

# Mathematics Teachers' Performance in the Industrial Revolution Era 4.0: A Structural Equation Model

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## Mathematics Teachers' Performance in the Industrial Revolution Era 4.0: A Structural Equation Model

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**Abstract:** This research aimed to find the structural equation model of mathematics teachers' Performance in the Industrial Revolution 4.0 that fits according to data in the field. The Research population was secondary mathematics teachers of Riau Province, Indonesia. Research samples were a part of teachers who were taken based on the purposive sampling. The instrument was a questionnaire developed and validated through content and construct validity. Data analysis was a correlational technique with a structural equation modeling approach. The analysis result showed that the structural model arranged based on the industrial revolution 4.0 variables that is; Leadership, work motivation, teachers' self-efficacy, teachers' Creativity, and organizational climate. TPACK did not affect the industrial revolution 4.0. Leadership significantly affected Teachers' Self-Efficacy, Teachers' Creativity, Work motivation, TPACK, and organizational climate. The organizational climate significantly affected work motivation, TPACK, Teachers' Self-Efficacy, and Teachers' Creativity. Work Motivation significantly affected Teachers' Self-Efficacy, Teachers' Creativity, and TPACK. Teachers' Self-Efficacy did not affect Teachers' Creativity and TPACK. Teachers' Creativity significantly affected TPACK. Of 15 paths from endogenous to endogenous variables, 13 paths are significant, and two paths are not significant.

**Keywords:** mathematics teachers' performance' industrial revolution era, structural equation model

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### INTRODUCTION

The industrial revolution 4.0 in this era has influenced various aspects of human life. In this era, humans are required to keep up with various technological developments that are changing very quickly. Education is an aspect that cannot be separated from the influence of the industrial revolution 4.0 so that all elements involved in the world of education can no longer be passive or silent about these developments. Elements of passive education will be degraded or stagnant. Without any development or innovation that can keep up with these developments, education is only a means of transferring knowledge that does not contribute to the development of skills to face the challenges of its time.

Improving mathematics teachers' performance in this era is important to think because a mathematics teacher is a teacher with the greatest teaching burden (Mutodi, 2014). The Mathematics teachers' performance is still felt to be problematic where there are still many teachers who have low motivation, come late, do not want to improve competence in teaching, and other problems that result in deteriorating teacher performance (Susanto, 2012). In this case, the key to teachers' success is highly dependent on renewable skills and teacher effectiveness in the classroom (Darling-hammond & Richardson, 2009). A teacher must be able to provide learning resources so that students get good learning experiences for cognitive, affective, and psychomotor development of students (Muralidharan & Sundararaman, 2011). Teachers' technological abilities are very important because in the digital era teachers almost use all learning with technology. Teachers and technology will go hand in hand in the learning process in the digital era (Birkollu et al., 2017). Under any circumstances, teachers must interact with technology.

In the era of the Industrial Revolution, mastery of technology is absolute (Ayele & Birhanie, 2018; Batane & Ngwako, 2017; Farooq & Soomro, 2018). Schools must provide extra services so that teachers can actively master technology (Lawrence & Tar, 2018; McKnight et al., 2016). Teachers must develop technology skills on an ongoing basis to be able to teach optimally in the digital era (Larson & Miller, 2011). Teachers must provide skills that are useful for students' future so that students are ready to face a more sophisticated future (Larson & Miller, 2011). Teacher performance in this era is largely determined by the ability of teachers to master technology (Boonmoh et al., 2021).

A teacher must be able to provide all the potential that can hone students' skills so that they become useful outputs in society (Greenhow & Lewin, 2016). In the era of the industrial revolution, mathematics teachers must hard work to transfer mathematics material so that students can have good technological skills to adapt to

this era (Rachmadtullah et al., 2020). Students who master mathematics will find it easier to master technology because mathematics is the key to the speed of technological development (Drijvers, 2015). Conversely, mathematics teachers can use technology to teach students in the classroom so that students enjoy learning mathematics-supported technology (Murphy, 2016; Stoyle & Morris, 2017).

Mathematics teachers contribute maximally to technology development because all computation in technology uses mathematics computation (Aldon et al., 2017). In this era is determined by the extent to which mathematics teachers give the best teaching practice in mathematics material so that teachers make maximum contributions to students in understanding a mathematics subject (Lau & Yuen, 2013). Mathematics teachers' performance in the industrial revolution era is very important and crucial because it determines the success of students in the future. Therefore, the factors that affect the performance of teachers in the era of the industrial revolution 4.0 need to be identified their contribution so that they can be taken into consideration by stakeholders in making policies. This study will answer three major hypotheses, namely; (1) the mathematics teacher performance model that has been designed is statistically fit the data obtained in the field?; (2) What are the most dominant factors that influence the success of mathematics teachers in the era of the industrial revolution 4.0 (IR.4)? (3) is there a significant effect of each endogenous variable on other endogenous variables.

Leadership is a concept in which a person influences a particular community (Hartiwi et al., 2020). In the context of education, leadership can affect the performance of teachers and education personnel (Aunga & Masare, 2017; Rahman et al., 2022). The characteristics possessed by a principal can affect teacher performance (Andriani et al., 2018). Leadership is the authority possessed by a principal in influencing teacher performance (Ratnasih, 2017; Sudrajat, 2011). Principal leadership can affect teacher performance in the Industrial Revolution Era 4.0 (Kadiyono et al., 2020). Instructions given by principals can improve teacher performance in the industrial revolution era because the times require teachers to adapt to technological sophistication (Tatlah et al., 2019). Leadership, directly and indirectly, affects teacher performance in the era of the industrial revolution 4.0 (Muda et al., 2021). Work motivation describes the seriousness of a teacher doing his job to improve his performance (Andriani et al., 2018; George & Sabhapathy, 2014; Ratnasih, 2017). Work motivation allows teachers to work hard and encourages teachers to improve their work abilities so that teacher performance in the industrial revolution era is maximized (Maryanti et al., 2020). Teachers who have a high commitment to developing themselves will try hard to improve their ability to adapt to the Industrial Revolution Era (Lestari & Rahmawati, 2020; Rusli et al., 2020). Teachers who have high motivation will increase their teaching competence so that adapting to the times is not a problem for teachers (Ismail et al., 2020). Work motivation is an important factor that can affect teacher performance in the Industrial Revolution 4.0 Era.

TPACK is a concept where a teacher must know, understand and use technology with complex networks in the learning process (Koehler & Mishra, 2008; Koehler et al., 2013). In the era of the industrial revolution 4.0, TPACK is an important factor in the success of teachers in the learning process (Loughran et al., 2012; Sintawati & Indriani, 2019). TPACK is a technology integration concept that must be mastered by teachers so that teacher performance in the Industrial Revolution Era 4.0 (Schmidt et al., 2014). The ability of teachers to integrate teaching skills and technological capabilities can improve teacher performance in the digital era (Butt et al., 2020; Farjon et al., 2019; Voogt et al., 2013). TPACK can affect teacher performance in the Industrial Revolution Era 4.0. Teacher creativity in the industrial revolution era is very urgent because it shows the extent to which a teacher can combine education with technology (Jalali & Heidari, 2016). Teacher creativity greatly influences the success of teachers in the industrial revolution 4.0 era (Parsa, 2017). Teacher performance is strongly influenced by the ability of teachers to develop themselves, innovate, and find new things to improve the quality of education (Williamson & Piattoeva, 2019; Wu & Wu, 2020). Teachers who can develop the latest learning concepts can produce maximum performance in the Industrial Revolution Era 4.0 (Lasky & Yoon, 2020; Mak et al., 2020). The creativity of a teacher is a determining factor for the success of teachers in following the times.

Teacher self-efficacy can improve teacher performance in the era of the industrial revolution 4.0 (Ismail et al., 2020). Teachers' confidence in their abilities will increase teachers' efforts to achieve academic achievement in the Industrial Revolution Era 4.0 (Ismail & Wahid, 2018). A strong belief that is followed by hard work makes it easier for teachers to adapt to learning activities in any field (Lastariwati et al., 2021). Self-efficacy of teachers increases work motivation in improving teaching skills in the era of the industrial revolution 4.0 (Teo et al., 2021; Widdah et al., 2021). Teacher self-efficacy creates best learning practices because teachers believe teachers can do their best in improving the quality of learning in the Industrial Revolution Era 4.0 (Mustakim et al., 2021). A strong belief in the teachers' abilities will eliminate the teacher's fear of any challenge.

An organization is a grouping of people into cooperative activities to achieve certain goals (Engkoswara & Komariah, 2012). Organizational climate can affect teacher performance results in the era of the industrial revolution 4.0 (Kawiana et al., 2021). A good organizational climate delivers teachers with high work commitment so that performance is maximized (Nurhatisyah et al., 2021). Teacher performance in this era can be improved through a work environment created through a conducive work climate (Mulyana et al., 2021). A good organizational climate in schools can affect teacher performance in the industrial revolution 4.0.

## METHODS

Quantitative research is proposed with SEM (structural Equation Modeling) approach. SEM enables researchers can relate some endogenous and exogenous variables simultaneously. SEM not only measures variables but also measures every indicator acquired from variables both endogenous and exogenous. SEM shows the correlation between exogenous with endogenous variables, the contribution of exogenous to endogenous variables, construct validity of every indicator from exogenous and endogenous variables. SEM is complete statistics that show the complex relationship between exogenous with endogenous variables and give some conclusion about its relation (Gozali & Fuad, 2008; Hair Jr et al., 2014). The population of this research was senior high school teachers in Riau Province. Sampling in this study uses a simple random sample. The random sample gives the best results for the researcher to general the conclusion to other populations because these techniques give every representative respondent become respondent according to the specified criteria (Setiawan et al., 2018).

The research variables in this study are the variables obtained based on previous studies that directly or indirectly affect mathematics teachers' performance. The identified variables that can affect teacher performance in the era of the industrial revolution 4.0 are; Leadership Style (X1) with indicators of directing, delegating, and skills; Motivation (X2) with indicators of responsibility in carrying out tasks, carrying out tasks with clear targets, having a sense of pleasure at work, always trying to outperform others, and achievement orientation; Teacher Self-Efficacy (X3) with indicators of Magnitude, Strength, Generality; Organizational climate (X4) with indicators of Responsibility, Support, and Support; Creativity (X5) with indicators Belief in Unconscious Processes, Use of Techniques, Final Product Orientation, Environmental Control, Superstition, and Use of Senses; TPACK (X6) with indicators of Knowledge of Technology and Its Applications, Ability to Integrate Pedagogics with Technology; teacher performance in the Industrial Revolution 4.0 (Y) with indicators of quality, quantity, independence

The collection procedure for this research uses a survey approach by sending a questionnaire in a Google Form to senior high school teachers to target schools that meet the criteria from every twelve districts in Riau Province. Data analysis in this study used a quantitative approach by describing the data statistically and then finding a statistically fit teacher performance model using correlational research, namely SEM. SEM will show or describe the extent to which the model is fitted with the data, whether the indicators obtained are valid and reliable, and which variables influence teacher performance in the era of the industrial revolution 4.0.

## RESULT AND DISCUSSION

Hypothesis testing can be carried out if the parametric statistical prerequisite tests are met. The prerequisite tests used in this research are normality, linearity, and multicollinearity tests. Normality and multicollinearity can be seen in Tables 1, 2, and 3.

**Table 1.** Normality Test of Teachers' Performance Model

Variables	N	Kolmogorov-Smirnov	Asymp. Sig	Conclusion
Leadership Style (LS)	235	1.027	0.242	Normal
Work Motivation (WM)	235	1.007	0.263	Normal
Self Efficacy of Teachers (SE)	235	1.576	0.114	Normal
Organizational Climate (OC)	235	1.344	0.054	Normal
Creativity (Cr)	235	1.247	0.089	Normal
TPACK	235	1.216	0.104	Normal
Teachers' Performance (TP)	235	0.868	0.438	Normal

Table 1 is the result of the normality test used to ensure the data is in a normal distribution. The analysis results show that the results of the seven variables are not significant because the sig value of the Kolmogorov-Smirnov statistic is greater than 0.05, so the normality test has been fulfilled. The next test was the linearity of independent variables to the dependent variable in Table 2.

**Table 2.** Linearity Test of Teachers' Performance Model

Linearity Standard	Variables	df	Mean Square	F	Sig.
Deviation from Linearity	Teachers' Performance* Leadership Style	27	11.949	1.635	0.053
	Teachers' Performance * Work Motivation	33	4.584	0.619	0.949
	Teachers' Performance * Self-Efficacy	19	10.509	1.13	0.322
	Teachers' Performance * Organizational Climate	15	9.472	1.022	0.434
	Teachers' Performance * Creativity	15	7.766	0.712	0.771
	Teachers' Performance * TPACK	15	4.273	0.378	0.983



Table 2 shows linearity results to check the correlation between independent variables to the dependent variable. The results show that the sig of Deviation from Linearity is more than 0.05, so it can be concluded that the correlation between independent variables on the dependent variable was linear. The multicollinearity test can be continued using the correlation of each variable to other variables. Table 3 shows the correlation variables as follows;

**Table 3.** Multicollinearity Test of Teachers' Performance Model

Variables	LS	WM	SE	OC	Cr	TPACK	TP
Leadership Style (LS)	<b>1.00</b>	0.87	0.82	0.82	0.80	0.80	0.85
Work Motivation (WM)	0.87	<b>1.00</b>	0.84	0.85	0.79	0.82	0.87
Self_Efficacy of Teachers (SE)	0.82	0.84	<b>1.00</b>	0.80	0.76	0.76	0.82
Organizational Climate (OC)	0.82	0.85	0.80	<b>1.00</b>	0.78	0.78	0.82
Creativity (Cr)	0.80	0.79	0.76	0.78	<b>1.00</b>	0.76	0.79
TPACK	0.80	0.82	0.76	0.78	0.76	<b>1.00</b>	0.79
Teachers' Performance (TP)	0.85	0.87	0.82	0.82	0.79	0.79	<b>1.00</b>

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Table 3 shows the correlation between the seven variables and each variable. The results show the highest correlation is variable leadership style (LS) with teachers' performance (TP) and the lowest correlation is variable Self-Efficacy (SE) with creativity (Cr). These results show that there is no perfect correlation between one variable to other variables, so a conclusion can be made; no multicollinearity between the observed variables, so a hypothesis test can be done using path analysis. The results of data analysis obtained a significant effect of exogenous to endogenous and endogenous to other endogenous variables. A summary of the results of the analysis can be seen in Tables 4 and 5.

**Table 4.** Direct Effect Exogenous to endogenous variables

Variables	T-values	R	Conclusion
Leadership Style*Teachers' Performance	3.25	0.22	Significant
organizational climate *Teachers' Performance	2.10	0.12	Significant
Work Motivation * Teachers' Performance	4.25	0.307	Significant
Self-Efficacy of Teachers * Teachers' Performance	2.49	0.148	Significant
Creativity * Teachers' Performance	2.39	0.12	Significant
TPACK*Teachers' Performance	1.37	0.07	No Significant

From Table 4, five significant variables affected the mathematics teachers' performance at Industrial Revolution 4.0 namely; Leadership Style, organizational climate, work motivation, self-efficacy, and teachers' creativity with each coefficient of 0.22, 0.12, 0.307, 0.148, and 0.12. TPACK didn't affect significantly the teachers' performance.

**Table 5.** Direct Effect endogenous to others endogenous variables

Variables	T-values	R	Conclusion
Leadership Style *Teachers' Self-Efficacy	4.37	0.308	Significant
Leadership Style *Teachers' creativity	3.72	0.302	Significant
Leadership Style *Work Motivation	10.52	0.41	Significant
Leadership Style *TPACK	2.94	0.23	Significant
Leadership* organizational climate	22.14	0.82	Significant
organizational climate * Work Motivation	8.21	0.41	Significant
organizational climate * TPACK	2.01	0.22	Significant
organizational climate *Self Efficacy	3.54	0.23	Significant
organizational climate *Creativity	3.24	0.24	Significant
Work Motivation *Self-Efficacy of Teacher	4.27	0.38	Significant
Work Motivation *creativity	2.49	0.22	Significant
Work Motivation *TPACK	3.63	0.31	Significant
Self-Efficacy of Teachers *creativity	1.87	0.141	No Significant
Self-Efficacy of Teachers *TPACK	0.90	0.11	No Significant
Creativity *TPACK	2.74	0.17	Significant

From Table 5, leadership Style affected significantly Teachers' Self-Efficacy, Teachers' Creativity, Work motivation, TPACK, and organizational climate with each coefficient of 0.308, 0.302, 0.410, 0.230, and 0.82. The organizational climate affected significantly work motivation, TPACK, Teachers' Self-Efficacy, and Teachers' Creativity with each coefficient of 0.41, 0.22, 0.23, and 0.24. Work Motivation affected significantly Teachers' Self-Efficacy, Teachers' Creativity, and TPACK, with each coefficient of 0.38, 0.22, and 0.31. Teachers' Self-

Efficacy didn't affect Teachers' Creativity and TPACK with each coefficient of 0.14 and 0.11. Teachers' Creativity affected significantly TPACK with a coefficient of 0.17. Of 15 paths from endogenous to endogenous variables, 13 paths are significant and 2 paths are not significant.

Based on the results of the study, it was known that the leadership style variable has a significant effect on teacher performance variables in the era of the industrial revolution 4.0. This shows that the good or bad performance of teachers is caused by the leadership style in the workplace, namely the school. Teacher performance in the Industrial Revolution 4.0 era is strongly influenced by leadership in schools (Kadiyono et al., 2020). A school principal can instruct teachers to follow the development of learning in the digital era through various training or workshops (Baporikar, 2018). Principals who already have digital skills can directly train teachers in their work environment (Hamzah et al., 2021). Principals can influence teachers to develop themselves following the times (Kawiana et al., 2021). Organizational climate affects teacher performance in the era of the industrial revolution 4.0 with a coefficient of 0.12. Organizational climate has a positive impact on teacher capacity development (Nugroho et al., 2020). The organizational climate in schools affects the behavior of teachers to develop themselves in keeping up with the times (Hermawati et al., 2020).

Psychologically, organizational climate can affect teacher performance in the industrial revolution era (Fikri et al., 2021). Teacher work motivation can affect teacher performance in the 4.0 industrial revolution era with a coefficient of 0.307. Teacher work motivation in this digital era can affect teacher performance where the teacher follows the times optimally (Maryanti et al., 2020). Challenges in the industrial revolution 4.0 era can be easily followed when teachers have high work motivation (Ismail et al., 2020). Work motivation increases the commitment of teachers to develop themselves so that they can follow the challenges of the times (Hasibuan & Rahmawati, 2019; Lestari & Rahmawati, 2020). Teachers who have high motivation will improve their professional abilities as part of improving performance in the era of the industrial revolution 4.0 (Agustini & Pujiastuti, 2020). Teacher self-efficacy has a significant effect on teacher performance with a coefficient of 0.148. Teacher self-efficacy gives teachers the strength to adapt to the era of the industrial revolution 4.0 (Ismail et al., 2020). Teachers who have high confidence in themselves will follow the times quickly and are happy with new challenges (Rafiola et al., 2020). Teachers with high self-efficacy will think creatively to succeed in the era of the industrial revolution 4.0 (Hamid et al., 2021). TPACK has no significant effect on teacher performance in the era of the industrial revolution 4.0. This is because the teacher's TPACK ability can mediate other exogenous or endogenous variables.

Leadership has a significant effect on teacher self-efficacy, teacher creativity, teacher work motivation, and teacher TPACK. Principals as school leaders can motivate and convince teachers that teachers can succeed in the era of the industrial revolution 4.0 by increasing creativity and ability in technology (Abdullah et al., 2018). Teacher motivation, teacher discipline, and teacher confidence in their abilities will increase when the principal provides maximum support (Setyaningsih, 2020). An authoritative and disciplined principal can increase work motivation, teacher creativity, and teachers' ability in using technology to adapt to the era of the industrial revolution 4.0 (Lee & Kuo, 2019; Mulyana et al., 2021). Principals who understand the character and abilities of their teachers will motivate, convince and improve the ability of teachers to adapt to technological developments in the era of the industrial revolution 4.0 (Setyaningsih, 2020; Shepherd-Jones & Salisbury-Glennon, 2018). Visionary school principals provide creative ideas to develop teacher abilities, teacher motivation, and teacher confidence in following the sophistication of learning technology in the era of the industrial revolution 4.0 (Prestiadi et al., 2020).

Organizational climate has a significant effect on the variables of work motivation, TPACK, self-efficacy, teacher creativity, and teacher performance in the era of the industrial revolution 4.0 with the contribution of each variable, namely 0.41, 0.22, 0.23, 0.24, and 0.12. The organizational climate raises teacher work motivation, develops creativity, and stimulates teachers to advance in their work (Tan & Rajah, 2019). A good organizational climate spurs teachers to compete and improve school quality (Chik et al., 2019). Teacher innovation and creativity can develop optimally in a conducive organizational climate because teachers and others help each other (Kadiyono et al., 2020; Prameswari et al., 2020). Organizational climate influences the mindset of teachers to work effectively and efficiently to adapt to technological developments in the industrial revolution era (Pfeiffer, 2016; Reeve, 2019). The organizational climate increases teacher work motivation, teacher creativity, and teacher confidence to succeed in following the development of learning which is followed by technological sophistication in the era of the industrial revolution 4.0.

## CONCLUSION

The mathematics teachers' performance model developed from exogenous and endogenous variables was statistically fit (Meets the Fit Model Criteria). The variable that had the greatest influence on mathematics teacher performance in the era of the industrial revolution 4.0 was the variable work motivation, while the smallest was the organizational climate. TPACK did not significantly affect teacher performance in the era of the

**industrial revolution 4.0. Leadership** significantly affected teachers' self-efficacy, creativity, work motivation, and TPACK. The organizational climate significantly affected Work Motivation, TPACK, Self-Efficacy, and Creativity. Work Motivation significantly affected Self-Efficacy, Creativity, and TPACK. Self-Efficacy didn't affect Creativity and TPACK. Creativity did not affect TPACK.

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