Original Article

Evaluation of Leading Safety Performance of Primary School Buildings in Alexandria, Egypt: Cross-Sectional Study

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Abstract

Background: Unsafe school buildings may adversely affect students, teachers, administrative workers, cleaning workers, and visitors.
Objective(s): The aim of the present study was to evaluate the leading safety performance of public, private, and experimental primary school buildings in Alexandria, Egypt.
Methods: A cross-sectional study was conducted in 30 primary schools in Alexandria selected by stratified cluster sampling. Two observational checklists were designed, validated, and used; including school building safety inspection checklist (SBSIC), and classroom safety inspection checklist (CSIC). The completed checklists were reviewed and coded. The safety performances (SP) for each category and for the overall checklists were then calculated.
Results: The SP in private primary schools and classrooms [(66.1±13.0%), (68.7±12.5)] were higher than that of experimental [(59.9±14.0%), (65.1±14.2%)] and public ones [(39.3±7.8%), (46.0±11.8%) respectively]. The most common causes of reduced school SP were "the absence of protective measures against vectors & insects," "the non-daily refuse disposal," "the non-inspected play areas." Other causes included "the irregular fire drills," "the absence of the alarm system," "the non-earthed electrical equipment," "the absence of emergency plan," and "the unmarked tripping/slipping locations." The most frequent unsafe classroom conditions were "the absence of classroom alarm point," "the on-board glare," and "the non-compliant windows to class area ratios."
Conclusion: Many safety violations were found to occur in Alexandria primary schools. This would cause a reduction of the safety performance and consequently a lack of safety management. Safety performance in private schools was better than that in experimental and public ones.

Keywords: Classroom safety; Electrical safety; Emergency preparedness; Fire safety; Ground safety; Housekeeping; Leading safety performance; School safety

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INTRODUCTION

Primary education stage usually occurs in primary schools, which are occupied by students, teachers, administrative employees, and cleaning workers. The World Health Organization (WHO) defines a health-promoting school as “one that constantly strengthens its capacity as a healthy setting for living, learning and working”.(1) The American Academy of Pediatrics defines a “healthful school environment” as “one that protects students and staff against immediate injury or disease and promotes prevention activities and attitudes against known risk factors that might lead to future disease or disability.” School safety management is a vital element of the healthy school environment, which is an essential part of the teaching and learning activities. It focuses on controlling the accident promoting factors within the school.(2) According to the proverb "you cannot manage what you cannot measure," it is essential to assess safety performance in order to manage safety. Previously, safety performance was measured by calculation of accident parameters, including frequency rate, severity rate, fatality rate, and frequency severity index (lagging indicators). Nowadays, it is periodically assessed using both

lagging and leading indicators. Leading safety performance is regularly used by employing the traditional safety checklist with yes, no, or not applicable responses. It aims at finding out the accident promoting factors and immediately executing the suitable corrective actions to prevent it.[3]

In Egypt, leading school safety performance is not periodically assessed. Hence, school safety cannot be managed. To bridge this gap it is important to assess the current situation of school safety. So, the aim of the present study was to evaluate the leading safety performance of public, private, and experimental primary school buildings in Alexandria, Egypt.

METHODS

A cross-sectional study design was conducted in primary schools in Alexandria, Egypt. Multistage stratified cluster sampling from Alexandria public, private, and experimental primary schools was conducted to cover all educational zones, including Eastern, Western, Central, El-Gomrok, El-Montazah, El-Amreya and Borg el Arab. According to the WHO practical manual 1991[4], the minimum sample size was 26 clusters at 95% confidence level and 5% expected error. It was raised to 30 schools. Two classrooms were randomly selected from each school. The sample was selected using a multistage stratified cluster sampling technique. The strata were classified into public, private and experimental primary schools in Alexandria. The seven educational zones in Alexandria Governorate (Eastern, Western, Middle, El-Gomrok, El-Montazah, El-Amreya and Borg El-Arab) were included in the present study.

Two observational checklists were designed after extensive literature review, school building and classroom safety inspection checklists (SBSIC and CSIC). The two checklists were designed with Yes, No or Not Applicable responses. The Yes response was scored as "one" and the No as "zero." [5-8] The first checklist (SBSIC) consisted of six categories, including housekeeping, maintenance, fire safety, electrical safety, emergency preparedness, in addition to ground safety, which had eight, four, eleven, ten, nine, and ten statements, with score ranges of (0-8), (0-4), (0-11), (0-10), (0-9), and (0-10) respectively added to the school data. The second checklist (CSIC) had three main categories, including classroom conditions, safety and emergency preparedness, as well as indoor air quality, which had eight, twenty eight, and six statements in the checklist, with score ranges of (0-8), (0-28), and (0-6) respectively in addition to the classroom data.

An occupational safety professor in High Institute of Public Health, Alexandria University was consulted to review the two checklists, which were later tested for their validation. This was conducted through completing the checklists by three researchers for the same five schools. Those schools were not included within the study sample. Pearson's correlation coefficients were calculated for the results of the first and second; first and third; as well as for second and third researchers respectively.[9]

The data were collected using the validated checklists. The completed checklists were reviewed and coded. The safety performance (percent safety score) for each category and for the overall checklist were then calculated according to equations (1) and (2). It was classified into "poor" (<60%), "moderate" (60-70%), "satisfactory" (70-80%), and "Good" (≥80%).[9]

The Number of Yes responses of the school = Number of Yes responses in SBSIC+ Number of Yes responses of CSIC of Class-1+Number of Yes responses of CSIC of Class-2 (1)

Where SP of SBSIC is the safety performance of school building inspection checklist, SP of CSIC of Class-1 is the safety performance of first classroom inspection checklist, and SP of CSIC of Class-2 is the safety performance of second classroom inspection checklist.

$$\text{Safety Performance \%} = \frac{\text{No. of YES Responses} \times 100}{\text{No. of YES Responses} + \text{No. of NO Responses}} \quad (2)$$

The data were entered and statistically analyzed using IBM SPSS 21 software package (IBM SPSS Statistics, Somers, NY, USA). The safety performance (% safety score) was checked for normality using One-Sample Kolmogorov-Smirov Test. One-Way ANOVA and the Post-Hoc Multiple Comparison Least Significant Difference (LSD) Tests were used to check the significance of variation for variables of more than two classes. The significance of the results was

estimated at 95% confidence interval (C.I). The results were considered significant at P-value ≤ 0.05.[10, 11]

Ethical Considerations

The study was approved by the Institutional Review Board and the Ethics Committee of High Institute of Public Health. The study conformed to the principles of Helsinki declaration (2013) and the international ethics guidelines. Confidentiality of collected information was ensured.

RESULTS

Regarding validation of the checklists, the correlation coefficients of the overall SP in schools and classrooms between the first and second researchers were 0.81, 0.87; the second and third were 0.84, 0.90; and between the first and third were 0.83, 0.89 respectively. The SP showed non-significant Kologorov Smirov Test (p>0.05, at 95% C.I.). Table (1) indicated that the SP of private primary schools and classrooms [(66.1±13.0%), and (68.7±12.5)] were higher than that of experimental [(59.9±14.0%) and (65.1±14.2%)] and public ones [(39.3±7.8%) and (46.0±11.8%) respectively]. Significant differences (p≤0.05, at C.I.=95%) of schools and classrooms' SP were observed among the three school types (public, private, and experimental). Further analysis showed highly significant variation in the schools and classrooms' SP between public and private as well as between public and experimental schools (P≤0.05, at C.I.=95%). Safety performance of schools and classrooms showed non-significant One-Way ANOVA Test among different districts (p>0.05, at C.I.=95%).

Table 1: Safety performance (percent safety scores) of primary schools and classrooms at different school types in Alexandria, Egypt 2014

Variable		n	%	Mean % Safety Score	SD	Minimum	Maximum	*p*-value*
School Type	Public	16	53.3	39.3	7.8	29.7	52.5	≤0.05
	Private	8	26.7	66.1	13.0	50.0	91.4	
	Experimental	6	20.0	59.9	14.0	59.8	81.5	
Classrooms	Public	32	53.3	46.0	11.8	30.9	64.3	≤0.05
	Private	16	26.7	68.7	12.5	50.0	91.2	
	Experimental	12	20.0	65.1	14.2	53.7	92.9	

*One-Way ANOVA Test; it is significant at P-value ≤ 0.0

The housekeeping SP in private schools was good (84.0%), while that of experimental and public schools were satisfactory (70.0%) and poor (41.0%) respectively (Figure 1). The SPs of the housekeeping category were significantly varied (p≤0.05, at C.I.=95%) among different school types. Further analysis disclosed the significant differences between public and private as well as between public and experimental schools (p≤0.05, at C.I.=95%). The reduction of the housekeeping SP below the 100% was attributed to the safety standards' violations. The major unsafe housekeeping conditions were "the absence of protective measures against vectors & insects" (100.0%, 50.0%, 66.7%), and "the non-daily disposal of Refuse" (100.0%, 12.5%, and 50.0%) in public, private, and experimental schools respectively as illustrated in (Table 2). The poor SPs of the maintenance (<60%) in each of public, private, and experimental schools (Figure 1) were obvious in the non-conformity with the safety benchmarks. One-Way ANOVA Test revealed significant variation in maintenance SP among the three school types (p≤0.05, at C.I.=95%). Meanwhile, significant differences in maintenance SP were noticed between public and private schools as well as between public and experimental ones (p≤0.05, at C.I.=95%). The most frequent unsafe maintenance condition was "the non-inspected play areas" (100.0%, 87.5%, and 100.0%) for public, private, and experimental schools respectively (Table 2).

The fire-safety SP in private schools was moderate (65.0%), while that of experimental (38.0%) and public (8.0%) were poor (Figure 1). The fire SP showed highly significant variation (p≤0.05, at C.I.=95%) among different school types (One-Way ANOVA Test). Further analysis showed significant differences between public and private as well as between public and experimental schools (p≤0.05, at C.I.=95%). The most frequent unsafe condition was

"the irregular fire drills" that present 100.0%, 75.0%, and 83.3% of public, private, and experimental schools respectively. "The absence of the alarm system" was found in 100.0% of public, 62.5% of private, and 83.3% of the experimental schools (Table 3).

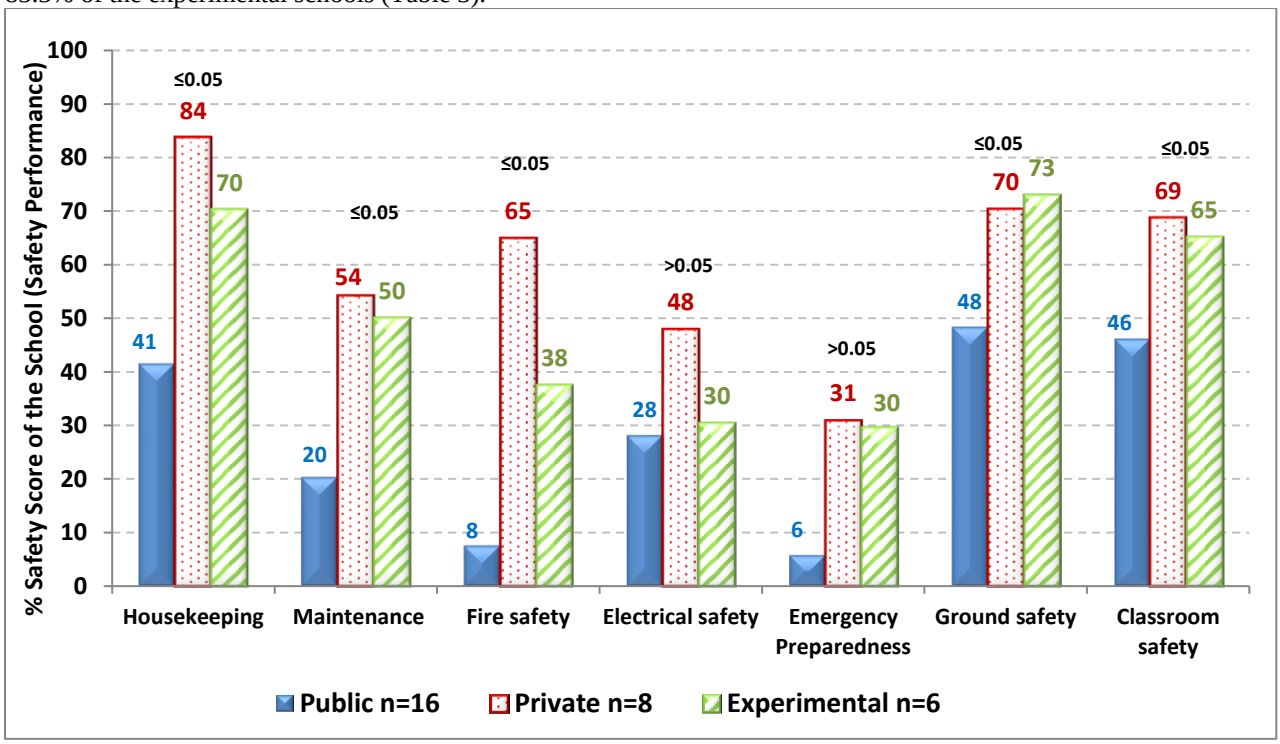

Figure 1: Primary Schools' Safety Performance (percent safety Scores) of different checklist categories at different school types in Alexandria, Egypt 2014.

Table 2: Distribution of the violated safety standards of housekeeping and maintenance at primary schools in Alexandria, Egypt 2014

	Variables	Public n=16		Private n=8		Experimental n=6	
		No.	%	No.	%	No.	%
Housekeeping	Presence of hazards in corridors	7	43.8	0	0	1	16.7
	Unclean of workers' uniform of kitchen or canteen	5	31.3	3	33.3	4	66.7
	Absence of protective measures against vectors & insects	16	100.0	4	50.0	4	66.7
	Absence of refuse container in each room	1	6.3	0	0	1	16.7
	Refuse disposal does not occur daily	16	100.0	1	12.5	3	50.0
	Water basins (sinks) are not clean	11	68.8	1	12.5	0	0.0
	The closets are not clean	13	81.3	1	12.5	1	16.7
Maintenance	Play areas are not inspected for accidents hazards	16	100.0	7	87.5	6	100.0
	Drinking tabs are not maintained	10	62.5	1	12.5	0	0.0
	Water basins are not regularly maintained	10	62.5	2	25	2	33.3
	Closets are not maintained	15	93.8	4	50	4	66.7

Table 3: Distribution of the studied primary schools according to violated safety standards of Fire and electrical safety, Alexandria, Egypt 2014

	Variables	Public n=16		Private n=8		Experimental n=6	
		No.	%	No.	%	No.	%
Fire Safety	Extinguishers are absent	13	81.3	1	12.5	3	50.0
	Extinguishers are not properly mounted	2	12.5	1	12.5	0	0.0
	Extinguishers are not accessible	2	12.5	0	0.0	0	0.0
	There is not alarm system	16	100.0	5	62.5	5	83.3
	Alarm system is not working	--	--	5	62.5	0	0.0
	Fire lane is absent	15	93.8	6	75.0	5	83.3
	Lane is not clear	1	6.3	6	75.0	0	0.0
	Fire drills are not undertaken regularly	16	100.0	6	75.0	5	83.3
Electrical Safety	Electrical cords near the foot traffic area	4	25.0	4	50.0	2	33.3
	All electrical cords near the foot traffic area are not tied up	0	0.0	0	0.0	0	0.0
	Power Strips are not used instead of extension cords	13	81.3	4	50.0	4	66.7
	Electrical Panels are not properly labeled	15	93.8	5	62.5	5	83.3
	Electrical Panels have open slots	15	93.8	6	75.0	6	100.0
	Electrical panels' rooms are not locked	7	43.8	3	37.5	5	83.3
	Electrical switch/junction boxes are not covered	16	100.0	6	75.0	4	66.7
	There are charred outlet faces	11	68.8	2	25.0	3	50.0
	Flammable materials are stored in heater rooms	9	56.3	2	25.0	4	66.7
	All electrical equipment are not earthed	16	100.0	8	100.0	6	100.0

Concerning the SP of the electrical safety, it was poor at the three school types (28.0%, 48.0%, and 30.0% respectively), although the difference was not significant (Figure 1). The main unsafe electrical safety condition was "the non-earthed electrical equipment" at all of the studied schools (Table 3). The safety performance of the emergency preparedness was poor in the public, private, and experimental schools (6.0%, 31.0%, and 30.0% respectively), with no significant difference was between the three school types ($p>0.05$, at C.I.=95%) (Figure 1). The most frequent unsafe emergency condition was "the absence of emergency planning manual" (100.0%, 87.5%, and 83.4% respectively) (Table 4).

Table 4: Distribution of the studied primary schools according to the violated safety standards of Emergency, and of Ground safety, Alexandria, Egypt 2014

	Variable	Public n=16		Private n=8		Experimental n=6	
		No.	%	No.	%	No.	%
Emergency preparedness	Emergency exits are absent	12	75.0	5	62.5	4	66.7
	Emergency Exits are not clear	4	25.0	1	12.5	1	16.7
	Emergency evacuation maps are absent	16	100	7	87.5	4	66.7
	Emergency Planning Manual is absent	16	100	7	87.5	5	83.4
	MSDSs are absent in the school	15	93.8	5	62.5	4	66.7
Ground Safety	There are slippery and broken stairs	12	75.0	2	25.0	2	33.3
	Yard ground texture is slippery	2	12.5	1	12.5	0	0.0
	Ground is not clean and not free from obstacles	2	12.5	0	0.0	0	0.0
	Aisles, stairs, and walking surfaces are not clear of obstacles	5	31.3	0	0.0	1	16.7
	Floors are not in good conditions with missing tiles	15	93.8	1	12.5	1	16.7
	Floors are slippery	0	0.0	1	12.5	0	0.0
	Areas with high fall potential (around drinking fountains, entryways, etc.) have not been marked	15	93.8	5	62.5	4	66.7
	High-visibility tape or paint are not used to point out hard to see steps, cracks, trip hazard	15	93.8	8	100.0	5	83.3

Considering the SP of the ground safety, it was the highest for experimental schools (73% Satisfactory), followed by private (70% Satisfactory) and public (48% poor) ones (Figure 1). One-Way ANOVA Test indicated the highly significant variation of SP between the three school types ($p \leq 0.05$, at C.I.=95%). Further analysis disclosed statistically significant difference between public and private as well as between public and experimental schools ($p \leq 0.05$, at C.I.=95%). As obvious in table (4), the unsafe condition of the highest frequency was "the unmarked tripping/slipping locations" (93.8%, 100.0%, and 83.3%) in public, private, and experimental schools respectively. According to the classrooms' SP, it was the highest at private schools (69% moderate), followed by experimental (65% moderate) and public (46% poor) ones (Figure 1), and it was statistically significant ($p \leq 0.05$, at C.I.=95%) at different school types. Additional statistical analysis declared significant differences between public and private as well as between public and experimental schools ($p \leq 0.05$, at C.I.=95%). The most recurrent unsafe classroom situations were "the absence of classroom alarm point" (100.0%, 87.5%, and 83.3%), "the on-board glare" (75.0%, 50.0%, and 75.0%), and "the non-compliant windows to class area ratios" (71.9%, 75.0%, and 58.3%) in public, private, and experimental schools respectively.

Table 5: Distribution of the studied primary schools' classrooms according to violated safety standards, Alexandria, Egypt 2014

	Safety Standards	Public n=32		Private n=16		Experimental n=12	
		No.	%	No.	%	No.	%
Classroom Conditions	Area available for each student is non-compliant	19	59.4	7	43.8	6	50.0
	Board is not maintained regularly	14	59.4	1	6.3	1	8.3
	Classroom is crowded	19	59.4	7	43.8	6	50.0
	Illumination source is not clean	17	53.1	0	0.0	0	0.0
	There is glare on board	24	75.0	8	50.0	9	75.0
	Windows are not clean	24	75.0	0	0.0	8	66.7
	Windows are not maintained periodically	12	37.5	1	6.3	4	33.3
	There is broken glass windows	18	56.3	4	25.0	0	0.0
	There is odor in the classroom	17	53.1	3	18.8	4	33.3
Classroom Safety and emergency preparedness	Absence of emergency exits	32	100.0	10	62.5	10	83.3
	Absence of emergency routes	32	100.0	10	62.5	10	83.3
	Absence of fire extinguishers in the class	32	100.0	11	68.8	10	83.3
	Absence of alarm point within the class	32	100.0	14	87.5	10	83.3
	There are Obstacles in the classroom	1	3.1	2	12.5	2	16.7
	There are extra cables in the classroom	4	12.5	4	25.0	2	16.7
	There are storage area in the classroom	0	0.0	3	18.8	2	16.7
	All classroom equipment is not checked on a regular basis	21	65.6	6	37.5	2	16.7
	First aid measures is absent	28	87.5	10	62.5	2	16.7
	Classroom is not vacuumed regularly	19	59.4	4	25.0	2	16.7
	Blackboards/whiteboards are not cleaned properly	8	25.0	0	0.0	2	16.7
	Trash is not removed daily	21	67.7	0	0.0	3	9.0
	Food is kept in the classroom overnight	21	65.6	10	62.5	4	33.3
	Desks and lockers are not cleaned regularly	27	84.4	4	25.0	8	66.7
Indoor air quality	On whiteboards, markers that release high levels of volatile organic compounds (VOCs) are used	1	4.8	0	0.0	1	8.3
	Windows to class area ratio is not compliant	23	71.9	12	75.0	7	58.3
	Windows are not facing each other's	7	21.9	5	31.3	0	0.0

DISCUSSION

This study assessed the presence and application of the minimal safety standards in school buildings of different types. Ensuring school safety is a very important public health issue worldwide. Evaluation of safety performance (SP) is essential for safety management,[3] which is necessary for improving SP.[12] The SP in public schools, and classrooms were poor. This can be explained based on two factors, including safety expenditure, and lack of safety rules' enforcement. The first is too high as compared with

the economic conditions in the Egypt. So, the private schools had the highest SP followed by experimental and public and ones. Safety rules in Egypt are enforced by the Ministry of Manpower and Immigration, which grants permits and approvals for any foundation after ensuring compliance with the minimal safety rules. Previously, it granted these permissions routinely for governmental foundations, but now it becomes stricter with both governmental and private institutions.

There is strong relationship between housekeeping and safety performance as stated in two Finnish studies 1989, and 2014.[13, 14] The housekeeping showed good SP in private, satisfactory in experimental, and poor in public schools. The major frequent causes of low SP in the present study were "the absence of protective measures against vectors and insects," and "non-daily refuse disposal." A Saudi study 1998 conducted safety inspection in large and small construction projects. It concluded that the housekeeping safety scores of large projects were good, while that of small projects were poor.[15]

Designers and managers must consider the fire-safety standards to ensure sustainability.[16] In this study; the fire SP was moderate for private schools, and poor for experimental and public ones. The most common fire hazards were "the irregular fire drills" as well as "the absence of the alarm system." In compliance with the present study, a Chinese study (1999) developed a fire-safety assessment system for existing buildings, and applied it on residence in Hong Kong. It found that the low safety score was observed for the alarm system.[17] In contrary to the present study, A US study 2009 checked 1052 public schools in Texas and revealed that the most frequent cause of reduced fire safety was the absence of fire sprinkler, and the absence of the alarm system was common in just 5.4% of the public schools.[18]

The electrical safety performances were poor in the three school types. The unsafe electric situation of the highest popularity was "the non-earthed electrical equipment," which is an actual problem of non-industrial buildings in Egypt. In agreement with the present work, the results of a study conducted in Tampere University of Technology 2010 revealed that the most common cause of electrical accidents was the failure to earth the electrical equipment.[19]

The SP of the emergency preparedness was poor at the three school types. The most frequent violations were "the absence of emergency planning manual," and "the lack of evacuation maps." Similarly, the main emergency problems in Saudi and Turkish schools were the absence of emergency plan, long response time to incidents, and lack of emergency training.[20, 21] The New Zealand study (2017) revealed that the most common emergencies were due to weather, fires, and earthquakes respectively, while the unusual crises were deaths of staff and students at school, and terrorism.[22]

Unsafe grounds may lead to falling, tripping, or slipping. The ground safety category revealed satisfactory SP for experimental and private schools, and poor for public ones. The most common unsafe situation was "the unmarked tripping/slipping locations." In accordance with these results, the findings revealed from a project conducted in Kenyatta University to assess school safety reported that about 17% of school accidents occur due to ground problems, and more than one-quarter of the students' injuries are on the ground.[23]

The classrooms' SP was moderate for private and experimental schools and poor for public ones. The most recurrent unsafe classroom situations at the classroom conditions, safety and emergency preparedness, and indoor air quality categories were "the on-board glare," "the absence of classroom alarm point," and "the non-compliant windows to class area ratios" respectively. Two studies conducted in Swedish and Arizona revealed the positive impact of classroom safety on the students' achievements and their ability to learn.[24, 25]

CONCLUSIONS AND RECOMMENDATIONS

The findings of the present study can lead us to conclude that there are many safety violations that occur in Alexandria primary schools. This causes reduction of the safety performance and lack of safety management. Safety performances of private schools are better than that in experimental and public ones. Emergency preparedness category is of the least SP, while housekeeping is of the highest in the three school types.

It is recommended to activate the licensing and inspection roles of the Ministry of Manpower and Immigration to enable enforcement of safety standards. In addition, the decision makers in the Ministry of Education must train and motivate the health and safety committee for each school to implement the school safety standards. Moreover, they must provide the suitable financial allocations necessary for safety equipment. Also, they had to consider categories, including housekeeping, maintenance, fire safety, electrical safety, emergency preparedness, ground safety, and classroom safety.

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