

Case study Report

on

Study of the impact of lighting intervention in historic and touristic city of Nepal



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Location: Bandipur, Nepal
Pokhara, Nepal

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Study of the impact of lighting intervention in historic and touristic city of Nepal

Nepal is an ideal destination for individuals who value an experience of culture, adventure, mesmerizing scenarios and variety of architecture. Tourism is one of the major sources of income to Nepal so it is necessary to promote the tourism sector. One possible means could be proper lighting.

Lighting carries an important role in the biological and physical aspects of human beings. Light gives the possibility of perceiving what surrounds them. Lighting has a huge impact on architecture. Lighting can bring an emotional value to architecture. People may experience and understand the same architecture differently with different lighting. Good lighting is one of the key factors in enhancing the beauty of any object or scenario. So good lighting is a must in tourist destinations. That is why it is necessary to study the current scenario of the tourist destinations lighting and give the suggestions and solutions to improve the lighting scenario. So, the study is done in two tourist destinations.

One of the selected sites is Bandipur which is one of attractive hilltop towns, located in the Tanahu district. Because of its intact traditional, cultural, and aesthetic values, it has been recognized as a tourist attraction at the current dates. Realizing this, Bandipur was chosen to investigate the present lighting practices in the area.

Another case study site is Pokhara, a city full of natural beauty. The stunning view of himalaya ranges, lakes, caves, exotic adventures it offers lists it as the tourism capital of Nepal. The number of tourists visiting Pokhara gradually increases every year. Pokhara is also famous for its beautiful night life. Considering these facts Pokhara was also selected for our case study.

1. Objectives of the study

Main objectives of the study are as follows:

- To study the present condition of the lighting schemes of the tourist destinations.
- To study the problems associated with lighting in the site and recommend the possible solution accordingly.

2. Methodology

Case studies of lighting in tourist areas were done through a one-week long site assessment. For that, Bandipur and Pokhara were selected as Pokhara is known as the capital of tourism of Nepal and Bandipur is another hot tourist destination with the cultural importance on the way to Pokhara. For the study following methods were used:

2.1 Questionnaire

Stakeholders were categorized into two groups for survey. One is locals or businessmen and another is visitors/tourists. Target groups were categorized based on their affiliation, influence, and utilization of the selected sites. The question sets were categorized into three groups based on the nature of the questions and the target audience. Set I consisted of general questions pertaining to personal information comprising lighting technology, lighting effects and their choices that were common to all target groups. Set II incorporates the lighting schemes, intervention in the site which was again common for all the target groups and Set III was directed only for the businessmen and local residents which incorporates the effect of lighting in their social activities and economy.

2.2 Observation and Measurement

Lighting conditions in the site were observed for both, the day time and night time. Situations and problems associated with lighting were observed and noted. Illuminance was measured and recorded during the night time of different spaces in the site. Tools used for the purpose were as follows

Lux meter: Lux meter is used to measure the total luminous flux incident on a surface per unit area. LMT Pocket- Lux 2 was used for the measurement of the illuminance at different spots.



Figure 1: Lux Meter

Luminance Camera: Luminance camera is used to measure the intensity of the light emitted from the surface per unit area.

Videos and Photos: Pictures and videos of the luminaire arrangement, lighting orientation, glares produced were clicked at several spots.

For Bandipur, four different spaces were chosen for the illuminance observation and measurement namely: Main Street, Bindabasini Mai Temple, Alley to Tindhare and Tindhare. Total 20 people were interviewed out of which 12 were locals/businessmen and 8 were visitors.

For Pokhara, five different spaces were chosen for the illuminance observation and measurement namely: Main Street, Lakeside, Disneyland, Street 17, Sub Street to Lakeside from Hallanchwok and Gupteshwor Cave. Total 37 people were interviewed out of which 18 were locals/businessmen and 19 were visitors.

3. Findings

The following are the findings from the questionnaire survey, observation and measurement at different sites.

3.1 Findings from the Questionnaire survey

The questions of three sets were presented to the respondents at each site. The total responses are less than the sample size where participants couldn't answer the questions properly.

3.1.1 Response of survey questionnaire Set I

This set incorporates the general knowledge and preferences about lighting technology. The associated graphs are presented in figure 1 and figure 2.

Bandipur

1. The majority of artificial lighting implementations used electrical power. Almost all (95%) used electrical, and few(5%) made use of both electrical and fuel-based.
2. The majority of artificial lighting is used for indoor illumination followed by usage for outdoor and special occasion lighting. Significant number of people use it for message display and decorative purposes also.
3. LED light sources have significant dominance over other sources. CFL and fluorescent lamps are most popular after LEDs. People were confused about whether the type of light they used was either CFL or LED.
4. Most of the respondents preferred an illuminance level of moderately bright matching the night ambiance and contrast. Too low and too high illuminance level was less likely their choices.
5. All of the participants were concerned about the effect of lighting on the environment to some extent.
6. More than half of the participants preferred the CT of the light source to be cool. It is the result of the popularity gained by CFLs at a time producing white light. Others were oriented towards warm lights.
7. Awareness about lighting pollution among the participants was almost the same for unaware and aware people. Mostly the visitors had an idea about it. Lighting pollution was a totally new topic for most of them.
8. The energy requirement of light sources was familiar with most of the participants and energy efficient light sources was confusing terminology for many. The time of the light source used was compared with the energy efficiency.

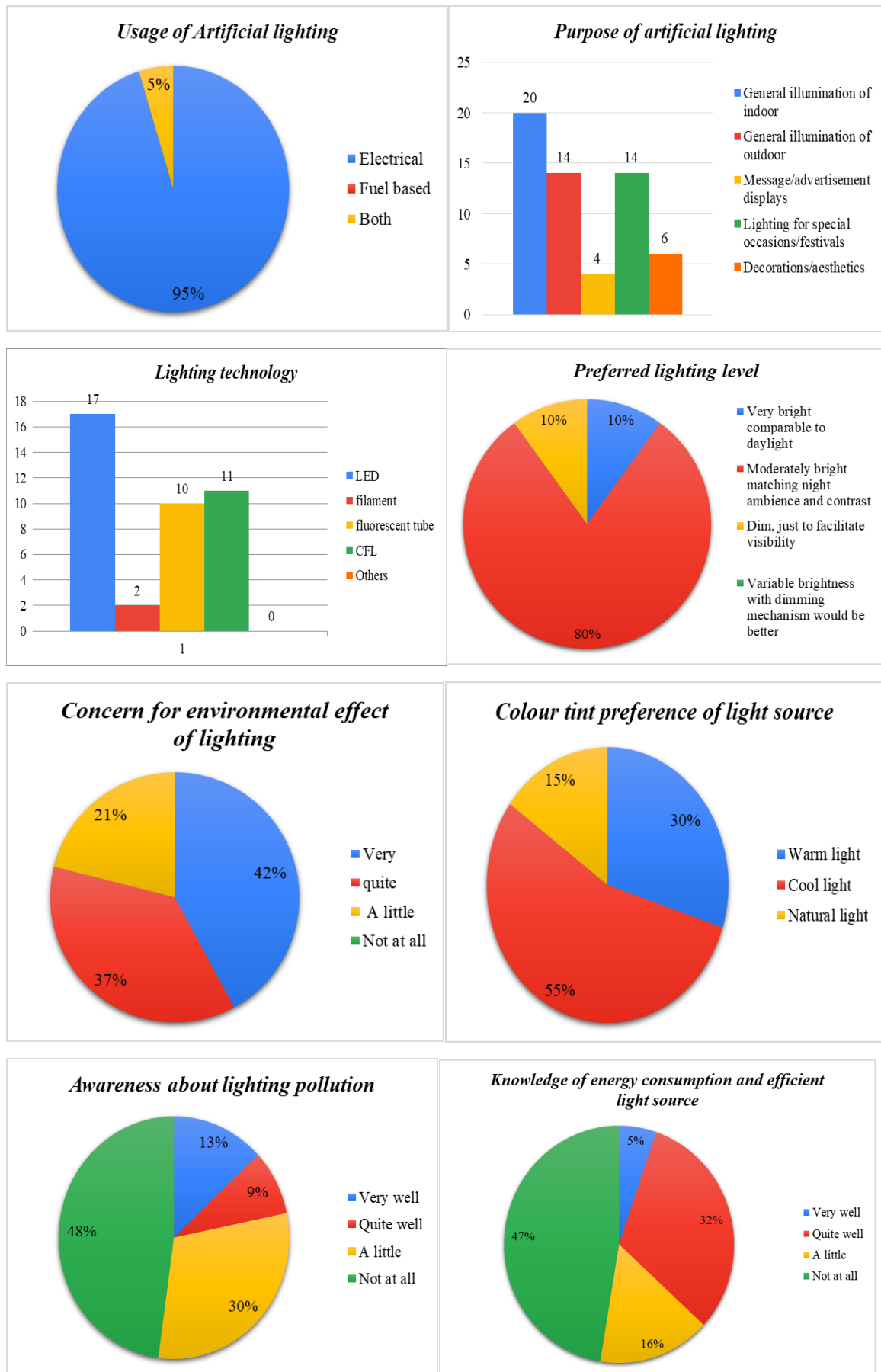
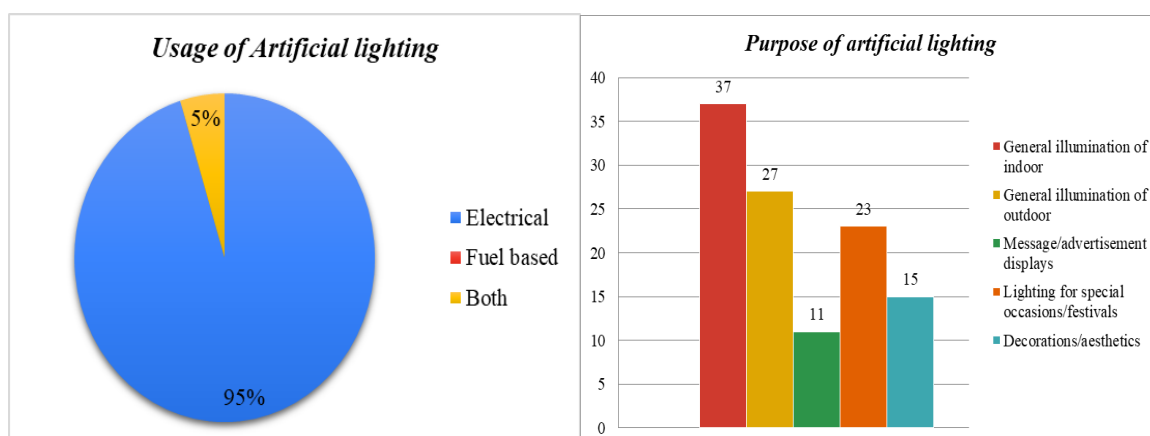


Figure 2: Graphical representation of questionnaire survey data of Set I (Bandipur)

Pokhara

1. The majority of artificial lighting applications used electrical power. Almost all (95%) used electrical, and few (5%) made use of both electrical and fuel-based.
2. The majority of artificial lighting is used for general indoor illumination followed by usage for outdoor and special occasion lighting. Significant number of people use it for message display and decorative purposes also.
3. The most preference of LED light sources was seen among both tourists as well as locals. CFL users were present to some extent also, but only too few were inclined towards the use of fluorescent or filament lamps.
4. A larger number of interviewees (48%) preferred moderate lighting with appropriate ambiance and contrast while a noticeable number of people (38%) liked high illuminance levels comparable to daylight.
5. Despite few (13%) every other respondent was concerned about the impact of lighting on the environment.
6. The preference of color tint (CT) of the light source is somehow uniformly distributed. However, the prevalence of cool light sources (>5000k) has a significant dominance on the quality and perception of light quality.
7. Many tourists seem to be quite aware of light pollution but the local businessman and residents were clueless (59%).
8. The majority of individuals were aware of the light sources' efficiency to some level. Use of energy efficiency seemed to be highly influenced by the government initiative to promote CFL and LEDs. But still one-fourth of were not sure about awareness of the energy - efficient light sources.



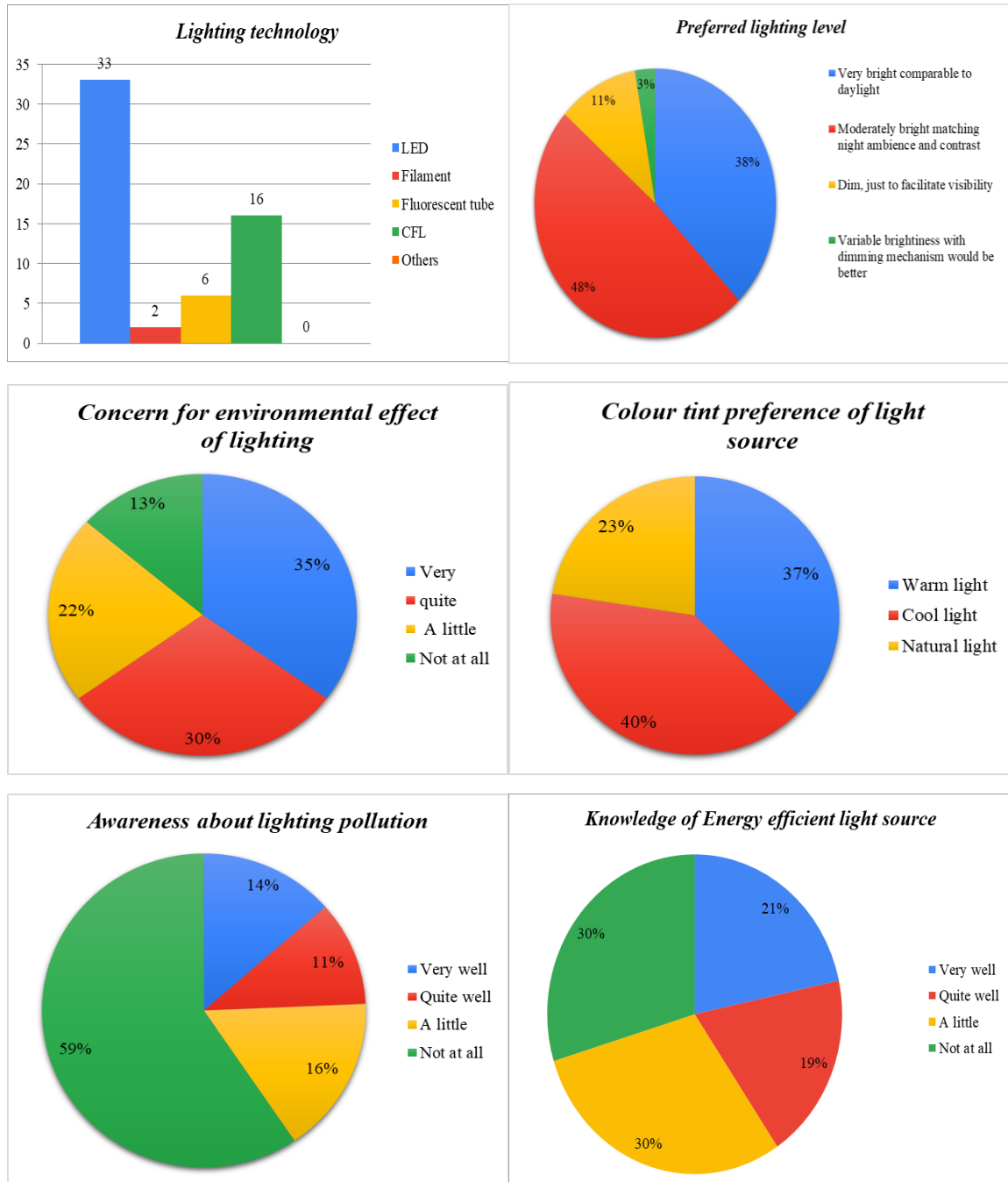


Figure 3: Graphical representation of questionnaire survey data of Set I (Pokhara)

3.1.2 Response of survey questionnaire Set II

Set II covers the responses to the questions linked with site illumination, tourism, and the lighting intervention in the site. The associated graphs are presented in figure 3 and figure 4.

Bandipur

1. The maximum number of visitors showed their strong will towards illuminating the Bandipur area for extended visiting hours till midnight while few didn't support the idea considering the night life of animals, birds and human work ability etc.

2. About 84% of the individuals were positive towards the use of artificial lights for lighting considering the enhanced beauty of Bandipur at night time also. The major concern of added artificial lights was the number of electrical wires added along and provision for emergency and safety purposes.
3. Difficulty in observing the monuments in the present scenario was pointed out by most visitors and few residents.
4. Almost more than half (60%) people found it easy to walk after sunset as well.
5. The ambience of the space after sunset was relaxing for most of the people whereas few showed unrelaxing attributes towards it.
6. Perception of glare in the area was mixed. Almost equal number of people observed glare in the area whereas others found it glare free.
7. People felt that the glory of the site might be affected by the intervention by the lighting while most visitors agreed the changes brought would be in the acceptable range.
8. Cool lighting was preferred for the area by most of the people. Even natural lighting seemed to be welcoming for quite a significant number as well. Tourists presented the idea of not adapting neon lighting in the area. Colorful lighting with proper proportions was also the choice for few.
9. Majority of the people were satisfied by the light fixtures available in the market considering its traditional values, modern fixtures were not entertained. Despite this, few showed interest in customized fixtures as well compared to other tourist destinations such as Pokhara.
10. The majority of people were enthusiastic about unique light fixtures like panas, diyos for the few temples while few didn't prefer such schemes considering the cultural beliefs.
11. Many interesting points were highlighted by the people in response to open questions seeking suggestions for the lighting of the tourist site. Some of the significant points are presented as follows:
 - Use of solar lights to save energy as well as add emergency lights.
 - Provision of more efficient and uniform street lighting.
 - Manage the extra wires added along with added luminaires.
 - All neighbors/ businesses should agree on uniform and consistent lighting and lighting fixtures.
 - Use of decorative or special lighting schemes during occasions.
 - Luminaires used should be of the same brightness and some are dim uniform lights are used.
 - Warm lighting should be used to preserve the originality.
 - Decorative lights at a few points for a good photographic view.
 - All the sites should be more comfortable from the light used.
 - Spot lights from the grounds or on the façade to embellish houses and the architecture.
 - Turn off lights after at least 2 am for animal tranquility and energy saving.

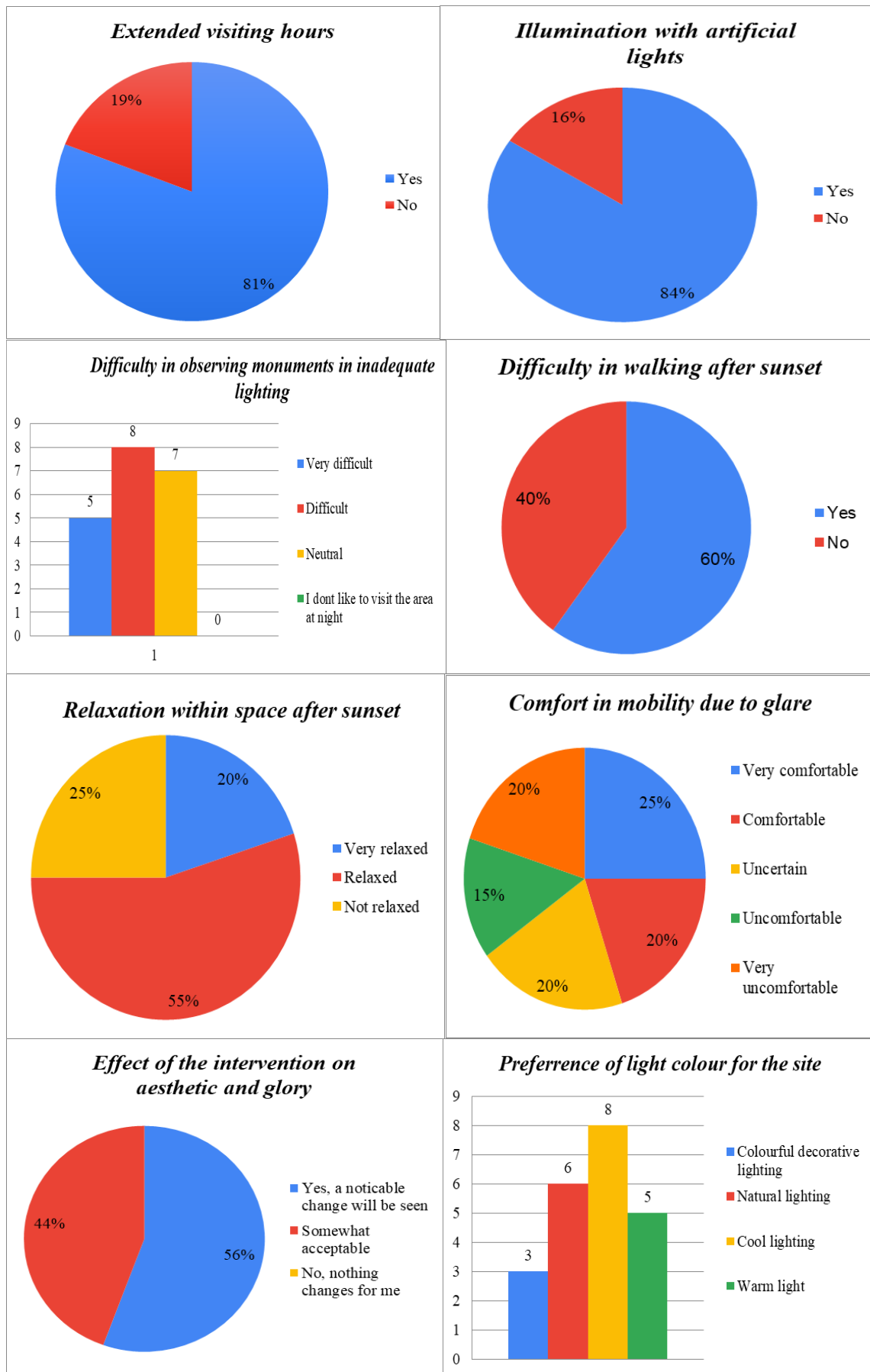
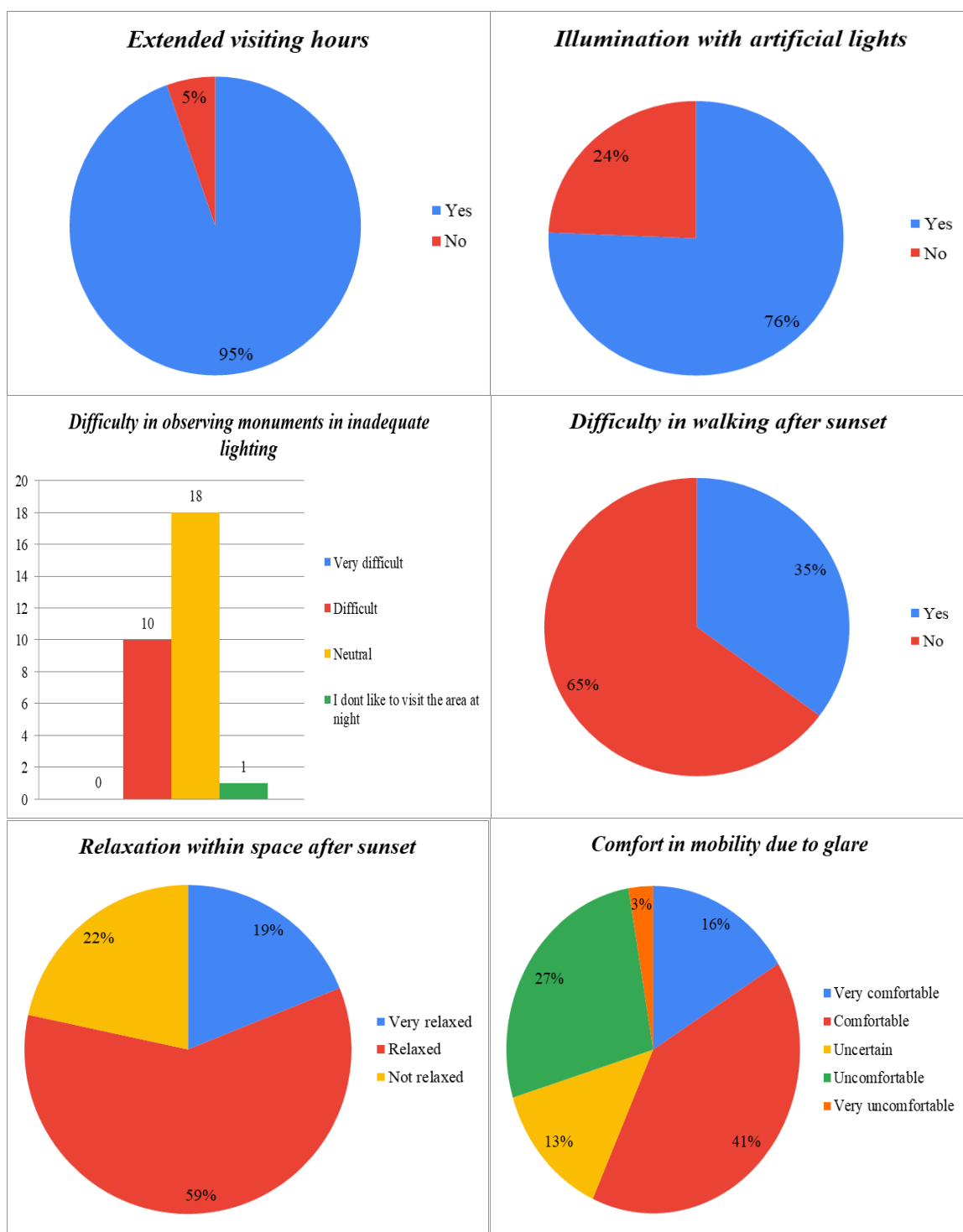


Figure 4: Graphical representation of questionnaire survey data of Set II(Bandipur)

Pokhara

1. The maximum number of visitors responded positively (95%) for illuminating the Bandipur area for extended visiting hours till midnight while few didn't support the idea considering the night life of aquatic creatures, human work ability etc.
2. Except one-fourth of the people, others were positive towards the use of artificial lights for lighting considering the enhanced beauty of Pokhara at night time also supporting the increased flow of tourists at night time also.
3. Difficulty in observing the monuments in the present scenario was not seen extensively as maximum people were neutral for this question.
4. Almost more than half (65%) people found it easy to walk after sunset as well.
5. The ambience of the space after sunset was relaxing for most of the people whereas few showed unrelaxing (22%) attributes towards it.
6. Very few people pointed out the issue of glare in the area that was disturbing them during mobility whereas most of them didn't notice such problems with lighting fixtures.
7. Almost equal number of people felt that the glory of the site might be affected by the intervention by the lighting and changes brought would be in the acceptable range. Few people were optimistic saying nothing would be changed.
8. With the concept of varieties provided by LEDs, cool lighting as well as was suggested for the area by most of the people. Even natural lighting seemed to be welcoming for quite a significant number as well. Colorful lighting with proper proportions was also the choice for few being Pokhara a tourist destination.
9. Majority of the people were satisfied by the light fixtures available in the market considering its traditional values, modern fixtures were not entertained. Despite this, few spoke in favor of experimenting with the customization of fixtures.
10. The majority of people were enthusiastic about unique light fixtures like panas, diyos for the few temples while few didn't prefer such schemes considering the cultural beliefs.
11. Many interesting points were highlighted by the people in response to open questions seeking suggestions for the lighting of the tourist site. Some of the significant points are presented as follows:
 - Government should be more concerned for the proper illumination.
 - Proper mixture of warm and natural lighting for the site.
 - Managed decorative lighting in the main street should be practiced.
 - Uniformity should be managed.
 - Lamps to be used around water areas should be of proper properties and managed.
 - Lightning should not hamper night vision of stars at night.
 - Safety lights should be installed.
 - The area needs to be illuminated for all the time except during daylight
 - Proper mixture of different colored lights should be used.
 - Glare should be reduced at places.
 - There should be efficient street lighting along with emergency lighting.

➤ Too bright lights should be avoided



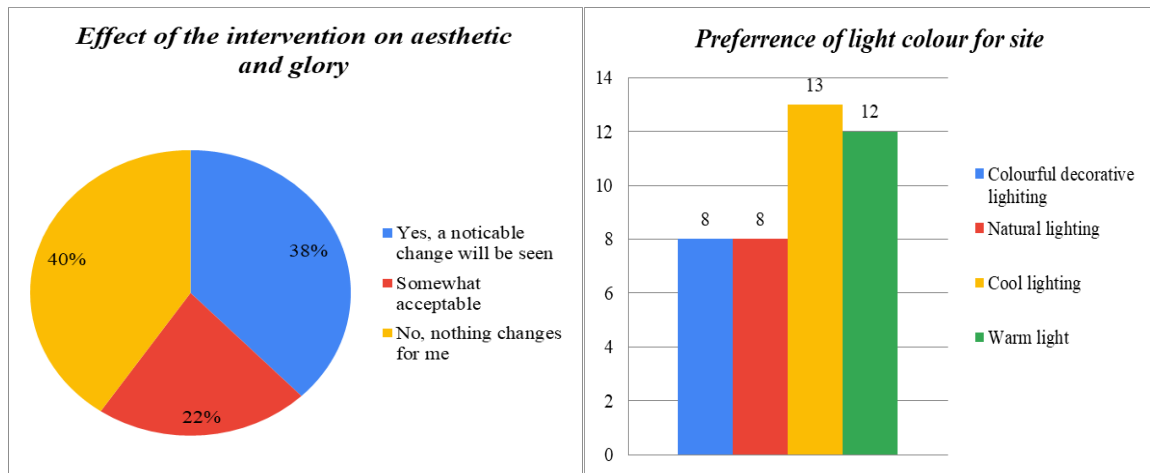


Figure 5: Graphical representation of questionnaire survey data of Set II (Pokhara)

3.1.3 Response of survey questionnaire Set III

This set is directed for local residents and businessmen and covers responses to the questions associated with social, cultural and economic aspects with the intervention of lighting on the sites.

Bandipur

1. There was 100% concurrence in the opinion of all regarding the positive effect on the neighborhood due to lighting of the touristic site.
2. The operating time of business peaked at 9:00 pm while few businesses were running till 11:00 pm as well.
3. Most (64%) of the business houses were willing to extend their operating hours until late at night if there were proper lighting arrangements and decent tourist flow while 36% were happy with their current working schedule.
4. All the local dwellers and business houses were confident about getting benefited by the lighting intervention at Bandipur. They put forward different reasoning to support their statement.
5. In response to the willingness to support the Municipality and concerned authority for the maintenance after installation, most (83%) were confident to support, and few (17%) were likely to support.
6. In response to the willingness to take responsibility for the safety of the lighting fixtures in the neighborhood after installation, all (100%) were positive to take the burden. Every individual seemed determined to have a sound lighting system in the area.
7. Most of the personnel highlighted the concept of durability of light fixtures while illuminating the area.



Figure 6: Graphical representation of questionnaire survey data of Set III (Bandipur)

Pokhara

1. There was almost 89% concurrence in the opinion of all regarding the positive effect on the neighborhood due to lighting of the touristic site whereas 11% disagreed to this point saying it would make the destination lose its natural importance.
2. The operating time of business peaked at 10:00 pm while few businesses were running after 11:00 pm as well.
3. Most of the business houses were willing to extend their operating hours until late at night if there were proper lighting arrangements and decent tourist flow along with the government provision while few were happy with their current working schedule.
4. All the local dwellers and business houses were confident about getting benefited by the lighting intervention at Pokhara. They put forward different reasoning to support their statement. The result highlights the awareness of people for the benefits of better lighting conditions.
 - Increment in sales and economic benefits for the business houses.
 - Scope for new entrants in the field.
 - Safer platform to relax in the environment.
 - Lifestyle upgrade and increase of recreational activities.
5. In response to the willingness to support the Municipality and concerned authority for the maintenance after installation, most were confident to support, few were

likely to support whereas few were not willing to help in any aspect saying it's the sole responsibility of the municipality.

6. In response to the willingness to take responsibility for the safety of the lighting fixtures in the neighborhood after installation, most of the people were positive, and few were reluctant to take any burden. Every individual seemed determined to have a sound lighting system in the area.
7. Equal number of people responded in favor and disfavor to the requirement of special provision for safety of the fixtures in the area.

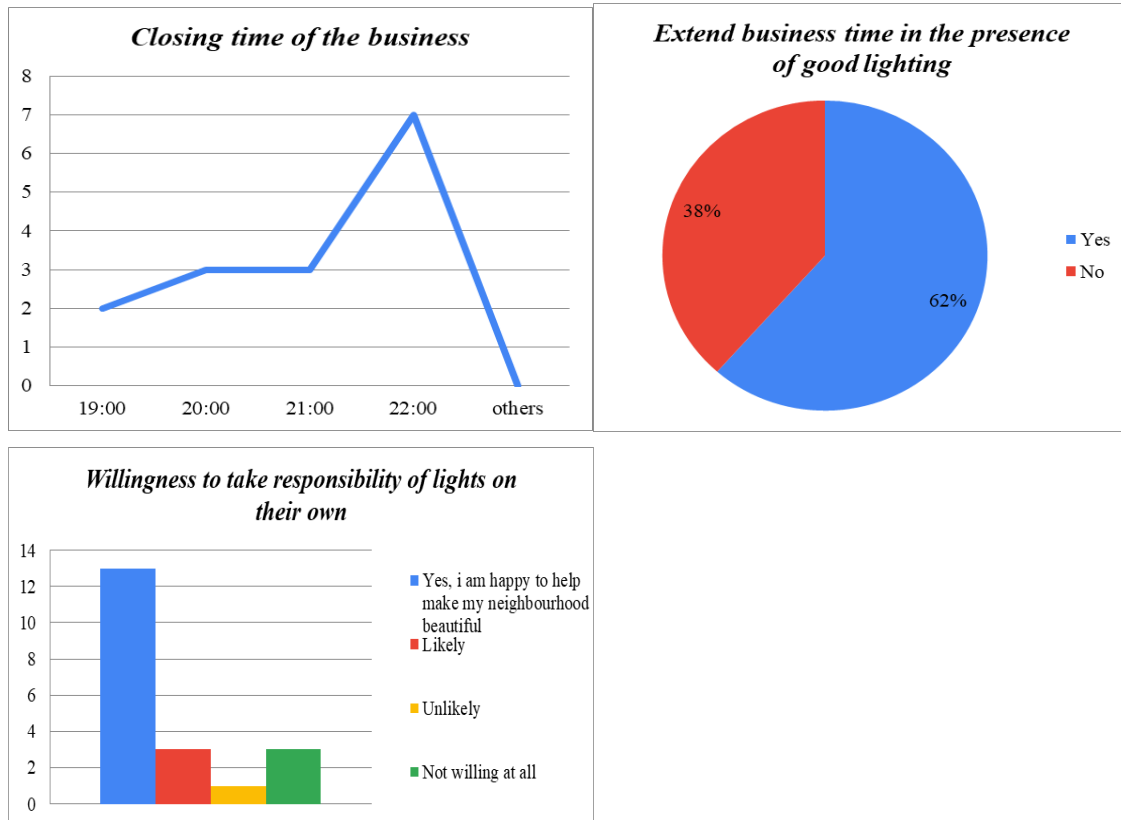


Figure 7: Graphical representation of questionnaire survey data of Set III (Pokhara)

3.2 Findings from the observation and measurement

Some issues and numeric values were found out from the observations and measurements at different spots of the sites.

3.2.1 Findings from Bandipur

Bandipur Main Street

1. Street is illuminated with the Post Top lights and the scattered light from the local businesses.
2. LED Post Top lights of the classical design with three light fixtures are used. Warm and cool lamps are mixed on them non uniformly.
3. Lights are not maintained as all light fixtures were not in working condition and some were dim.
4. No uniformity in the lighting distribution.
5. Glare is seen at some point by the lights used by local businesses.
6. Use of a wide variety of lights creating unpleasant visual appeal.
7. No provision of emergency lighting.
8. Overhead electrical cables were unmanaged, degrading the beauty of the street.
9. Illuminance:
 - a. $E_{\text{horizontal}} = 10.878 \text{ lux}$
 - b. $E_{\text{vertical}} = 13.45 \text{ lux}$
 - c. $E_{\text{max}} = 17.11 \text{ lux}$

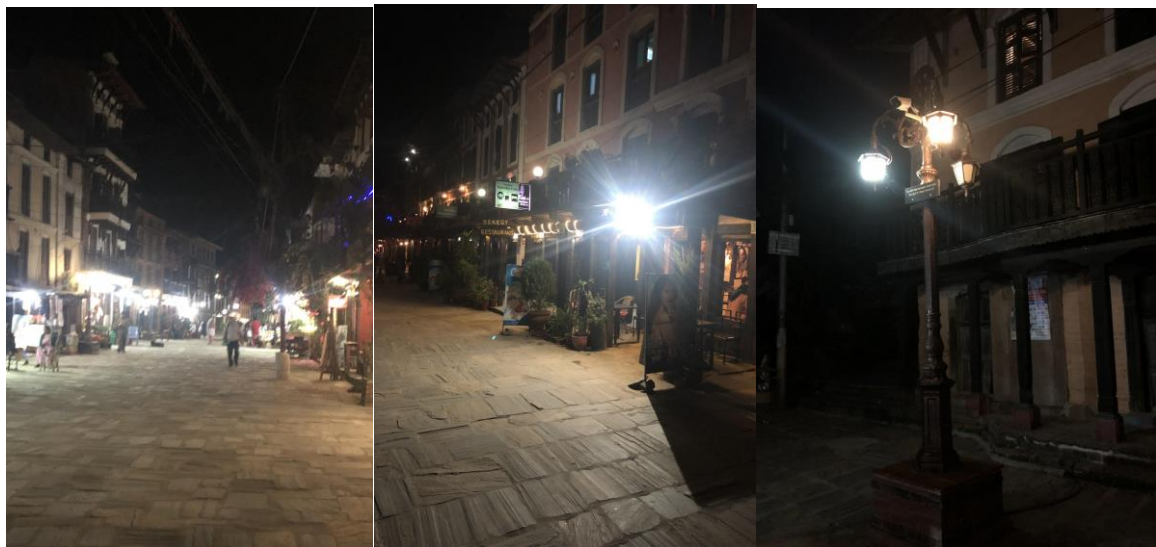


Figure 8: Main street at night time and Street Light

Bindabasini Mai Temple

1. LED bulbs were installed at the corners of the temple but were not in working condition.
2. No provision of emergency lighting and special lighting schemes.

3. As the lights were damaged, the architecture of the temple was not visible clearly. Temple was visible only because of the spilled lights from street lights and business's light.
4. Illuminance:
 - a. $E_{\text{horizontal}} = 0.43 \text{ lux}$
 - b. $E_{\text{vertical}} = 4.9 \text{ lux}$
 - c. $E_{\text{max}} = 4.9 \text{ lux}$

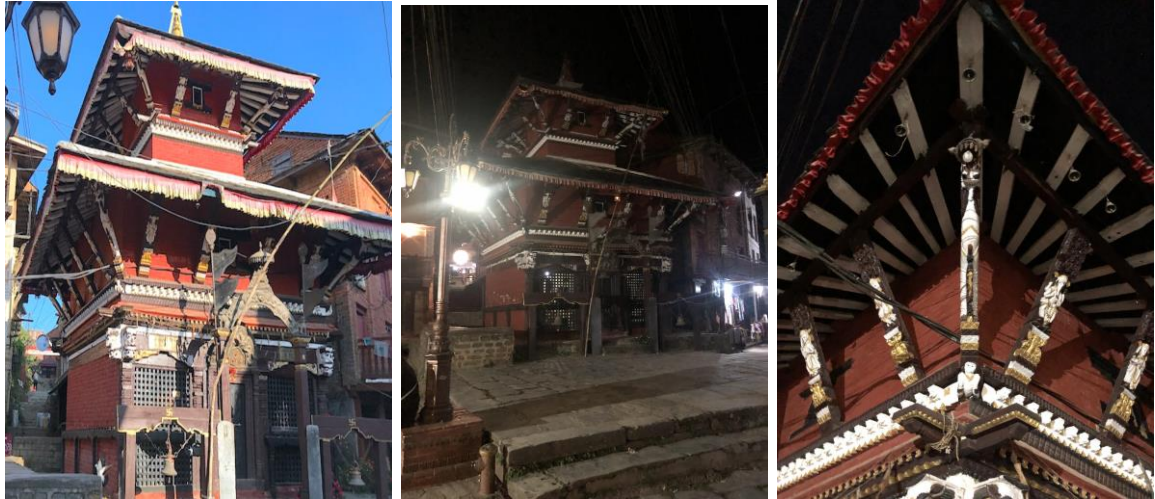


Figure 9: Bindabasini Mai Temple during day time and night time

Alley to Tindhare

1. There were no lighting schemes. Only one LED street light was working.
2. There were some light poles installed but most of them have no light fixtures while some installed lights were also not in working condition.
3. Too many dark spots.
4. Glare due to the only light working.
5. No provision of emergency lighting.
6. Illuminance:
 - a. $E_{\text{horizontal}} = 3.347 \text{ lux}$
 - b. $E_{\text{vertical}} = 2.36 \text{ lux}$
 - c. $E_{\text{max}} = 4.2 \text{ lux}$

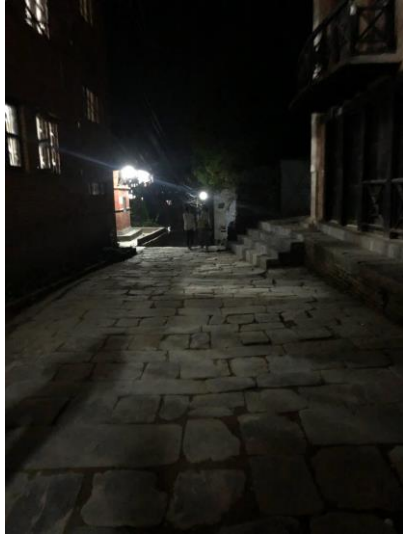


Figure 10: Way to Tindhare during night time

Tindhare

1. There were no lighting schemes. Only one LED street light was installed about 15m away facilitating dim visibility of the stone spouts.
2. No provision of emergency lighting.
3. Illuminance:
 - a. $E_{\text{horizontal}} = 1.2 \text{ lux}$
 - b. $E_{\text{vertical}} = 0.865 \text{ lux}$
 - c. $E_{\text{max}} = 1.67 \text{ lux}$



Figure 11: Tindhare during day time and night time

3.2.2 Findings from Pokhara

Main Street

1. Street is illuminated with the LED Street lights and the scattered light from the local businesses.

2. Lights are not maintained as all light fixtures were not in working condition and some were dim.
3. No uniformity in the lighting distribution.
4. Not enough light in the main road after the shutdown of all shops and local business during night time.
5. Illuminance:
 - a. $E_{\text{horizontal}} = 19 \text{ lux}$
 - b. $E_{\text{vertical}} = 23.5 \text{ lux}$
 - c. $E_{\text{max}} = 24.2 \text{ lux}$



Figure 12: Main Street during night time

Lake side

1. Street lights were placed at gaps of 25 to 30m.
2. Some of the lights were not working.
3. Local businesses have installed strip lights of different colors around their area which produce non uniformity in lighting distribution and glares at some points.
4. Since light from street lights is not enough, local businesses installed lamps of high wattage mounted with lower heights causing glare.
5. Use of various kinds of lights within the area.
6. Solar Lights were seen but not in working condition.
7. Illuminance:
 - a. $E_{\text{horizontal}} = 14.3 \text{ lux}$
 - b. $E_{\text{vertical}} = 13 \text{ lux}$
 - c. $E_{\text{max}} = 13.2 \text{ lux}$



Figure 13: Lake side during night time

Street 17

1. Street is illuminated with the LED Street lights and the scattered light from the local businesses.
2. Lights are not maintained as all light fixtures were not in working condition and some were dim.
3. Not enough light in the main road after the shutdown of all shops and local business during night time.
4. No uniformity.
5. Illuminance:
 - a. $E_{\text{horizontal}} = 9.3 \text{ lux}$
 - b. $E_{\text{vertical}} = 8.7 \text{ lux}$
 - c. $E_{\text{max}} = 9.1 \text{ lux}$



Figure 14: Street during night time

Street to lakeside from Hallanchwok

1. Street is illuminated with the LED Street lights and the scattered light from the local businesses.
2. Lights are not maintained as all light fixtures were not in working condition and some were dim.
3. Not enough light after the shutdown of all shops and local business during night time.
4. Very poor lighting.
5. Illuminance:
 - a. $E_{\text{horizontal}} = 8.9 \text{ lux}$
 - b. $E_{\text{vertical}} = 8.1 \text{ lux}$
 - c. $E_{\text{max}} = 8.4 \text{ lux}$



Figure 15: Street during night time

Disneyland

1. LED strip lights are used to define the feature of the gaming units which also provides the light for activities around.
2. Excessive use of colorful LED strip lights.
3. Post Top LED lights are used at some places.
4. Glares at some points.
5. No uniformity in light distribution.
6. Illuminance:
 - a. $E_{\text{horizontal}} = 15.8 \text{ lux}$
 - b. $E_{\text{vertical}} = 19.2 \text{ lux}$
 - c. $E_{\text{max}} = 19.1 \text{ lux}$

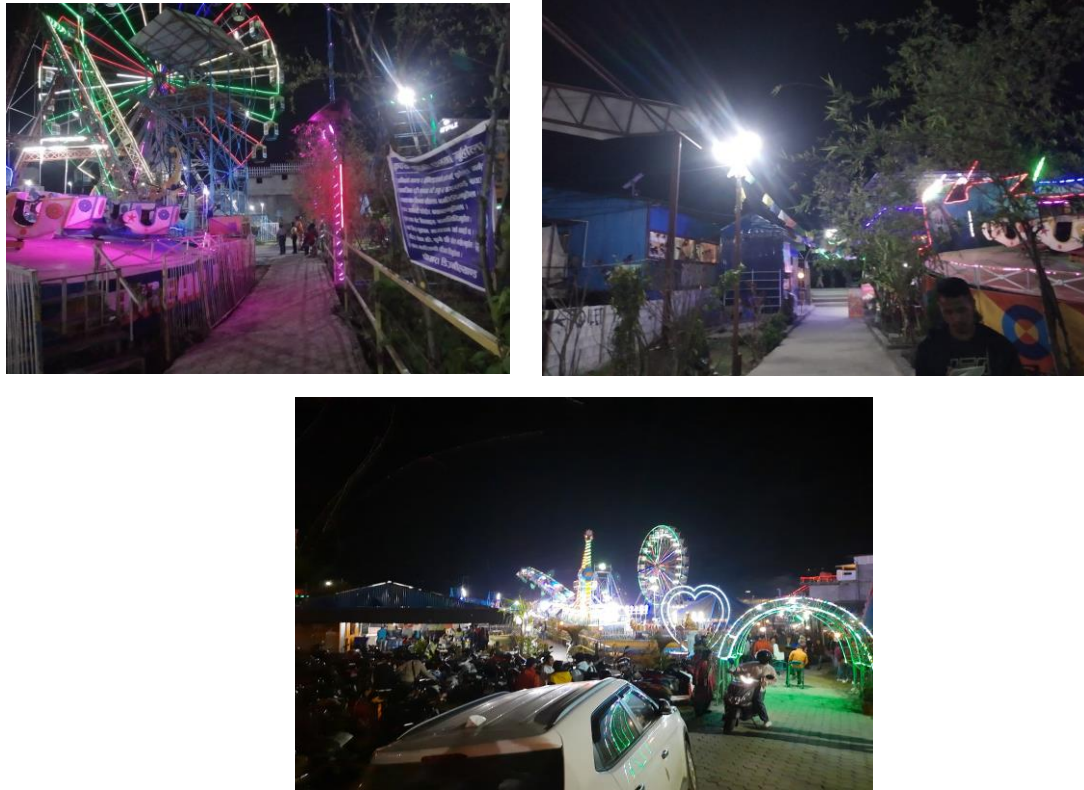


Figure 16: Disney Land during night time

Gupteswor Gufa

1. Site was moist and water was dripping.
2. Cool LED light bulbs were used.
3. Wiring was unmanaged leading to risk of short circuit, 220 V ac system was used.
4. Mounting height of the lighting fixtures was low.
5. Lighting installations produced glare at a lot of points disturbing the visibility.
6. Poor maintenance was seen as few bulbs were flickering.
7. Illuminance:
 - a. $E_{\text{horizontal}} = 15.6 \text{ lux}$
 - b. $E_{\text{vertical}} = 17 \text{ lux}$
 - c. $E_{\text{max}} = 17 \text{ lux}$

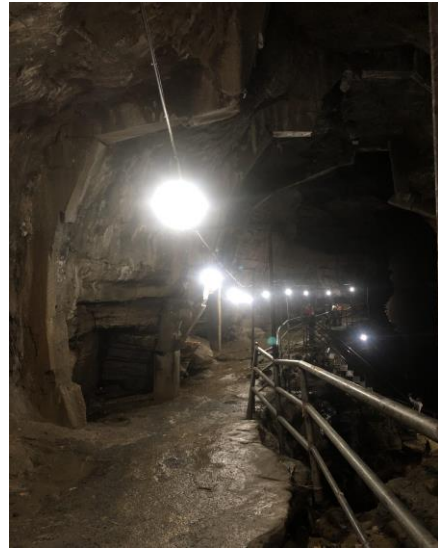


Figure 17: Gupteswor Gufa

4. Summary and Recommendations

Nepal is one the most chosen destinations by the tourists. Places such as Pokhara, Bandipur, Kathmandu, Bhaktapur, Chitwan tops the list. These places have the highest potential to attract the tourists all over the globe. Natural beauty of these places has the self-ability of alluring tourists at the day time but one of the crucial acts that can enhance the elegance of these destinations even at night time is lighting. Policies guiding the proper and effective lighting at these places is still an untouched field. There is a lot of scope of illumination in the development of the tourism industry. Pokhara and Bandipur are one of the prime choice destinations which are responsible for increasing the yearly flow of the tourists. Hence, a proper case study and recommendations for better lighting at these places is essential.

People are acquainted with modern lighting and few technical aspects. They understand the environmental impact of lighting, energy efficiency and color of a light source. But still there is a typical concept of lighting for just facilitating visibility that needs to be changed. The additional benefits of the modern lighting system influences people to support its intervention in the area.

Bandipur

1. Cool light and warm light shall not be mixed/ installed on the same post as it seems so mismatching and decreasing the beauty of the light fixture itself.
2. Damaged lights shall be replaced or maintained. For the effective maintenance of the light fixtures even locals shall take the responsibility of it.
3. Lights shall be installed such that it provides uniform light throughout the road avoiding glares and dark spots.
4. Wall washers can be used at the walls of the old traditional buildings to embellish its architecture.
5. Underground transmission lines would be best as they hamper the beauty of the traditional building.
6. For the temples and other heritages specialized lighting schemes need to be implemented.

Pokhara

1. Vertical illumination should be reduced for glare reduction. Warm lighting should be focused on relaxing area like near lake.
2. To avoid the improper lighting by the local businesses there should be regulations regarding the lighting so that the natural environment at lake side would not be disturbed.
3. Not only installation but maintenance shall also be taken care.
4. Waterproof (IP65 or above) lights should be used at places such as cave where problem of water dripping is prevalent.
5. Warm lights and spotlights should be used where the stone's gradient can be observed.
6. Caves should be illuminated with low illuminance (low brightness) lights.
7. Street lighting should be done with adequate span and durable LED lamps of enough brightness.