

STC 2019 QAI Conference

Research Paper titled
"QA Methodologies for Smart Lights:
A Tester's Perspective"

by Dr. Kiran Marri, Suganthi S, Karthikeyan Swaminathan, and James Mathew

was recognized among the Top 3 Papers in the
Best of the Best Testing Leadership Award category



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Smart Lights Growth and Trends

Smart lighting are illumination sources wherein one can control the light, usually draws less power, customize based on moods or themes, and well integrated & truly connected

'Smart Lights' Growth in this Decade...



Growth of 'Smart Lights' by Region (2019-24)



Indoor Smart Lights Deployment



LEDs use only 20-25% of electricity as compared to traditional bulbs, and last about 25 times longer Flipkart and Amazon have over 88 brands on smart lights varying from 1W to 20W and numerous color choices Highest adoption is predicted in Asia; More than 60% of outdoor lighting in APAC would be smart lights by 2023

Popular Customer Experience Needs

- Is the brightness of light as per the indented ratings
- Wi-Fi and its influence on light performance
- Are 'no shadow' is for real?
- Is there any difference in warm and yellow light
- Is there any flickering effect on LED lights
- Is my 18W LED truly 18Watts?
- Between Brand A 15W vs B 15W, what is the difference
- How does height of the roof impact the light source

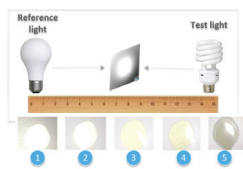
Scope of CX Testing

- Software**
- Color Consistency
 - Dimming Light Analysis
 - Brightness Test
 - Color Deviations
- Hardware**
- Network Interference
 - Flickering Analysis
 - Beam Angle Impact
 - Fluctuations

Experimental Methodologies for Various Customer Experience Based on Hypothesis Testing

Hypothesis: Light source under test has similar and/or equal brightness as the reference source

Experimental Test Setup



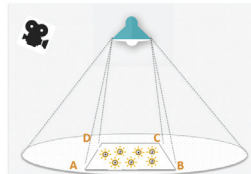
Crossover Point Analysis



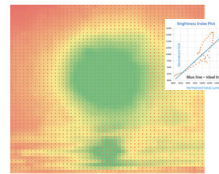
Useful method for verification | Crossover analysis can display variations and margin of errors

Hypothesis: Light source under test has equal spread distribution and as per specifications

Setup & Recording



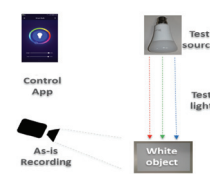
Normalized RGB Heat Map



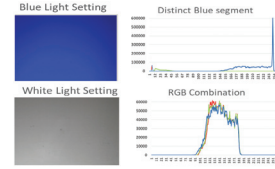
Provides the deviation of light source at heights | Accurate method to study intensity variations and flickering effects

Hypothesis: Colour tone settings are accurate and meets specification without any variations

Experimental Test Setup



Color Spectral Analysis



Minor flicker appeared on different tones | White light settings showed distinct differences | RGB analysis is critical in drawing inference

Key Results and Inferences

Wi-Fi have a major dependency on network connectivity due to concrete walls, and this is demonstrated using Meta-heuristic algorithm| Wooden & glass partitions have lower attenuation | Benchmarking with **reference source can detect +/-15%** deviations | **Color tone method** can measure 10-40% variations |With object & without object method is effective in comparative analysis

Learnings & Recommendations

- **Hypothesis testing** helped as this topic had many unknowns
- Experiments conducted are **exploratory by nature**
- Multi skill teams are effective for these complex projects wherein skills such as Computer Vision, Design Thinking, Machine Learning, Engineering & Physics are essential, apart from problem solving skills

References

1. Gardner, M.-A., Sunkavalli, K., Yumer, E., Shen, X., Gambaretto, E., Gagné, C., & Lalonde, J.-F. (2017). Learning to Predict Indoor Illumination from a Single Image. Retrieved from <http://arxiv.org/abs/1704.00090>
2. Goudarzi, A. R. (2018). Smart City by Smart Lighting: Utilizing Smart Lighting in Urban Texture Based on Effective Using of Power to Save in Macro Economy and Create Diversity in Cities. Trends in Civil Engineering and Its Architecture, 2(5). <https://doi.org/10.32474/TCEIA.2018.02.000149>
3. Johnsen, S., Kelber, A., Warrant, E., Sweeney, A. M., Widder, E. A., Lee, R. L., & Hernández-Andrés, J. (2006). Crepuscular and nocturnal illumination and its effects on color perception by the nocturnal hawkmoth Deilephila elpenor. Journal of Experimental Biology, 209(5), 789-800. <https://doi.org/10.1242/jeb.02053>