

Investigation of Role of Green Roofs as a Strategy for Improving the Quality of Urban Environment in Terms of Sustainable Architecture

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Abstract: The green roof is one of the new subjects of architecture and urbanization that underlines to sustainable development in cities. Greenroof can be used to increase the green space percapita, to improve the urban environment and to increase urban sustainability. The main objective of this study is investigation of the role of green roofs as a strategy for improving the quality of urban environment in Isfahan city. The descriptive-survey method was used to do this study and 30 questionnaires about the importance of green roofs and the differences between green roofs and common roofs were distributed among architecture and urbanization experts in Isfahan. Data analysis was done using Excel and SPSS 18 software. Results showed that most of experts believe that the green roofs have the important role in the ecological and natural conditions in cities, filtration of the suspended particles in urban air, reduction of the noise pollution, reduction of entree of the electromagnetic radiation to the buildings and reduction of the disease and stress in urban environment. In addition the effect of green roofs to decrease the heat transfer of roofs and to increase the insulator lifetime is more than common roofs. The runoff volume in common roofs also is more than green roofs. The final results of this research showed that the green roofs have important role in improvement of the urban environment quality in terms of sustainable architecture.

Key words: Green roof • Urban environment • Sustainable architecture

INTRODUCTION

Development of the modern cities causes the destruction of the human environment. The low buildings with garden have been replaced by the high multi-story buildings without garden. Further, the adjacent areas of the high buildings have been allocated to uses such as roads or parkings. Thus cities can take advantage of the green roofs for visual - aesthetic benefits, climate improvement and environment quality [1].

The roof garden that is also called the green roof, include a green space engineering system that allows he plants to grow on the roof and protects of the roof at the same time. The roof garden is an area that has been covered by green color and it is a living surface that include the growing plants in the soil layer above the roof [2].

The green roof is one of the new subjects of architecture and urbanization that underlines to sustainable development in cities. The applied use of the roofs in the urban environment can be provided the possibility of optimum utilization of urban lands [3]. The green roofs can reduce the negative effects of the high buildings in the local ecosystem and the energy use in the buildings subsequently. So these green systems can have the determining role in the energy changes in the buildings [2]. The green roofs can help to restore the replaced vegetation coverage by reducing the negative impacts of commercial and residential development in cities [4].

Regarding to the importance of the green roofs to improve the quality of urban environment, many researches have been done in this field. Abdullahi and Valibeigi (2010) investigated the role of green roofs as

a strategy for improving the quality of the urban environment using descriptive-survey method [5]. Zahrabi (2011) also researched about green roof development in terms of the sustainable agriculture. Research method was descriptive - survey based on data collection using the library studies and questionnaires. The results showed that the green roofs have the great effect on urban environment and sustainable architecture [6]. Fallahand Nemati (2011) also investigated the role of green roofs in the sustainable development using library studies [7].

Feng *et al.* (2005) investigated the comprehensive planning of the green cities based on the ecologic principles in Pekan. Results showed that the green belts should be developed sides of the roads and parks and the green roof should be increased in the cities to reach to more sustainability in urban environment [8]. Results of another study in Germany showed that the green roofs significantly reduce the electromagnetic radiation entering to the building [9]. Results of an accomplished study by Canadian National Research Council (2012) showed that green roofs are very effective in reduction of the roof heat transfer [10]. A green roof can reduce the daily energy demand average of a building with 122 square meters until 75 percent [11]. In addition, results of another study in Chicago showed that in energy demand maximum if all of the roofs be green, consumption can be decreased until 720 Mega-watt [12]. Canadian Mortgage and Housing Corporation (2004) by supporting Canadian environment Organization also accomplished the researches about importance, benefits and recognition of the green roofs to develop green roofs in national area in 1999. Results showed that there are the great barricades to develop green roofs in Canada [13].

Thus investigation of the role of the green roofs and their development has great importance in the environmental quality enhancement and the urban sustainable development considering to the mentioned studies and environmental problems. We can hope to improve the urban environment by introducing the green roof role by raising the public awareness. Thus the present study has been done to investigate the role of green roofs as a strategy to improve the environmental quality of Isfahan city.

MATERIALS AND METHODS

This study has been done by descriptive-survey method. Descriptive method was used to present the portrait of existence situation and survey method was used to collect the data by sampling of statistical society.

The statistical society included all of the architecture and urbanization experts in Isfahan city that 30 experts were selected as sample. Then 30 questionnaires about the importance of the green roofs and differences between green roofs and common roofs were distributed among sample experts. Data analysis was done using Excel and SPSS 18 software.

RESULTS

The results of this study are presented based on the discussed cases in the questionnaires.

Sex: Most of experts are men (86.7%) based on the results of the questionnaires analysis. The results have been presented in Figure 1.

Academic Degree: Most of experts have the bachelor's degree (76.7%) according to Figure 2. In addition, 10% of them have the up-diploma degree, 6.7% of them have the master's degree or higher and 6.6% of them have diploma degree.

Specialty: Most of experts have the architecture specialty (60%). 40% of them also are the urbanization specialists (Figure 3).

Work Experience: Most of experts have 1 to 5 years of the work experience (30%) and 11 to 15 years of the work experience (Figure 4).

The Importance of the Green Roofs in the Ecological Impacts in Cities: About 80% experts believe that green roofs have high and very high importance in the ecological effects based on results of this research (Figure 5).

The Importance of the Green Roofs in the Natural Life Conditions in Cities: The importance of the green roofs is high (50%) and very high (30%) in the natural life conditions in cities because of the protection of the natural habitat and biodiversity (Figure 6).

The Effect of the Green Roofs in Reduction of the Daily Temperature Difference and Annual Temperature Changes: 80% experts believe that the green roofs are very effective in reduction of the daily temperature difference and the annual temperature changes according to Figure 7 (very high and high opinions).

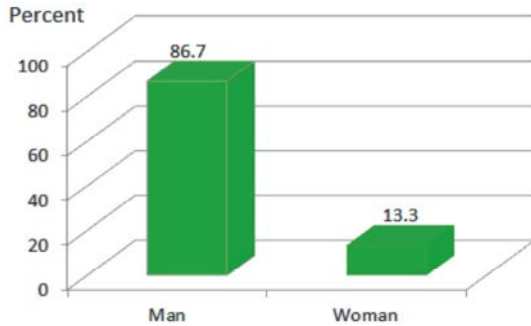


Fig. 1: Expert's Sex

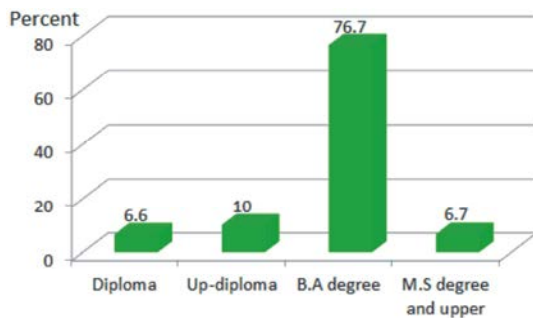


Fig. 2: Expert's academic degree

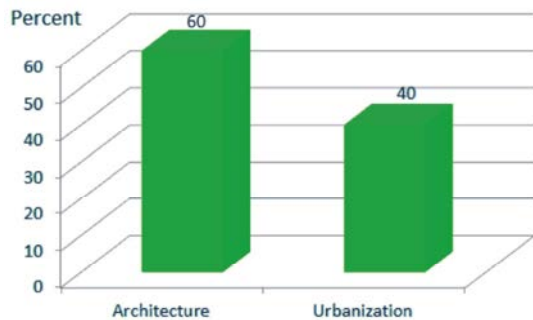


Fig. 3: Expert's specialty

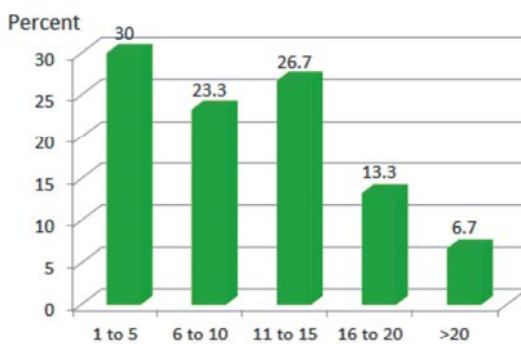


Fig. 4: Expert's work experience

The Importance of the Green Roofs Inthe Filtration of the Suspended Particles in the Airand Reductionof the Air Poor Quality: The importance of the green roofs is high (46.6%) and very high (30%) in the filtration of

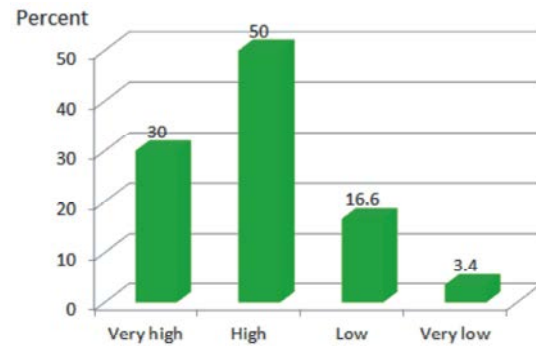


Fig. 5: The importance of the green roofs inthe ecological impacts in cities

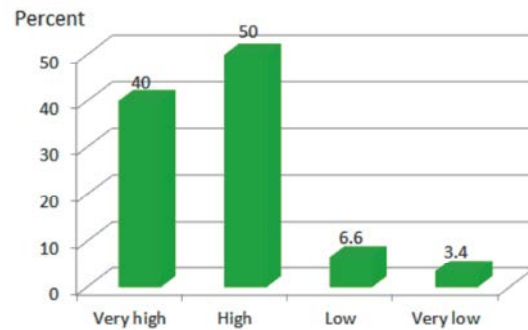


Fig. 6: The importance of the green roofs in the natural life conditions in cities

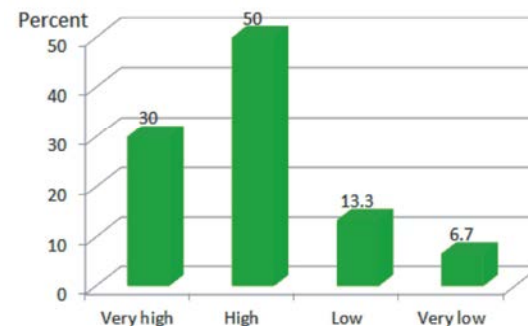


Fig. 7: The effect of the green roofs in reduction of the daily temperature difference and the annual temperature changes

the suspended particles in the air and reduction of the air poor quality based on expert's opinions (Figure 8).

The Effect of the Green Roofs in Reduction of the Sound Rather than the Sound Reflection: Results show that the effect of the green roofs in reduction of the sound rather than the sound reflection is high (40%) and very high (23.3%) (Figure 9).

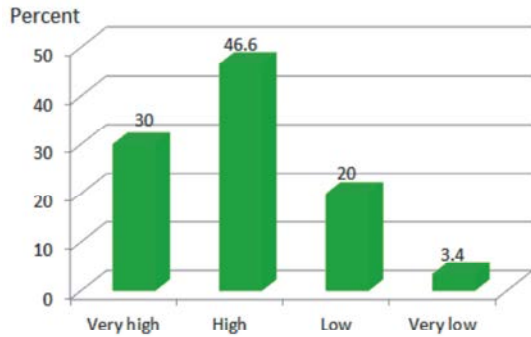


Fig. 8: The importance of the green roofs in the filtration of the suspended particles in the air and reduction of the air poor quality

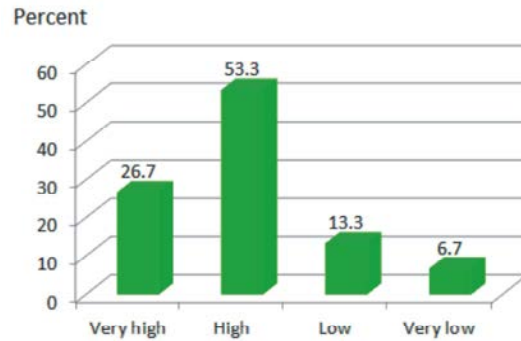


Fig. 11: The effect of the green roofs in protection of the roof insulator against ultraviolet rays and temperature changes

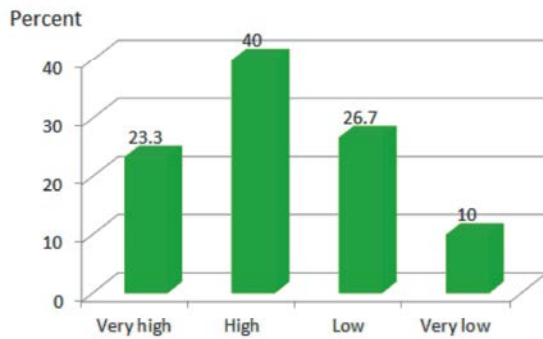


Fig. 9: The effect of the green roofs in reduction of the sound rather than the sound reflection

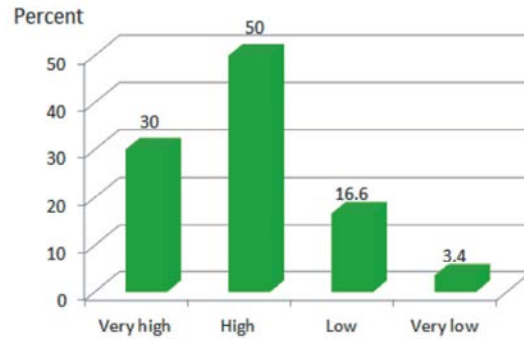


Fig. 12: The importance of the green roofs in conversion of the noisy city to the calm city

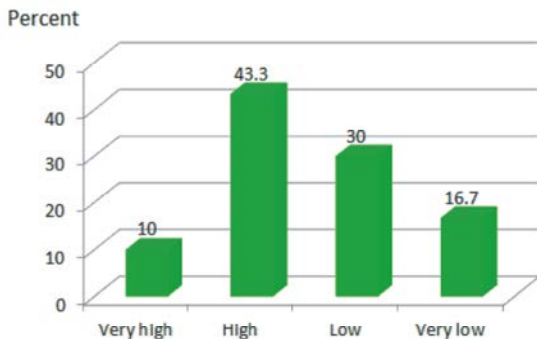


Fig. 10: The importance of green roofs in reduction of entry of electromagnetic radiation to the building

The Importance of the Green Roofs in Reduction of Entry of the Electromagnetic Radiation to the Building:

The green roofs are effective (53.3%) in reduction of entry of the electromagnetic radiation to the building according to most expert's opinions (Figure 10).

The Effect of the Green Roofs in Protection of the Roof Insulator Against Ultraviolet Rays and Temperature Changes:

The effect of the green roofs is high (53.3%) and very high (26.7%) in protection of the roof insulator against ultraviolet rays and temperature changes based on results of this research (Figure 11).

The Importance of the Green Roofs in Conversion of the Noisy City to the Calm City:

The importance of the green roofs is high (50%) and very high (30%) in conversion of the noisy city to the calm city based on the results of this research (Figure 12).

The Importance of the Green Roofs in Reduction of Disease and Stress:

Most experts believe that the importance of the green roofs in reduction of disease and stress is high (43.3%) to very high (33.3%) (Figure 13).

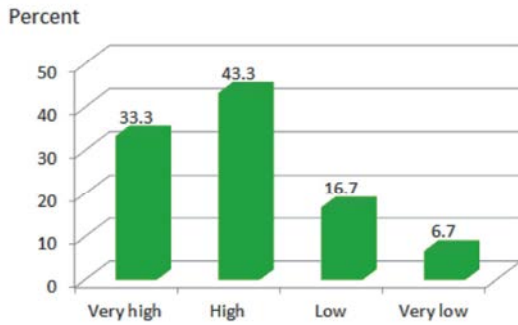


Fig. 13: The importance of the green roofs in reduction of disease and stress

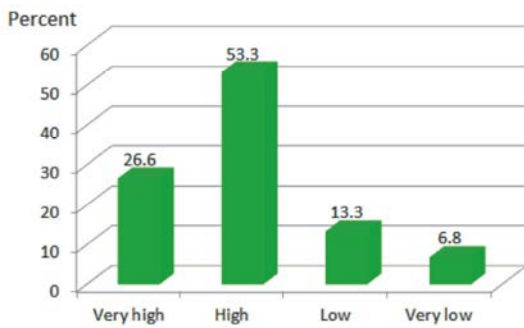


Fig. 14: The importance of green roofs in reduction of heat transfer of the green roof compared to the common roof

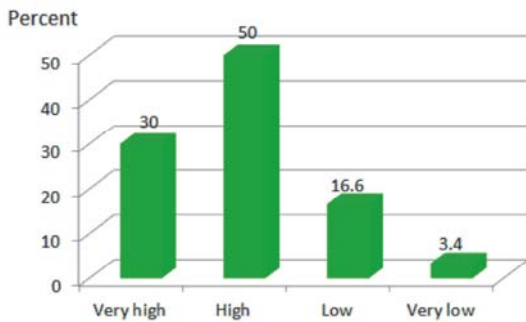


Fig. 15: The management requirements of the green roofs rather than the common roofs

The Importance of the Green Roofs in Reduction of Heat Transfer of the Green Roof Compared to the Common Roof:

The results show that the effect of green roofs is high (53.3%) and very high (26.6%) in reduction of heat transfer of the green roof compared to the common roof (Figure 14).

The Management Requirements of the Green Roofs System Rather than the Common Roofs System:

The management requirements of the green roofs system

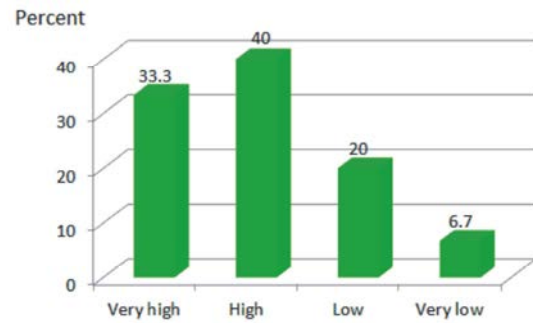


Fig. 16: The roof insulator lifetime of the green roofs system rather than the common roofs system

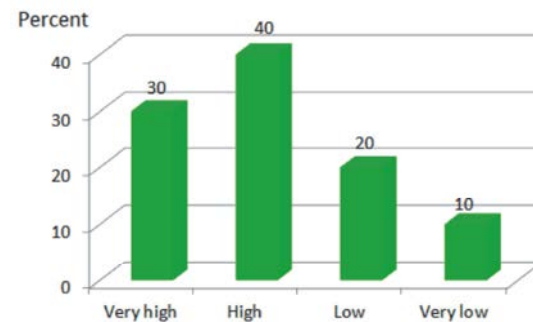


Fig. 17: The runoff volume from rainfall in the green roof rather than the common roof

is 80% more than the common roofs system(50% high and 30% very high) based on expert's opinions (Figure 15).

The Roof Insulator Lifetime of the Green Roofs System Rather than the Common Roofs System:

The results show that the amount of lifetime of the roof insulator of the green roofs system is more than the common roofs system(40% high and 33.3% very high) (Fig. 16).

The Runoff Volume from Rainfall in the Green Roof System Rather Thanthe Common Roofsystem:

The runoff volume from rainfall in the common roof system is much more than the green roof system (70%) based on expert's opinions (Figure 17).

Requirement Tothe Continuous Maintenance in the Green Roofs Compared to the Common Roofs:

Requirement to the continuous maintenance in the green roofs compared to the common roofs is high (46.6%) and very high (20%) based on results of this research (Figure 18).

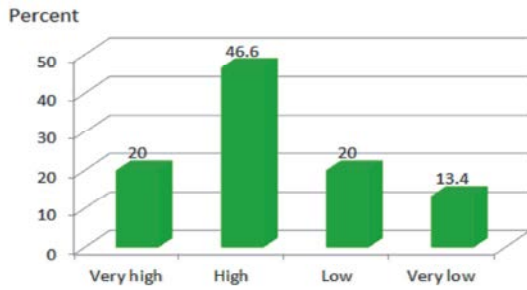


Fig. 18: Requirement to the continuous maintenance in the green roofs compared to the common roofs

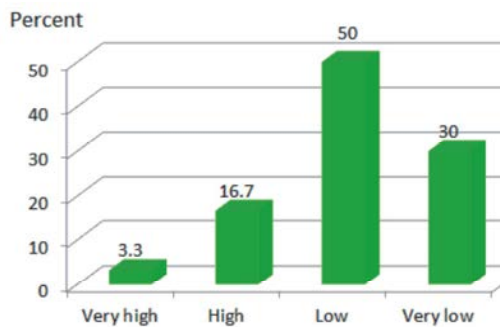


Fig. 19: Absorption of solar energy in the green roofs system compared to the common roofs system

Absorption of Solar Energy in the Green Roofs System Compared to the Common Roofs System: The results show that the absorption of solar energy in the common roofs compared to the green roofs is low (50%) and very low (30%) based on expert's opinions (Figure 19).

DISCUSSION AND CONCLUSION

The green roofs have been converted to the essential part of the buildings in European countries because of the great visual landscape, energy consumption saving and environmental positive effects. In addition the green roofs have been recognized as the new and growing elements in eastern Asia and northern America, although the green roof is still an unknown element in many third world countries like Iran. The green roofs are not commonly used in our country until now which it requires the use of them in the country.

This study has been done to investigate the role of the green roofs as a strategy to improve the environmental quality of Isfahan city. The results showed that most of experts are men (86.7%) which most of them have bachelor's degree (76.7%) in the architecture field (60%) and the work experience of most of them is 1 to 5 years (30%) and 11 to 15 years (26.7%).

About 80% experts believe that the green roofs have high and very high importance in the ecological effects based on the results of this research. The importance of the green roofs also is high (50%) and very high (30%) in the natural life conditions in cities because of the protection of the natural habitat and biodiversity. Feng *et al.* (2005) also suggest that the green roof and parks should develop to reach to more sustainability in the urban environment [8]. These cases show the importance of the green roofs in improvement of the ecological and environmental conditions in cities. In addition 80% experts believe that the green roofs are very effective in reduction of the daily temperature difference and the annual temperature changes. This shows that the green roofs have the important role in adjustment of the environment temperature. The importance of the green roofs is high (46.6%) and very high (30%) in the filtration of the suspended particles in the air and reduction of the air poor quality based on results of this research. In addition the effect of the green roofs in reduction of the sound rather than the sound reflection is high (40%) and very high (23.3%). These cases mean that the green roofs have the important role in reduction of the air and sound pollution in the crowded cities. Results of this study show that the green roofs are effective (53.3%) in reduction of entrance of the electromagnetic radiation to the building according to most expert's opinions. In addition the effect of the green roofs is high (53.3%) and very high (26.7%) in protection of the roof insulator against ultraviolet rays and temperature changes. These results are similar to Minke's results (2007) that showed the green roofs significantly reduce the electromagnetic radiation entering to the buildings [9]. The importance of the green roofs is high (50%) and very high (30%) in conversion of the noisy city to the calm city based on the results of this research. The importance of the green roofs in reduction of disease and stress also is high (43.3%) to very high (33.3%). These show that the green roofs have the great effect on citizen's social and mental calmness.

In this study, comparison the benefits of the green roofs to the common roofs showed that the effect of the green roofs in reduction of the roof heat transfer and the roof insulator lifetime is higher than the common roofs. This result conforms to the results of Canadian National Research Council (2012) [10]. In addition results of this study show that the runoff volume from rainfall in the common roof system is much more than the green roof system based on expert's opinions. Requirement to the continuous maintenance in the green roofs compared to the common roofs also is high (46.6%) and very high

(20%) based on results of this research. These cases require the economic revenue of the use of the green roofs regarding to the environmental conditions. Another important result of this study is that the absorption of solar energy in the common roofs compared to the green roofs is low (50%) and very low (30%) that this conform to the results of other studies about role of the green roofs in reduction of the energy consumption [11, 12]. This shows the importance of the green roofs in the optimal use of solar energy and its store.

The final results of this research show that the green roofs have the important role in improvement of the urban environment quality in terms of sustainable architecture.

The major problems to develop the green roofs in cities include the lack of the sufficient knowledge of the benefits of the green roofs, lack of the motivation in the governmental and private sections, the economic barriers associated to the costs of the green roofs, lack of the knowledge of the long-term economic benefits of the green roofs and lack of the agreement of the probable risks due to uncertainties in some of the technical issues and new technology of green roofs. Thus it is suggested that the studies should be done to identify and to develop the green roofs. In addition some plans would be planned to create the cheap green roofs by providing the financing facilities to motivate the investors to invest in the green roofs. In addition some advertisements must be developed about the importance of the green roofs in the urban environmental quality and the necessity of the participation of all people in operation of these plans by public media. Municipalities can play an important role in this field by presenting the required equipment and facilities of the green roofs development to investors and people.

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