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IDENTIFICATION OF BARRIERS THAT HINDER THE EFFECTIVE IMPLEMENTATION OF BUILDING ENERGY CODES

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In response to the growing energy consumption levels in buildings, many countries have introduced standards and codes aimed at reducing their national building energy consumption and managing the amount of emissions. Title 19 of Iran's National Building Regulation (NBR) was first introduced in 1991. It was projected that Title 19 can lead to a 30 to 50% reduction in building energy consumption in the country. Nevertheless, evidence suggests that the introduction of Title 19 NBR has not led to substantial saving in building energy consumption. Unlike Title 19 NBR, similar standards in other countries have proven to be very effective in reducing the building energy consumption levels. For instance, it is believed that the implementation of Title 24 of California's Building Energy Efficiency Standards has led to $66 billion dollars of energy savings over the past 35 years. The objective of this study is to utilize content analysis and experts' opinion in order to identify and categorize the barriers that hinder the effective implementation of Title 19 NBR in Iran. The contribution of this study to the state of knowledge is the identification of barriers that could hinder the effective implementation of building energy codes.

Keywords: Sustainable construction, Environment impact, Built environment, Construction policy, Standards, Developing countries.

1 INTRODUCTION

The growing problems caused by the use of energy-consuming equipment in the building sector and the increased utilization of electricity and fossil fuels have led to the development of standards and codes that are aimed at optimizing building energy consumption. Increased energy consumption is directly related to the emission of environmental pollutants. These emissions could be reduced through appropriate measures. Building energy efficiency codes are regulatory tools that establish minimum levels of energy efficiency for different building types. They typically cover the design and construction of various building energy systems. They play a fundamental role in achieving energy efficiency objectives, particularly for new construction.

Title 19 of Iran's National Building Regulation (NBR) developed in 1991. It was expected that its implementation can promote energy saving in buildings (National building regulation office 1997). It was projected that Title 19 NBR can lead to a 30 to

50% reduction in the amount of building energy consumption (IFCO 2005). Nevertheless, evidence suggests that the introduction of Title 19 NBR has not led to substantial reduction in building energy consumption. As a result, the average energy consumptions by buildings in Iran are currently 1.9 times the world average (Development Organization of Kashan 2011).

2 BACKGROUND

Unlike Title 19 NBR, similar standards adopted by other countries have proven to be very effective in reducing the building energy consumption levels. China is the second largest energy consumer, after the United States. Buildings account for 28 percent of Chinese energy consumption (DOE 2009). Building energy efficiency issues in China have drawn increasing attention from the government since the mid-1980s (Huang & Joe Deringer 2007). The Ministry of Housing and Urban-Rural Development coordinates and develops China's national building energy codes. It has issued a series of national and industrial codes to promote building energy efficiency. As a result, China has become one of early adopters of national building energy codes (1986) among Asia-Pacific Partnership on Clean Development and Climate countries. In 2004, an ambitious energy conservation plan for Chinese buildings became effective. It required 50% energy conservation for all new buildings. Several major cities such as Beijing and Tianjin shall take a lead in implementing s more strict 65% energy saving standard. Tianjin is one of the most successful Chinese cities in compliance enforcement of building energy efficiency codes with nearly 100 percent compliance. Strong determination of the Chinese government and broad international collaboration are among the key factors contributing to the success of these plans (PNNL 2009).

In United States, see a range of benefits have been realized from the development and implementation of building codes. These benefits include lower energy use, reduced energy costs, reduced pollutant emissions, stronger local economies, improved energy resource reliability and improved health (State Climate and energy program). An analysis by the Department of Energy (DOE) estimates that cumulative energy savings from 1992–2012 were approximately 4.2 quads and cost savings to consumers have been more than $44 billion in USA (PNNL 2014). The use of building energy efficiency code is not just a national endeavor. In 1978 California became the first state in the United States to enact a statewide building energy code (California Title 24 Part 6). Title 24 establishes prescriptive and mandatory guidelines for construction methods, materials, equipment, and controls. These guidelines are used in new construction and major retrofits. It is believed that the implementation of Title 24 of California's Building Energy Efficiency Standards has led to $66 billion dollars of energy savings over the past 35 years. The Energy Commission estimates that energy efficiency investments in California (encouraged by Title 24 building codes and Title 20 appliance standards along with utility efficiency programs) have resulted in an estimated $56 billion in electricity and natural gas savings through 2006. An additional $23 billion in savings anticipated through 2013. These savings have yielded almost $5 billion in net benefits from avoided generation, transmission, and distribution and natural gas usage. More than $900 million in savings has been reported in year 2008. Between 2006 and 2008, utility programs generated savings at a cost of less than $0.03/kWh compared with $0.08/kWh for base-load power (Berkeley National

Laboratory 2012). These savings resulted primarily from DOE supported activities that help upgrade model energy codes, accelerate their adoption by states and localities, and improve code compliance via software tools, training, and technical support (State Climate and energy program).

Therefore, evidence suggest that, compared to similar energy efficiency codes, Title 19 NBR has not been successful in achieving its target saving levels. Research is needed to identify barriers that hinder its effective implementation. The objective of this research is to identify and classify these barriers.

3 METHODOLOGY

To achieve the objective of this research, a comprehensive review of literature was conducted in order to identify the barriers that hinder the effective implementation of Title 19 NBR. The findings of this literature review were verified and enhanced through interviews with several experts. In order to evaluate the impact of each barrier, a survey was distributed among subject matter experts. The responses to questionnaires were compiled and analyzed in order to identify the most prominent barriers.

Through literature studies and numerous interviews with experts, the barriers that reduce the effectiveness of Title 19 NBR, are identified as following:

- Authorities have competing and conflicting interests (Kari 2014)
- Authorities have failed to recognize the need for localized code (Kari 2014)
- Code failed to offer appropriate validation methods (PNNL 2011)
- Authorities have failed to recognize the need to separate the codes for new construction and retrofit (Berkeley National Laboratory 2012)
- Authorities have failed to update and revise the code in a timely fashion (PNNL 2003, Pakravan 2014)
- Municipalities have not participated in the code development process (Eslami 2015)
- Compliance costs are high (IFCO 2005)
- Investors do not consider the implementation of Title 19 as value generating (Pakravan 2014)
- Check lists are complicated (IFCO 2005)
- The code is not accompanied by appropriate software (PNNL 2011, Iwaro & Mwasha 2010)
- Construction materials are sub-standard (Pakravan 2014)
- The current manufacture rating system is ineffective (Pakravan 2014)
- Liability insurance services are inadequate (Pakravan 2014)
- Engineers and inspectors are unfamiliar with technical details (Kari 2014)
- Due diligence is not performed (Eslami 2015)

- Practitioners fail to meet ethical codes and standards (Pakravan 2014)
- Policies imposed by ministries are conflicting (IFCO 2005)
- Penalty system is ineffective (Pakravan 2014)
- Government incentives are inadequate (Pakravan 2014)
- End-users are not willing to pay price premium for buildings that comply with the code (Kari 2014)
- Energy subsidies are high (Eslami 2015)
- A new generation of engineers has failed to thrive (Kari 2014).

Table 1. Barriers hindering the Implementation of Title 19 NBR.

Description of Barriers	Category	Impact
Code failed to offer appropriate validation methods	Adoption	**Very High**
Authorities have failed to recognize the need to separate the codes for new construction and retrofit	Adoption	
Authorities have failed to update and revise the code in a timely fashion	Adoption	
Municipalities have not participated in the code development process	Adoption	
Investors do not consider the implementation of provided Title 19 as value generating	Implementation	
Check lists are complicated	Implementation	
The code is not accompanied by appropriate software	Implementation	
Construction materials are sub-standard	Implementation	
The current manufacture rating System is ineffective	Implementation	
Due diligence is not performed	Control	
Policies imposed by ministries are Conflicting	External factors	
Penalty system is ineffective	External factors	
End-users are not willing to pay price premium for buildings that comply with the code	External factors	
Energy subsidies are high	External factors	
A new generation of engineers has failed to thrive	External factors	
Authorities have competing and conflicting interests	Adoption	**High**
Compliance costs are high	Implementation	
Liability insurance services are inadequate	Implementation & Control	
Engineers are unfamiliar with technical details	Control	
Inspectors are unfamiliar with technical details	Control	
Practitioners fail to meet ethical codes and standards	Control	
Government incentives are Inadequate	External factors	
Authorities have failed to recognize the need for localized code	Adoption	**Medium**

7 RECOMMENDATIONS

Based on a comprehensive content analysis and interviews with experts, a series of strategies that can potentially overcome the abovementioned barriers were identified. The recommended strategies to overcome the barriers to the effective implementation of building energy codes are the followings:

- The content and background calculations of energy codes should be developed considering the capabilities of stakeholders.
- Energy codes should be updated and revised on a regular basis to reflect the changes in technologies and policies.
- The use of modeling and simulation methods in order to calculate and compare the effect of codes and their provisions should be promoted.
- Engineers and inspectors should be trained and familiarized with details of the code on a frequent basis.
- Checklists should be designed with the objective of facilitating effective and efficient monitoring of compliance level.
- An appropriate building rating system should be developed as a supplement to building energy codes.
- An appropriate manufacturer rating system should be developed in order to prevent low quality materials and equipment from entering the market.
- Appropriate regulatory and statutory environment should be created to guarantee the effective implementing and monitoring of building energy codes.
- Ethical standards should be enforced throughout the implementation and monitoring process.
- Providing liability insurance mechanisms should become mandatory as part of the building energy code implementation process.
- Public authorities should offer appropriate incentives to promote the implantation and compliance with regards to building energy codes.
- Public authorities should invest in enhancing the culture of energy conservation.

8 CONCLUSION

Currently, buildings account for about 30% of all energy consumption globally and a significant share of greenhouse gas emissions. In response to the growing energy consumption levels in buildings, many countries have introduced standards and codes aimed at reducing their national building energy consumption and emissions. Title 19 of Iran's National Building Regulation (NBR) was first introduced in 1991 with the aim of promoting energy saving in buildings across the country. Title 19 NBR helps ensure that new buildings use energy efficiently. It is estimated that this code can reduce building energy use by 50% or more compared to buildings designed without energy efficiency in mind. Nevertheless, evidence suggests that so far the introduction of Title

19 NBR has not led to substantial reduction in building energy consumption. The objective of this study was to identify the barriers that hinder the effective implementation of building energy codes such as Title 19 NBR. Using literature review and interviews, with experts, barriers to effective implementation of Title 19 NBR were identified. In addition, through a survey, the level of impact of each barrier was identified. The results of survey suggest that, lack of attention to validation methods, integrate issues of new construction and retrofit, postponing the time of edition, absence of municipality in development process and attitude of investors are the most important barriers in reducing the impact of Title 19 NBR in Iran. A variety of strategy can be implemented by the authorities to promote the adoption and effective implementation of the code.

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