ENHANCING BUILDING CODE COMPLIANCE IN THE MUNICIPALITIES OF NEPAL: AN ASSESSMENT OF THE KEY CONTRIBUTING FACTORS

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Abstract

Effective implementation of building code is one of the most fundamental means to reduce the potential risk of casualty from earthquake in a country like Nepal where more than 80% of the earthquake risk are accounted by vulnerable buildings (Coburn and Spence, 2002). Majority of the buildings are constructed without following the provisions of the national building code, and hence, likely to be extremely vulnerable to earthquakes. Most municipalities are not capable of exercising effective control over the building permit and building inspection processes due to the lack of appropriate mechanisms and lack of capacity. Low public awareness of earthquake-resistant construction and its effectiveness is another hindrance in enforcing building code.

The study and the assessment of efforts in building code implementation over the years in the municipalities of Nepal, has identified; Increased level of awareness on safer construction; Enhanced capacity of the construction workforce and; Improved system and process in the municipalities for building code implementation as the key contributing factors for effective building code implementation. Reflecting on the problems identified, gaps to bridge and the present need, NSET's support for building code implementation has involved a comprehensive approach that includes awareness raising among residents for creating a demand for increased safety, a simultaneous focus on capacity building, both human resources and institutional structure, and development of municipal procedures and related policies. To understand the influence of change in risk perception; influence of improved system/status and capacity of the municipalities to the change in building code compliance, different studies were conducted in the 30 municipalities of Nepal under Building Code Implementation Program in the municipalities of Nepal (BCIPN) being implemented by NSET. Improved system and capacity of municipalities was assessed by measuring the observed change in the status of Building code implementation in the municipalities over the years which included assessment of three major elements: 1) Institutional system for building permit process and building code enforcement, 2) Technical capacity within municipal offices and in municipality areas, and 3) Budget allocation for BCI. Change in the level of risk perception of the house-owners was assessed by measuring knowledge on earthquake risk, their attitude towards existing risk and their behaviour for risk reduction. And finally, the success in achieving building code compliance was measured by assessing the code compliance expressed in the quality of the drawings submitted, and more significantly, in the way the building is actually constructed on site. The buildings designed and constructed in three time periods, 2012, 2014, and 2016, were analysed separately. Thus, level of risk perception, improvement in the system and capacities of the municipality together with the level of building code compliance were measured. It has been observed that level of building code compliance increased significantly as the level of risk perception enhanced and change in the municipal systems of building permits and building code implementation was observed.

This study focuses on measuring the change in the municipal systems of building permits and building code implementation, reflects/examines the positive changes observed through years towards building code implementation in the municipalities and further analyses the interlinkages between the factors contributing towards the change.

Keywords: Institutionalization, Risk Perception; Capacity building; Building Code Compliance

1. Introduction

A significant proportion of existing building stock in Nepal is highly vulnerable, and a great majority of new buildings being constructed also do not comply with the code. This is a well-accepted fact that damage and destruction of the buildings is the main cause of casualties during earthquakes. Analysis of data from recent Gorkha earthquake revealed that more than 80% of the casualty is due to the damage or collapse of buildings. Consequently, earthquake risk of Nepal is growing continuously and will grow faster if not checked. More and more buildings are constructed in urban and urbanizing centres in the country. However, a majority of the buildings are constructed without following the provisions of the national building code, and, hence, likely to be extremely vulnerable to earthquakes(WB/GFDRR, 2016). Most municipalities are not capable of exercising effective control over the building permit and building inspection processes due to the lack of appropriate mechanisms and lack of capacity. Low public awareness of earthquake-resistant construction and its effectiveness is another hindrance in enforcing building code.

The Building Code Implementation Program in the municipalities of Nepal (BCIPN) program was conceptualized and implemented to support the municipalities in the process of building code implementation to address these problems of low capacity, low awareness, and a lack of appropriate mechanisms for permitting and oversight (BCIPN Program Completion Report, 2017). A total of 30 municipalities across the country were the part of the BCIPN program. The BCIPN program municipalities are grouped into three regions -- Eastern, Central and Western -- based on their geographical location.

During the five years of BCIPN implementation in 30 municipalities, more than 150 numbers of training and awareness activities were conducted in close coordination with the municipalities who also increasingly allocated budget for the implementation of activities. More details on BCIPN interventions can be referred in the BCIPN Program Completion Report 2017. More than 1,100 Engineers, 4,600 Masons, 100,000 house owners/community members, 6,300 Social Mobilizers, 630 municipal professionals and political leaders, 103 Master Instructors have been trained and oriented in earthquake resilient construction through BCIPN.

BCIPN has helped to enhance earthquake awareness of the residents and technical knowledge of the municipal officials, technical professionals on aspects of earthquake risk management including earthquake-resistant design and construction. In addition to the awareness and capacity enhancement programs, BCIPN worked towards assisting the municipalities in building their institutional capacities to effectively enforce building code and institutionalize the code compliance system.

To measure the changes overtime, different types of survey or data collection were carried out: i) Risk Perception Survey to measure the change in awareness of the population; ii) Building Code Implementation Status Survey (BCISS) to measure the change in the municipal systems of building permits and building code implementation; and iii) Building Code Compliance Survey (BCCS) to measure the actual changes in construction practices.

The BCISS, one of the major surveys conducted, is the focus of this study. To measure the change in the municipal systems of building permits and building code implementation, Building Code Implementation Status Study (BCISS) was conducted in the program municipalities. The main objectives were: to know the level of capacity of the municipalities for building code implementation; to assess the change in elements of building code implementation over the period in BCIPN program municipalities; and to measure the level of sustainability of building code implementation reflected in robust building permit process and building code enforcement system.

2. Methodology

2.1 Elements of Building Code Implementation System:

Based on the experiences and interactions with the participating municipalities, three major elements were identified for assessing building code implementation. The three major elements were: 1) Institutional system for building permit process and building code enforcement, 2) Technical capacity within municipal offices and in municipality areas, and 3) Budget allocation for building code implementation (BCI). Under each of these elements, a weighted score of several key indicators was created.

Status of building code implementation (BCI) in each of the municipality was evaluated in terms of these institutional systems, technical capacities, and budget allocation. Under each of these elements, a weighted score of several key indicators was created. The weight of each indicator reflects its level of importance. The selection of indicators and their weighting were based on the experience of working with the municipalities and interactions with the municipal professionals.

Further, the indicators and scoring were also guided by the Government of Nepal's Minimum Conditions and Performance Measures (MCPM) and Performance Evaluation System, measurements established to assess the performance of the municipalities. Until recently, the MCPM measured the performance of local bodies; the Government of Nepal (GoN) tied block grants and revenue sharing to the performance results.

2.2 Major indicators, weightage and scores for BCI status:

Element 1 measures the institutional mechanism, system, and capacity of the municipality in implementing the building code. It also measures the system for overall disaster risk management. There are seven indicators in this element such as (Table 1); Advisory/Technical guide/committee for BCI, Separate EQ Safety Unit or Separate BCI Cell or dedicated technical staff, Need structural drawing for building class "C" and detail designs for class A and B buildings, Use of detail checklist for building code compliance check (bld. configuration, bld. strength, bld. Ductile detailing), Provision of field inspection for structural details: i) foundation, ii) Plinth level, iii) storey structure, System of registration of masons and roster of trained masons, Provision for strengthening of existing buildings/Retrofitting (such as for construction of addition storey).

Table 1: Indicators and Scores assigned to measure the Institutional System on Building Permit Process in the municipality

S.N	Does Municipality Have	Yes/No	Weightage	Mark	Remarks
E1.1	Advisory/Technical guide/committee for BCI		0.5		(If yes=1, if No=0)
E1.2	Separate EQ Safety Unit or Separate BCI Cell or dedicated technical staff		0.75		(If yes=1, if No=0)
E1.3	Need structural drawing for building class "C" and detail designs for class A and B buildings		0.5		(If yes=1, if No=0)
E1.4	Use of detail checklist for building code compliance check (bld. configuration, bld. strength, bld. Ductile detailing)		1		(If yes=1, if No=0)

S.N	Does Municipality Have	Yes/No	Weightage	Mark	Remarks
E1.5	Has provision of field inspection for structural details: i) foundation, ii) Plinth level, iii) storey structure		1		(If yes=1, if No=0)
E1.6	Has a system of registration of masons and roster of trained masons		0.75		(If yes=1, if No=0)
E1.7	Has a provision for strengthening of existing buildings/Retrofitting (such as for construction of addition storey)		0.5		(If yes=1, if No=0)
	Total Score Possible = 5 (S1)				

The second element measures the available technical capacity within the municipality. Here, the strength on human resources who are directly involved in the construction of house (engineers, masons and the house owners) is assessed. Four indicators are used to assess Element 2 they are; Capacity of Municipal Engineers/Sub-engineers, Trained Masons Capacity, Trained Engineers (Consultant) Capacity, Percentage of Educated House-owners available in the municipality (Table 2).

Table 2: Indicators and Scores assigned to measure the availability of Technical Capacities within the municipality

S.N	% of human resources trained/oriented with respect to numbers of new building constructed per year				Remarks
	Human resources	Nos.	Percentage	Score	
E2.1	Municipal Engineer & Sub engineer Capacity	E	(E/X) *100	S=0 to 1	>1% = 1 0.75% to 1% = 0.75 0.25% to 0.75% = 0.5 0.01% to 0.25% = 0.25 0% = 0
E2.2	Trained Mason Capacity	M	(M/X) *100	S=0 to 2	>50% = 2 25% to 50% = 1 12.5% to 25% =.5 0.1% to 12.5% =0.25 0% = 0
E2.3	Trained Engineer (Consultant + Contractor) Capacity	ET	(ET/X) *100	S=0 to 1	>10% = 1 10% to 5% = 0.75 5% to 2.5% = 0.5 0.1% to 2.5% = 0.25 0% = 0
E2.4	Percentage of House-owners Orientated	HO	(HO/X) *100	S=0 to 1	>75% = 1 50% to 75% = 0.75 25% to 50% = 0.5 1% to 25% = 0.25 0% = 0
	Total Scores out of 5 (S2)			TS	
	Numbers of new building constructed per year=X				

The third and final element measures the proportion of budget the municipality allocates for building code implementation. Municipalities are grouped into three different categories based upon the size of the annual revenue generation from building permit process. Scores are assigned based on the budget allocated from the revenue generation in the municipality (Table 3).

Table 3: Scores assigned based on the budget allocated from the revenue generation in the municipality

S.No.	Category	Revenue from Building Permit	Budget Allocation	Code(S3) Score out of 5
E3.1	1	100,000 - 1,000,000	<25000	0
			25,000 (2.5%)	1
			25,000-50,000	2
			50,000-100,000	3
			100,000-150,000	4
			>150,000 (15%)	5
	2	1,000,000 - 5,000,000	<50,000	0
			50,000-100,000	1
			100,000-200,000	2
			200,000-300,000	3
			300,000-500,000	4
			>500,000	5
	3	5,000,000-10,000,000	<50,000	0
			100,000-200,000	1
			200,000-300,000	2
			300,000-500,000	3
			500,000-800,000	4
			>8,00,000	5

A survey questionnaire was used to collect data from 29 out of 30 BCIPN municipalities (Fig. 1). Various modes of communication such as telephonic conversation, emails, in-person interviews and exploratory visits to municipalities etc. were used for the data collection.

The assessment was done in three phases: at the initial phase before the implementation of BCIPN program (2012, Baseline), at the mid-term of the program implementation (2014, Midterm); and then towards the end of the BCIPN program (2016, End line) to measure the change in the status of building code implementation in the municipalities.

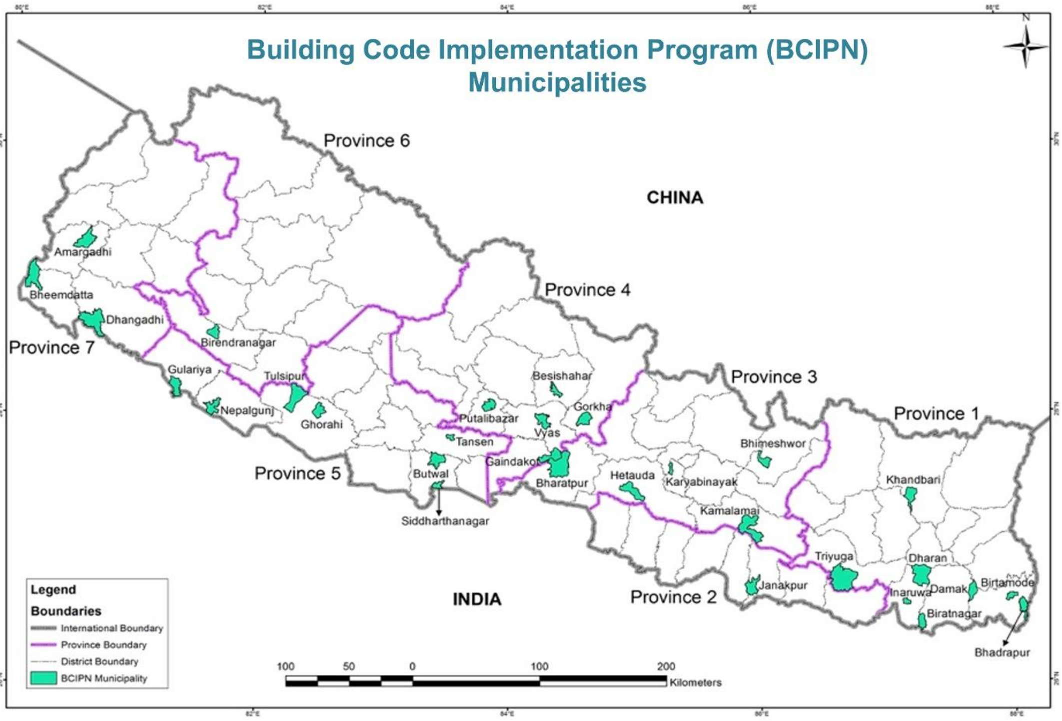

Fig. 1 Map showing the BCIPN program municipalities

3. Evaluation of BCI Status in the municipalities

The overall status of BCI, was calculated as per the methodology described above, in all 29 municipalities in the different years and evaluated the changes/progress overtime. Table 4 and Figure 2 show the overall score and changes of status over the years.

It was observed that there has been significant improvement in the capacity of municipalities towards implementing building code over the years (Fig 2). Of the three major elements of BCI Status, the Institutional System (S1) has had a greater change than the other two components. The value increased from 6% to 68% for Institutional System, 17% to 49% for Technical Capacity and 14% to 43% for Budget Allocation.

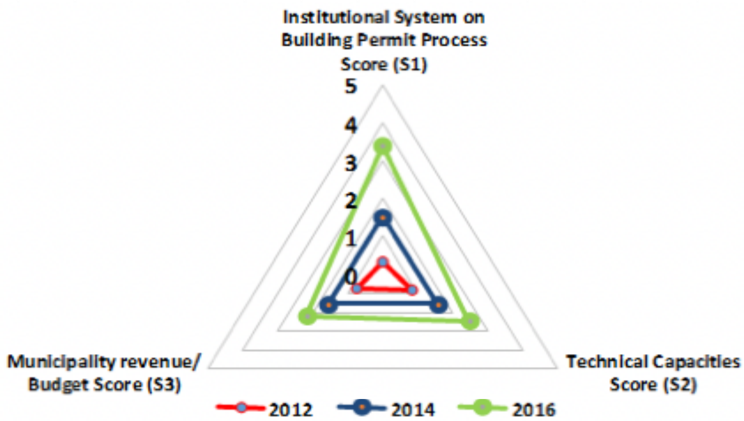

Fig. 2 Average scores for BCI status in the municipalities in the year 2012, 2014 and 2016

Table 4: Average scores and change of status for BCI in the municipalities in the year 2012, 2014 and 2016

Year	**Institutional System (S1)**		**Technical Capacities(S2)**		**Municipality revenue/Budget (S3)**	
	Value	Proportion (%)	Value	Proportion (%)	Value	Proportion (%)
2012	0.30	6%	0.84	17%	0.72	14%
2014	1.52	30%	1.56	31%	1.55	31%
2016	3.41	68%	2.47	49%	2.17	43%

3.1 Results for Element 1: Institutional System

It was observed that the score for the Institutional System has increased from an absolute score 0.30 out of 5 in 2012 to 3.4 in 2016, corresponding to an increase from 6% to 68% during that period (Table 4). The key indicators contributing to the rise in the institutional system score were presence of dedicated technical staff /separate earthquake safety unit, requirement of structural drawing for all building classes, use of detail checklist for building code compliance check and provision of field inspection for structural details.

The number of program municipalities having a separate earthquake safety unit, or a dedicated technical staff has increased from 5 in the year 2012 to 22 in the year 2016. However, there are still several municipalities without any dedicated technical staff for building code implementation. Similarly, by 2016 the municipalities have established a system where structural drawings are required for all building class. Out of the 29 municipalities, 28 municipalities have established the system. Before the start of the program only one municipality i.e. Dharan Municipality had started the system of use of detail checklist for building code compliance check which included building configuration, building strength and building ductile detailing and also had initiated the provision of field inspection for structural details: i) foundation, ii) Plinth level, iii) storey structure. There was some increase in number in the year 2014 and now almost 75% of the municipalities have initiated the system. Further in the recent years, all of the BCIPN municipalities have started a system of registration of masons and have been maintaining a roster of trained masons. The process has been initiated in all of the 29 municipalities. The vast majority of municipalities still do not have any provision for strengthening of existing buildings/ retrofitting (for example, during the construction of an additional storey). Only three of the municipalities have begun to do so, and even there a fully functional system has not been established.

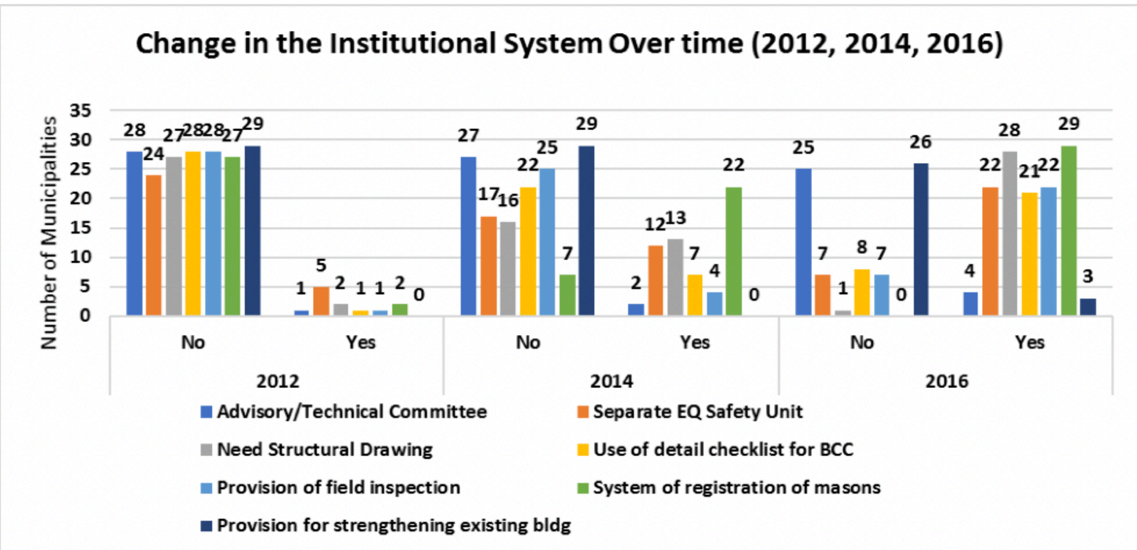

Fig. 3 Change in the Institutional System for BCI in municipalities

3.2 Results for Element 2: Technical Capacities

In regard to the second element measuring technical capacity within the municipality, municipalities still scored lower though the score did increase from 2012 to 2016. The number of new buildings constructed per year in the municipalities has been increasing even as the municipalities lack sufficient technical human resources (engineers, masons) to carry out safe construction. Overall 29 municipalities surveyed, the S2 score rose from 0.84 (17%) in the year 2012 to 1.56 out of 5 (31%) in the year 2014 and 2.47 (49%) in 2016, clearly shows that demand still exceeds capacity in Nepal.

While municipalities have set up and conducted a number of training programs for masons, engineers and other professionals, that increased the number of trained technical workforce in the municipality, the demand still exceeds the supply. There are still not enough trained construction professionals to fulfil the ever-growing rate of construction.

On an average, there are just two to three engineers in municipalities while the average number of buildings constructed is more than 500 per year. It is estimated that for every 100 buildings there has to be at least one engineer in the municipal office for ensuring safer construction. Therefore, for nearly 600 buildings there has to be at least six (6) engineers in the municipal office, but the available engineer is only two to three. This clearly shows that the average number of engineers available in the municipality office is not sufficient as per the number of building construction in the municipalities. In addition, in some of the municipalities there is just one sub- engineer and in some there is not a single engineer to look after the construction process. It was observed that the number of available engineers as per the number of buildings constructed in that municipality is also not sufficient.

3.3 Results for Element 3: Municipality Revenue/ Budget Score

The revenue generated from the building permit process is a source of income for the municipalities and there was no system in most of the municipalities to allocate certain amount from the collected revenue to support for the building code implementation process, such as budget for conducting capacity building and awareness programs. Recently, after the implementation of BCIPN program and through continuous advocacy and interactions with the municipalities, the municipalities have now started allocating some amount from generated revenue for a budget to support the BCI activities in the municipalities.

The increased allotment of a dedicated budget for the BCI process was observed during the survey. The municipalities started allocating some budget for the implementation of building code. Overall, S3 representing budget allocation increased from 0.72 out of 5 (14%) to 2.17 (43%). There was almost no provision or minimal provision of allocating budget for implementing BCI. Less than 2% of the budget generated from revenue was allocated to building code implementation in the year 2012 which has increased up to 4-5% over the years.

3.4 Test of Statistical Significance for the Difference in BCI Scores in 2016 compared to 2012

The statistical significance for the difference in Institutional System (S1, S2 & S3) scores between 2012 and 2016 was examined using the Wilcoxon Signed Rank Test as the assumptions for paired samples t-test were not satisfied. However, it is important to note that using Wilcoxon Signed Rank Test, the decision is made for median values of the data sets, and not the mean, by computing ranks of each score.

The assumptions for the test used were examined before running the analysis.

Accordingly, we proceeded with the following hypothesis:

Null Hypothesis, H_0: The median of the differences between two set of ranks equals zero.

Alternative Hypothesis, H_1: (Median S1, S2 and S3 Ranks) 2016 are statistically significantly higher than (Median S1, S2 and S3 Ranks) 2012

Based on the output of the statistical analysis it can be concluded that the median S1 ranks for 2016 were statistically significantly higher than the median ranks for 2012. Also, since the test was run because the data was skewed, we may conclude that mean S1 scores (3.4±1.1) in 2016 were statistically significantly higher than mean S1 scores (0.3±0.9) in 2012, Z= -4.73, p<0.00; an improvement of 3.1±1.3.

Similarly, the mean S2 scores (2.5±0.8) for 2016 were statistically significantly higher than the mean S2 scores (0.8±0.8) for 2012, t (29) = -12.7, p<0.00; an improvement of 1.7±0.7. And the median S3 ranks for 2016 were statistically significantly higher than the median ranks for 2012. Also, since the test was run because the data was skewed, the result implies that mean S3 scores (2.2±0.9) for 2016 were statistically significantly higher than mean S3 scores (0.7±0.9) for 2012, Z= -4.39, p<0.00; an improvement of 1.4±0.9.

3.5 Establishing Relations Between Different Contributing Factors Of BCI

Over the years' experience of working in building code implementation in the municipalities of Nepal, three different factors; Increased level of awareness on safer construction; Enhanced capacity of the construction workforce and; Improved system and process in the municipalities for building code implementation has been identified as the key contributing factors for effective building code implementation. The study therefore tried to find/establish the interlinkages between these three factors if there is any.

To understand the influence of change in risk perception(increased level of awareness); influence of improved system/status and capacity of the municipalities to the change in building code compliance, different studies were conducted in the 30 municipalities of Nepal under Building Code Implementation Program in the municipalities of Nepal (BCIPN) being implemented by NSET.

Improved system and capacity of municipalities was assessed by measuring the observed change in the status of Building code implementation in the municipalities over the years as described above.

Change in the level of risk perception of the house-owners was assessed by measuring knowledge on earthquake risk, their attitude towards existing risk and their behaviour for risk reduction. Household level samples were administered in the different wards across municipalities during the year 2013 -2015. Later in the year 2016, the municipalities were revisited and the change in perception was measured. It was observed that there has been a notable increase in the practice scores (31 in the End line Vs 20 in the Baseline) and Knowledge scores (54 in the End line Vs 47 in the Baseline) of people in the surveyed municipalities over the years.

And finally, the success in achieving building code compliance was measured by assessing the code compliance expressed in the quality of the drawings submitted, and more significantly, in the way the building is actually constructed on site. An elaborate methodology for evaluating code compliance was developed based on study and analysis of the building plans and designs submitted to the municipality by the homeowner and field inspection of the actual building constructed on sight. Elaborate criteria were developed which ultimately helped evaluate three major attributes of vulnerability, namely, building configuration in plan and elevation, strength of the building elements and materials and the ductility of the structural elements. Weights were assigned to the individual criteria to make a cumulative total of 100 with the scores of less than or equal to 20 considered as compliant, score more than 20 and less than or equal to 30 as partially compliant and scores over 30 considered non-compliant. The buildings designed and constructed in three time periods, namely, 2012 (2068-2069 Bikram Era), 2014 (2070-71) and 2016 (2071-72 Bikram Era) were analysed separately. The result showed significant change in compliance expressed in the quality of the drawings submitted along with the building permit applications and, more significantly, in the way the building is actually constructed on site.

Thus, all these factors; level of risk perception, improvement in the system and capacities of the municipality together with the level of building code compliance were measured and assessed for establishing relation among them. Significant relation between these factors was observed. It was observed that level of building code compliance increased significantly as the level of risk perception enhanced and change in the municipal systems of building permits and building code implementation was observed (Fig 4).

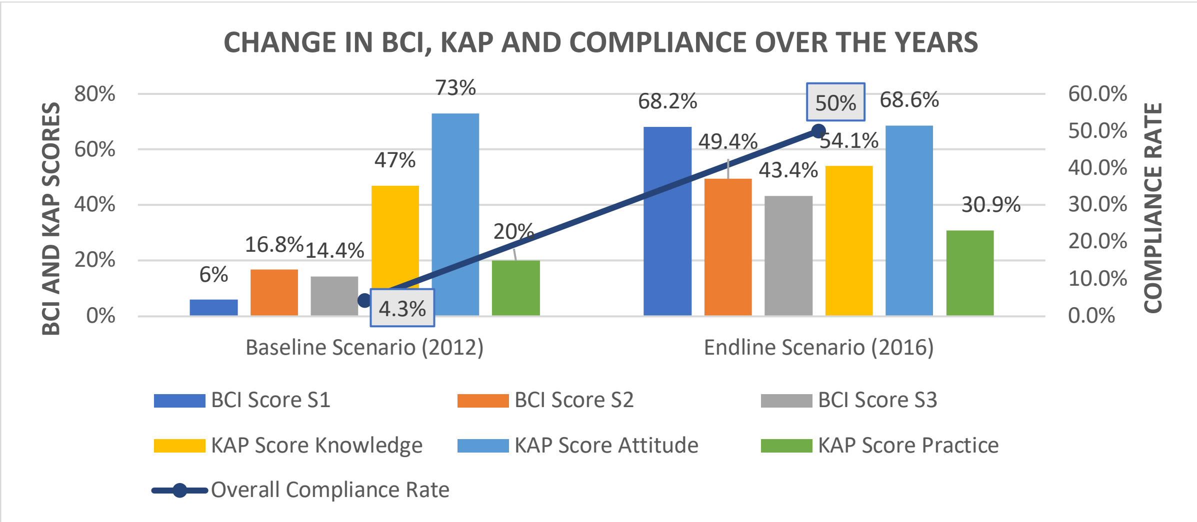

Fig. 4 Relationship between BCI Score, KAP Score and Compliance Score

This indicates that the municipalities in Nepal will be able to enhance the seismic performance of new buildings if they are provided with technical assistance for capacity enhancement and for improvements in municipal institutional structure as well as in municipal policy and legal environments.

4. Conclusions and Recommendations

The Building Code Implementation Program in Municipalities of Nepal (BCIPN), which was implemented in 30 municipalities of Nepal, has been instrumental in providing technical support to municipalities and has helped them increase the effectiveness of their building code implementation systems. The technical support consists of 1) awareness-raising of populations on possibility of safer building construction, 2) building capacities of construction stakeholders i.e. masons, technicians, contractors, municipal engineers through training courses, and 3) improving institutional systems of municipalities to implement the code.

The Building Code Implementation Status Survey was carried out to measure the status level of each municipality in terms of creating an effective building permit and code enforcement system. The BCI Status was defined as a score of 15 (5 each in all 3 elements identified).

Of the 29 municipalities surveyed, substantial progress was seen in most of the municipalities over the assessment time period. Overall, the 29 municipalities started in 2012 with an average BCI Status Score of 1.9 (out of 15) and by 2016 they had increased to an average of 8.1.

Looking at the three major elements of BCI: Institutional System; Technical Capacity and Budget Allocation, establishment of Institutional System increased more than the other two elements. Further, in the recent years, all of the BCIPN municipalities have started a system of registration of masons and have been maintaining the roster of trained masons. The process has been initiated in all of the 29 municipalities. While there have been substantial changes in most areas, still much needs to be done. Most municipalities still don't have any provision for strengthening or retrofitting of existing buildings; only three of the municipalities have taken the initiation in this area even they still lack a fully functional system of existing building review.

The number of new buildings constructed per year in the municipalities has been increasing, but the number of human resources (engineers, masons) in the municipalities has not kept pace. While there has been a number of training programs for masons and engineers in the municipalities, conducted by the municipality and other organizations, and while these programs have increased the number of trained technical workforce in the municipality, their numbers are still not enough to fulfil the ever-growing rate of construction. Within the municipal office, there are just 2-3 engineers (average) to look after the construction while the average number of buildings constructed is more than 600 per year.

The revenue generated from the building permit process is one of the major sources of income for most of the municipalities. However, there was no system in most of the municipalities to allocate appropriate budget to support aspects of the building code implementation process, such as budget to conduct capacity building training and awareness programs. Recently, after the implementation of the BCIPN program and through continuous advocacy and interactions, municipalities have now started allocating some budget for supporting BCI activities.

Readiness to accept changes, strong leadership role, and positive attitude of the municipality and continuous support of BCIPN program had made possible to achieve this change.

While the BCIPN program has contributed to change in the perception of municipalities about building code implementation: Earlier, officials and staff at municipalities used to think that Building Code Implementation is a very difficult task, and they were very much reluctant to initiate the process. However, now most of the municipalities think BCI is possible and very much needed to ensure life safety of the population. BCI is possible with little additional efforts. There is a major change in perception of municipal staff.

Many positive changes has been observed through years towards building code implementation in the municipalities. It was further observed that level of building code compliance increased significantly as the level of risk perception enhanced and change in the municipal systems of building permits and building code implementation was observed.

The BCIPN program implemented during 2012-2017 has thus been instrumental in making remarkable progress and achievements and provides key inputs in paving future course of action.

Municipalities have expressed that the approaches and focus of technical support have been very useful and could motivate municipalities to continuously work toward ensuring safer construction through building code enforcement. The approaches and activities need continuation in the current municipalities and expansion to all other municipalities.

4. Acknowledgements

This paper is prepared based on the study of various surveys conducted by NSET as a part of monitoring and evaluation component of BCIPN program in the municipalities of Nepal implemented by NSET with funding support from USAID/OFDA. The work was carried out with the involvement of municipalities,VDCs, community health mobilizers/volunteers, local communities, the BCIPN program team and the M&E team. We acknowledge the continuous support of USAID/OFDA and all the municipalites, institutions and people involved during the study.

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