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The development of Disaster Preparedness and Safety School model: A Confirmatory Factor Analysis

Evi Widowati [a,b,*], Wahyudi Istiono [b], Adi Heru Husodo [b]

[a] Department of Public Health, Faculty of Sport Science, Universitas Negeri Semarang, Semarang, 50229, Indonesia

[b] Department of Family and Community Medicine, Faculty of Medicine, Public Health and Nursing Universitas Gadjah Mada, Jl. Farmako Sekip Utara, Yogyakarta, 55281, Indonesia

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ABSTRACT

Educational institutions are obligated to protect children from multi-hazard disaster risks. The development of reliable and valid measuring instruments for school safety is an important component for reducing the impact of disasters on children's future at schools. This study aimed to examine the appropriateness of measuring instrument models, constructs and indicators of the Disaster Preparedness and Safety School (SSSB) program to be used in the assessment of the multi-hazard-based child safety education system in schools. This study used an explanatory research design with a cross-sectional approach. The sampling technique used was multistage cluster sampling with 539 elementary schools as samples. The data were analyzed by Confirmatory Factor Analysis (CFA) using Lisrel 8.80 software. The CFA results showed that the SSSB constructs are considered valid and reliable. The modified model fulfilled the Goodness of Fit criteria so that the model is considered fit and suitable to be applied at schools, with school commitment as the strongest forming factor (R^2 of 82%) for creating a successful SSSB program.

1. Introduction

A broad and human-centered approach to disaster prevention is essential and disaster risk reduction (DRR) practices must cover multi-hazard situations that should be implemented in an active and continuous manner [1,2]. In Indonesia, the Disaster Preparedness and Safety School program (SSSB) involves the application of a new concept, which does not only emphasize on disaster education but also involves comprehensive and integrative children's safety education. Developed from various existing school assessment instruments, SSSB integrates safety education for the prevention of accidents/injuries that may occur in children from doing various activities, with education for prevention of violence against children (physical, verbal/psychological, sexual, including bullying) in schools and disaster education in a simultaneous manner to ensure the safety of children at schools. There are 15 reference literatures used as the basis for drafting the SSSB concept, namely the Law of the Republic of Indonesia Number 24 of 2007 concerning Disaster Management, Law of the Republic of Indonesia Number 35 of 2014 concerning Amendments to Law Number 23 of 2002 concerning Child Protection, Hyogo Framework for Action 2005–2015, Sendai Framework for Disaster Risk Reduction 2015–2030, Mainstreaming Strategy for Disaster Risk Reduction in Schools, Module 1 on Safe School Facilities, Module 2 on Disaster Management in Schools, Module 3 on Risk Reduction Education, Framework Disaster Prepared School Work, Guidelines for Implementing Disaster-Safe Schools/Madrasas, School Safety [3], FRESH (Focusing Resources on Effective School Health), Child Friendly School Guidelines from the Indonesian Ministry of Women's Empowerment and Child Protection, Guide for Monitoring and Evaluation of Disaster Prepared Schools from the Indonesian Institute of Sciences and the School Health Index from the Centers for Disease Control and Prevention.

The SSSB concept and instrument are new products that resulted from phase 1 of this study which had been conducted within a research roadmap. In stage 1, this new instrument was developed through literature studies and continued with qualitative studies that involved 9 experts from international and local level organizations/institutions. The 9 experts covered 4 key areas of expertise, namely disaster education, safety education, child protection and elementary education. The second stage of this study was testing the feasibility of the model as described in this publication which was then continued to stage 3 to develop a user-friendly mobile health (m-health) application from the SSSB instrument to serve a wider distribution of schools in Indonesia.

* Corresponding author. Department of Public Health, Faculty of Sport Science, Universitas Negeri Semarang, Semarang, 50229, Indonesia.
E-mail addresses: eviwidowati@mail.unnes.ac.id (E. Widowati), ono_ikm@ugm.ac.id (W. Istiono), adiheruhusodo@gmail.com (A.H. Husodo).

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In the first stage, literature studies and systematic reviews were conducted systematically. The literature review showed the need and demand for schools to provide comprehensive and contextual safety education in Indonesia, which minimally includes safety education to prevent accidents/injuries to children, education for prevention of violence in children and disaster education referred to in this article as the SSSB concept. Meanwhile, the results of the systematic review which identified relevant data were retrieved from academic electronic databases at EBSCO, PubMed, Science Direct, SAGE Journal, ProQuest and Emerald Insight published in English between January 2009 and January 2019. The search results showed that only two of the 114 articles met the inclusion criteria. There is presently no study specifically conducted to develop an m-health application to assess children safety education, especially at schools. Accordingly, this study was considered urgent as an attempt to develop comprehensive children safety education based on valid instruments. The m-health application developed is expected to reach a wider distribution of Indonesian schools [4].

In Indonesia, this SSSB instrument was created to assist the schools and the National Education Office in assessing school resilience through a multi-hazard approach. The development of SSSB instrument was administered through a series of steps: 1) developing a conceptual definition, 2) developing an operational definition, 3) determining a scaling technique, 4) reviewing the item justification related to the predetermined scaling technique, 5) determining the response format, 6) preparing the instructions for the response, 7) preparing a draft instrument, 8) preparing the final instrument, 9) collecting preliminary trial data, 10) analyzing test data using factor analysis, item analysis and reliability analysis, 11) revising the instrument (if necessary), 12) conducting additional validity and reliability analysis, and 13) preparing test manuals [5]. The scope of this publication was on the data analysis using factor analysis, item analysis and reliability analysis.

The SSSB consists of 7 constructs which were then broken down into 80 assessment items. The 7 constructs include school commitment, formal education curriculum, information exposure, school infrastructure and facilities, preparedness, supervision system, empowerment of the institutional role and ability of the school community. All constructs and items in the SSSB were developed based on the results of the literature review of 15 relevant references. The step was then continued with the expert justification process through in-depth interviews. Items in the SSSB instrument would be used to assess the real condition at the school using a 4-point Likert scale, namely (1) not available or currently being developed, (2) available but not yet implemented/non-functional, (3) available but only partially implemented, and (4) fully implemented. Detailed SSSB concept ideas and instruments can be accessed from the SSSB (Sekolah Selamat Siaga Bencana) book released in Indonesia in 2020. This SSSB instrument and software have been copyrighted in 2020 according to the national laws of Indonesia with the copyright number EC00202005667 and EC00202003082.

The publication in this article is limited to stage 2, namely further quantitative testing of the SSSB instrument that was produced in the previous stage, while the primary purpose of this current study was to determine: “Is the instrument model of the Disaster Preparedness and Safety School, or *Sekolah Selamat Siaga Bencana* (abbreviated as SSSB) feasible to be used in assessing multi-hazard based child safety education systems in schools?” and the second was to know “Are SSSB constructs and indicators appropriate to be used in assessing a multi-hazard based child safety education system in schools?”. The contribution obtained from this research is that it confirms that the SSSB instrument model, its constructs and indicators are suitable for assessing the multi-hazard based child safety education system in schools in Indonesia and accordingly, this instrument can be considered ready to be replicated.

1.1. *Identifying multi-hazard threats in schools*

Safety involves the efforts to prevent injuries that might occur due to incidences of danger, accidents and violence. Injuries can also take place at schools, which sometimes results in disability or death of students [6]. Schools are a place vulnerable to safety hazards, because they are where children generally gather who are mostly not trained in evacuation drills and who are easily panicked, difficult to be managed in an emergency or crisis and at risk of high death rates and/or injuries because they are less able to take the necessary immediate action, for example in the case of fire [7].

In the past ten years, several disasters have caused huge casualties which affected the welfare and safety of the people, society and the countries of the world. Indonesia is one of the most disaster-prone countries in the world. The number of disasters in Indonesia has been exceedingly high in the past 4 years. From 2016 to March 2019, respectively, there were 2302 incidents with 3,161,231 people affected and displaced; 2853 incidents with 3,674,168 people affected and displaced; 2572 incidents with 10,333,309 people affected and displaced; and 721 incidents with 186,204 people affected and evacuated. These statistics show that there has been a significant number of people affected and evacuated due to recent disasters in Indonesia. Furthermore, high occurrence of earthquakes in Indonesia have negatively impacted the 1000’s of school buildings [8,9]. Therefore, building disaster preparedness starting from schools and building resilience mechanisms that can strengthen school safety are essential to build disaster resilient communities and ensure a safe environment for children’s education.

Disasters can inhibit the progress of sustainable development so that the efforts at disaster risk reduction require a multi-hazard approach. Accordingly, the development of various effective instruments to measure disaster preparedness and public safety is very important to increase awareness and develop appropriate educational programs [2,10].

In addition to the safety and disaster aspects, violence against children also affects the children’s safety in schools in general. According to the national law of Indonesia, it is required to protect children in schools from acts of physical, psychological, sexual violence and other crimes committed by educators, education personnel, fellow students and/or other parties [11]. Violence in schools which is done by peers is a global public health problem, including bullying where the dynamics of power between perpetrators and victims are very important [12]. In general, bullying in schools is a major risk factor for poor education, health and social functioning outcomes [13]. The effects of being bullied are immediate and long-lasting, with the worst effects involve both those who are victims and those witnessing bullying [14]. Girls have a higher risk of experiencing emotional violence than boys. The results of research in Luwero showed that there is a relationship between physical and emotional violence from peers with mental health problems among children. As a commitment to student safety, building resilience in the school environment and building emotional resilience among the students are essential to implement to ensure protection from these multi-hazards [15]. Therefore, the use of reliable and valid measuring instruments for school safety is an important component needed to improve student behavior and safeguard their well-being [16].

This description explains that schools should not only be resistant to the threat of natural disasters but also from multi-hazards, such as: physical, biological, chemical, ergonomic and psychosocial hazards [17] which can cause school children to experience injury, disability and death, or experience psychological and social impacts.

1.2. *Multi-hazard vs. child education in schools*

Disasters affect our lives in various ways, such as physical, psychological and social aspects. The impact of a disaster on children is far greater than at other ages. Schools can provide opportunities to help children develop the knowledge and skills needed to keep themselves safe. One of the best ways to prepare children for the consequences of disasters is an approach that includes psycho-social preparedness through teachers [10,18], but most (87%) of the sample schools in this study have not applied this approach in their school safety programs.

The Hyogo Framework for Action (HFA) is focused on reducing vulnerability and hazard risk through a strategic and systematic approach, by identifying ways to build the resilience of nations and communities to disasters. The third focus of HFA during 2005–2015 has been using knowledge, innovation and education to build a culture of safety and resilience at all levels. This point encourages the efforts to promote the implementation of programs and activities in schools to learn how to minimize the impact of hazards, as well as the development of supports for the implementation of risk assessments conducted locally in schools [19]. The Hyogo Action Framework has become an important instrument for raising public and institutional awareness which can generate political commitment from various stakeholders at all levels. The commitment also emphasizes that DRR practices must be based on multi-hazard and multi-sectoral approaches because they are very important to achieve sustainable development [2].

Disaster risks can naturally occur in schools. These risks occur when hazards interact with physical, social, economic and environmental vulnerabilities [19]. Therefore, is very important to routinely assess school safety in order to improve the school system [20]. School improvement can only be achieved if all parties are involved to make changes in the school environment [21,22], namely through the regulation and management of innovative activities in elementary and primary schools [23] which also include activities for students and their parents [24]. This broader community approach is appropriate because schools are not only educational institutions for children but in many countries, schools are considered to be the centers of the community [25]. The parties involved include the community [19], government entities, international institutions such as UNICEF [26] and non-governmental organizations or local organizations such as the Red Cross Organization and others [27,28].

1.3. Schools in creating safety culture in children

Education must be given a greater role in the humanitarian response in disasters compared to other sectors because it can provide holistic benefits which can not only save lives but also sustain livelihoods [29]. Schools are the foundation of the children's community as well as a suitable vehicle in providing effective transmission of information, knowledge and skills to the nearest community. Therefore, it is important to develop strategies that support schools in building the culture of disaster prevention and raising public awareness [30,31]. The role of children in building community resilience is also very effective in creating public awareness about disasters because lessons learned at school will be a provision of knowledge across generations over time. Accordingly, actively and continuously introducing disaster preparedness, risk reduction and mitigation programs as part of the education in the school curriculum will greatly assist in increasing the understanding of children, teachers and their family members about the potential hazards in their environment [1,32,33].

At school, many children are vulnerable to various dangers. As a result, the concept of disaster management must be taught since early ages to build correct understanding related to the concepts of safety education. Schools that implement comprehensive safety management and moreover have an assessment system that supports the implementation of disaster management in schools, will be able to increase school resilience to effectively reduce the potential for incidences of injury, death and property damage [34,35].

This approach to building community resilience includes being resistant to biological hazards such as SARS-CoV-2, which causes COVID-19, especially when children start returning to school after the extended closure during the current pandemic. The dangers at schools now include the children sitting too close to each other, making contact when greeting, sharing stories and snacks and even singing or exercising together since there are greater chances of disease transmission, making them more vulnerable to SARS-CoV-2 infection. Respiratory droplet transmission can occur when a person is in close contact (within 1 m) of an infected person who has respiratory symptoms (e.g. coughing or sneezing) or who is talking or singing. This is because respiratory droplets which may contain the virus can reach the mouth, nose or eyes of susceptible people and can cause infection. Meanwhile, indirect contact transmission can also occur in schools, namely when there is contact between vulnerable hosts and contaminated objects or surfaces [36,37].

2. Methods

2.1. Background to the present study

Assessment and evaluation are needed to ensure that all DRR mainstreaming strategies are optimally implemented in schools. In Indonesia, the results of monitoring and evaluation are used as material for decision-making to continuously improve the implementation of the DRR strategies [38]. The assessment and evaluation of existing disaster management systems in schools can increase the effectiveness of the existing systems. The key indicators must focus on the implementation of the programs, services, system functions and emergency prevention materials which are taught at various levels. Schools must be aware of the difference between school management in normal and in emergency situations. Research shows that the development of a school assessment system can contribute in reducing the after-effect of disasters which will affect the future of children [39]. For example, one study found that the average student mortality rate in Taiwan per year was 958 and that number has decreased every year as a result of effective disaster prevention education in schools [40].

School safety survey instruments can be developed for several respondents, including parents, school staff and students [3]. The results of safety instruments are very effective in evaluating disaster resilience intervention programs in schools [41]. Consequently, developing an appropriate evaluation tool becomes an important initial step to assess the effectiveness of risk communication messages during disasters or emergencies [42].

2.2. Study design

This study used an explanatory research design with a cross-sectional approach.

2.3. Procedure and participants

This study used multistage cluster sampling [43], with four stages. The first stage was selecting provinces in Indonesia by using the purposive sampling technique. Yogyakarta Province was chosen as the research setting because it is one of the most disaster-prone provinces in Indonesia with a very complex disaster variation. The types of disasters that have occurred in Yogyakarta Province include flood, tornado, landslide, forest and land fire, drought, earthquake, high tide/abrasion and volcanic eruption [8]. The population of this study included all elementary schools in Yogyakarta Province with a total of 1843 schools, consisting of five clusters based on the number of regencies/cities in the province. These five clusters are Sleman regency, Yogyakarta city, Bantul regency, Kulon Progo regency and Gunung Kidul regency.

The second stage determined the minimum sample size, using the minimum sample formula for testing the instrument with Confirmatory Factor Analysis (CFA), with the ratio of 5 respondents: 1 item [43]. Since the SSSB measuring instrument had 29 variables and 80 item questions then there was a total of $80 \times 5 = 400$ elementary schools as a minimum sample.

The third stage consisted of applying the proportional random sampling technique, which determined proportional samples in each district/city for all elementary schools in the regions to obtain the minimum sample size as shown in Table 1. After knowing the number of elementary school samples in each district/city, then the fourth stage

Table 1
Total of research respondents.

Regency/city	Population	Design of minimum sample*	Total sample**	%
Yogyakarta city	166	(166/1.843) X 400 = 36	136	25,2%
Sleman regency	508	(508/1.843) X 400 = 110	113	21%
Bantul regency	361	(361/1.843) X 400 = 78	83	15,4%
Kulon Progo regency	335	(335/1.843) X 400 = 73	83	15,4%
Gunung Kidul regency	473	(473/1.843) X 400 = 103	124	23%
Total	**1.843**	**400**	**539**	**100%**

Note.—* The total of minimum sample, proportion of total population in regency/city.
—** Total sample in the research.

was to randomly select the elementary school category. The total sample covered 539 elementary schools, with the largest number of respondents from Yogyakarta city with 25.2% (136 schools) and Gunung Kidul regency with 23% (124 schools), followed by Sleman regency with 21% (113 schools), Bantul regency with 15.4% (83 schools) and Kulon Progo regency with 15.4% (83 schools). The detailed data are presented in Table 1.

2.4. Data collection

The research data were collected from the questionnaires completed by 539 elementary schools. Completion of the questionnaire in each school was done by the school principal and/or a school representative who understood the aspects of child safety education at school. The data collection stages began with inviting sample schools through the Education Authorities in each district/city in several time periods, with each period having invited approximately 25 schools. The data collection process was started by explaining the research objectives to the informants through the Research Subject Information Sheet, followed by training to equalize perceptions between researchers and respondents. This short training was given for approximately 60 min in the form of delivering school safety material to the respondents, to provide an understanding of the basic concepts and components contained in SSSB as a new instrument. This training was required to reduce the accuracy respondent-related biases due to lack of understanding of certain aspects, such as the items about reunification procedures, evacuation procedures, risk assessment, etc. Training would not lead to biases since SSSB instrument does not measure respondents' level of knowledge. The SSSB instrument was employed to assess the extent to which the SSSB indicators have been implemented at schools. The training was mainly intended to provide explanations regarding items that must be understood by informants prior to assessing the current conditions at their respective schools. After that, respondents completed the informed consent forms and SSSB assessment to observe and assess the current progress of the comprehensive and integrative children safety education system implementation at schools. The total time needed to complete all steps in this study was approximately 120 min. To anticipate fatigue in respondents, most of the training and data collection activities were designed in the morning and given intermission for approximately 15 min between training and filling out the research instruments. The instruments consisted of the informants' and school's identity along with the 80 item questions on the SSSB instruments. Informant data and school data would only be used for data validation process. The researchers remained on standby at the research location to reduce any bias or lack of completeness in filling out the instrument because of the possibility of questions that still needed further explanation considering that not all respondents have a sufficiently comprehensive understanding of the safety aspects of this multi-hazard threat assessment.

The researchers maintained all procedures related to research ethics, especially those relating to the protection of research subjects using the research respondent information sheet, ethical clearance and informed consent. The data entry process, especially on informant data and school data, was done using coding. The data will be kept confidential. The presence of the researcher in data collection was also intended to maintain the data confidentiality. This research protocol was approved by the Medical and Health Research Ethics Committee (MHREC) of the Faculty of Medicine, Public Health and Nursing at Universitas Gadjah Mada with number: KE/FK/0820/EC/2019.

2.5. Analysis

The validity and reliability of questionnaire items were tested through SPSS 20.00 version for Windows, with a single test (Cronbach's alpha). This study used Covariance Based Structural Equation Modeling (CB-SEM) analysis with a reflective 2nd order (2^{sd}) CFA type of modeling, which uses unidirectional modeling from exogenous variables to the constructs and constructs to the indicators. The process was assisted by LISREL 8.80 program to test the validity and reliability construct and Model Fit from the model was produced in both the initial model and the re-specification model. All of the data analysis processes were done anonymously to guarantee the security of informants' data.

3. Results

3.1. Results of validity and reliability test of questionnaire

The results of the validity and reliability of the questionnaire by using IBM SPSS Statistics 20 software, 100% of the items resulted in r values above the r table (0.088) so that this measuring instrument is considered to have good validity. To calculate the validity of the instrument, r count > r table and r table were measured for a sample of 500 which was equal to 0.088. Of the 80 question items in the item-total statistics, the item level, all items showed r counts greater than 0.088. Therefore, all items in the SSSB instrument were declared valid [44]. In addition, reliability test for SSSB instrument in the form of Cronbach's alpha coefficient on all sets of items was also performed. The alpha coefficients of the 7 constructs obtained were 0.976. The measuring instrument that has an alpha coefficient of 0.90 means that it has excellent reliability [43], so it can be concluded that this measuring instrument is also reliable. After the instrument is declared valid and reliable, it will proceed to the Confirmatory Factor Analysis (CFA) test.

3.2. Result of Confirmatory Factor Analysis (CFA) test

In this research, the CFA test was aimed to determine to construct validity and good model fit. The variables used in this study were the variables for Disaster Preparedness and Safety School (SSSB), which consisted of 7 constructs namely school commitment, formal education curriculum, information exposure, school infrastructure and facilities, preparedness, supervision system, as well as empowerment of the institutional role and ability of the school community. Each construct of SSSB consisted of several indicators explained in the identification of the model.

3.2.1. Normality

One of the requirements of the data to be processed by SEM is normality. The assumption of normality could be tested with z statistical value for skewness and kurtosis. If the z value ($z_{kurtosis}$ and/or $z_{skewness}$) is not significant (greater than 0.05 at the 5% level), it could be considered that the data distribution was normal [45]. The results of univariate normality and multivariate normality data of this research are presented in Table 2. Data were considered normally distributed if *p*-value skewness and kurtosis >0.05. Univariate analysis showed the results of the normality test for each indicator. Based on the results of Table 2, there

Table 2
Univariate normality and multivariate normality.

Variable	Skewness			Kurtosis			Skewness and Kurtosis	
	Value	Z-score	P-value	Value	Z-score	P-value	Chi-square	P-value*
Univariate Normality								
KS1		1	0,447		−8903	0	79,836	0
KS2		1	0,197		−7558	0	58,79	0
KS3		4	0		−8217	0	85,264	0
KS4		3	0,003		−11,073	0	131,37	0
KS5		8	0		0,237	0812	65,189	0
KS6		3	0,002		−7476	0	65,765	0
KP1		1	0,427		−10,384	0	108,449	0
KP2		8	0		−1238	0	62,757	0
KP3		3	0,006		−11,158	0,216	132,023	0
KP4		20.00	0,005		−7352	0	62,076	0
KP5		−2	0,029		−16,676	0	282,843	0
PI1		2	0,017		−4691	0	27,746	0
PI2		−1	0,221		−2199	0,028	6,33	0,042
IS1		−1	0,24		−3,03	0,002	10,565	0,005
IS2		0	0,932		−8,75	0	76,564	0
IS3		2	0,024		−5458	0	34,867	0
IS4		0	0,934		−10,876	0	118,303	0
SG1		9021	0		0,913	0361	82,217	0
SG2		9	0		0,754	0451	74,89	0
SG3		10	0		2,14	0,032	98,109	0
SG4		11	0		4255	0	132,736	0
SG5		4	0		−6498	0	60,004	0
SG6		4	0		−10,899	0	136,85	0
SG7		10,837	0		4,31	0	136,016	0
SP1		8	0		0,109	0914	65,013	0
SP2		9	0		2223	0,026	91,24	0
SP3		11	0		4,31	0	136,016	0
PS1		3	0,004		−6944	0	56,401	0
PS2		7	0		−2011	0	58,141	0
Multivariate normality								
	-	-	-	-	-	-	-	-

Note.—* The data distribution is normal if greater than 0.05.

were no variables that met normality because *p*-value skewness and kurtosis values were <0.05 so that the assumption of multivariate normality could not be estimated because the covariance matrix was not positive. Therefore, the model was re-specified to be estimated and obtain a fit model.

3.2.2. Model specification

The model specification stage was the stage of forming the correlation between one latent variable with another latent variable and forming a latent variable correlation with an observed variable which was based on the prevailing theory. This step was done to help determine the causality relationships which have been tested, which can be seen in Table 3.

3.2.3. Model identification

To identify the model, information on the amount of data and the estimated parameters were needed. The amount of data can be calculated using the following equation:

$$\frac{n(n+1)}{2}$$

According to the data analysis, the results showed that the model of this research was over-identified. The total data were $\frac{29\times(29+1)}{2} = 435$, while the total estimated parameter was 73. The total of the estimated parameter could be calculated by identifying the number of Λ_x, Λ_y, B, Γ, coefficients and four covariance matrix of $\Theta_\delta, \Theta_\varepsilon, \psi$ and φ. From the result, the degree of freedom obtained was $435 - 73 = 362$, because the value of the degree of freedom was $362 > 0$, thus the model could be estimated because it was over-identified.

3.2.4. Estimation of the 2[sd] CFA model

The measurement model showed the correlation between latent variables and observed variables. The measurement model aimed to confirm whether the observed variables were the real measurement or reflections of a latent variable. The results of CFA were obtained through the suitability test of the overall model, analysis of model validity and model reliability analysis. In the offending estimate, it was checked for negative error variance (Fig. 2) and standardized loading factor > 1.0 (Fig. 1), as well as a large standard error value. In Fig. 2, there was no negative error variance, a standardized loading factor value < 1.0 (in Fig. 1) and a standard error value which was not too large (in Fig. 2).

3.2.5. Suitability test of the model

The estimation stage showed the final scores of the estimated parameters. According to Hair et al. (1998) in Wijanto [46]; the evaluation of the data compatibility level with the model is done through several stages, namely the suitability of the overall model, the suitability of the measurement model and the suitability of the structural model [46].

The first stage of the suitability test was generally evaluating the Goodness of Fit (GOF) Statistics between the data and the model. From 18 GOF measures, 4 measures indicated the criteria of "good fit", 4 measures indicated the criteria of "marginal fit" and 10 measures indicated the criteria of "less good or not fit". Apart from GOF measures, the estimated output of the covariance matrix model was not positive, so it can be concluded that the research model has not reached the fit criteria. In other words, the sample of the covariance matrix was very different from the estimated covariance matrix. To obtain a fit model, the model needed to be re-specified by removing invalid variables and correcting some for standard errors.

The second step was the matching stage of the 2[sd] CFA measurement model. The evaluation at this stage was done on each construct separately on each latent variable through validity and reliability. The validity analysis of the measurement model can be done by checking the value of the standardized loading factor (λ) of the observed variables

Table 3
Model identification.

Variable	Construct	Indicator	Symbol of indicator*
Disaster Preparedness and Safety School (SSSB)	School commitment (KS)	Policy	KS1
		Planning	KS2
		Budgeting	KS3
		Reporting	KS4
		Task force	KS5
		DRR programs/ activities	KS6
	Formal education curriculum (KP)	Teaching materials	KP1
		Laboratory guidelines or modules	KP2
		Learning instructions	KP3
		Evaluation tool	KP4
		Extracurricular	KP5
	Information exposure (PI)	Information related to DRR	PI1
		Knowledge of school community DRR	PI2
	School infrastructure and facilities (IS)	School Building	IS1
		Communication and information facilities for DRR and early warning	IS2
		Learning and playing environment	IS3
		Evacuation facilities	IS4
	Preparedness (SG)	SOP response	SG1
		SOP referral	SG2
		SOP evacuation	SG3
		SOP reunification	SG4
		Training	SG5
		Simulation/drilling	SG6
		Risk assessment	SG7
	Supervision system (SP)	Internal (self assessment)	SP1
		Participatory monitoring and evaluation	SP2
		Organizational structure and mechanism of advice and complaints	SP3
	Empowerment of the institutional role and ability of the school community (PS)	Partnership	PS1
		Partnership mechanism	PS2

Note.—* Symbol of indicator that will appear on the model figures.

≥ 0.50, while the reliability analysis is obtained by calculating the value of Construct Reliability (CR) and Variance Extracted (VE) of standardized loading factors and error variances values [46]. The results of the validity and reliability analysis of the CFA model showed that there was an invalid indicator in developing the latency variable construct of Preparedness, namely SG 6 (which was simulation/drilling) because the standardized loading factor value was $0.45 < 0.5$. It can also be interpreted that the SG 6 indicator was not suitable if it was used to measure the latency variable of preparedness in the study samples. Therefore, this invalid indicator should not be included again to measure the Preparedness variable if it was used in further research on a similar sample.

The third stage consisted of the suitability of the structural model. The evaluation of the structural model covered the examination of the significance of the estimated coefficients. Those which needed to be evaluated on the suitability of the structural model were t-value, coefficient of structural equation and overall coefficient of determination (R^2). The t-value value was significant if t-value ≥ 1.96 for each causal relationship between latent variables. Besides t-value, the evaluation was also done on the beta coefficient, where all beta coefficients had the same variance and the maximum value was 1.

The SEM model formed showed the direction of the causative effect between latent variables of SSSB with the construct of school commitment (KS), formal education curriculum (KP), information exposure (PI), school infrastructure and facilities (IS), preparedness (SG), supervision system (SP), as well as empowerment of the institutional role and ability of the school community (PS). The calculation results showed that the 2^{sd} CFA standardized loading factor for each SSSB construct was more than the critical value of 0.50. This result showed that all constructs were valid in constructing the latent variables of SSSB. Thus, it could be concluded that in the sample of elementary schools in Yogyakarta Province, the factors which formed the SSSB included school commitment (KS), formal education curriculum (KP), information exposure (PI), school infrastructure and facilities (IS), preparedness (SG), supervision system (SP) and empowerment of the institutional role and ability of the school community (PS). Based on the t-value signification test and the structural equation coefficient, it could be seen that each construct had a significant causative relationship with the latent variables of the SSSB and the average value of the causative relationship with SSSB was 69.6%, with the indicator of information exposure being the strongest forming factor of SSSB with R^2 of 75%.

3.2.6. Model Re-specification

The following step after the compatibility test was reconfirmation. In the suitability test of overall models, the model was considered less fit, so that the model needed to be specified to obtain a better model. To improve the suitability of all models, modification indices could be used. Modification index could be used by adding trajectories or adding error covariances. Besides the modification index, improvements to the model were done by removing invalid variables and confounding variables.

3.2.7. Estimation of 2^{sd} CFA model modification

After being modified by removing three indicators namely training (SG 5), simulation/drilling (SG 6) and risk assessment (SG 7), a new 2^{sd} CFA model estimation was obtained. The estimation results of the modified model are shown in Figs. 3 and 4. In the 2^{sd} CFA model re-specification matching test, GOF output of the specified model is presented (Table 4). As seen from the 18 GOF measures, 13 measures showed the criteria of "good fit", 1 measure indicated the criteria of "marginal fit" and 4 measures indicated the criteria of "less good or not fit". Therefore, it could be concluded that the research model has reached the criteria of "good fit," or the covariance matrix of the sample was not much different from the estimated covariance matrix.

From the 2^{sd} CFA model compatibility test, the results of the validity and reliability analysis of the 2^{sd} CFA model which has been specified are presented in Table 5. It showed that in the preparedness construct, training indicators (SG 5), simulation/drilling (SG 6) and risk assessment (SG 7) have been excluded from the construct, because these variables were invalid or not suitable to be applied to the study sample which previously made the model not fit. After the re-specification of the model, all constructs on each indicator were valid and reliable.

In the 2^{sd} CFA model suitability test, the estimation results of the modified structural model were shown on the test results of the significance of the t-value and structural equation coefficients, as presented in Table 6. The SEM model showed the direction of the causative effect between SSSB variables and all formation factors. The calculation results in Table 6 showed that the standardized loading factor of each SSSB indicator was more than the critical value of 0.50. This result showed that all indicators were valid in constructing SSSB variables. Therefore, it could be concluded that in the sample of elementary schools in Yogyakarta Province, SSSB formation factors included school commitment (KS), formal education curriculum (KP), information exposure (PI), infrastructure and school facilities (IS), preparedness (SG), supervision system (SP) and empowerment of the institutional role and ability of the school community (PS). Table 6 shows that each indicator had a significant causative relationship with SSSB variables and the average causative relationship with SSSB was 67.5%, with school commitment being the strongest forming factor (R^2 of 82%) for the formation of SSSB.

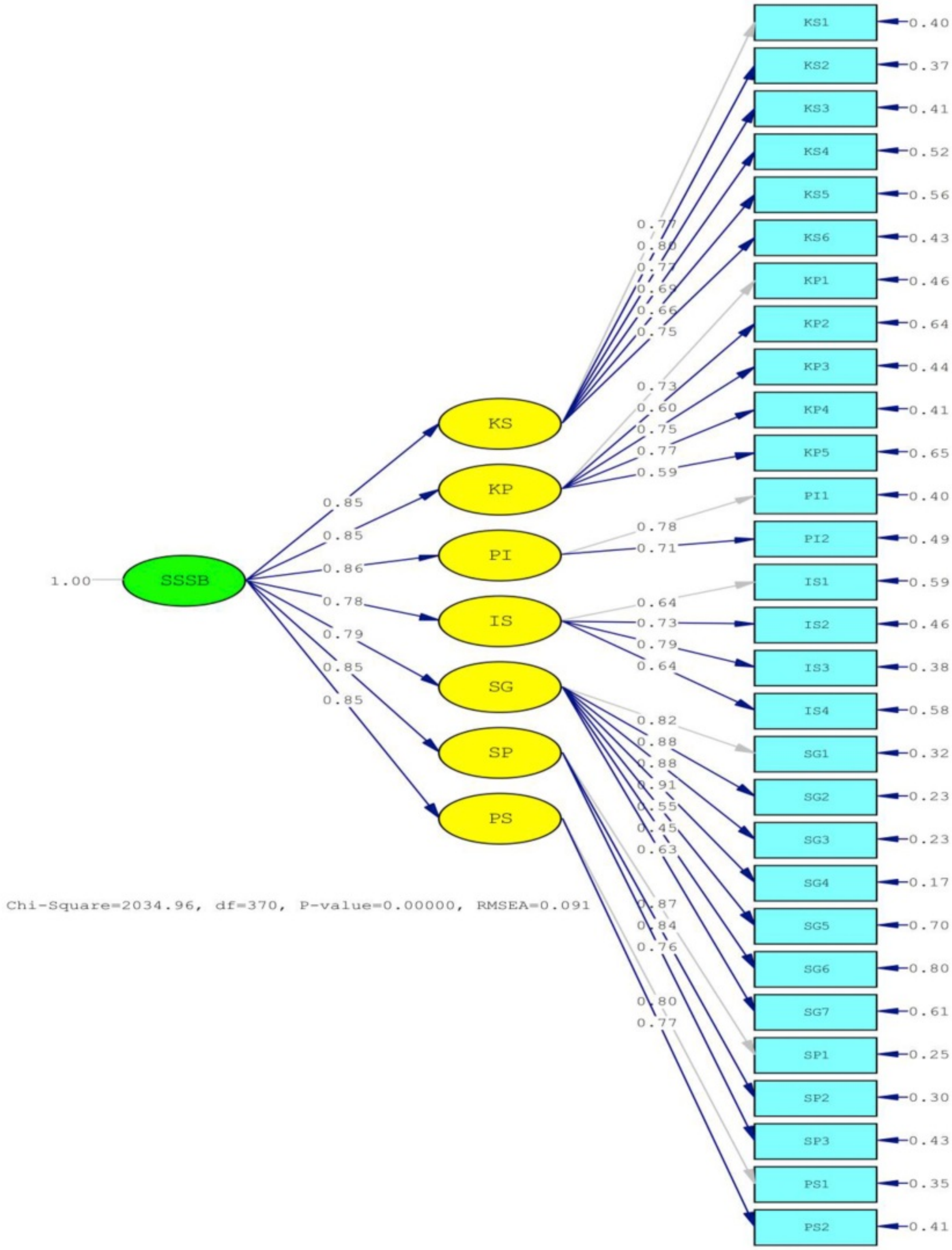

Fig. 1. Standardized 2^{sd} CFA model.

4. Discussion

4.1. The development of SSSB instruments for improving student welfare

The instruments of the Disaster Preparedness and Safety School (SSBB) were prepared by using a multi-hazard approach. The approach could be used to evaluate and assess the extent schools were able to implement a child safety education system in terms of the DRR aspects of disaster risk, safety and prevention of violence against children in schools, through the implementation of an independent assessment. The

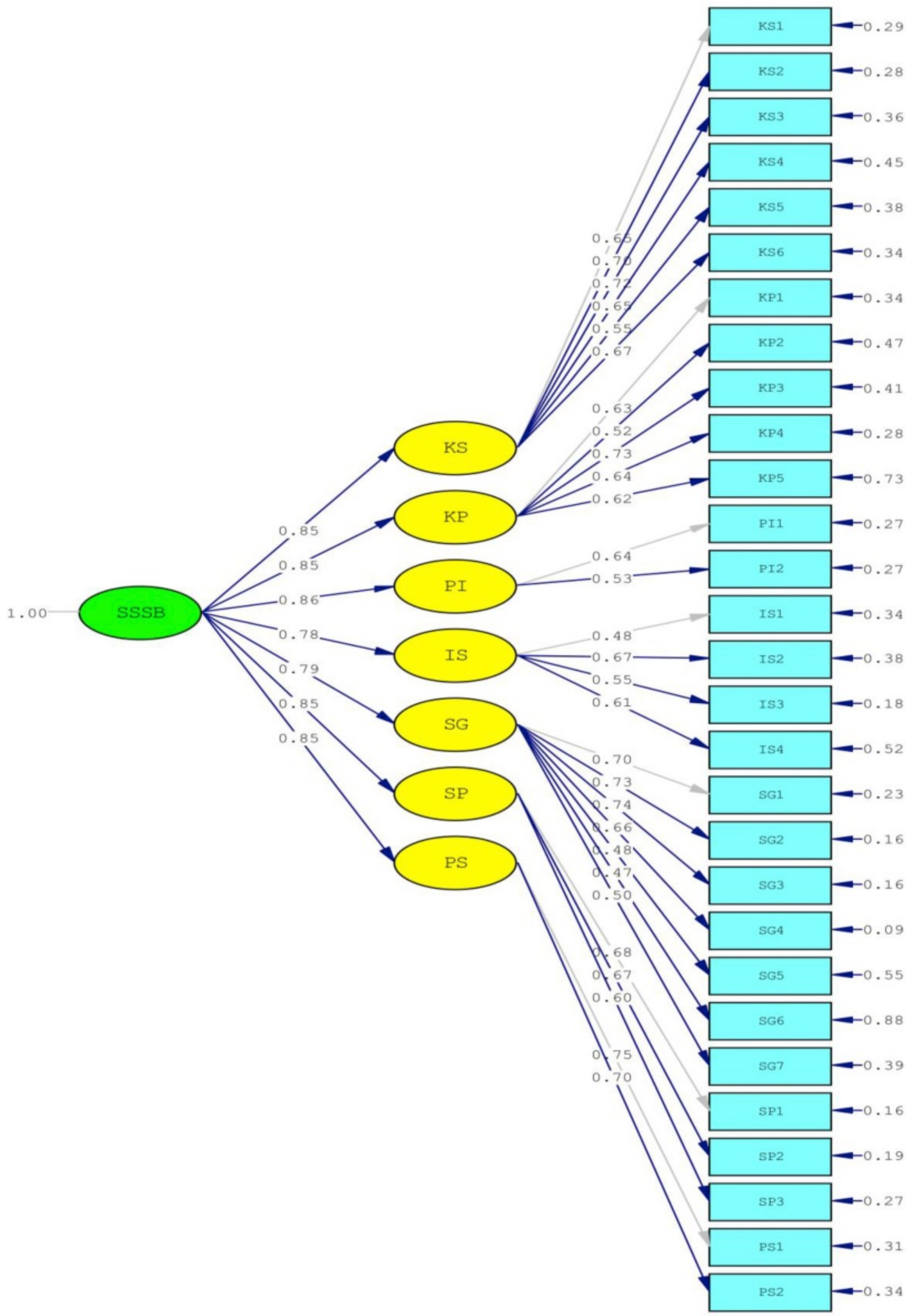

Fig. 2. Estimated 2[sd] CFA model.

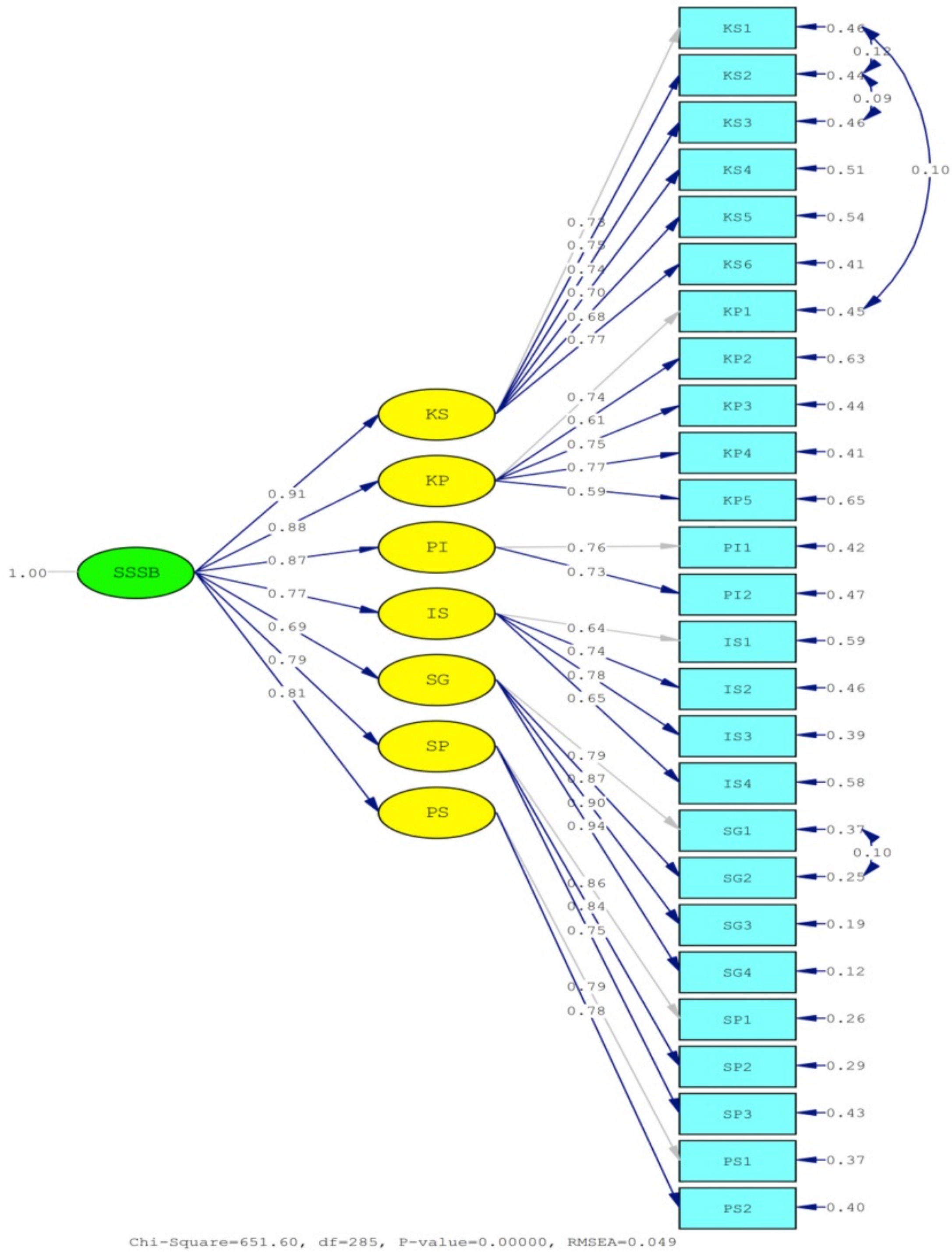

Fig. 3. Re-specification output of standardized loading factor 2[sd] CFA model.

results of this SSSB assessment can be used as a baseline for schools to gradually and systematically improve the safety systems that currently exist. Improvements can be made pertaining to school safety conditions to realize the goals of school resilience in facing multi-hazard threats. To ensure safety in schools, various types of school safety evaluation instruments have been developed which are used based on region, type of school, school size, infrastructure, risk assessment, security assessment, or school vulnerability. Larger schools are more likely to apply school safety measures instruments than small schools. Likewise, public schools which tend to be larger than private schools, are more likely to

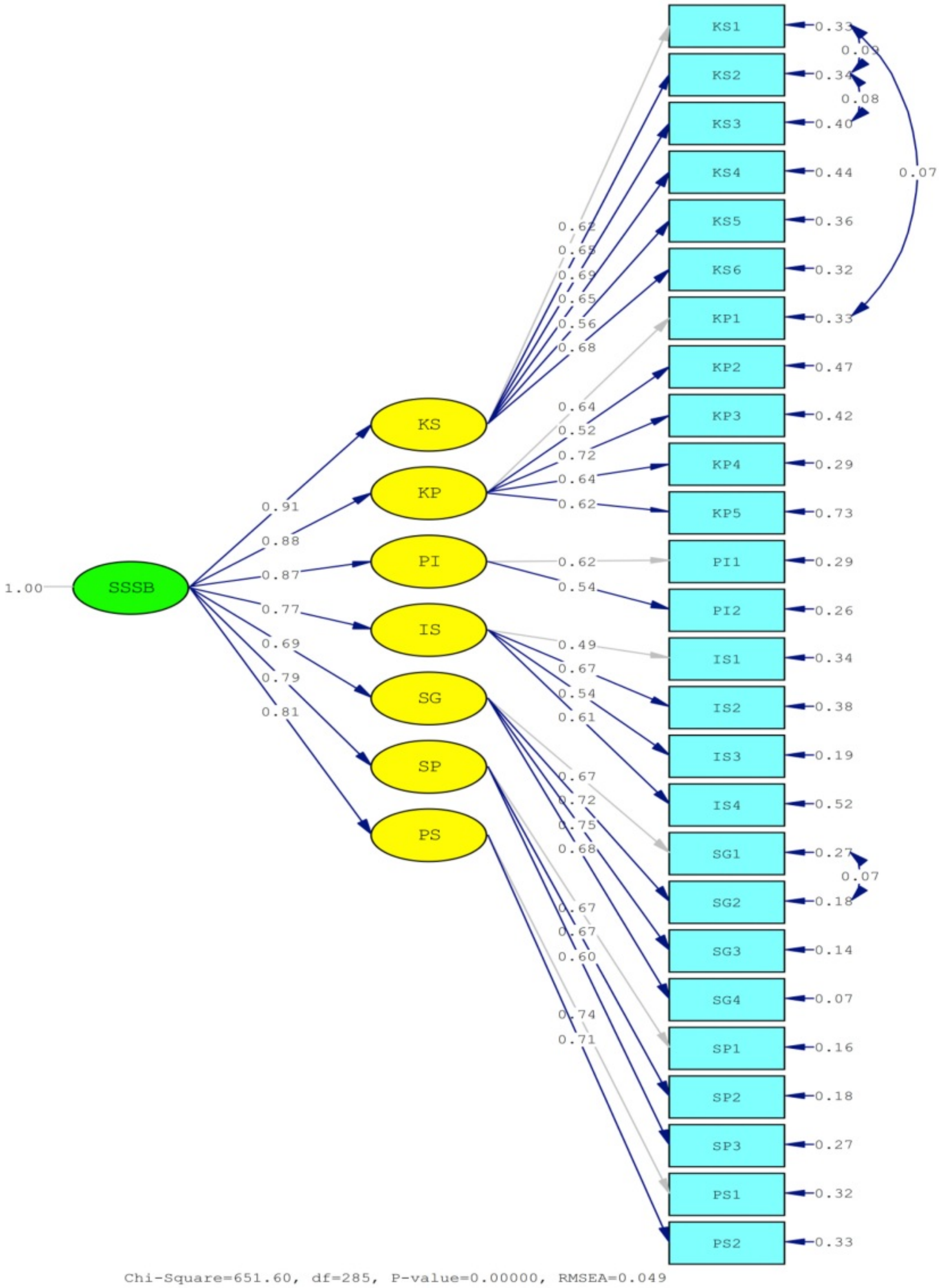

Fig. 4. Re-specification output of estimated 2[sd] CFA model.

Table 4
Match test of re-specification of 2sd CFA model.

GOF	Acceptable match level	Model index	Explanation*
Chi-square	$Chi-square \leq 2df$ (good fit), $2df < Chi-square \leq 3df$(marginal fit)	651,6	Marginal Fit
P-value	$p \geq 0,05$	0,000	Good Less
NCP	The smaller, the better	366,6	Good Less
GFI	$GFI \geq 0,9$ *(good fit)*, $0,8 \leq GFI \leq 0,9$ *(marginal fit)*	0,91	Good Fit
RMR	$RMR \leq 0,05$	0,03	Good Fit
RMSEA	$0,05 < RMSEA \leq 0,08$ *(good fit)*, $0,08 < RMSEA \leq 1$ *(marginal fit)*	0,049	Good Fit
ECVI	The closer to value of *saturated* ECVI, the better	(1,46; 1,30)	Good Fit
NNFI	$NNFI \geq 0,9$ *(good fit)*, $0,8 \leq NNFI < 0,9$ *(marginal fit)*	0,99	Good Fit
NFI	$NFI \geq 0,9$ *(good fit)*, $0,8 \leq NFI < 0,9$ *(marginal fit)*	0,98	Good Fit
AGFI	$AGFI \geq 0,9$ *(good fit)*, $0,8 \leq AGFI < 0,9$ *(marginal fit)*	0,90	Good Fit
RFI	$RFI \geq 0,9$ *(good fit)*, $0,8 \leq RFI < 0,9$ *(marginal fit)*	0,98	Good Fit
IFI	$IFI \geq 0,9$ *(good fit)*, $0,8 \leq IFI < 0,9$ *(marginal fit)*	0,99	Good Fit
CFI	$CFI \geq 0,9$ *(good fit)*, $0,8 \leq CFI < 0,9$ *(marginal fit)*	0,99	Good Fit
PGFI	The bigger, the better	0,74	Good Fit
PNFI	The bigger, the better	0,86	Good Fit
AIC	The closer to value of *saturated,* AIC is better	(783,6; 702)	Good Less
CAIC	The closer to value of *saturated,* CAIC is better	(1132,72; 2558,69)	Good Less
CN	$CN \geq 200$	289,58	Good Fit

Note.—* The main criteria used in considering the fit and suitable of the model.

Table 5
Validity and reliability analysis results of re-specification of model 2sd CFA.

Latent variable	Construct	Error var	Std loading $\geq 0,5$	Reliability		Explanation on validity*	Explanation on reliability*
				CR $\geq 0,7$	VE $\geq 0,5$		
School commitment (KS)	KS1	0,46	0,73	0,87	0,53	Valid	Reliable
	KS2	0,44	0,75			Valid	
	KS3	0,46	0,74			Valid	
	KS4	0,51	0,7			Valid	
	KS5	0,54	0,68			Valid	
	KS6	0,41	0,77			Valid	
Formal education curriculum (KP)	KP1	0,43	0,74	0,82	0,5	Valid	Reliable
	KP2	0,63	0,61			Valid	
	KP3	0,44	0,75			Valid	
	KP4	0,41	0,77			Valid	
	KP5	0,65	0,59			Valid	
Information exposure (PI)	PI1	0,42	0,76	0,71	0,56	Valid	Reliable
	PI2	0,47	0,73			Valid	
school infrastructure and facilities (IS)	IS1	0,59	0,64	0,80	0,50	Valid	Reliable
	IS2	0,46	0,74			Valid	
	IS3	0,39	0,78			Valid	
	IS4	0,58	0,65			Valid	
Preparedness (SG)	SG1	0,37	0,79	0,78	0,77	Valid	Reliable
	SG2	0,25	0,87			Valid	
	SG3	0,19	0,9			Valid	
	SG4	0,12	0,94			Valid	
Supervision system (SP)	SP1	0,26	0,86	0,86	0,67	Valid	Reliable
	SP2	0,29	0,84			Valid	
	SP3	0,43	0,75			Valid	
Empowerment of the institutional role and ability of the school community (PS)	PS1	0,37	0,79	0,76	0,62	Valid	Reliable
	PS2	0,4	0,78			Valid	

Note.—* All constructs on each indicator are valid and reliable.

use more school safety instruments [1,40].

This SSSB instrument can be used as a guide to assist schools at all levels (school management, teachers and staff) in making improvements to the school safety system as a whole, starting from improvements to commitments such as policies, planning, budgeting, reporting and availability of disaster response teams in schools; improvements to the curriculum and teaching materials; exposure to information and increased knowledge of school members of the multi-hazard based safety system; provision of infrastructure and supporting facilities that are safe and child-friendly; and improvements to the school preparedness through risk assessment, availability of procedures, training and multi-hazard response simulations; monitoring/supervision system; empowerment and school partnerships. Improvements to the school safety system that are done systematically and continuously will be able

Table 6
Significance test of t-count and coefficient of structural equation.

Path*	Estimate	Error var	R^2	Nilai-t $\geq 1,96$	Explanation**	Std loading factor $\geq 0,5$	Explanation***
SSSB → KS	0,91	0,18	82%	17,18	Significant	0,91	Valid
SSSB → KP	0,88	0,22	78%	16,85	Significant	0,88	Valid
SSSB → PI	0,87	0,24	76%	16,60	Significant	0,87	Valid
SSSB → IS	0,77	0,40	60%	12,86	Significant	0,77	Valid
SSSB → SG	0,69	0,52	48%	14,67	Significant	0,69	Valid
SSSB → SP	0,79	0,38	62%	17,50	Significant	0,79	Valid
SSSB → PS	0,81	0,34	66%	16,07	Significant	0,81	Valid

Note.—* Show the direction of the causative effect.
—** Each indicator has a significant causative relationship with the SSSB variable.
—*** Valid indicator in constructing SSSB variable.

to build school resilience which will have a significant impact on improving the protection and welfare of students and all school members.

Development and integration of student welfare models into comprehensive education programs are still very much needed [47]. Another study also stated a growing need to assess the impact of school-based prevention program interventions validly and efficiently [48]. This SSSB instrument can be used to complete the Teacher Observation of Classroom Adaptation-Checklist (TOCA-C) and Item Response Theory (IRT) Instrument [48]. The SSSB was developed to improve aspects of student welfare more comprehensively which could further complement existing instruments. The welfare aspects developed by the SSSB include the aspects of overall student safety at school, protection of children from violence and disasters (natural disasters), both in the aspects of learning, infrastructure, supervision systems, academic services and other supporting services in schools. Because the services provided by elementary schools have a significant impact on the conditions of people's life in the community and in the future [23], a constructive organizational learning perspective is very important for the success of school system improvement [49].

An example of the implementation of the SSSB component is that school infrastructure is ideally designed to protect children from injury, whether caused by natural disasters or other safety incidents and to protect children from incidents of violence against children in schools. The standards in school infrastructure should include strong, sturdy and stable school building structures; schools should have a functioning fire protection system; have egress and accessibility for firefighters; school buildings should meet the requirements of electrical installations; not be located under high voltage power grids; have an adequate disaster evacuation system; have a system adequate lighting including emergency lighting; the minimum width of the corridor allows two people passing each other; class door width of at least 80 cm, easy to open and opens outwards; available toilet whose number corresponds to the number of students and separated between men's and women's toilets, the water supply in the toilet should be quite adequate, the toilet should be clean, the floor should not be slippery, has good lighting and ventilation and complementary facilities according to the size of the user, there is a separation of toilet access for boy students and schoolgirls and available toilet for persons with disabilities; available sink suitable for children with clean running water with hand soap; available safe stairs; prayer room available; the building structure should not have sharp and rough corners; school buildings should minimize empty and dark spaces; furniture should not have sharp angles and endanger the user; a monitoring camera should be available (CCTV) in the classroom and in the school environment, especially in places that are vulnerable; the school should have space for school health unit (UKS) complete with bed and first aid kit; the school should have a counseling room and a chat box for students; and the school should have a play area that can be used by all students, including children with disabilities [50,51].

4.2. Differences and similarities of SSSB instruments with other instruments

Regular SSSB assessments are important, to monitor and evaluate school preparedness so that the schools' commitment to implementing SSSB from time to time can be seen. School assessment stages are conducted for continuous improvement efforts which are more effective and readily implemented in realizing multi-hazard risk reduction in schools [52]. There are philosophical similarities between SSSB guidelines and the School Health Index (SHI) guidelines, namely the existence of an independent assessment process and an independent planning process for the corrective stage. The improvement stage could be implemented by schools or other stakeholders, especially the Education Authorities because this instrument can present the results of identifying the strengths and weaknesses of school policies and programs/activities in fulfilling safety aspects at school. As in SHI, this guideline was not intended for giving penalties, therefore this instrument did not have a passing grade or minimum passing grade. SSSB or pure SHI is a tool for self-assessment for schools. Scoring results are used to better understand strengths and weaknesses and develop action plans to improve safety policies and practices in schools in dealing with multi-hazard threats [6].

In terms of differences, this SSSB measuring instrument differed from several measuring tools developed for schools, including evaluation tools developed by Bergeron and Friedman [42]. This measuring instrument was designed as an evaluation tool for assessing the effectiveness of disaster risk messages which could measure content, reach and understanding of messages used during disasters or emergencies. It was also different from the measuring instrument developed by Wang [35]; which produced five main assessment dimensions, namely the environmental context, school capabilities, school disaster management maps, resources and teaching materials. Also, the SSSB measurement tool differs from the measurement tool produced by Dwiningrum [53]; who developed a model of school resilience constructs with two main factors, namely mitigating risk factors and building resilience in the environment. One recent study which was conducted in Sri Lanka demonstrated its suitability to evaluate the effectiveness of school-based programs [18].

4.3. Implications

The results of CFA in this study indicate that the existing constructs are valid and reliable in forming SSSB, identifying the modified model as fit and suitable when applied to a sample of primary schools in Yogyakarta Province. Even though three important indicators, namely: training, drilling and risk assessment were removed from the construct of preparedness, the researchers are well aware that the implications can affect the effectiveness in building school resilience as well as the effectiveness of disaster education in schools [40].

The reason for the exclusion of these three indicators was that almost all the schools in this study sample had never carried out training, drilling and risk assessment activities based on the multi-hazard approach. This fact statistically skewed the results of the model fit test in the sample population. Most of the sample schools were still very minimal in applying these SSSB indicators. Due to decentralization and historical contexts, most of them do not have enough commitment, knowledge, team support, nor basic procedures in disaster mitigation, even though these core aspects represent the basic components that underscore the achievement of other indicators. Since the concept of preparedness is sufficiently covered in other item constructs, eliminating the three indicators made the model fit and suitable to be applied to school situations in Yogyakarta Province.

Further researchers are encouraged to conduct a comparative test of the implementation of SSSB in different types of schools in several countries to determine the level of school resilience in each country in facing the multi-hazard threats in their respective country. This step is also a way of replicating the results of this assessment.

4.4. *Study limitations*

This study does not distinguish between the application of the school safety system in public and private schools that may have differences in planning and implementing a school safety system. Also, this study did not differentiate schools based on resources, including their average income levels (low-medium-high). However, the SSSB instrument, which was built with various expert considerations, has given a different (slightly lower (1 point)) weight to the points of infrastructure and availability of facilities because these points are conditions with high financing so that if given the same weighting as other points, it will potentially demotivate the implementation of SSSB for the low-income schools.

The presence of researchers during the data collection brought both positive and negative impacts. Researchers' presence guaranteed the confidentiality of data during the data collection process and can reduce biases from respondents' errors in filling out the SSSB instrument considering that SSSB is a new concept in Indonesia. Some respondents needed further explanation in filling out this instrument. The researchers provided the explanations needed by respondents. However, the researchers' presence might cause some social desirability bias, since the respondents were obliged to complete all the items on the SSSB instrument within the time given for data collection.

5. Conclusions

Disaster Preparedness and Safety School (SSSB) was developed to allow schools to conduct self-assessments to increase their resilience in the face of multi-hazard threats, both hazards arising from natural disasters, as well as hazards arising from the absence of an adequate safety system and hazards from acts of violence against children. The factors of SSSB formation included school commitment, formal education curriculum, information exposure, school infrastructure and facilities, preparedness, supervision system, empowerment of the role of institutions and the ability of the school community. Each factor had a significant causative relationship with SSSB variables, with an average causative relationship of 67.5% and school commitment became the strongest forming factor (R^2 of 82%) in the formation of SSSB.

The CFA results showed that the model which had been modified by removing three indicators, namely training, simulation/drilling and risk assessment, to meet the GOF criteria, resulted in the SSSB model was fit and suitable when it was applied to the sample of elementary schools in Yogyakarta Province. The GOF criteria which were fulfilled included the value of Root Mean Square Error of Approximation (RMSEA) that was less than or equal to 0.05, Comparative Fit Index (CFI) > 0.90 and the Relative Fit Index (RFI) > 0.90 so that it could be considered to have a good fit and to be a suitable model when applied to school samples. These results could answer the first research purpose that asked: "Is the model of the Disaster Preparedness and Safety School (SSSB) instrument feasible to assess a multi-hazard-based child safety education system in schools?".

Since the results of 2^{sd} CFA found each construct had a standardized loading factor value ≥ 0.5, then the constructs and indicators were considered valid and reliable to form SSSB. This result could answer the second research purpose that asked whether "the constructs and indicators of the Disaster Preparedness and Safety School (SSSB) were fit to be used to assess the multi-hazard-based child safety education system in schools?".

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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She is Lecturer (Assistant Professor) in Department of Public Health, Universitas Negeri Semarang, Indonesia. She also Doctoral student in Faculty of Medicine, Public Health and Nursing Universitas Gadjah Mada.

He is Senior Lecturer in Faculty of Medicine, Public Health and Nursing Universitas Gadjah Mada.

He is Professor in Faculty of Medicine, Public Health and Nursing Universitas Gadjah Mada.

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