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RESEARCH ARTICLE

EXISTING SCENARIO OF BUILDING CODE IMPLEMENTATION IN NEWLY FORMED "NAGARJUN MUNICIPALITY"

Subash Kumar Bhattarai and *Anjay Kumar Mishra

Assistant professor, Nepal Engineering College, Center for Post Graduate Studies, Nepal

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ABSTRACT

Government of Nepal has enforced to implement the building code and bye-laws in all municipalities. So, implementation status of building code must be evaluated in newly formed municipality. The research is focused to find the existing scenario of building code implementation through Mandatory Rule of Thumb (MRT) along with adopted process, existing institutional mechanism, existing level of awareness, capability, perspective and the % of various components of cost for building in newly formed Nagarjun Municipality. The adopted process and existing institutional mechanism for the implementation of building code is not effective due to lack of building code implementation section and non-functionality of environmental section and insufficient manpower. The awareness level of stakeholders was found good regarding technical matter on building bye laws and building code. The designers and local contractors were capable in implementing building code through trainings though they realize need of trainings for continues improvement. Municipal engineers and technical manpower were academically sound though they lack relevant trainings for effective implementation of building code and bye-laws. Due to awareness of house owner they were found positive for building code and bye-laws to have systematic construction with a view to reduce the impact of earthquake. The implementation of MRT was applied in permitted drawings and in construction also. The cost of a residential building was found 21 % on an average for its structural component, 45 % for non-structural components and remaining 34% by content cost. Content cost depends on owner's perspective but other two costs depend on MRT. It showed that % cost of structural component is less though it provides structural strength in buildings

INTRODUCTION

Most of the residential buildings in Nepal are constructed and constructing without following the National Building Code (NBC). Avoiding the minimum requirements in design amplifies the damage during the earthquake. Loss of life and loss of property are triggered by earthquake if it finds the weak design and insufficient structural member. However the existing design does well but the performance of building cannot be computed as good in regular reinforcement. But, slight increment in the reinforcement would impart the better performance at the same level of the ground shaking i.e. implementation of Mandatory Rule of Thumb (MRT) in construction. Nepal is a disaster prone country and it is suffering since the time immemorial from the devastation from different hazards. The country is exposed to high earthquake hazard due to its location along the convergence boundary of two active tectonic plates along the Himalayas. There are active fault lines crossing over the country and the capital city Kathmandu is also prone to earthquakes because of its proximity to earthquake sources and also because of its formation. The soil stratum over which the city is formed is mostly soft soil which further escalates the earthquake hazard. Therefore, the built environment consisting buildings and various other engineering structures in Kathmandu are constantly under risk. At present the urbanization has resulted in rapid growth of infrastructures in order to accommodate various functional needs. Despite of high seismic risk, the buildings and infrastructure in Kathmandu are mostly non-engineered and do not meet seismic safety requirements. Kathmandu lives with high earthquake hazard and has majority of buildings vulnerable to earthquake which put the city in high earthquake risk. "Earthquake alone does not kill people; it is the non-engineered buildings that kills, i.e. the collapse of man-made structure do" (Hough & Jones, 2002). Although people cannot control the occurrence of earthquakes, people can definitely control the quality of man-made structures. As a mitigation planning, one need to evaluate the buildings that are either feasible to live or not during the seismic activities. Managing the construction of buildings is an uphill task and performing the design and construction for a seismic zone is difficult. The monitoring, evaluating and supervising the design and construction are keen on the

Corresponding author: **Anjay Kumar Mishra,**
Assistant professor, Nepal Engineering College, Center for Post Graduate Studies, Nepal.

seismic details which make an ordinary building a seismic resistant building. The recent i.e. on 25 April 2015, at 11:56 local time, devastating earthquake of about 7.6 magnitude struck in Nepal, with epicenter in Barpak VDC (15 KM depth) of Gorkha District (north-west) of Kathmandu; south of China border(Shrestha *et al*, 2017). Many aftershocks were continued and majority of population remain outside the house at least for 4-5 nights. The districts of Western and Central Development Region including Kathmandu valley were highly affected by the earthquake. Most affected districts are Gorkha, Lamjung in Western Region and Kavre, Sindhupalchowk, Dhading, Nuwakot, Rasuwa, Dolakha and Kathmandu valley in the Central Region. Several villages were collapsed in rural areas; collapsed and damage of public and historic buildings in Kathmandu valley. Total death reached to 8020, Injured-16033 and missing-375. According to initial assessment report, total of 416359 houses were damaged (fully damage – 202157, partially damage-214202). Among which, Full damage of Physical infrastructure (including Government buildings, Temples, Educational and Health institutions and others)-1661, partial-11332; Damage of private houses: full-200546, partial-202870 (MoHA, Nepal, May 2015).

Municipalities in Nepal

Nepal has adopted federal administrative system with 7 Provinces and 753 Local Levels. All together there are total 293 Municipalities and 460 rural municipalities in new federal dispensations (MOFALD, 2017). All of these entities are planned to be enforced with Building Codes and Bylaws.

Nepal National Building Code (National Building Code (NBC)

A building code, or building control, is a set of rules that specify the minimum standards for constructed objects such as buildings and non-building structures. The main purpose of building codes are to protect public health, safety and general welfare as they relate to the construction and occupancy of buildings and structures. The building code becomes law of a particular jurisdiction when formally enacted by the appropriate governmental or private authority (GoN, 1998).
Building codes are generally intended to be applied by architects, engineers, constructors and regulators but are also used for various purposes by safety inspectors, environmental scientists, real estate developers, subcontractors, manufacturers of building products and materials, insurance companies, facility managers, tenants, and others. Codes regulating the design and construction of structures where adopted into law. Implementation of building code which in turned describe the implementation of seismic resistant design for all types of buildings are utmost need.

Statement of the Problem

Urbanization in the city is growing at a rapid pace and so is the building construction industry. Most of the house owners are building their houses without due consideration to earthquake safety. Slight increment in the structural components of a building will positively increase the strength of the building and can save the buildings from damage during an earthquake thus saving significant cost in its lifetime. Loss of the property due to earthquake could be avoided with the help of slight increment in the dimension of the structure that is changing the regular reinforcement with improved one i.e., following the MRT (Building Code). Government of Nepal has enforced to implement the building code and bye-laws in all municipalities and urbanized VDCS. Therefore implementation status of building code must be evaluated in newly formed municipality. Implamentability is the issue of Nepal rather than Planing (Mishra and Magar, 2017) National Building Code (NBC) has already been put in implementation. So it's implementation status need to be assessed as compliance of fire safety code and preparedness were weak (Mishra and Shrestha, 2017).

Research Objective

The overall objective of this research is to find the existing scenario of building code implementation in newly formed Nagarjun Municipality. Specific objectives of this research are as follows:

- To analyze the sufficiency and effectiveness of the adopted process and existing institutional mechanism for building code implementation.
- To find out the existing level of awareness, capability and perspective of different stakeholder's involved in implementation of building code and bye-laws.
- To assess implementation status of building code in permitted drawings.
- To trace the % of various kinds of cost of building designed by building code (MRT)

Scope and Limitation of Research

Building code here defined as MRT for RC without Masonry infill (NBC, 205) i.e. *Bhukampa Pratirodhi Bhawan Nirman Nirdesika 2071*. Adoption of building code or not in municipality is studied from that date by when municipality decided to enact it. Only limited numbers of design checks were carried out. Comparison of structural drawings provided by designer for the approval and leaflets provided by DUDBC for MRT has been checked to draw the conclusion.

MATERIALS AND METHODS

Study Area

It is newly formed municipality of Nepal. Government of Nepal declared 61 new municipalities by 2nd Decemeber, 2015. Among them Nagarjun is one. Nagarjun comprises of 5 existing VDCS named Ichangunarayn, Sitapaila, Ramkot, Bhimdhunga and Syuchatar with headquarter at Harisiddhi, Sitapaila. It covers an area of 29.8 square kilometers. It is located in western part of Kathmandu district within latitude of 27º 40' to 27º 44' North and longitude of 85º 12' to 85º 17' East. It comprises an altitude varies in between 1300 to 2500 AMSL.

Sampling Method

Random sampling method was used for sampling the population (questionnaire survey for contractor). Total population was used to collect information from consultants and municipal engineers/ technical personnel. Similarly convenience sampling was carried out for the selection of house owner.

Sample Sizes

Cochran equation as given below is used to calculate the sample size with 90% confidence level and confidence interval of 10. This sample was taken for the selection of contractors.

$$n_0 = \frac{Z^2 pq}{e^2}$$

For a finite sample

$$n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

This formula is modified as

Here,

n_0 = Size of infinite population,
Z = Area of normal curve and its value is 1.64 for 90% confidence level.
e = Desired level of precision (Confidence interval) p = Estimated proportion of an attribute that is present in the population, and q is 1-p.
N= Population Size

Since the variability in the proportion is not known, therefore, maximum variability of 0.5 (i.e. p=q=0.5) is assumed.

Sample size for local contractor

Sample size for questionnaire to local contractors: 39, for this N = 90. N is the number of trained masons / local contractors on behalf of municipality. Here all 39 responses were collected.

Sample size for municipal engineers and technical personnel

Similarly, sample size for questionnaire to municipal engineers and technical personnel, all the population of total number 7 was considered for questionnaire.

Sample size for consultants

Similarly, sample size for questionnaire to designers and consultant, all the population of total number 10 was considered for questionnaires.

Sample size for house owners

Similarly, sample size for questionnaire to house owners, all population of total number 10 was considered for questionnaires. Altogether 10 numbers of new buildings was permitted by municipality in this fiscal year till date (after enacting building code). To check the implementation of bye laws and building code in permitted drawings, 5 numbers of buildings was taken as sample. Sample of 5 was selected because among 10 of permitted drawings, 5 of them were completed in construction up to plinth level. Out of remaining 5, 2 of them are not yet started to construct. Therefore, three of them which are under construction were taken

Sample size for general public

Lastly, a convenient sampling was carried for three days interval and total numbers of 30 respondents replied the answer in those three days interval. Therefore, sample size equal to 30 was carried out for questionnaire schedule. Sample sizes of 30 were taken because it was seen that large number of public visited municipality for various purposes rather than for building permit. So it was hard to get the answers from all public who visited as it was irrelevant to most of the public.

Techniques of Data Collection

Primary data

Primary data are the main data for the analysis and interpretation of result for this research work. Primary data have been collected in following ways.

Questionnaire Schedule

Questionnaires were prepared for drawing the respondents' opinion regarding the awareness level, capability and perspective towards building bye-laws, building code and its implementation.

The questions were generalized for four stakeholders

- The designer (consultant)
- Municipal Engineer and Technical Personnel
- The contractor
- The house owners and general public

Focus Group Discussions

Focus group discussions were carried with the municipal engineers and technical personnel to find out the adopted process and existing mechanism of municipality in implementation of building code. Similarly it was carried out to find out the gap and to recommend the effective mechanism. The subject of focus group discussion was limited to:

- The existing adopted process and institutional mechanism to implement the building code
- Lags in effective implementation of building code
- How to make effective mechanism for the implementation of building code

Collections of site photographs from municipality

Permitted drawings were observed in site for verification of building code in construction. For these purpose site photographs of under construction buildings have been taken through site visit.

Secondary data

Government policy documents, laws, literature, books, manual, guidelines, directives, journals, project document, were studied either on line or of line.

Collections of published document from municipality

Municipal Council Document, municipality organization structure and other related documents were collected to

analyze adopted process and existing mechanism along with the effort of municipality towards the implementation of building code.

Collections of permitted drawings from municipality

Approved Drawings were collected to check whether the designers submit the drawing as per Bye-laws and MRT or not.

Analysis and interpretation of data

The results obtained after analysis are represented in graphical form. Since the study is an action type simple frequency distributions are used as an analytical tool. Information obtained from the respondents was analyzed and are presented using different charts and tables.

Research matrix

The research matrix summarized in the table 1 below defined the over methodology of research.

From focus group discussions FGD, it was found that three sections provided by MOFALD is not sufficient for the efficient and effective implementation of building code in municipality as for checking / verify structural drawings/ designs as per National Building Code (NBC) and to recommend "No Objection" for further process of Building Permit, giving suggestions to house owners and masons regarding earthquake safe technology in building constructions, monitoring construction fields regularly, conducting training/ orientation programs to designers, technicians, contractors and house owners, formulating new program proposals for effective implementation of National Building code (NBC) one separate section should be established for performing these implementation activities. So, the section could be named as building code implementation section which is missing in existing institutional mechanism. Regarding environmental section it was stated that environment could not be managed by assessing isolated building drawings, it should be viewed based on allocated area as environmental norms for a single plot could not be sufficient due to externalities effect. So the environmental section was not found functional.

Table 1. Research Matrix

Objective	Information required	Data source	Methodology / Tools
To find out the suitability of adopted process and existing institutional mechanism for building code implementation	Publication, Government norms	Ministry, Municipality	Study of Documents, FGD
To find out the existing level of awareness, capability and perspective of different stakeholder's involved in implementation of building code and bye-laws	Awareness, Capability and perspective of stakeholders	Stakeholders: municipal engineers / technical personnel, consultant, contractor and house owners	Questionnaire, FGD
To assess implementation status of building code in permitted drawings	MRT	Stakeholders	Questionnaire Study of drawings
To trace the % of various kinds of cost of building designed by MRT	Drawings	Stakeholders	Questionnaire Cost estimates

RESULTS AND DISCUSSION

Existing Institutional mechanism for building permits and building code implementation

The municipal's current institutional mechanism for the implementation of Building code is guided by various legal provisions and documents. At the beginning from its formation Ministry of Federal Affairs and Local Development (MOFALD) provides an organizational structure for the newly formed municipalities regarding building permit, infrastructure development and environment protection as follows

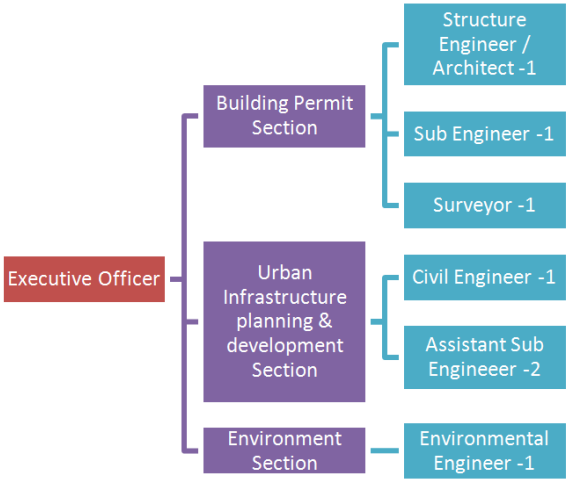


Figure 1

Adopted Sequential Steps for building permits process

Step 1: Submission of application letter and building drawings both architectural and structural along with other required documents like copy of citizenship, blue-print, land owner's certificate, trace map, 4-corners details.

Step 2: Registering the application

Step 3: Checking for required documents and finding out whether the submitted drawings fulfill architectural design requirements and building bye-laws or not. If ok go to step 4 if not go to step 1

Step 4: Checking for structural design requirements and finding whether MRT has been adopted or not. If no go to step 5 if not inform applicant to re draw

Step 5: Forward the drawings and application to respective ward office for 15 days' notice publication to adjacent neighbor. If ok go to step 6

Step 6: Field check by technical manpower of respective ward and completion of other administrative job. If ok go to step 7 if not report to municipality.

Step 7: Collection of Taxes

Step 8: Permission granted up to plinth level (temporary permit) After constructing up to plinth level, owner again apply for permanent permit.

Step 9: Application by owner to check plinth level

Step 10: Plinth level check by technical manpower of municipality. If ok go to step 11. If not inform applicant for design alternation up to possible extent

Step 11: Permission granted for permanent construction After constructing and completion of building as per drawings, owner again applies for building completion report.

Step 12: Application by owner for building completion report

Step 13: Field check by technical manpower. If ok go to step 14. If not inform applicant for design alternation to the possible extent

Step 14: Building completion report issuance.

During FGD, it was found that the permitted drawings from municipality were not inspected before completion up to plinth level. Therefore, it was hard to comply on construction with respect to design of footings and other structure underneath the ground as inspection is carried out after construction up to plinth level. The current numbers of man power is not sufficient for the frequent inspection and monitoring of constructed site. All constructed site could not be verified by a single expert from municipality. Study shows that though municipality has developed a sequential procedure for building permit but existing organizational mechanism and structure is not sufficient for the effective implementation of building code. Also there are no provisions for the designer's verification and frequent site monitoring and inspection from municipality. The step shows the field monitoring after construction up to plinth level and after completion of building. But there should be site visit in between these two stages for the effective implementation of building code.

Awareness, Capabilities and Perspective of the Stakeholders

Level of awareness of stakeholders

Table 2 refers to the awareness level of different stakeholders regarding the earthquake resistant design and construction.

Awareness regarding general concept on earthquake and its phenomena

Out of seven municipal engineers / technical personnel of municipality, all of them have sufficient level of awareness on general concept on earthquake and its phenomena. Similarly, designers and consultants have also sufficient level of awareness on the subject matter. But, respondents amongst contractors, 22 of them have sufficient level of awareness. Remaining 13 numbers of them have partial and 3 of them have no awareness on the subject matter. This is shown in Figure 2.

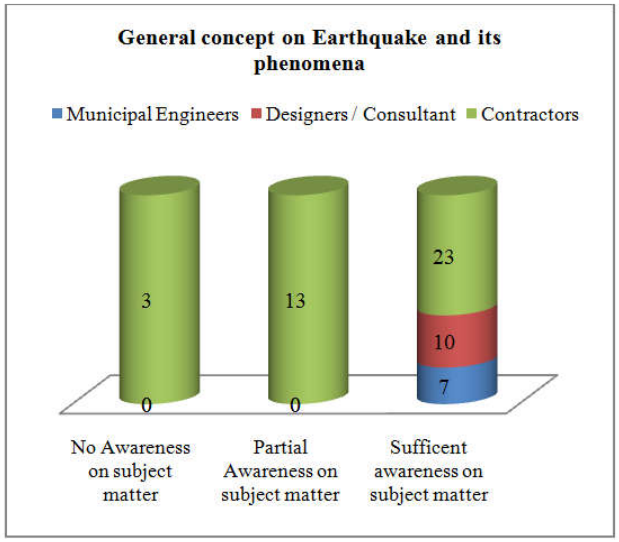


Figure 2. Stakeholders Level of Awareness on General Concept on EQ and its Phenomena

Majority numbers from all stakeholders are confidence in subject matter. Therefore it was concluded that level of awareness is satisfactory.

Awareness Regarding Earthquake Resistant Design and Construction

Out of seven municipal engineers / technical personnel of municipality, 5 of them have sufficient level of awareness on earthquake design and construction and 2 of them have partial awareness level on subject matter. Similarly, 40% of designers and consultants have partial level of awareness on subject matter and 60% of them have sufficient level of awareness on earthquake resistant design and construction. In case of contractors, 18% of them have no awareness on earthquake resistant design and construction. 38% of them have partial awareness and remaining 44% have sufficient level of awareness on the subject matter. This is shown in Figure 3. Relevant trainings to municipality should be required. Similarly, refreshment training should be conducted for local contractors. Designer's training to consultant should be conducted. This is required to achieve the sufficient level of awareness regarding EQRD and construction.

Table 2. Awareness Levels of Stakeholders

S.N	Description	Municipal Engineers / technical personnel = 7			Designers / Consultants = 10			Contractors = 39		
		1	2	3	1	2	3	1	2	3
1	General concept on Earthquake and its phenomena	0	0	7	0	0	10	3	13	23
2	Earthquake resistant design and construction	0	2	5	0	4	6	7	15	17
3	Building Bye-laws and its provision	0	0	7	0	0	10	2	9	28
4	Building code (MRT) and its provisions	0	2	5	0	2	8	5	10	24
5	Municipal legislative documents	0		7	0	3	7	6	11	22

legend:
1 - no awareness
2- have partial awareness
3- have sufficient level of awareness

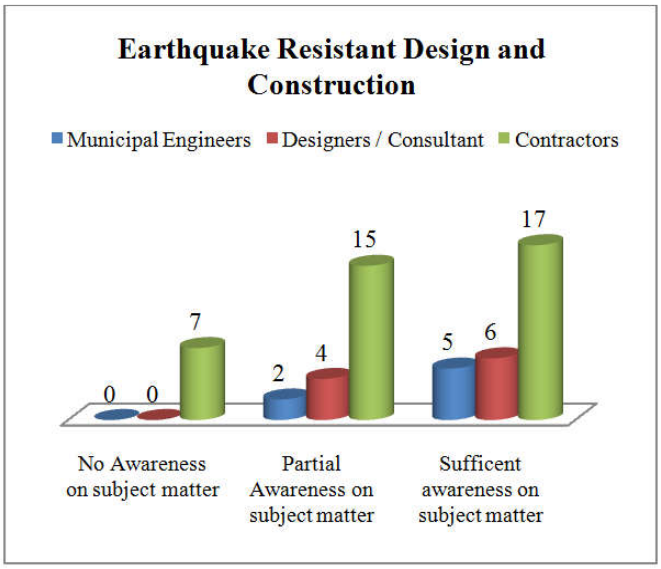


Figure 3. Stakeholders Level of Awareness on Earthquake Resistant Designs and Construction

Awareness Regarding Building Bye-laws and its provision

All of the municipal engineers / technical personnel and designers and consultants have sufficient awareness level on building bye laws. In case of contractors, 2 of them have no awareness on building bye laws. 9 of them have partial awareness and remaining 28 of them have sufficient level of awareness on the subject matter. This is shown in Figure 4.

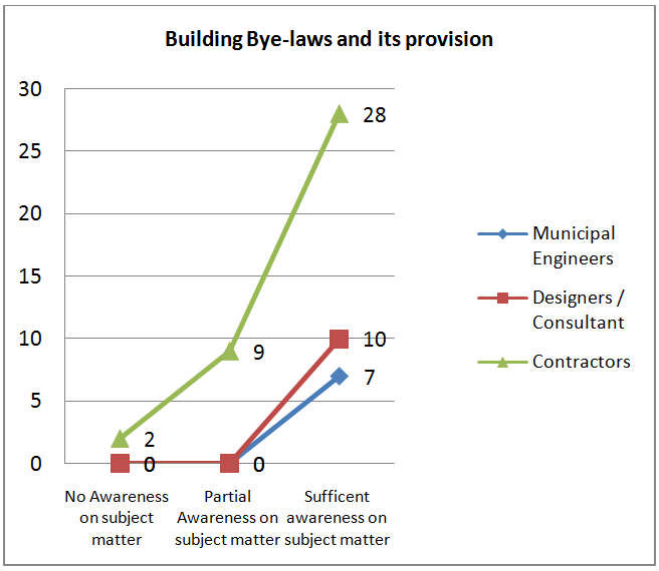


Figure 4. Stakeholder level on Bye-Laws

Required level of orientation on bye-laws should be carried out frequently for the local contractors.

Awareness Regarding Building Code and its provision: 5 of the municipal engineers / technical personnel have sufficient level of awareness on building code and its provision. Remaining 2 of them have partial level of awareness on subject matter. Regarding designers and consultants, 20% (2 of them) have partial awareness level and 80% (8 of them) have sufficient level of awareness on building code and its provisions. In case of contractors, approximately 12% (5 of them) have no awareness on building code. 25% (10 of them) have partial awareness and remaining 63% (24 of them) have sufficient level of awareness on the subject matter. This is shown in Figure 5.

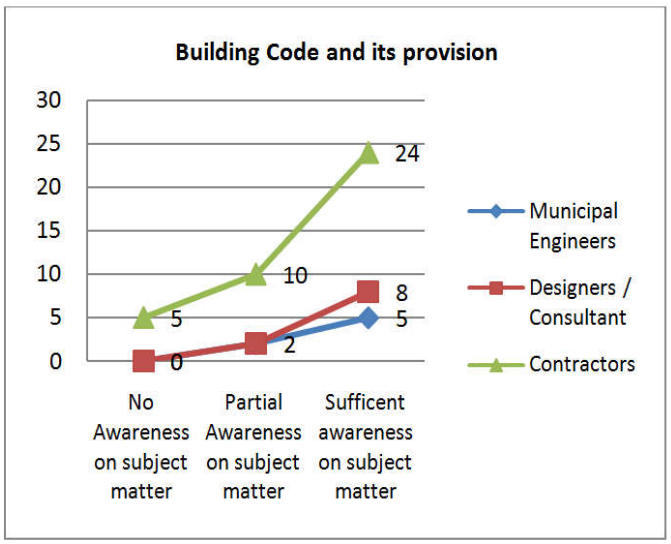


Figure 5. Stakeholders Level of Awareness on Building Code

Though the awareness level regarding building code of all stakeholders are satisfactory relevant trainings on building code and its provisions should be carried out for effective implementation.

Awareness Regarding Municipal legislative documents: Almost 100% of municipal engineers and technical personnel have sufficient level awareness on municipal legislative document regarding building code implementation. But, 70% of designers and consultants and 56% of contractors have sufficient level of awareness on subject matter. This is shown in Figure 6.

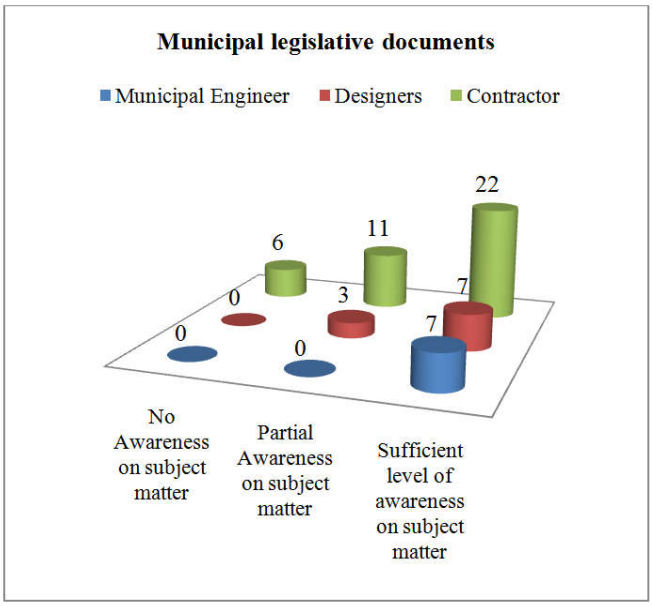


Figure 6. Stakeholders Level of Awareness on Municipality Legislative Document

Municipality should aware regarding decisions made by it to the designers and contractors working in this regards.

Capabilities of stakeholders to implement building code

Out of 7 numbers of municipal engineers/ technical personnel, 57% of them have academic knowledge, 29% of them have general knowledge just 14% of them have relevant trainings on building code implementation.

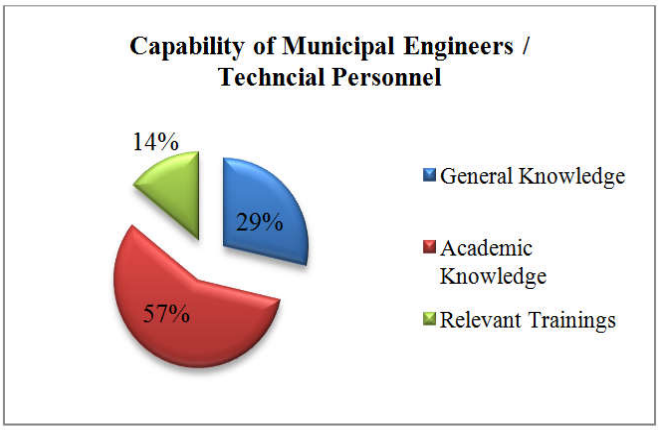


Figure 7. Capabilities of municipality to implement building code in terms of knowledge

Though the academic knowledge on building code is seen positive in municipality, proper competence on implementation of building code could not be achieved from academic degree only so; relevant training and practicum should be carried out for the municipality. Capacity building trainings should be carried out. Similarly, 30% of the designers and consultants have academic knowledge and remaining 70% have relevant trainings on subject matter.

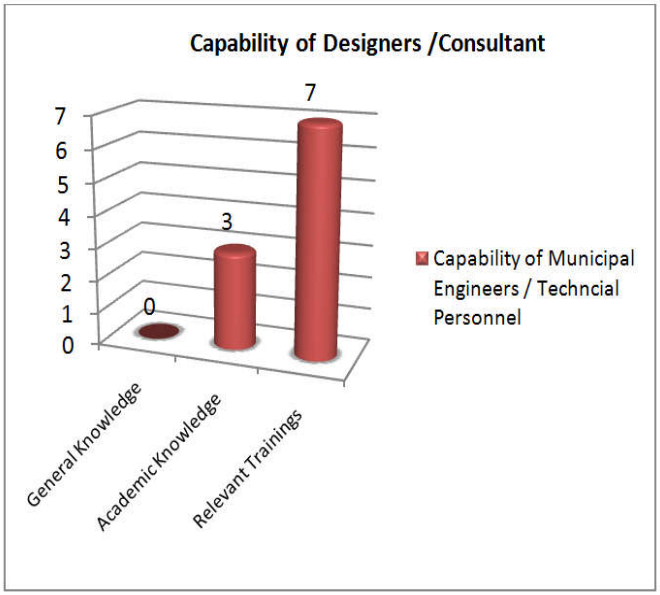


Figure 8. Designers/Consultant Capabilities in terms of knowledge

It could be seen that municipality should provide relevant refreshment trainings to consultant who are working in this field of study. Municipality should capacitate the designer's in this aspect. Similarly, 8 % of the contractors have general knowledge, 13% of them have academic knowledge and remaining 79% of them have relevant trainings on subject matter.

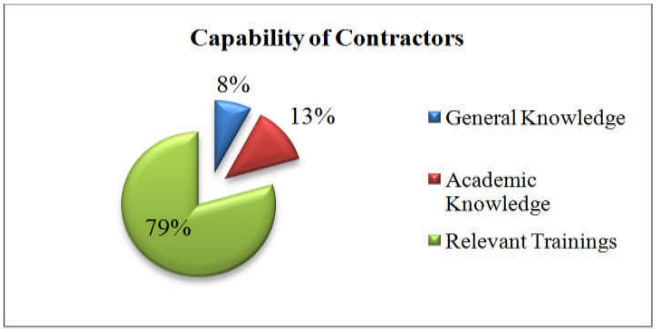


Figure 9. Contractors Capabilities in terms of knowledge

The results concluded that relevant refreshment trainings should be provided for local contractors in frequent basis regarding building code implementation to enhance their capabilities.

Perspective of stakeholders to implement building code

Perspective of general public: Out of 30 respondents 25 of them heard about building code. Respondents have heard about the building code from paper media and television. Remaining 5 numbers of respondents have not heard about building code. This is shown in chart below.

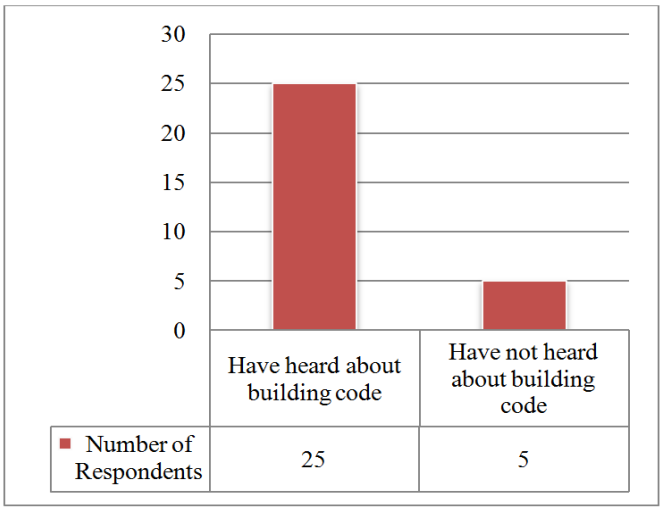


Figure 10. General Public's Perspective on building code

From schedule questionnaire, out of 30 respondents, 27 numbers urged that building code is required. They answered that building code is required to avoid the haphazard construction and to build earthquake resistant buildings construction. Remaining 3 respondents did not satisfy with it because they urged building code will increase the construction cost. Out of 30 respondents, 20 of them (60%) answered that building code and bye laws are same. Remaining 10 (40%) have given clear differences between building code and bye-laws. Results showed that a level of awareness is increasing each day on individual and public. But awareness program at community and household level are required.

Perspective of respondents who got the building permit

Out of 10 respondents, 3 of them answered that they have followed building code due to strict government rules and

regulations. 7 of them answered to built strong buildings. Even the house owners are convinced to implement the building code, results showed that partial of them are convinced to implement building code due to strict rules and regulations of government. Therefore, mass campaign and proper counseling to house owners should be carried out for the effective implementation of building code.

Perspective of Municipal Engineers, Contractors and Designers

All engineers and technical personnel of municipality were found positive towards building code and its implementation. 7 of the designers and consultants were found positive, 3 of them were found neutral. Whereas, 30 numbers of the contractors were found positive, remaining 8 were found neutral. One contractor was found negative. This is shown in Figure 11.

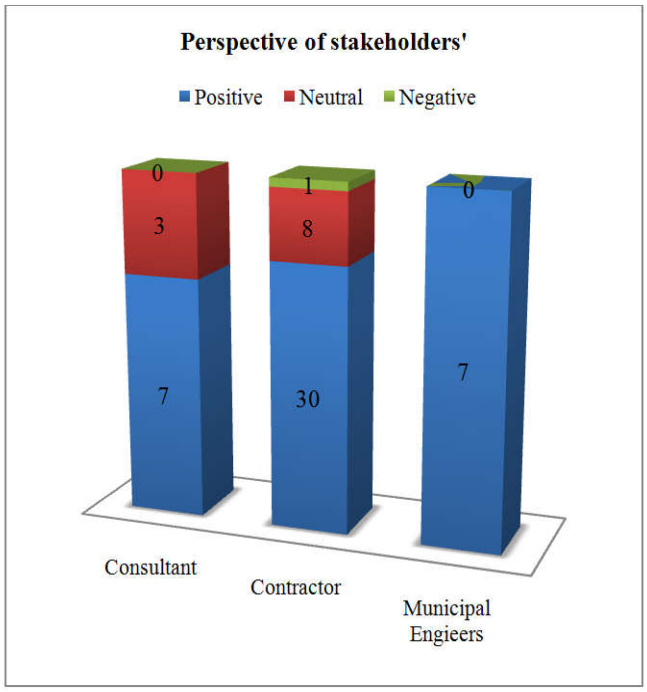


Figure 11. Stakeholders Perspective on building code

Stakeholder's perspective on implementation of building code is satisfactory but, effective implementation should be planned by municipality for good results. Similarly, perspective towards bye laws is shown in chart below. Almost 100 % of municipal engineers are agreed for new by-laws. Similarly 80 % of consultants and 70 % of contractors respond positive towards new bye-laws. But only 46 % of house owners showed positive response towards new bye-laws. During FGD, satisfaction was found that the city is in the process of conversion of concretize jungle so municipality should actively control the haphazard construction as earthquake could not be avoided being in zone V, so prevention should be focused. Similarly for dissatisfaction of house owners, the provisions of Right of way of roads and setback related issues in property line were found. During FGD, perspective of stakeholders for the effective implementation of building code, stakeholders were asked for suggestions. A multiple suggestions were drawn. From stakeholder's point of view the results are drawn in table below.

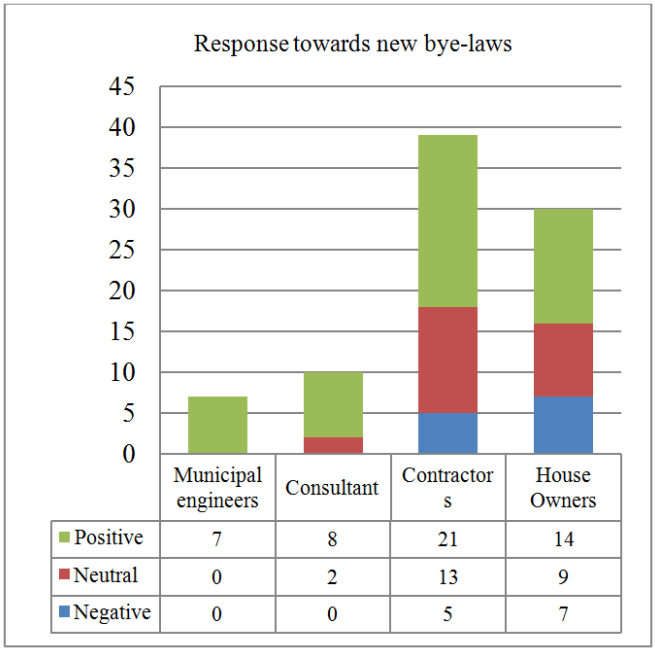


Figure 12. Stakeholders Response towards new bye-laws

Extremely high Priority

High priority

Medium Priority: Here result could be drawn that strict rules and regulation are suggested and of high prioritized for the effectiveness in implementing building code. From owner's perspective, all suggestions are of equal important. Law is for the development of society.

To have a law driven society, institution should adopt the system reward and punishment such as tax discount as reward and monetary penalties should be implemented through effective law.

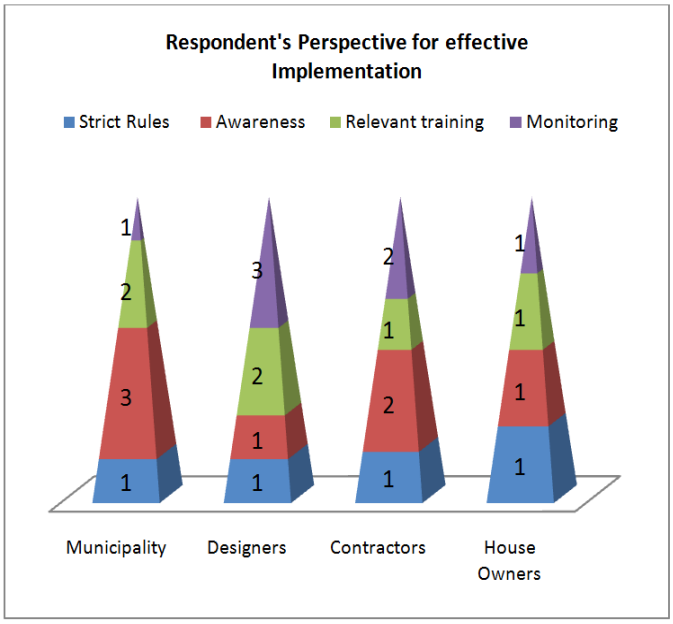


Figure 13. Respondent's perspective for effective implementation

Table 3. Stakeholders' suggestion

S.N	Stakeholder	Suggestion made and prioritization			
		Strict rules and regulations	Awareness campaign	Relevant Training	Regular monitoring
1	Municipal Engineer	1	3	2	1
2	Designers (Consultant)	1	1	2	3
3	Local Contractors	1	2	1	2
4	House owners	1	1	1	1

Table 4. Consideration in design practice: Foundation

Description	Building Under Consideration				
	1	2	3	4	5
Foundation					
Foundation depth from Ground Level (minimum 5')	√	√	√	√	√
Footing thickness at edge (minimum 8")	√	√	√	√	√
Combined footing or strap beam for corner and sides	√	√	√	√	√

Table 5. Consideration in design practice: Column

Description	Building Under Consideration				
	1	2	3	4	5
Column					
Column size (minimum 12" X 12")	√	√	√	√	√
Reinforcement in Center column (Min 8 numbers of 12 mm dia)	√	√	√	√	√
Reinforcement in Corner Column (Min 4 numbers of 16 mm dia)	√	√	√	√	√
Spacing of Stirrups	√	√	√	√	√
Lap length	√	√	√	√	√
Hook in stirrups	√	√	√	√	√

Implementation status of building code in permitted drawings

Building type and Column Bays: As suggested by MRT all of the buildings are of residential type with maximum column bay not exceeding 4.5 m x 3 m.

Foundation

The MRT urged the minimum foundation depth of 5 feet from ground level in general. The footing thickness must be at least 8 inches thick at edge. Provision for combined footing or strap beam for corner and sides. These all provisions have been fulfilled in design consideration of selected sample. It is shown in Table

Column

All buildings under study fulfilled the minimum sizes and minimum reinforcement provision for column. Stirrups, its spacing and hook are designed as per MRT. Similarly lap length is provided according to MRT. Minimum column sizes of buildings under study were of 12" x 12". It is shown in Table

All sample permitted drawings of buildings have followed these provisions.

Beam

Table 6. Consideration in design practice: Beam

Description	Building Under Consideration				
	1	2	3	4	5
Beam					
Reinforcement (Min 4 nos of 16 mm dia)	√	√	√	√	√
Spacing of Stirrups	√	√	√	√	√
Lap length	√	√	√	√	√
Hook in stirrups	√	√	√	√	√

Beam column joint

As specified in MRT, beam and column joint are designed. Provisions made in MRT are fully satisfied in drawings and design.

Table 7. Consideration in design practice: Beam Column Joint

Description	Building Under Consideration				
	1	2	3	4	5
Beam column joint					
Development length (min 60 * dia of bars)	√	√	√	√	√
Stirrups spacing (minimum 4")	√	√	√	√	√

Sills and Lintels

Sills and lintels are provided in design. Both of them are of minimum 3" thickness as specified in MRT.

Table 8. Consideration in design practice: Sills and lintels

Description	Building Under Consideration				
	1	2	3	4	5
Sills and lintels bands					
Provision for lintel and sills	√	√	√	√	√
Thickness (min 3mm)	√	√	√	√	√

Slab

Provisions for reinforcement in slab were fully adopted as specified in MRT.

Table 9. Consideration in design practice: Slab

Description	Building Under Consideration				
	1	2	3	4	5
Slab					
Reinforcement (min 8mm)	√	√	√	√	√
Spacing (min 6")	√	√	√	√	√
R.C.C chairs	√	√	√	√	√

Staircase

Minimum thickness of slab and the arrangements of reinforcement in the buildings under study followed the provisions mentioned in MRT.

Table 10. Consideration in design practice: Staircase

Description	Building Under Consideration				
	1	2	3	4	5
Staircase					
Thickness (minimum 5")	√	√	√	√	√
Provisions for nose bars	√	√	√	√	√
Development length	√	√	√	√	√

It was found that permitted drawings from municipality followed the minimum requirements as specified in MRT. The drawings under observation followed the minimum requirements as stated by MRT, therefore designer's capability to design the buildings following MRT is 100 %.

Percentage of cost composition in buildings designed by MRT

Generally, there are three types of cost which jointly determined the total cost of building. Structural cost, non-structural cost and content cost. Structural costs are those costs related structural components of building. Structural component of building are foundations, columns, beams, slab etc. cement, sand, aggregate, reinforcement are the construction material used in structural component of buildings. Similarly non-structural cost comprised of masonry infill, openings etc. Similarly content cost is cost of electrical, sanitary, furniture and fixtures. Three buildings under study are estimated as per prevailing government rate and analysis to determine the structure and non-structural cost. Similarly content cost is determined from house owner. On an average 21 % of building cost covered by structural component, 45 % by non-structural and remaining 34 % of cost covered by content.

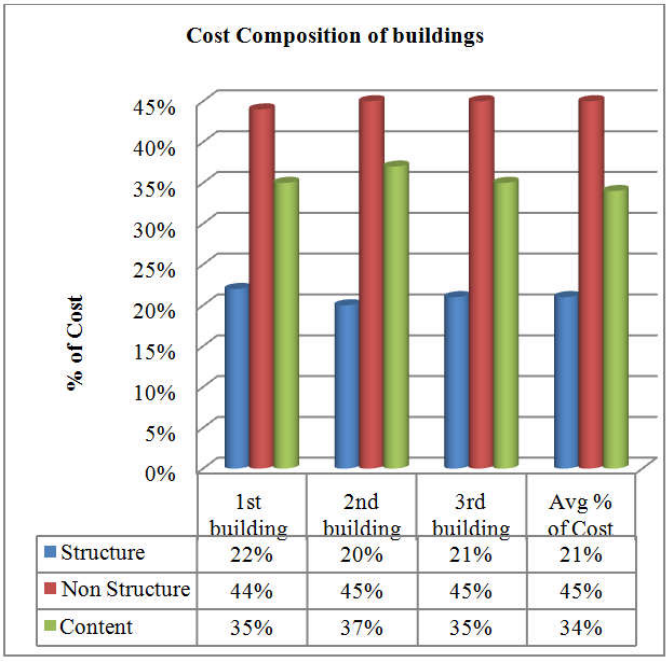


Figure 14. Cost Composition of buildings

Conclusion

The adopted process and existing institutional mechanism for the implementation of building code is not effective due to lack of building code implementation section, insufficient manpower and non-functionality of environmental section. The stakeholders' level of awareness is found to be good regarding technical matter on building bye laws and building code. Contractors, designers and technical manpower are aware of building code and most of them are fully confident i.e. building code is being implemented. The designers and local contractors have enhanced their capability in implementing building code through relevant trainings. Whereas, municipal engineers and technical manpower have academic achievements though they lack relevant trainings for effective implementation of building code and bye-laws. Due to awareness of house owner they are found positive for building code and bye-laws to have systematic construction with a view to reduce the impact of earthquake.

However, unaware house owner expressed their dissatisfaction in terms of right of way and setback related issues. Similarly local contractors, municipal engineers and designers are positive and agreed in implementation of building code. MRT has been implemented in permitted drawings and implemented in construction also. The designers are capable to design the buildings following MRT as they have relevant trainings also the municipal engineers have capacity to review the drawings as they academic knowledge. Similarly, local contractors have implemented the design in construction as they have relevant trainings. A residential building upon completion and finishing maximum % of cost about 45 % covers by non-structural components, 21 % by structural component and remaining by content cost. Content cost depends on owner's perspective but other two costs depend on MRT. It showed that increment in structural cost would not increase the overall cost of buildings.

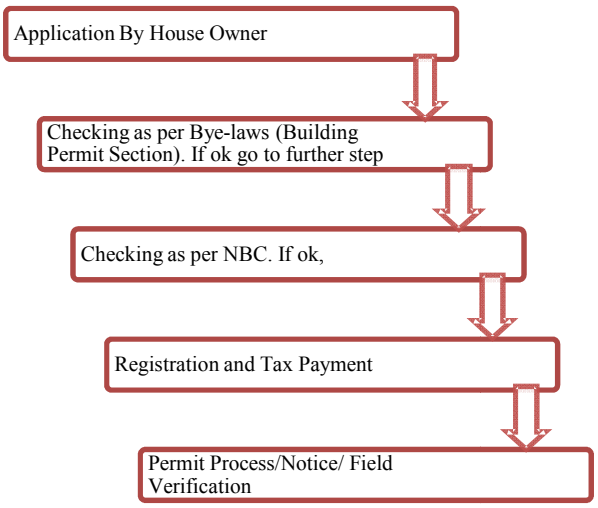
Recommendations

Following are the recommendation for the study.

- Municipality should developed and create new section i.e. building code implementation section under technical section in parallel with building permit section whose major work is confined to check the bye laws approved drawings as per Building code or not .
- The role of building code implementation section are suggested as:
- To check/ verify structural drawings/ designs as per National Building Code (NBC) and to recommend "No Objection" for further process of Building Permit
- To give suggestions to house owners and masons regarding earthquake safe technology in building constructions ;
- To monitor construction fields regularly;
- To conduct training/ orientation programs to designers, technicians, contractors and house owners;
- To carry out awareness programs on earthquake safety to general public; and
- To formulate new program proposals for effective implementation of National Building code (NBC).

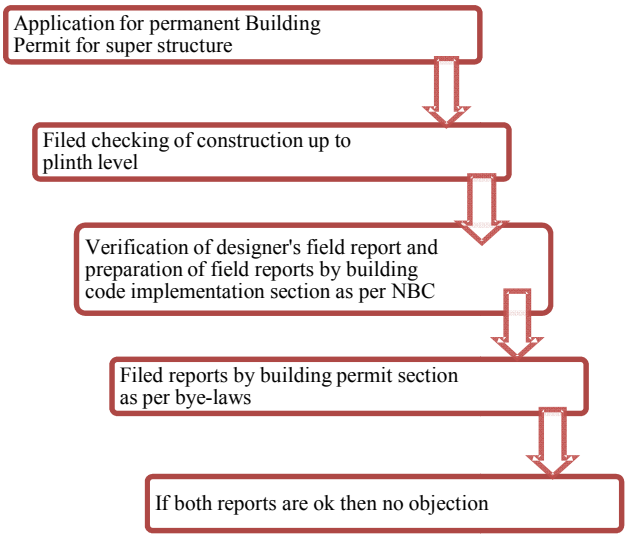
Recommended Sequential Steps for building permits process

First Stage



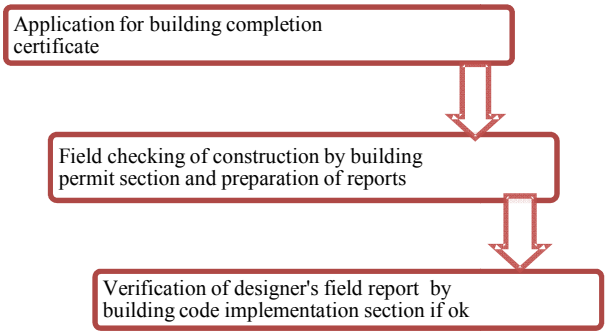
Output: Building Permit up to Plinth Level (Temporary Permit)

Second Stage



Output: Permit for permanent building

Third Stage



Output: Issuance of completion certificate

Recommendation for further study

- Similar studies should be conducted in other municipalities and VDCs level.
- Similar studies should be conducted on other documents of Nepal National building code such as NBC 202, NBC 105 or other building code.
- A study on functionality of environment section should be conducted to make it functional.
- A study on numbers of manpower and their capabilities to implement building code in newly formed municipality.

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