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Can Street Lights Aid in National Security?

Marcus Lloyde George
Ultimate Virtual Market Limited, San Fernando, Trinidad and Tobago

Abstract: National security is generally a concept that the institution of government, along with its many arms/components should protect the state and its citizens against all national crises through a variety of power projections. There are many elements of national security such as military security, political security, cyber-security, economic security, environmental security, etc. Threats to national security reside inside and outside of the boundaries of the country. Some of the internal threats are vehicular accidents, riots, criminal activities such as murder, robbery, assault, etc. Traditionally street lighting systems were used for provision of lighting to communities and on roadways especially for visibility purposes only. What if street lights could be used for improving national security? One innovative solution to maximizing national security is by development of a scalable smart street lighting system capable of maximizing national security in communities and roadways as well as minimizing operational costs. The system should be capable of communications with a central administrative unit for analysis and citizen awareness purposes. This paper discusses the use of street lights in impacting national security.

Keywords: Street Lights, Smart Street Lights, Street Lighting System, Road Lighting, Crime Reduction

1. Introduction

When one thinks of national security, cyber security, chemical warfare etc, one needs to go no further than the corner or center of every street. The street light has been a corner stone of national civilization since its inception proliferating uncontested, uncontrolled and unquestioned. It has transformed our species and allowed us to traverse the night safely. The modern street lights come out of the desire to feel safe in the dark. The widespread use of street lights is attributed to government's utilization of them as a safety measure for the population. After the inception of street lights, evidence disputing their effectiveness has arisen and has led to an academic debate lasting decades with no definitive answer. There is evidence for and against their use in the fight against criminal activity giving rise to the notion that they are situational rather than blindly lighting every nook of our cities they need to be controlled, as do all our technologies. This also lends to the other more holistic factors of national security such as the sociological, psychological physiological, environmental and even spiritual impact of street lights on our way of life.

The population may fear the unknownso when faced with the premise of illuminating the night sky with street lights they feel safer and assume that they are. During the 1980's the American government took an interest in this concept and began a street lighting campaign in several cities. Initial reports indicated good results, fear of crime decreased and crime also showed a decrease. However under closer scrutiny flaws in the studies of both theoretically and methodologically were realized [9]. It was assumed that street lights had no impact on crime after evaluation studies. A decade later in the UK the government attempted a similar street lighting scheme and the studies seemed to support their use with mostly positive results [7]-[9] [11] despite a few studies grossly contradicting them. It was generally accepted that street lights have a positive impact reducing situational crime while maintaining instances that it can have the opposite effect, increasing/aiding crime. Within the last two decades most studies support the notion that based on the context of the situation it can have positive and negative effects. Where lighting may assist criminal elements by highlighting individual targets or escape routes the street lights have had a negative impact [2]-[5] [16]-[24] [34]. When lighting aids citizens by dissuading attack, allowing better judgement of situations or increasing indirect surveillance through greater numbers of people active at night the lighting has had a positive impact [2]-[14][16]-[24]. Street lights are without doubt situational in impact and thus better control of lighting based on context can lead to improved results.

2. Overview of the Connection between Street Lighting and National Security

National security is generally a concept that the institution of government, along with its many arms/components should protect the state and its citizens against all national crises through a variety of power projections. National security involves the protection of citizens by the government from any ostensible threat through military, political, environment, economic and technological security. Street lighting much like its impact on crime has both positive and negative impacts on all these various arms of national security. Simply by

their presence on the street they increase a community's self-image, giving the impression of a more developed and invested area. This in turn can affect community cohesion, overall community satisfaction and impact crime and other societal factors via a sociological impact.

Moving away from crime another obvious point of street lights is accident prevention. There is no dispute that when introduced street lights reduced the number of road accidents and decades of research has supported this however they may be flawed [25] [45]. Most lights contend with glare, a main contributor to accidents and street lights are designed to minimize it. The main method of glare reduction is reducing the luminous intensity however street lights are designed to follow international standards and produce a fixed amount of illumination which is far above the required amount for adequate visual prowess [15] [33]. The design also fails to take into consideration environmental factors specific to an area such as overall temperature, humidity and even weather patterns. Creating a one size fits all for street lights fails to address the unique environment they operate in, a failure of modern design [33]. Drivers feel more inclined to exceed speed limits and pedestrians believe themselves to be completely visible and take more risk due to the presence of street lights [1][17] [44]. Even the spacing of street lights has an impact. Their unchanged and fixed luminescence can produce a physiological response, similar to light therapy, making drivers less aware of their surroundings and even producing a sleep response [29].

Ironically a sleep response is generated when driving through street lights but the opposite occurs for residence. The night time glare from street lights has been attributed to a reduction in melatonin which alters the sleep cycle of humans reducing the amount/ quality of sleep [30]-[32]. This in turn affects other physiological aspects such as respiratory, heart, neurological factors and in several studies weight gain and cancer and linked to the suppression of melatonin [26] [42]. Human beings aren't the only ones affected by street lights and it borders on absurd to consider it that way. Apart from the environmental impact from energy considerations of street lights most natural habitats even a great distance away from the street lights are affected [28]. The night time glare of street lights is capable of inducing physiological responses in plants that can affect the phenology, growth form and resource allocation [35].

On a larger scale of the environment it is wise to consider the energy consumption aspect of street lights which borders on the absurd. Globally street lights account for 114 terawatt hours of electricity every year, for a rough approximation, 400 times the electricity of New-York city [15]. The issue is much of this energy is put to waste, if there are no pedestrians, no cars and no activities outdoors at night the illumination and thus the energy is going to be wasted. This is a common case especially in residential and sub-urban areas where activity is near null after midnight yet the street lights remain on. Light Emitting Diodes (LED) technologies, which have been around for decades, even while on all night, can save upward of 60-70% of the operational cost when compared to the High pressure sodium street lights we use. Integrating control options such as dimming when not in use or even shutting the systems off as certain hours has the capacity to increase savings to over 80% [15] [36]-[38]. Most governments however are slow to adopt because of upfront cost, Return on Investment (ROI) periods and a lack of concern. The upfront cost of installing or refitting street lights with LED technology is fairly expensive when compared to the more commonly used high pressure sodium lamps but this does not take into consideration maintenance. HPS lamps need to be replaced every 4-5 years resulting in unpredictable and expensive operations while LED based lamps can last up to 20 years. Apart from the maintenance cost the power saved from both dimming, shutting off and overall control of the system creates a ROI of 3-5 years in most cases, well worth it when considering all the other factors discussed [43].

Street lights have the capacity to disrupt entire eco-systems especially those of nocturnal animals. Birds which hunt and navigate by use of moonlight are several impaired. Migratory birds are also affected by street lights which can cause them to migrate off schedule [27]. Compositions of insect eco systems are also altered by the presence of street lights, encouraging predatory insects over scavenging [36]. This can lead to dramatic changes in the overall food chain and alteration of eco system in the long-term. Considering the fact that street lights have been implemented for several decades in most developed countries the far reaching impact may not be noticeable because it has already occurred.

3. Equipping Street Lighting Systems with Intelligence Capabilities

Having seen the negative impacts of street lights it may be difficult to justify their use in their current state. Regardless of those factors there is a need to make most use of them and no solution is as remarkable as intelligent street lighting. In intelligent street lighting, the individual street lights are fitted with LED based technologies and sensory equipment allowing it to operate autonomously. It can determine the weather and time allowing it to operate at night or in darkened skies. More importantly the sensory equipment, infrared or otherwise can detect the presence of individuals and vehicles from a pre-defined distance away, hence operating when needed only. This increases savings and minimizes the negative impacts of the traditional street lights (which were discussed previously) while not reducing its capability as a crime and accident deterrent. With

intelligence also comes the capacity for self-monitoring. The system can determine when a malfunction, anomaly or even when generic maintenance is required and sends this information to an administration centre. This further reduces maintenance cost and times. Currently most street lights are fixed when citizens report malfunction or worse when active maintenance is carried out which can cause waits times of even months in some cases.

The true impact of the system is not having a single lamp turn on in an intelligent fashion but rather networking all of them. If you imagine a single street light as a neuron networking all of them in an area transforms the landscape into a pseudo brain capable of so much more from data acquisition and analytics to adaptable behavior and herein lies the true capability of intelligent street lighting. Consider when an individual walks onto the sidewalk the lamps detect his presence, turn on in a slow controlled fashion for his eyes to adapt, all surrounding lamps in his path/predicted path turn on allowing visual prowess in his range while highlighting other individuals in the area (criminals or otherwise). Cars are no different, the road is illuminated in a controlled fashion for vehicles but consider the following. If the street lighting system is integrated with analytics to determine the optimal path in the event of adverse weather conditions, it's possible for a driver to be informed of this optimal path via smartphone. What better device to observer roadways and traffic than the one placed every 10 feet on it, the streetlight?

The possibilities are limitless with networking the street lights forming the ideal platform for sensor networks due to their prevalence. They can be integrated with criminological systems such as gunshot/scream detection systems to locate crimes as they happen or warning systems in case of terrorist attacks or natural disasters. The street lights can be outfitted with displays to indicate safer paths, courses of action etc. When not in use the same displays can even generate income by using them for advertising purposes. Not that the more networked layers added, the greater the integration of other systems using the street lighting scheme the more a move from intelligent street lights to something larger. This transformative concept is currently discussed in Europe where the future of humanities habitation seems to lie in intelligent cities.

Numerous schemes for intelligent street lights are being developed with very few large scale implementations. They range from generic systems capable of determining light intensity and manipulating LED's to attempts of autonomous street lighting systems each with unique characteristics such as solar powered systems, networking architectures (such as PLC, Wi-Fi or Li-fi)[37]-[41]. Despite the differences of implementations, initial results are positive showing energy savings, reduced carbon emission projections and overall improved operation while improving functionality.

4. Conclusions

It must be accepted that despite the widespread proliferation of street lights they host a large number of negative effects that have not been discussed until recently. The solution does not lie in cutting of our dependence on the system but rather adding control and efficiency to it to minimize the negative ecological, environmental and physiological impacts while maintaining its use as a tool for national security. Street lights can indeed aid in national security once they are made intelligent and adapted to not only providing information to stakeholders on the environment around but also information that can be used for forecasting security threats.

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Author Profile

Marcus Lloyde George received the Bsc degree in Electrical and Computer Engineering from the University of the West Indies, St. Augustine in 2007, his MPhil degree in Electrical and Computer Engineering from the University of the West Indies, St. Augustine in 2011 and his PhD degree in Electrical and Computer Engineering from the University of the West Indies, St. Augustine in 2019. He is the author of several academic books. His research engineering interest include the business administration, strategic planning and management, engineering education, formal specification, modelling and verification, field programmable architectures, intelligent electronic instrumentation and biomedical engineering.