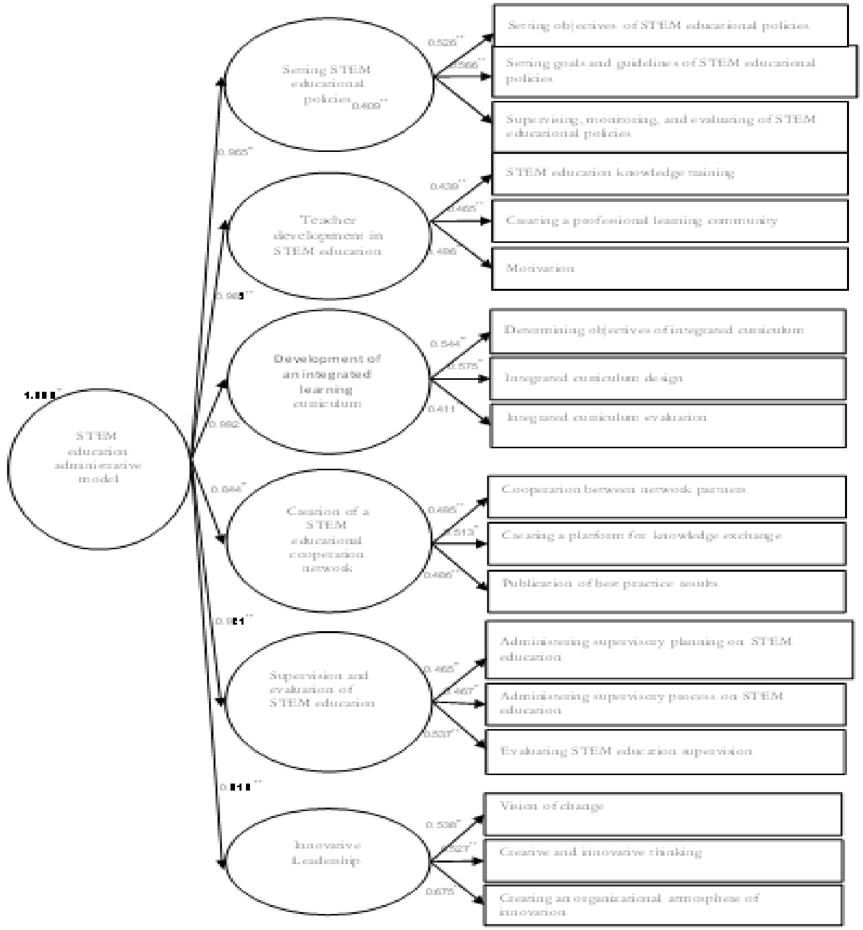

Figure 2: STEM Education Administrative Model.

Conclusion

The results of this research revealed that extra-large size secondary school administrators can administer the STEM education effectively by incorporating the six factors and their indicators in order to encourage a culture of continuous improvement by promoting collaboration, innovation, and lifelong learning among teachers, students, and policymakers. The results are found in parallel with the past research such as Geesa et al. (2021), Mumcu et al. (2023), and Petrosino et al. (2020). The results imply that extra-large school administrators must ensure that the curriculum integrates science, technology, engineering, and mathematics subjects with real-world applications and project-based learning. Besides, they should provide ongoing professional development opportunities, workshops, and collaboration platforms to keep teachers updated with the latest trends and best practices in STEM education.

On top of that, school administrators are suggested to implement periodic evaluations to assess the effectiveness of STEM programs so that they are able to identify areas for improvement, and recognize exemplary schools and teachers. In conclusion, the researchers would like to suggest to Thailand Ministry of Education to establish a central governing body responsible for overseeing STEM education initiatives. This body sets policies, guidelines, and standards for STEM curriculum development, teacher training, and resource allocation using this STEM education administrative model as reference.

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