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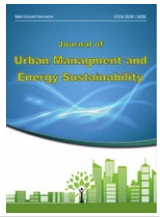

ORIGINAL RESEARCH PAPER

The impact of modern construction technology in improving the quality of the architectural environment of sustainable educational buildings

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ABSTRACT

The low quality of the educational environment due to its long lifespan and the improper maintenance and reconstruction not only cannot provide a healthy and high-quality learning environment, but also leads to spending more than six billion dollars annually on energy costs and reducing the budget assigned for employing teachers, buying textbooks, computers and other items. Thus, the construction of sustainable educational buildings with high performance can be a suitable strategy for solving the existing problems. In this regard, the present study is aimed to analyze the effects of modern construction technology in improving the quality of the architectural environment of sustainable educational buildings. The study methodology is a descriptive-survey design. The statistical population consisted of architects and designers of smart buildings, 170 of whom were selected using the Cochran formula. A researcher-built questionnaire was distributed and its face validity and Cronbach's alpha reliability were confirmed as 0.910. The data were analyzed using correlation tests and multivariate regression in spss software. The results showed that the new technology variables of energy consumption reduction, using water resources, indoor environment quality, site selection and materials have a significant relationship with the environmental quality and sustainability of educational buildings. Among the mentioned variables, the modern technology of indoor environment quality by 25% and modern technology of materials by 24% showed a significant impact on the quality and sustainability of the educational buildings environment. Finally, it can be said that there is a wide range of innovative materials and methods and the design of educational buildings to respond to new conditions, and to achieve these goals, key measures such as financial support, awareness, international cooperation for enhancing product development, infrastructure development, developing zero energy buildings, etc. are required.

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1. Introduction

1.1. Statement of the problem

In order to develop and improve living facilities, mankind has attempted to exploit resources and consider optimal consumption. In the 21st century, the globalization process and the use of innovations have been accelerated. The technology speed has received much attention in various industries, as well as the construction industry, and this issue has been investigated by many researchers (Kahermani, 2008: 3). In today's world, due to the ever-growing population growth, increasing production, reducing construction costs, meeting the existing demand, improving standards, reducing land use , introducing appropriate structural systems, reducing the weakness of some traditional materials, and eliminating the lack of skilled manpower in new technology in the construction industry, it is necessary to speed up the construction process. However, promoting the construction industry and increasing production has created many environmental crises and has obliged governments to investigate this issue. Based on the studies, the construction industry uses about 40% of the world's energy, 30% of mineral resources and 20% of water, as well as 40% of carbon dioxide emissions, 30% of solid waste and 20% of water pollution around the world (Akadiri et al., 2012: 126; Somali and Ilicali, 2009: 19; Kiang, 2016: 54). Therefore, the sustainable construction approach is a suitable solution for optimal use of water, soil and energy resources and preventing the building pollutants (Abidin, 2010: 421). Sustainable architecture, green architecture and ecological architecture are concepts that are all used in the same direction- the optimal use of the facilities and materials of construction technologies and optimizing the consumption of energy, building materials and reducing the operational costs of the building and improving its quality (Poursistani, 2015: 6).). Educational building is one of the types of buildings in cities in which the standards and principles of construction technologies in the construction and application of materials should be observed . According to statistics, buildings and educational uses do not have a great contribution in urban land per capita, and the sustainable construction of schools can encourage, motivate and provide additional education to students. (Tasci, 2015: 870). In the future, they can develop these approaches in their personal and social behavior and move towards a sustainable society (Barshadet et al., 2018: 172; Boss, 2007: 5).

Today, there is no official educational building as sustainable schools in Iran. Indeed, few efforts have been undertaken to adopt sustainability criteria in the construction of schools, or, these buildings are in the initial stages of sustainability due to the lack of providing all conditions. Therefore, we can not consider these educational buildings as sustainable schools (Mahdavinjad et al., 2014: 235). The lack of observing the principles of sustainable architecture in the construction of existing schools has resulted in many consequences, such as: climate problems, dedicating a lot of energy to provide environmental comfort conditions, isolation of vernacular architecture, lack of attention to the environment and climate in construction process etc. New construction technology in the design and creation of educational buildings is a solution that can reduce or eliminate the problems caused by non-compliance with the principles of sustainable architecture. To achieve this purpose, energy-saving technologies, new and recyclable materials, climatic-based construction standards, etc. can be used. If Iran's 20-year development plans emphasize the use of building construction technologies, but so far it has not been actualized and this plan has not been progressed. The reason for this can be the lack of required infrastructure in Iran and the lack of determining an integrated strategy for its implementation on a national and regional scale (Cabinet Office of the Islamic Republic of Iran, 2016). The important point here is what is the effect of new construction technology on the quality and environmental sustainability of educational buildings?

1.2. Research background

Sustainability is a concept with various environmental, social, economic and cultural aspects being discussed. Sustainability and sustainable development are defined as meeting today's needs without endangering the needs of the future generation. This concept was widely

accepted and requirements and criteria were determined. One of its requirements is to create a production system that considers the ecological base required for development (Tasci, 2015: 869).

One of the issues that is closely related to the concept of sustainable development is the architecture and building construction process, which has been developed as sustainable design since the mid-1990s. Sustainable architecture as a comprehensive approach entailing all traditional and modern approaches is highly concerned about the environment and requires futuristic design (Tasci, 2015: 870). In this approach, all processes from the infrastructure to the construction process (the supply of materials to treatment, and from the use of materials to disposal management) should be implemented accurately. Also, issues such as decreasing material waste, recycling, ensuring energy efficiency in the building, water consumption saving, minimizing maintenance costs with pre-planning should be taken into consideration in the sustainable design of the building (Cebeci, 2005: 4). Thus, it is necessary to redesign the method of buildings redesigning to improve the environmental quality and at the same time reduce the negative effects on the global environment (Martinez et al., 2021: 3).

There are different views about the relationship between technology and architecture, which in the first aspect; technology and architecture are a type of human activity, in the second aspect; both are tools to reach a goal and in the third aspect; architecture and technology are introduced as a quality to discover and define realities. The first two aspects consider technology and architecture as two separate issues, but the third defines the truth of architecture and technology. Also, the third aspect deals with the nature of contemporary architecture and modern technology and not to their appearance. In its nature, modern technology establishes a special relationship with human being and nature. Sometimes, the extreme and improper use of the relevant aspects of this technology turns nature into an instrument for exploitation.

However, architecture is a domain using technology in a manner that is close to its nature (Asfi and Imani, 2012: 24). Hence, in order to design a livable building with high environmental quality, the followings should be identified:

a) Activities to be performed in the building;
b) User needs related to those activities;
c) The requirements that spaces and technological systems should have to meet user demands;
d) Some issues that should be considered as "the movement of individuals, goods or materials in their specific place" (Chiesa and Grosso, 2017: 703). Smart buildings are among the buildings that consider the mentioned items and attempt to find environmental quality. Smart building is a combination of technologies and systems to enhance the life quality of users and the performance of the building (Moten 2020). Sinopoli (2009) explains that a smart building is built using useful and automated technology systems that provide safety and comfort in individuals' lifestyles. According to Ochoa & Guedi (2008), the design of smart buildings has created a new expectation about architectural design to use the lowest amount of energy, inhibit intelligence for sustainability and environmental design. Accordingly, in this study, a smart and sustainable educational building is defined in which the principles of sustainability and modern construction technologies are observed in order to present a high-quality and healthy environment for learning. Professor Lawson defines the quality of the educational environment as follows:

"Among all the architectural projects that should be designed, none can be as attractive and interesting as the design of a school because it leads to many important human activities and the education and development of our children" (Lawson, 1994: 52). In his book, Atay, quoted Tasci (2015), considering that school design with a sustainability view to be a very important part of sustainability education and represents this great position among children's rights in the category of education. Allen Ford (2007) believes that school buildings have a crucial position on human life because people always keep these primary learning places in their mind. John Paul Eberhard (2009) writes: The brain is developed by important methods during this period, and the quality of school environments plays a significant role in enhancing the level of learning or slowing it down. He introduced the architectural

design of schools that are not dangerous for the environment, the principles and rules of design with high performance are observed, natural and renewable energies are applied to provide the energy required for the building, and it is perfect from architectural aspects. Among the general design criteria that affect students' imaginations, we have the followings: the suitable facilities and equipment, providing environmental comfort, protecting the school against physical damages, and the possibility of direct and indirect supervision and control. Therefore, the building volume should be designed in such a way that while meeting the demands, it is associated with the mental world of the students, that it means providing an environment to encourage him mentally to visit frequently (Lotfata, 2008: 26). Thus, to achieve sustainability in a school, sustainable design and construction strategies should be included in the development process from the early stages. A sustainable building relies on a fully integrated 'whole building' approach being applied throughout its design, construction and operation (Olson and Carney, 2003: 30). A smart and sustainable educational building can be considered as a building that is designed and built using modern technologies in the field of site selection, using energy, water, materials and other valuable resources, design and quality of the indoor environment is modern and the students and teachers who are active in the building, teach how to use resources optimally, protect the environment and sustainability, increase financial benefits during the life of the building and improve academic results, health and well-being of students. Today, there is rarely any new building that does not use new technology. The use of technology in the existing schools in Iran is limited only to new audio and video systems to help with new teaching methods or related administrative applications, and technology has not yet been able to enter the school construction industry (Dadvar and Nazim al-Baka, 2012: 101). Several local and international studies have been performed in this regard, some of which are presented in Table 1:

A review of local and foreign researches indicated that the approaches of human and environment relationship have received much attention, which considers the importance of protecting the environment and preserving resources for future generations. In the above researches, this issue is much evident. For example, some studies have presented guidelines and criteria according to the culture, economic, social and environmental conditions of the construction site of buildings, especially educational buildings, which indicates that design and construction without considering environmental conditions is incorrect. Some other studies have discussed the importance of designing green schools and sustainable structures and their role in individual and society's awareness, because society's awareness of sustainable architecture can accelerate the design implementation process and even support it. In some researches, the standards defined in the field of sustainable building, their comparison in buildings with different performances, and the evaluation of green schools and sustainable educational buildings have been considered with multi-criteria decision-making methods and LEED and BREEAM evaluation systems, as we can be familiar with the principles of sustainable building construction, difference of each of these principles in the buildings with different applications and the benefits of using new construction methods in educational buildings. The definition of architecture with modern technologies, the comparison of traditional and industrial methods in the construction of construction projects and the benefits of using industrial and modern methods in the construction of educational spaces, how to use smart building technology to improve the quality of the indoor environment of educational buildings are other topics that have been discussed by researchers.

There are new construction technologies in different areas of energy consumption, water resources, indoor environment quality, site selection, and new materials, which have been less studied in educational spaces. As mentioned, the environmental quality of educational spaces is affected by various cultural, social, economic and environmental factors; therefore, it is necessary to perform research that can consider and analyze all these factors with a sustainable approach based on modern technologies. The

Table 1: Research background

Researcher and year	Title	Methodology	Result
Ramli et al. (2012)	Guidelines To establish green schools in Malaysia	Comparative study of guidelines by investigating the current literature and using the secondary data	Six criteria including indoor air quality, daylight, suitable temperature, noise pollution, energy efficiency, safety and health were presented as the main criteria to establish green schools in Malaysia and emphasized that information and instructions are modified in accordance to their culture and cultural, economic and social conditions.
Hazman Hashim and Denan (2014)	The importance of protecting the natural environment in the design of schools in Malaysia	The observation analysis and questionnaire design	Students prefer to have a natural environment in their surrounding and this may stimulate their creativity.
Kang & Rhee (2014)	The principles of sustainable architecture design for primary school buildings in the central part of Korea	By systematic approach and exact evaluation of existing literature, the sensitivity analysis and variance analysis	Penetration, suitable building orientation, optimization of school building walls for achieving sustainable architecture of schools, type of external (environmental) walls, type of openings, Heat absorption coefficient, spaces width, height of spaces and architectural variables are effective on reducing energy consumption.
Zhoa et al., (2015)	Green school project: a tool to accelerate sustainable development	Review of literature and descriptive	Managers and policy makers in the world should enforce laws, regulations and standards in this field to enhance people's environmental awareness.
Tasci (2015)	Sustainability education via the design of sustainable schools	Review of literature and descriptive	Different sections are defined in the building energy consumption assessment system including: materials and resources, water, energy and atmospheric impacts, sustainability, indoor air quality and innovation. This system presents approvals at different levels and different sections that directly depend on the type and performance of the building.
Zhang et al. (2016)	Comparison of the assessment standards of green buildings in China, Britain, and the USA	Review of literature and the introduction of the latest standards of building evaluation	In these three countries, the standards are compared from 5 aspects including energy saving, water saving, material storage, site selection, and the quality of the open space environment and the outdoor environment.
Chiesa and Grosso (2017)	An environmental technology approach to architectural planning in school facilities	Combinational and descriptive based on the analysis of the activities and needs of user and deep evaluation of all aspects	Based on combinational approach, a method is described that integrates functional, technological, and environmental aspects of architectural planning for school facilities. This method is based on analyzing the activities and needs of users. An in-depth evaluation of all relevant functional and environmental aspects that are usually not taken into consideration in current design practices, such as climate change response, comfort requirements, analysis of energy and material flows, spatial-temporal features of activities, private/ public concept and their interdependence and internal/external relations to users' multisensory perception are explained in the followings.
Da Silva & Gouvenia (2018)	A model for building high-quality educational environments - related factors	Review of literature and present a model using literature analysis	It suggests a model of the learning space organization based on the identification of factors that are essential to create high-quality educational environments. Also, design changes, cultural changes along with the technology of rich spaces and planning of new spaces lead to the construction of high quality educational environments.

Continued Table 1: Research background

Researcher and year	Title	Methodology	Result
Fahmy & Othman (2020)	Flexible Design: An Innovative approach to achieve sustainability in public primary schools in Egypt	Review of literature method	Public schools in Egypt are considered a valuable asset, but they are currently not sustainable from social, economic, and environmental aspects, as they are generally heavy, fixed and after completing the construction, they are usually irreversible. This is because of the traditional construction method used in the construction of schools. With the increase in labor costs, the lack of skilled force for various jobs, the demand for faster construction, the increase in safety and environmental considerations, and above all meeting these demands at an economical and appropriate price, the need to change the approach used in construction is revealed. The results indicated that the flexible design criteria with sustainability are correlated to achieve sustainability in the primary schools of Egypt.
Matins et al. (2021)	How does the use of smart building technology improve the quality of the indoor environment in educational buildings?	Case study method	An educational building should combine smart building strategies to ensure indoor environmental quality. Thermal, audio, visual comfort and indoor air quality should be taken into consideration, otherwise they can create sick building syndrome. Smart buildings solve this potential problem by providing a highly efficient living environment including safety, comfort, and good quality of living/learning/working experience that helps users achieve their highest possible performance. In this research, an architectural project for a primary and secondary high school university campus in Nuevo León, Mexico is presented, which should deal with the extreme climatic conditions of the location. By observing these issues, the use of the surrounding natural conditions and by using the latest environmentally friendly systems and technologies, a comprehensive environmentally friendly building is established. As a result, a healthy, safe and productive environment is created for its users, which greatly enhances the teaching-learning process.
Mazzoli et al. (2021)	Building information modeling as an effective process for sustainable forming of the built environment	Case study method	Based on a case study, this study has been performed on student residence in Athens, indicating that BIM has high potential to develop construction processes and efficient renovation toward the buildings with high quality standards.
Zomorodiano Nasrollahi (2013)	Investigate the criteria for the climatic architecture design of schools in the hot and dry climate of Iran with the aim of reducing energy consumption.	Review of literature and dynamic simulation	The studies on the optimization of school buildings are divided into three groups: 1-Researches on the optimization of mechanical and electrical facilities of school buildings 2-Researches on architectural design and building parameters including canopies and thermal insulation, 3-Researches on energy management in school buildings, and stated that the school renovation organization, as the authority of school building in Iran, has not considered the criteria of climatic architecture design, namely in the hot and dry climate of Iran. However, the energy consumption of schools in this region is 41.91% of the energy consumption of the total schools in Iran.

Continued Table 1: Research background

Researcher and year	Title	Methodology	Result
Vojdanzadeh (2013)	The use of nano technology in architecture	Review of literature and descriptive	Nanomaterials are a new type of building materials with high function and multi-purpose. The multi-purpose function is the presentation of new and different properties compared to the ordinary materials, as the materials can provide various applications and meet the demands and goals of the product applicant.
Bayyat and Taherkhani (2016)	Comparative study of traditional methods and building industrialization in terms of time and cost	Review of literature and comparative study	The benefits of industrial construction of building, lightweight, strengthening, saving materials, optimal energy consumption during construction and operation, elongation of life and quality of building, parts and components, forecasting the quality of the building and mitigate the construction period and as a result reduce the construction costs. In order to reduce the time, the planning and control system can be used efficiently in the projects. Indeed, the use of new construction technologies and the project management methods in this field can helps us to achieve this goal.
Nazashtkaran et al. (2017)	Optimize the walls of the school building in order to achieve the sustainable architecture of the best schools in Shiraz city	Quantitative research method and doing calculations with the simulator software and modeling by	After optimizing the walls, the total spaces of the school building will be twice more than the comfort zone.
Mamandi and Khorrami (2017)	Present nanotechnology research center design patterns with ecotect architectural approach	Review of literature and descriptive	Nanotechnology and materials play a crucial role in energy conservation and sustainable design, and achieving sustainable architecture of buildings.
Meibodi (2017)	Evaluation model of Iran's green schools using fuzzy multi-criteria decision-making methods to evaluate the evaluation models of green schools in Iran and the world	Quantitative research method and fuzzy multi-criteria decision-making approaches	Based on these researches, 4 main criteria of education, management, energy and architecture and also 13 sub-criteria for evaluation of green schools have been provided in Iran. It is worth to mention that the researcher mostly focused on the educational and managerial aspects in this study.
Nazarpour and Noruzian (2018)	Identification of effective architectural components in enhancing students' learning by emphasizing open spaces in schools based on the document of the fundamental changes of education	Qualitative (Delphi technique) and quantitative (questionnaire) The content analysis method and evaluation	By using the opinions of architectural designers and experts, environmental psychologists, experts of educational spaces working in the school renovation, development and equipment of the schools of Iran and the officials of the main office of Education , the effect of the extracted factors in enhancing the learning and creativity of students were evaluated and prioritized. Finally, it was stated that design principles for the spatial organization of schools were presented, which can be a design guideline for architects and professionals, based on the various demands of students.
Barshadet et al., (2019)	Explain the components and indices of environmental sustainability of educational spaces in Iran by emphasizing on the evaluation systems of educational green spaces	Descriptive-analytic research method and combination of grounded theory and content and comparative analysis	By combining LEED and BREEAM systems, a new system can be presented for the design of sustainable educational spaces in Iran, including 7 components and 46 indicators, as 19 indicators are influenced by environmental factors and should be localized.

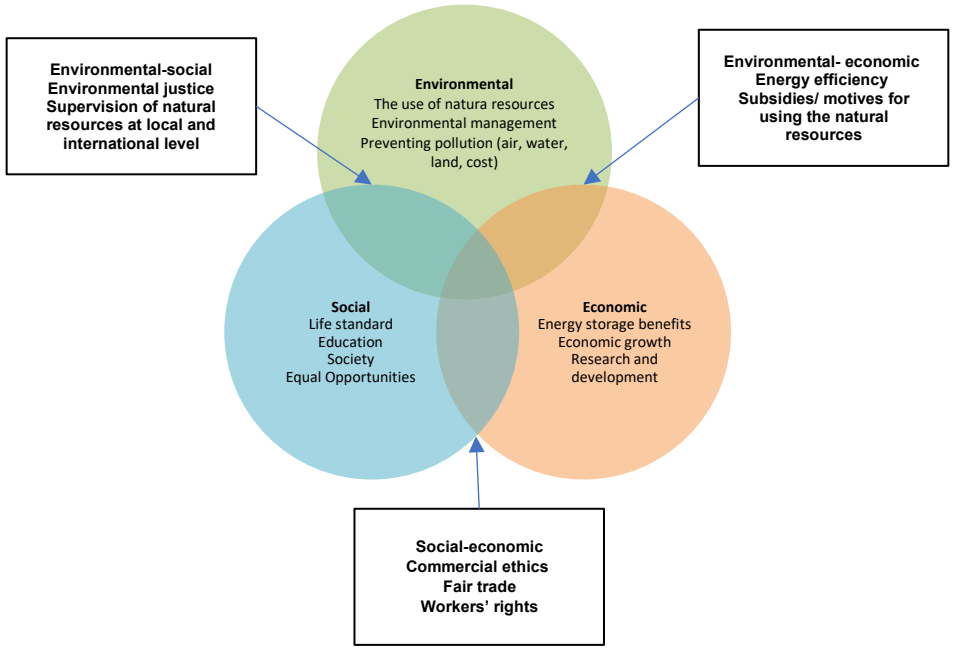

Figure 1. The sustainable aspects
Source: Fahmi and Othman, 2020

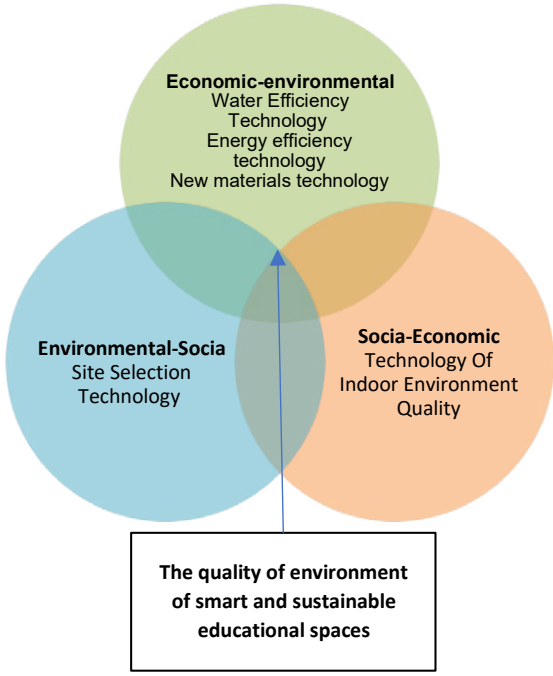

Figure 2. The conceptual model of research
Source: Author

current research is different from previous researches due to considering all the above factors with a sustainable approach based on modern construction technology and is innovative. Based on the theoretical model of sustainable development, the proposed research model is presented.

2. Research method

The present research is applied based on the purpose and is non-experimental and correlational. The data collection method is library and field study. In the library method, the data were collected from articles, books, research projects and scientific internet sites, and in the field method, the data were collected using a researcher-made questionnaire - whose variables and indicators were designed with the theoretical basics and existing backgrounds and its distribution among the statistical population. The statistical population of this research consists of architectural experts and specialists, with unlimited numbers. In this research, due to the uncertainty of the number of the statistical population and due to the limitations of the research and the impossibility of examining the total statistical population, Cochran's formula was used to determine the sample size. Because the population size is not known and information about the variance of the population is not available, the questionnaire has a 5-point Likert scale with the largest value 5 and the smallest value 1, so its standard deviation is equal to 0.66. This maximum value is the standard deviation. Also, 95% confidence interval and 0.01 estimation accuracy have been considered. Thus, the sample size is equal to:

$$Z\alpha/2 = 1.96,\ \varepsilon = 0.01,\ \sigma = 0.66 \Rightarrow n = 170$$

The sampling method in this study is purposeful and non-probable. Hence, experts and specialists, architects and designers of smart buildings who are familiar with new construction technologies had been purposefully identified and a questionnaire was distributed among them. In order to evaluate the validity of the questionnaire, the face validity and opinion of experts and specialists and the reliability of the questionnaire were evaluated using Cronbach's alpha, the results are presented in Table 2. As shown, the calculated Cronbach's alpha coefficient is 0.910, which indicates the high internal correlation of the questions.

Data analysis in this research has been performed in two descriptive and inferential parts. In the descriptive section, the sample and data are described using frequency statistics, frequency percentage, mean, standard deviation, etc., and then the data are analyzed using correlation and

Table 2: Cronbach's alpha coefficient

Variable	Number of items	Alpha coefficient	Total alpha
New construction technology	46	0.958	0.910
The quality of the environment of educational buildings	46	0.943	

Table 3: Frequency distribution of the statistical sample of the research in terms of age

Age group	F	%	Education	F	%
21-30	24	14.1	Below diploma	14	8.2
31-40	49	28.8	Diploma	22	12.9
41-50	91	535	Associate	58	34.1
Above 51 years	6	3.5	BA	67	39.4
Job experience	F	%	MA and above	9	5.3
5 years and below	65	38			
6-10	84	22			
11-15	94	39			
15 years and above	110	71			

regression tests in the software in the inferential section.

3. Results

In this section, at first, the descriptive analysis and then inferential data analysis hypothesis testing have been discussed.

Demographic characteristics: Table 3 indicates the frequency distribution of the statistical sample of the research in terms of age, education, and work experience. As shown, the highest frequency of age is 41 to 50 years old with 53.5%, the highest frequency of education is related to BA with 39.4% and the highest frequency of work experience is 15 years and above with 71%.

Descriptive statistics of the research variables: Table 4 indicates the descriptive statistics of the research variables. Indoor environment quality with the mean of 2.48 has the highest average among the independent variables, and environmental quality and sustainability as a dependent variable has the highest mean with 4.15. Also, the independent variable of materials has the lowest average with a mean of 2.31.

Descriptive statistics of the research variables: Table 5 indicates the descriptive statistics of the research variables. Among the independent variables, the quality of the indoor environment has the highest value with an average of 2.48, and materials have the lowest value with an average of 2.31. In other words, according to experts, the components of construction technology have been less considered in educational spaces. Also, the environmental quality and sustainability variable has the highest average as a dependent variable with an average of 4.15. This means that experts believe that each of the components of modern construction technology can increase the quality of the environment of educational spaces with a sustainable approach. The calculated standard deviation shows the average difference of the values from the average of the sample or population. Thus, it shows the value of the average difference of the variables from the given average value (3).

Inferential data analysis

To test the research hypotheses, correlation and multivariate regression tests were used

Table 4: Descriptive distribution of research variables

Variables / Descriptive statistics	energy consumption reduction	use of water resources	indoor environment quality	site selection	materials	Quality and environmental sustainability
N	170	170	170	170	170	170
Mean	2.32	2.33	2.48	2.35	2.311	4.15
Median	2.20	2.16	2.36	2.23	2.08	4.21
SD	0.896	0.971	0.901	0.778	1.110	0.638
Min	1	1.17	1	1	1	5.24
Max	5	5	5	5	5	5.24

Table 5: Examine the relationship between independent and dependent variables

Independent variables / Coefficients	Energy consumption reduction	use of water resources	indoor environment quality	site selection	materials
Pearson correlation coefficient	-0.244	-0.301	-0.356	-0.280	-0.324
Significance level (Sig)	0.001	0.000	0.000	0.000	0.000
F	170	170	170	170	170

in SPSS software. As shown in Table 5, the significance level of (Sig=0.000) is less than 0.01 percent of error. This means that there is a significant relationship between the variables of new construction technology and improving the quality and environmental sustainability of educational environments. This relationship for the indoor environment quality variable with the importance of improving the quality and environmental sustainability of educational buildings is estimated as -0.356, which has an inverse and significant relationship. In other words, the lower the quality of the indoor environment of educational buildings, the more important it is to improve the environmental quality. For other independent variables and their relationship with the dependent variable, we can say: materials (-0.324), use of water resources (-0.301), site selection (-0.280), reducing energy consumption (-0.244) variables have a significant relationship with the importance of improving the environmental quality of educational buildings. Thus, the lower the quality of these variables in educational buildings, the higher is the importance of improving the quality of educational environments using the principles of sustainable architecture.

The relationship between the indoor environment quality variable and the improvement of the quality and environmental sustainability of educational buildings was confirmed with a significant level (0.000) and with a correlation coefficient of (-0.356) and this relationship is inverse and significant. In other words, the lower the quality of the indoor environment of the educational buildings, the higher the importance of considering the indices of quality and environmental sustainability in these buildings.

There is an inverse and significant relationship between the variable of materials and enhancing the quality and environmental sustainability of educational buildings with a significant level (0.000) and the correlation coefficient of -0.324. In other words, the lower the materials used in educational buildings, the higher the importance of considering the indicators of quality and environmental sustainability in these buildings.

There is an inverse and significant relationship between the variable of the use of water resources and enhancing the quality and environmental sustainability of educational buildings with a significance level (0.000) and a correlation coefficient of -0.301. In other words, the lower the amount of attention paid to reducing the use of water resources in educational buildings, the more important it is to pay attention to quality indicators and environmental sustainability in these buildings.

There is an inverse and significant relationship between the variable of site selection and enhancing the quality and environmental sustainability of educational buildings with a significance level (0.000) and a correlation coefficient of -0.280. In other words, if we are not careful about the selection of the site and the location of the construction of educational spaces, the higher the importance of paying attention to the indicators of quality and environmental sustainability in these buildings.

Finally, there is an inverse and significant relationship between the variable of mitigating energy consumption and enhancing the quality and environmental sustainability of educational buildings with a significance level (0.000) and a correlation coefficient of -0.244. In other words, the lower the degree of considering the reduction of energy consumption in educational buildings, the higher the importance of considering quality indicators and environmental sustainability in these buildings.

Main hypothesis: New construction technology is effective in improving the quality and environmental sustainability of educational buildings.

As shown in Table 6, the assumption of independence between errors is supported. Thus, Durbin-Watson statistic is ranging 1.5 and 2.5 (1.699), there is no autocorrelation between the errors. Therefore, the regression analysis is valid for the data.

Correlation between the variables of modern construction technology and improving the quality and environmental sustainability of educational buildings is equal to 0.407. The coefficient of determination is 0.166 and this value indicates that 16.6% of changes in the quality and environmental sustainability of educational

buildings are explained by construction technology variables. Considering mentioned indicators, the model has acceptable adequacy.

On the other hand, the F value obtained from the analysis of variance is equal to F=6.517 and its significance level is sig=0.000, which is significant at a level less than one thousandth. It means that there is a significant model between two variables.

Based on the output of the coefficients of Table 8 in this regression equation, the improvement of the quality and environmental sustainability of educational buildings was considered as a dependent variable. The results indicate that the effect of the new technology component of reducing energy consumption, new technology of using water resources, new technology of site selection, in improving the quality and environmental sustainability of educational buildings was not confirmed. However, the effect of modern technology on the quality of the indoor environment and the effect of modern technology on materials and materials in improving the quality and environmental sustainability of educational buildings were confirmed. In total, according to the calculated coefficient of determination, these five variables (x1, x2, x3, x4, and x5) have contributed 16.6% in improving the quality and environmental sustainability of educational buildings (y) and the rest are the factors that are considered in this research. The cause of subject limitation was not investigated.

Table 6: Durbin- Watson test

Model	Correlation coefficient	Coefficient of determination	Adjusted coefficient of determination	standard error of estimation	Durbin--Watson
4	0.407[a]	0.166	0.140	0.592	1.699

Table 7: Regression variance analysis

Model		Sum of squares	Degree of freedom	Mean of squares	F statistics	Significance level
4	Regression	11.429	5	286	6..517	0.000[b]
	Sum of error squares	57.519	164	0.351		
	Total	68.948	169			

Table 8: Regression equation coefficients

Model		Non-standardized coefficients		Standardized coefficients	T-statistics	Significance (sig) level
		B	Standard error	Beta		
1	Intercept	4.733	0.148		32.041	0.000
	New technology of energy consumption reduction	0.192	0.107	0.269	1.795	0.403
	New technology of the use of water resources	-0.140	0.105	-0.212	-1.323	0.069
	New technology of indoor environment quality	-0.245	0.127	-0.345	-1.931	0.006
	New technology of site selection	0.215	0.145	0.262	1.486	0.500
	New technology of materials	-0.256	0.111	-0.363	-2.308	0.037

The results show that the impact coefficient of the independent variable of the new technology component of reducing energy consumption (x_1) is not significant at the level of 0.05 (t=1.795, Pvalue=0.403). Thus, the first hypothesis of the study (the impact of the new technology component of reducing energy consumption in improving the quality and environmental sustainability of educational spaces) was not verified.

The impact coefficient of the independent variable of new technology of the use of water resources (x_2), which was entered into the model at the same time as the variable of new technology of reducing energy consumption (x_1), is not significant at the level of 0.05 with a probability of 95% (t=-1.323, Pvalue=0.069). Therefore, the second hypothesis of the research (the effect of the new technology component of using water resources in improving the quality and environmental sustainability of educational spaces) was not verified.

The impact coefficient of the independent variable of new technology of indoor environment quality (x_3), which was entered into the model at the same time as the variable of new technology of mitigating energy consumption (x_1) and new technology of using water resources (x_2), is significant at the level of 0.05 with a probability of 95%. (t=-1.931, Pvalue=0.006). Thus, the third hypothesis of the study (the impact of modern technology on the quality of the indoor environment in enhancing the quality and environmental sustainability of educational spaces) was verified.

The impact coefficient of the independent variable of new technology of site selection (x_4), which was entered into the model at the same time as the variable of new technology of reducing energy consumption (x_1), new technology of resource use (x_2) and new technology of indoor environment quality (x_3), at the level of 0.05 with 95% probability (t=1.486, Pvalue=0.500) is not significant. Therefore, the fourth hypothesis of the study (the impact of the new technology of site selection in improving the quality and environmental sustainability of educational spaces) was not verified.

The impact coefficient of the independent variable of new technology of materials (x_5) which entered the model simultaneously with the variable of new technology of energy consumption reduction (x_1) and new technology of resource use (x_2) and new technology of indoor environment quality (x_3) and new technology of site selection (x_4), is significant at the level of 0.05 with a probability of 95% (t=-2.308, Pvalue=0.037). Thus, the fifth hypothesis of the study (the impact of modern technology of materials in improving the quality and environmental sustainability of educational spaces) was verified.

Briefly, according to the calculated coefficient of determination, these five variables (x_1, x_2, x_3, x_4, and x_5) have been important in 16.6% in enhancing the quality and environmental sustainability of educational spaces (y) and the rest are the factors that are not considered in this research due to the subject limitation.

4. Conclusion

The mutual relationship between human being and the environment is evident, and both man and the environment affect each other. Theoretical foundations and analyzed researches verifty the sustainable development approach and its importance to achieve the desired environmental quality. The good environmental quality in an educational building can be effective in all economic, social and environmental fields and increase productivity. According to many researchers including Allan Ford (2007), Remley et al. (2012), Zhua et al. (2015), Zhang et al. (2016), Tasci (2015), Eun Ko Ray and Hajin Kong (2014) and Barshadt et al. (2019), site selection, high quality materials, energy saving, water saving, material storage, outdoor and indoor environment quality are among the basic factors that should be selected for improving the quality of educational buildings environment and the environment should be protected be protected (Hazman Hashim and Denan, 2014). A high quality environment can help us to achieve the goals of an educational project. An educational project should not be conceptualized merely on the issue of conservation, but should be designed with the aim of how its future users will be optimally developed. The present research was aimed to analyze the effects of modern construction

technology in improving the environmental quality with a sustainable architecture approach using a descriptive-survey method. It was found that new construction technologies are effective on improving the environmental quality and sustainability of educational buildings. The degree of correlation between the variables of modern construction technology and improving the quality and environmental sustainability of educational buildings is equal to 0.407. Also, the coefficient of determination indicates that 16.6% of changes in quality and environmental sustainability of educational buildings are explained by construction technology variables. According to the latest localized standards in Iran, new construction technologies include new technology to reduce energy consumption, correct use of water resources, indoor environment quality, site selection, and materials.

According to school renovation experts, the most effective factor on the enhancement of the quality and sustainability of educational buildings is the new technology of materials, which has been effective by 25%. This variable includes the use of local and organic materials and products, the use of renewable materials, the reuse of structural elements of the building, the reuse of non-structural elements of the building, the use of recyclable materials and strengthening design. By using local materials, it is possible to create a structure conforming to the local climatic characteristics and avoid additional costs. Also, in the current era, the existence of new technologies in the field of recyclable and renewable materials (smart and nano materials) has enabled creating structures with the ability to reuse its materials. The formation of such structures may involve a lot of initial costs, it minimizes the consumption of energy and resources but in the long run.

One of the most important factors affecting the improvement of the quality and sustainability of educational buildings is the modern technology of the quality of the indoor environment, which has been effective by 24%. This variable includes the components of light controllability, creating outlook, improving the performance of lighting levels, achieving enough daylight, natural ventilation, not using volatile organic compounds, reducing microbiological pollution, reducing sound pollution, reducing light pollution, improving acoustic performance, comfort and humidity/ heat and cold control . As other researchers also referred to the issue that the quality of the indoor environment is effective on the satisfaction of students and teachers, improving their performance, learning more and their thermal comfort, this study also found that the quality of the indoor environment is of great importance. The design of the interior environment of educational buildings should be as to use the natural light at maximum, have suitable ventilation, use suitable cooling and heating devices according to the climate of the environment, and while paying attention to these points, provide suitable thermal conditions by observing the principle of reducing energy consumption and minimizing construction costs.

Finally, it can be said that there is a wide range of innovative materials and methods and design of educational buildings to respond to new conditions and to achieve these goals, we need key measures such as financial support to help create test infrastructure and building mechanisms and low cost with higher performance, advanced materials and products to create sustainable business models, reduce barriers to create a fair market, energy efficient building materials, research and find new innovative materials with international researchers to help product and infrastructure development, present innovative products and deep renovation with a long-term vision to prevent added capacity and promote zero energy buildings. In order to enhance innovation in constructions, the necessary strategies should be taken in organizations and the environment, and the organizational structure, strategy and management methods, attracting professional employees and environmental conditions consistent with the new technologies should be provided in order to enhance innovation and creativity. Some factors such as organizational and national culture and changing the executive technical system are essential to promote innovation in this industry. Since considering the climatic conditions of the region can have a great effect on the sustainable design of the building, some recommendations can be presented to use new technologies to build educational buildings.

Thus, we can consider the effective climatic factors such as temperature, rainfall, humidity, wind and sunlight in the construction of schools. In the design of schools, the effect of geographical width, the amount of vegetation and soil type, etc. and the components and indicators of sustainability should be taken into consideration. Due to the limited number of educational buildings and the large population of students, the level of space occupation and density in these schools are different; therefore paying attention to the climatic conditions and thermal requirements of the spaces should also be different. Thus, in creating suitable thermal conditions, the indoor environment quality, and resources saving (water, energy, land, materials) for different climates, the necessary issues should be taken into consideration. In order to mitigate the use of resources such as water and electricity, nano technologies such as the use of solar panels can be used to provide lighting and generate electricity for school electrical equipment and rainwater collection pools for some school activities such as watering the green spaces of schools, cleaning the campus and the school. Also, suitable vegetation of the desired climate of the region to provide thermal comfort, create a beautiful landscape and suitable shade can be used. The use of natural light is necessary in order to provide lighting and protect the health of students, so it is possible to use self-cleaning, energy-controlling, and fire-resistant glass windows in order to mitigate energy consumption and control energy consumption. Light coloring, compatible with the morale of students is another necessity of educational buildings. Also, by using color, heat or cold can be transferred to the environment. For this purpose, nano insulating paints can be applied with a 40% decline in the costs of heating and cooling systems and increasing the life of building facilities. The use of double-skin facades with 50% savings in the building is appropriate for cold and mountainous climates and optimizes light and energy consumption. Therefore, this facade can be used for cold climates.

Recommendations

There is a wide range of innovative materials and methods and the design of educational buildings to respond to new conditions, and to achieve these goals, key measures are required as followings:

- Financial support to help create testing infrastructure and building mechanisms and lower cost with higher performance materials and advanced products to establish sustainable business models
- Reduce barriers to create a fair market
- Building materials with efficient energy
- Exploration and finding new innovative materials with international researchers to help product development and infrastructure development
- Provide innovative products and deep renovation with a long-term vision to avoid added capacity and promote zero energy buildings
- Create the necessary ground in organizations and the environment to enhance innovation in construction
- Changing organizational structure, strategy and management methods, employment of professional employees and environmental conditions in accordance with new technologies in order to provide the ground for innovation and creativity.
- Strengthening innovation and creativity in the construction industry based on the organizational and national culture and changing the executive technical system
- Considering the climatic conditions of the site including (temperature, rainfall, humidity, wind and sunlight), topography (latitude, vegetation and soil type, etc.) and population needs (space occupation level and density) and its great impact on the sustainable design of educational buildings and providing thermal needs in these spaces
- The use of new energy supply technologies such as solar panels and geothermal energy to provide lighting and electricity, and collecting rainwater to solve some school problems such as watering school green spaces, cleaning the yard and the school)
- The use of suitable vegetation for the climate of the region for providing thermal comfort, create a beautiful landscape and provide shade.
- The use of natural light in order to provide

lighting and enhance students' health and benefit from new technologies in this field (use of self-cleaning, energy-controlling and fire-resistant glass in order to reduce energy consumption and control the amount of energy consumption)

– The use of happy colors based on the mood of the students and the transfer and induction of heat or cold to the environment (the use of nano-insulating colors with a 40% reduction in the costs of heating and cooling systems and increasing the life of building facilities)
– The use of double-skin facades with 50% saving in the building, appropriate for cold and mountainous climates and optimizing light and energy consumption.

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