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Stop Støj!

The Feasibility of Implementing a Nightlife Noise Data Collection System in Nørre Kvarter



An Interactive Qualifying Project submitted to the faculty of WORCESTER POLYTECHNIC INSTITUTE in partial fulfillment of the requirements for the Degree of Bachelor of Science.

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Abstract

Copenhagen's energetic nightlife scene is an everyday problem for residents living in the inner city district, many of whom don't feel like their voices are being heard by the city. We worked with Miljøpunkt Indre By & Christianshavn to determine the feasibility of implementing a mobile application for collecting data on nightlife noise disturbances. To accomplish this, we identified the problem's stakeholders, determined the app's users and their motivations, discovered technical considerations for the app, then designed and developed a prototype app. Following the research and development process, we created visualizations showcasing the potential of the app's data analytics and proposed further steps to improve the app and Copenhagen's existing nightlife noise management strategies.

Acknowledgements

We would like to thank everyone who was involved in our project and Miljøpunkt Indre By & Christianshavn for providing us with the support and resources we needed to complete our project. Specifically, we would like to thank Center Leader Marianne Spang Bech for providing our team with incredible feedback and guidance throughout the process. We would also like to thank our advisors, Holly Ault and Constance Clark, for their hard work and guidance throughout the course of this project. Additionally, we would like to thank Seth Tuler, our preparatory course professor, for helping us craft our project proposal. We would also like to thank the Copenhagen Noise Network, and all of our interviewees for supporting our project and providing us with their perspectives on the nightlife noise problem. Lastly, we would like to thank Worcester Polytechnic Institute for providing us with this opportunity.

Executive Summary

The Nørre Kvarter neighborhood of inner city Copenhagen is characterized by a vibrant nightlife scene that is fueled by the sale of cheap alcohol from more than one hundred alcohol selling venues in the area. The nightlife scene is an attractive destination for young adults, who party into the early hours of the morning. The youth drinking culture, combined with the lack of an open container policy and an abundance of cheap alcohol, brings the party out into the streets and subjects the area's residents to unhealthy noise levels. The residents currently lack an effective way to submit noise complaints to the police and municipality, who are responsible for handling them. Residents are unhappy with the response they receive to their complaints and are asking for changes to be made to the current nightlife noise management system.

Our sponsor, Miljøpunkt Indre By & Christianshavn, is a non-profit environmental organization dedicated to improving the sustainability of Copenhagen. One of their sustainability initiatives is to reduce noise levels in the city. They helped develop the Noise Network in an effort to raise awareness of the nightlife noise problem. The network is composed of local residents and noise activists who are working to find solutions to the nightlife noise problems and build a bridge between what they call "life in the city" and "a place to live." Our project goal was to collaborate with Miljøpunkt Indre By & Christianshavn to determine the feasibility of implementing a mobile phone application for collecting data on nightlife noise disturbances in inner city Copenhagen, specifically in Nørre Kvarter.

Methodology

Our team completed the following objectives during our research and development process:

- Identified the authorities invested in the nightlife noise problem and the data they believe are useful.
- Identified potential users of a noise complaint application and their motivations to use it.
- Discovered technical considerations in the development and implementation processes.
- Developed a prototype noise disturbance reporting app for testing and data collection.

Our team utilized participatory research with co-creative design methods to give the community a greater role in identifying the root of the problem and developing a solution. We actively sought to build connections with residents of inner city Copenhagen and representatives from the Copenhagen Police, København Kommune, and Noise Network to gain a better understanding of the inner workings of the nightlife noise management system.

Findings

Finding #1: The current nightlife noise management system of inner city Copenhagen is complex and poorly conveyed to the public.

Copenhagen's nightlife noise management system is complex and has several different bodies responsible for making key decisions. During interviews with several residents of inner city Copenhagen, we repeatedly found that they had misconceptions about how the city's nightlife management system works. Discussion with city officials revealed that the municipality (including the Noise Guard) is responsible for responding to noise complaints regarding bars and restaurants, and have three separate ways to submit complaints, depending on the time of the day. Likewise, the police are responsible for responding to complaints on street noise, and private celebrations.

Finding #2: The current noise disturbance reporting mechanisms are unclear to residents and obstruct data collection.

In interviews, some residents expressed that they have a difficult time identifying which authority they're supposed to report noise complaints to, as different organizations accept different complaints at different times. The Noise Guard is only available for five hours on weekend nights (Thursday through Sunday), and these hours don't necessarily coincide with peak nightlife activity. On weekdays, the Noise Unit is available during regular work hours (9:00 to 15:00). Police are available at all times, but only handle street noise complaints. If residents submit complaints to the wrong authorities, the complaints are typically deemed invalid and go unaddressed.

Finding #3: Limited resources means police reaction to nightlife noise incidents is rarely immediate.

Our interview with Jakob Vilner, Vice Chief of the Copenhagen Police, revealed that the police are unable to address every complaint they receive because they prioritize more pressing issues like terrorism, violence, and drugs. The police are only able to dedicate six to twelve officers for managing the nightlife scene on any given night. While they keep a record of every noise complaint they receive, they don't always keep a copy of the complaint's details (like its category, for example). Mr. Vilner explained that, if they do address a complaint, the police are more likely to issue a warning than take disciplinary action.

Finding #4: A lack of response from the current nightlife noise management system, paired with a complicated complaint submission process, has discouraged residents from submitting complaints.

In interviews with residents, they explained that they felt ignored by city officials when voicing their concerns over the noise problem due to a lack of responses received from authorities. Some residents have given up on submitting noise complaints due to the lack of response they receive, claiming that the noise complaints are no longer worth the time it takes to fill out the complicated complaint forms.

Finding #5: Important noise complaint data includes category, time, and location.

Interviews with Noise Guard and Copenhagen Police management revealed that the type of disturbance, when a disturbance occurred, and where it happened is all the information necessary for them to take action—everything else is supplemental. Evidence like audio and video recordings requires a secondary source of information to validate the source of information and does not provide meaningful evidence to the complaints submitted.

Finding #6: The Copenhagen Police have to follow strict data security standards, set by the European Commission and the Municipality, which restrict their use of data from external sources.

In talking to Vice Police Chief Vilner, we learned that that laws and restrictions set in place by both the local municipality and the European Commission prevent them from accepting our data into their system or making their data available to the public. This, among other regulations,

introduces several legal obstacles that must be overcome before a fully integrated system can be developed.

Finding #7: Simple data analysis can provide nuanced insight into the inner workings of Copenhagen's nightlife.

The police and city officials can gain a better understanding of how much the nightlife scene impacts the local quality of life through simple analysis of the data collected through our prototype app. The police and city officials also showed interest in visualizing these data through media like heat maps and timelines. To demonstrate the potential analysis that can be performed on the data collected by our app, we generated a realistic set of simulated data that allowed us to develop a series of visualizations. These visualizations can provide valuable insight into the inner workings of Copenhagen's nightlife scene.

Finding #8: According to prospective users, a successful noise complaint app should be simple, easy to use, and provide deeper insight into the nightlife noise problem.

During interviews with some residents of inner city Copenhagen, they explained that they do not want to navigate through a complicated form to submit a report if they are awoken in the middle of the night. Additionally, residents explained that they wanted more information on where their complaints go and how they would be handled. The app should be easily accessible, simple, and educate the public on how to submit noise complaints to the correct authorities.

Recommendations

Recommendation #1: The Copenhagen Police utilize the data collected by the app to improve the allocation of nightlife management resources.

The city of Copenhagen should utilize the system we have developed to improve the way noise disturbances are managed. With a deeper understanding of the trends in nightlife disturbances, the police would be able to prioritize and concentrate resources on specific areas at peak times.

Recommendation #2: City officials utilize the collected data to influence their decision-making processes when issuing liquor licenses in active nightlife areas.

We recommend that city officials, including those in the department for Culture and Leisure and the department for Technology and the Environment, utilize the data collected through our app to identify localized patterns of noise disturbances before issuing licenses to any new bars or restaurants in an area. These data can provide the municipality with insight on how the local businesses are affecting the quality of life of the area's residents and should be considered when issuing liquor licenses.

Recommendation #3: We encourage Miljøpunkt Indre By & Christianshavn and the Noise Network to promote the use of this app to increase data collection.

The larger the audience this app reaches, the more people are likely to use it. More people using the app increases the sample size, which generally leads to a more representative data set.

Recommendation #4: We encourage Miljøpunkt Indre By & Christianshavn and the Noise Network promote the development of a comprehensive noise complaint app.

We encourage our sponsor promote the development of a comprehensive noise complaint app for the following reasons:

- Centralized data collection promotes communication between relevant authorities.
- Ease and accessibility allows for quick, convenient complaint submission.
- A streamlined complaint submission process can automatically direct complaints to the proper authorities and has the potential to facilitate a unified response system.
- Centralized data collection allows for analysis and visualization, which can illustrate the situation in a comprehensive manner and help the authorities better manage the nightlife scene.

Recommendation #5: We recommend the future developer of this app implements additional features to the prototype app.

In our surveys and interviews, prospective users provided us with feedback on additional features that they would like to see in future iterations of our app. We recommend the following enhancements for the app: an official complaint response system, the ability to auto-detect location, the ability to upload audio and media, improved mobile functionality, improved user

account features, the ability to “quick submit” a complaint, making the data open source, adding complaint threads, allowing users to add tags to noise complaints, virtual marketplace availability, and handicap accessibility features.

Recommendation #6: The future developer create additional data analytics and visualization tools to best represent collected data.

A well-designed and developed data visualization and analytics dashboard within the app would provide an easy way to view the nightlife noise situation in inner city Copenhagen and determine if the situation is improving—or getting worse—over time.

Recommendation #7: The Copenhagen Police and Municipality work together to develop an app that streamlines the noise complaint process.

The development of a fully comprehensive and integrated noise complaint app would require collaboration between the Copenhagen Police and Municipality. We encourage both authorities to work together to develop a streamlined system that automatically routes complaints to the correct authority, has built-in channels for communication, and promotes the sharing of data on the nightlife noise problem.

Contributions

Christopher Cyr

Chris was a primary author and editor of all sections of this report. Chris was responsible for the drafts and finalization of the Executive Summary, Background, Methods, Findings, and Recommendations & Conclusions chapters of this report. He also assembled all citations for this report. Chris was the primary contact for all interviewees, and co-lead all interviews. He also developed all interview questions and surveys that were distributed throughout the course of this project.

Brent Reissman

Brent served as the primary interviewer throughout our project. He was a primary editor of all sections of this report, and co-authored the Background, and Findings sections of this report. He transcribed interview proceedings in great detail and accuracy. Brent also developed the majority of the graphics found within this report, and was responsible for assembling all appendices. Additionally, he was responsible for formatting the final document.

Michael Taylor

Mike was one of the two technical leads in our project. Mike worked arduously to develop the interface and user experience model for the web app our team developed. In addition to the research the team conducted on the noise problem, Mike spent a great deal of time researching industry standard coding languages to develop a product that can be expanded upon by any computer scientist. Mike co-authored the technical documentation for our web app that accompanies this report. He also co-authored the Introduction, Background, and Recommendations sections of this report.

Chad Underhill

Chad was one of the two technical leads in our project. Chad worked relentlessly to develop a production-level backend for the application, including a fully-functional API. He oversaw development operations (DevOps) for the project and configured the web servers that hosted our application. He worked to provide hosted web space for our app, making it available to the public. Chad provided the team with his expertise in editing all sections of this report for content, grammar, and flow. He was a primary author for the Introduction, Background, Findings, and Recommendations and Conclusions sections of this report.

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1. Introduction

Copenhagen, Denmark's largest city and capital, is a hub for culture and social experience for both residents and tourists (Roberts, Turner, Greenfield, & Osborn, 2006). Today, the inner city neighborhood of Nørre Kvarter is an attractive nightlife destination for young party-going individuals. Cheap alcohol and 100+ alcohol-selling venues draw large crowds into the cramped streets and fuel the nightlife scene into the next morning. For residents, this has become a major annoyance. In October 2017, a WPI IQP team conducted a survey of thirty-six local residents, enquiring about how much the street noise bothers them. Thirty of the thirty-six residents reported that the nightlife noise bothered them at least moderately (Flibbert, Hearls, Nicolella, & Suwirjo, 2017).

Nighttime noise disturbances are not exclusive to Nørre Kvarter; evening disruptions create unsustainable living environments in urban areas worldwide (Roberts et al., 2006). The World Health Organization says that average exposure to noise above 40-decibel (dB)—about as noisy as a quiet residential street—during one's sleep can result in adverse health effects, including sleep disturbances and insomnia (The Noise Center, 2014). Such health effects can have a dramatic impact on both the amount of time people spend sleeping and their workplace performance. Furthermore, prolonged exposure to noise levels beyond 55dB can result in elevated blood pressure and trigger heart attacks (World Health Organization, 2009).

In Copenhagen, official noise complaints can be submitted through the København Kommune website. However, the website states that the city municipality will not handle complaints related to street noise and suggests contacting the police instead (København Kommune, 2018). According to residents who have submitted complaints to the municipality, the complaints “don't do anything” (Flibbert et al., 2017). As a result, the residents of Nørre Kvarter have no meaningful way to submit complaints for nightlife-related disturbances. Additionally, policing forces are stretched thin within the city; Copenhagen dedicates just six to twelve police officers to nightlife patrol citywide, and the municipality does not have access to information that indicates where the most troublesome locations are (Flibbert et al., 2017).

Noise is an ever-present problem in cities around the world, and many places have found alternative solutions. Amsterdam and Dublin require local establishments to pool money into a fund that takes care of nightlife promotion and cleanup. Zurich and Amsterdam employ social

workers to act as area “hosts,” who remind nightlifers to stay safe and respect those around them (Roberts et al., 2006). Self-reporting mechanisms, like “The Noise App” in England or Amsterdam’s online nuisance report form, allow residents to submit complaints to authorities in a convenient manner (The Noise App, 2018). The municipalities in Amsterdam, Zurich, and New York City all utilize self-reporting mechanisms to collect critical nightlife data, which are used to delegate city resources to manage nightlife disturbances. Access to nightlife noise information may allow the Copenhagen police to foresee and defuse potential noise disturbances before they happen (Flibbert et al., 2017). By equipping the police and local legislators with relevant data, the municipality can become better informed regarding the nightlife problems and the police can use their limited resources more effectively. Collecting these data could also be helpful in developing evidence that might encourage the city to increase the resources available to these authorities.

The goal of this project was to provide Miljøpunkt Indre By & Christianshavn with an app for collecting noise complaint data throughout inner city Copenhagen. In order to accomplish this, we:

- Identified the authorities invested in the nightlife noise problem and the data they believe are useful.
- Identified potential users of a noise complaint application and their motivations to use it.
- Discovered technical considerations in the development and implementation processes.
- Developed a prototype noise disturbance reporting app for testing and data collection.

2. Background

This chapter presents issues surrounding the noise generated by the nightlife scene in inner-city Copenhagen, specifically the Nørre Kvarter neighborhood. Section 2.1 provides insight into Nørre Kvarter, the history behind the community, the local culture, and legislation relevant to the problem. Section 2.2 looks into the drinking culture in Denmark. Section 2.3 investigates existing solutions developed by similar cities with similar nightlife problems. We analyzed this information to develop a greater understanding of what impactful nightlife management looks like and the effectiveness of different complaint systems used in other cities.

2.1. History of Nightlife in Nørre Kvarter

Nørre Kvarter, colloquially known as the Latin Quarter, is located in Indre By, the central district of Copenhagen. During the daytime it is known for its trendy cafes and boutiques; at night, it is a center for youth nightlife (Stensgaard & Schaldemose, 2006). The nine streets that make up Nørre Kvarter [Figure 1] house over 100 establishments that sell alcohol [Figure 2], many of which stay open until the early hours in the morning (Flibbert et al., 2017). While Nørre Kvarter is a successful and lively shopping and nightlife destination today, it used to be much different.

Before the 1900's, Nørre Kvarter was an impoverished neighborhood. When the red-light district of Copenhagen moved from Magstræde to Nørre Kvarter at the turn of the 20th century that began to change (Nielsen, 2011). The red-light district drew in an eclectic crowd, and soon Nørre Kvarter became a hub for the social rejects in the city (Stensgaard & Schaldemose, 2006). The nickname "Pisserenden" (Danish for "the urinal") was quickly coined, as a reference to the constant stench of urine on the streets which came from the large, intoxicated crowds occupying the streets at night (Mouritsen & Osborne, 2010). The local residents reported hearing "characteristic howls of jealousy" (Stensgaard & Schaldemose, 2006) through the night from inside their homes. It was, and still is, a common occurrence for visitors to hop between bars and local parks late into the night.

The red-light district remained active until 1990, when it was replaced by legitimate establishments and the next wave of people that were attracted to the area who are characterized by Stensgaard and Schaldemose as "pseudo-sophisticates and hippies" (Stensgaard & Schaldemose, 2006). Nørre Kvarter was transformed into a more glamorous nightlife center for

the city by the new, trendy cafes, stores, and clubs this next wave brought with them (Bonetto, 2015). This change in the neighborhood's attitude appealed to a broader audience than its red-light precursor.

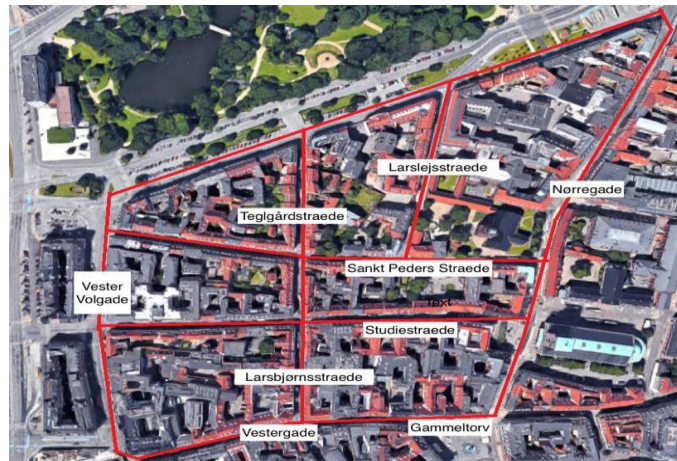


Figure 1: A map of Nørre Kvarter. [Flibbert et al., 2017]

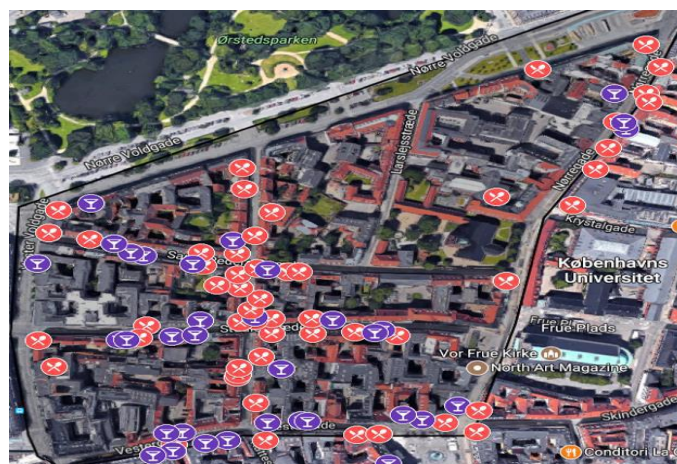


Figure 2: Alcohol Selling Venues in Nørre Kvarter [Flibbert et al., 2017]

2.1.1. Current Nightlife Situation in Nørre Kvarter

Residents of inner-city Copenhagen claim that excitable, young partygoers disrupt their lives by screaming and shouting in the streets throughout the night, especially during warmer months (Christian, 2016). In 2016, Copenhagen's mayor Frank Jensen proclaimed that, "Copenhagen should remain a city with a lively nightlife, but it must be possible for citizens to move about safely and be able to sleep at night without drowning in noise, filth, and trouble" (Christian, 2016). To this point, the city has been unsuccessful in finding effective ways to address these nightlife disturbances due to a lack of resources (Flibbert, et al. 2017). During nighttime

hours, there are only six to twelve police officers patrolling the streets for nightlife disturbances. The municipality created groups like the Noise Guard, who operate under the Noise Unit. The Noise Guard helps the police control the nightlife scene by enforcing noise regulations on businesses and nightlife venues but have no authority to regulate street noise (Flibbert, et al. 2017).

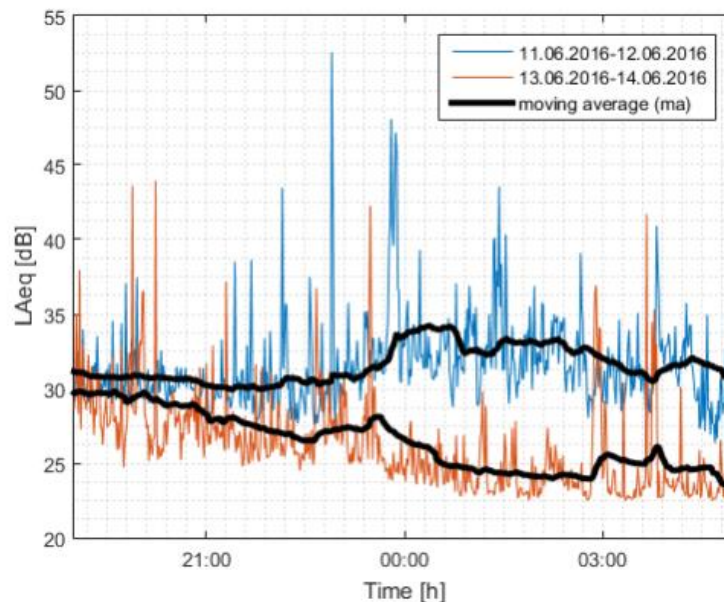
Several *beboerforenings*—or residents’ associations—have sprung up throughout the city, partially in an effort to combat these disturbances. Examples of these are the “Nørre Kvarter Beboerforening,” and the “Foreningen Københavns BeboerNetværk” (FKBN, the Copenhagen Residents Association). One member of the FKBN, Hannibal Holt, proclaimed that the city is “depriving citizens of one of the most fundamental rights a person may have: the right to be in his own home” (Foreningen Københavns BeboerNetværk, 2016). According to Mr. Holt, the nightlife scene is starting to “feel more like vandalism than a party”. The FKBN has initiated legal action against the city, claiming the city is neglecting the responsibility it has to its residents (Rødgaard, 2017).

Residents of Copenhagen have just one way to submit noise complaints, and they can only be submitted under certain conditions. Københavns Kommune (KK), the municipality of Copenhagen, has an online form where residents can submit complaints regarding noise, odor, or dust. However, the website specifies that the municipality does not process complaints for street noise, private celebrations, delivery of goods on public roads, or cars in idle. For these specific instances, KK requests that individuals contact the police (Københavns Kommune, 2018b). The municipal page directs residents with complaints to other resources, like the Noise Unit (*støjgeneenheden*) and the Noise Guard (*støjvagt*). Both the Noise Unit and Guard deal with the complaints that are submitted to the municipality in regards to excessive noise levels produced by bars, restaurants, and other businesses. It is their responsibility to investigate the scene and measure the noise to see if it exceeds the city’s volume limits (Københavns Kommune, 2018b). They have the authority to issue fines and enforce noise mitigation efforts such as closing the doors or windows of an establishment. The Noise Unit operates during the week between 9 AM and 3 PM and oversees the Noise Guard. The Noise Guard is active throughout the night from Thursday through Saturday until 3 AM. A diagram of the current noise complaint submission process can be seen in Appendix A.

In 2016, Miljøpunkt Indre By & Christianshavn began collaborating with representatives from the local residents’ association to launch their Noise Network: “*Støjnetværket*”. This group

intended to open a dialogue through which they could begin addressing the noise problem themselves. Since the beginning of 2017, the Noise Network has expanded beyond Nørre Kvarter to include three other beboerforenings in Indre By (Foreningen Københavns BeboerNetværk, 2016).

In addition to the nuisances the nightlife brings, the noise produced by the nightlife scene also imposes potentially adverse health effects on the residents of the area. Noise produced by these crowds often exceeds the 40-decibel (dB) standard for healthy noise levels set forth by the municipality and World Health Organization (WHO) (World Health Organization, 2009). A study on the levels of noise inside homes of Nørre Kvarter's residents, conducted by a group of students from the Danish Technical University (DTU), revealed that the noise levels produced by nightlife activities exceeded the WHO's noise limit of 40-dB several times throughout the average weekend summer night as illustrated by the blue line on the graph in Figure 3. The red line on the graph shows the noise levels recorded on weekday nights. The data collected by the DTU students, coupled with the World Health Organization's recommendations, emphasizes the effects the ongoing nightlife noise problems have on Nørre Kvarter (Kavardzhikova, Mageswaran, Scarlatti, Smits, 2016).



*Figure 3: Recorded Results from DTU: Night time Noise Levels on Studiestræde
[Kavardzhikova et al., 2016]*

Despite the detrimental effects the nightlife activities can have on the residents, these activities can benefit the city as a whole. The active nightlife scene helps stimulate the economy,

define the culture, and make Copenhagen an attractive destination to party-going individuals (Bayliss, 2007). The area is known for selling cheap alcohol, and many of the venues in the area have licenses that allow them to serve customers past 5 AM. This, paired with the fact that the legal age to purchase alcohol in Copenhagen is relatively low—16 in retail establishments and 18 at bars and restaurants—fuels the young nightlife crowds into the early hours of the morning (Carlström, 2017). While specific figures which detail the economic benefits of a strong nightlife scene (like revenue, local economic value, job creation, etc) are difficult to find, many cities report that maintaining a lively nightlife scene provides significant economic growth (Wickham, 2012). A Greater London Authority report cited significant growth in business activity and consumer spending as key benefits to a growing nightlife economy. The City of Sydney acknowledged localized gains in employment as another reason to promote nightlife growth (Bevan, Turnham, & Lester, 2011).

2.1.2. Local Legislation in Copenhagen and Nørre Kvarter

Copenhagen's existing nightlife noise legislation is ineffective in addressing the current nightlife noise problems. The resources dedicated to managing the nightlife are insufficient, and the local legislators have an incomplete understanding on the nightlife noise problem. In the fall of 2017, a WPI team interviewed Marianne Spang Bech, director of the noise project at Miljøpunkt Indre By and Christianshavn. She explained that there are three primary reasons for the legislative limitations. First, the disturbances usually dissipate before authorities arrive, meaning the disturbances are infrequently observed and documented. Second, there is little evidence of nightlife problems in the morning, since local residents and sanitation workers clean the streets and collect waste from the night before. Third, the relevant legislators simply do not live in Nørre Kvarter, and thus have not experienced the problem firsthand (Flibbert et al., 2017). With few regulations in place, the residents of inner-city Copenhagen remain subject to frequent noise disturbances caused by the nightlife scene, as seen by the research conducted by the students from the DTU (Kavardzhikova et al., 2016).

Current legislation on noise in Copenhagen has imposed limits on noise exceeding 30-dB before 10 PM and exceeding 25-dB after 10 PM (Flibbert et al., 2017). This is no louder than the ambient noise in rural areas (IAC Acoustics, 2008). Businesses and other establishments are allowed to operate until midnight, 2 AM, or 5 AM (Roberts et al., 2006). In Nørre Kvarter, all

outdoor establishments that serve alcohol are required to stop serving alcohol to their patrons outside at midnight and are then only allowed to sell alcohol inside the establishment. These local legislative measures are enforced by the Noise Guard and police, who patrol bars and restaurants and issue warnings and fines to establishments that are breaking the rules. However, police details for these problems are limited, making it nearly impossible to handle every problem that arises. Additionally, the legislation that exists is enforced merely on establishments, and there is no way for citizens to turn attention toward the problem when it moves from businesses to the streets or homes (Roberts et al., 2006).

2.2. Danish Drinking Culture

Alcohol has been prominent and ingrained in the Danish culture for nearly 5000 years, and the average Dane drinks more than eighty liters of beer alone per year (Ministry of Foreign Affairs of Denmark, n.d.). Although Denmark only ranks 20th out of thirty-three OECD countries in alcohol consumption per capita, the Danish youth are the highest consumers of alcohol in the European Union (World Health Organization, 2017; Demant & Krarup, 2013). Drinking has remained a staple of Danish culture for two main reasons. First, the Danes do not have a state monopoly on alcohol sales, unlike the other Nordic countries. Over time, the Danes have loosened their restrictions on alcohol sales, excise taxes, and the licensing requirements for serving alcohol. The lack of a state monopoly, coupled with a young legal drinking age, has fostered the development of a prevalent drinking culture amongst the Danish youth (Demant & Krarup, 2013).

Second, the rapidly-growing nightlife scenes in Denmark expose the Danes to risks, like drugs and alcohol, at younger ages (Recasens, Marlière, & Hebberecht, 2007). Young adults frequently run from bar to bar, bringing the party out into the streets, as they go to drink the less expensive alcohol sold at local convenience stores, before returning to the bars and clubs to drink even more. This behavior, called club street drinking, results in long lines and large crowds of rowdy teens gathering in the streets. Club street drinking has become a popular activity among the Danish youth, a strong contributing factor of the current nightlife noise problem. Residents have complained to the municipality about the noise and litter that the young partiers produce in their neighborhood, and criticize the relaxed drinking laws, which they believe is a chief contributor to the problem (Demant & Landolt, 2014).

2.3. Nightlife Noise Management Strategies

The following sections will introduce strategies that have been implemented to address noise problems both within Copenhagen and in cities analogous to it; this includes the Spandauer Vorstadt neighborhood in Berlin, Temple Bar in Dublin, Rembrandtplein in Amsterdam, and Zurich. Evaluating experiences in cities similar to Copenhagen in size, location, and/or culture, then evaluating how they handle nightlife noise problems, can provide solid reference points when developing localized solutions.

2.3.1. Nightlife Management through Liquor Licenses & Committees

Liquor licenses enable restaurants, bars, and other venues to serve alcohol to patrons based on the rules set by the local municipality. These municipalities control the liquor licensing strategies implemented within their districts, and thus how—and how late—alcohol is served. Allowing businesses to serve alcohol later in the night promotes sales and boosts the economy, but can lead to increased nightlife traffic (Demant & Landolt, 2014). Similarly, granting large numbers of licenses results in an influx of alcohol-serving businesses. Preventing businesses from serving alcohol late at night, or restricting the number of licenses issued, generally has the opposite effect (Demant & Landolt, 2014).

Nørre Kvarter liquor license applications must be reviewed by the city board, the Copenhagen Police, and building and safety inspectors before a license is granted (Roberts et al., 2006). Many residents believe too many liquor licenses have been awarded, allowing bars and clubs to remain open all night and adding to the growing nightlife noise problem (Foreningen Københavns BeboerNetværk, 2016). However, in November of 2016, local politicians decided to put pressure on the license-awarding organizations, encouraging them to reduce the number of licenses and improve overall regulation. These organizations include the department for Culture and Leisure—*Kultur- og Fritidsforvaltningen* (KFF)—and the department for Technology and the Environment—*Teknik- og Miljøforvaltningen* (TMF). In response, the KFF and TMF proposed solutions like increasing the spacing between permitted businesses, slowing down the approval process for late-night permits, improving communication between stakeholders, and increasing the involvement of police, city officials, businesses, and residents (Christian, 2016).

Similar to Copenhagen's police, the Berlin Police were not included in the liquor licensing process until 2000 (Process and Organisation of the Berlin-Agenda, n.d.). To address their rapidly-

growing nightlife scene, the city completely disallowed nighttime-only venues and began requiring input from the Berlin Police before issuing licenses. The police began cracking down on “unlicensed premises” and closing public gathering places, such as courtyards and gardens, after 10 PM. The city also moved to conduct Agenda 21 committee meetings (a UN initiative to promote sustainable development) every month to discuss progress, including representation from the City Council, residents, businesses, and police (Roberts et al., 2006).

Giving police an active role in the control of nightlife venues is just one approach to addressing the ongoing problems. When nightlife problems in Dublin reached a peak in 1998, the Dublin Corporation—a revitalization group which aimed to improve the local economy—closed alcohol expansion within the city and placed more controls over alcohol-related use. While seemingly counterintuitive, these changes ended the rampant parties in the streets and made the area a nicer place to be. This increased tourism by up to thirteen percent which, at the time, brought an additional £55 million/year into the local economy (Roberts et al., 2006).

Amsterdam had a different take in approaching their nightlife problems; rather than increasing restrictions, licensing expanded and businesses were allowed to stay open twenty-four hours a day. Mirik Milan, Amsterdam’s “Night Mayor” (charged with promoting a healthy and productive nightlife scene), noted that everyone vacates bars and clubs at once when the district-wide closing hour comes. Naturally, this leads to lots of noise in the streets (Scruggs, 2017). Milan pushed to have the closing hour restriction removed, claiming that “often people in nightclubs don't want to go home at 4 AM—only some of them do. By having free opening hours the club can decide when they want to open and close, which means that 1,000 people aren't suddenly thrown out onto the street at five in the morning.” (O'Sullivan, 2016).

2.3.2. Improving Nightlife Management by Pooling Resources through Business Associations

In other major European cities, the establishment of business associations has proved to be an effective method of managing the nightlife scene. These business associations bring the community together to promote the nightlife scene as a whole. In Amsterdam, bars and clubs are required to pay into a pool that funds area branding, signage, cleanup, and other nightlife sustainability programs. This allows the nightlife venues to benefit from both a cleaner urban environment and better promotion of their businesses. In an interview, Amsterdam’s Night Mayor

noted that these improvements lowered street violence and noise significantly, just two years after being implemented (Scruggs, 2017).

In Dublin, similar measures have been taken to help revitalize the nightlife scene in Temple Bar. The Temple Bar Properties group formed a traders' association among local businesses to promote the area as a new commercial and cultural district within the city. The association agreed to limit parties within venues and contributed to a pool to fund more frequent street cleaning. Cleaner streets are more attractive to tourists and customers of the area and decrease the potential for safety hazards (Roberts et al., 2006).

2.3.3. Mitigating Nightlife Disturbances through Social Workers and Direct Confrontation

Cities have also seen a great deal of success in managing rowdy nightlife crowds by employing social workers to patrol the streets during the peak nightlife hours. Amsterdam's Night Mayor has employed "square hosts" in an attempt to moderate the nightlife scene. These social workers roam the streets at night and try to keep the peace by reminding patrons of noise limits and defusing potential conflicts. According to the Night Mayor, the square hosts are able to resolve most problems before they escalate, which has led to a significantly improved atmosphere in the streets (O'Sullivan, 2016).

Zurich, Switzerland has taken a similar approach with social workers in their entertainment districts. The social workers in Zurich are responsible for conducting alcohol and drug prevention work by addressing any troublesome individuals they encounter, reminding them to be responsible for their actions. Often times the social workers will intervene when they are concerned with the amount of alcohol individuals are consuming and/or the amount of noise they are producing (Demant & Landolt, 2014).

2.3.4. Utilizing Reporting Mechanisms for Effective Nightlife Management

Allowing individuals to report noise disturbances can provide the city with critical information and aids efforts to mitigate the nightlife disturbances (Scruggs, 2017). Several cities, facing similar nightlife problems, have employed various reporting mechanisms in the form of mobile applications. Smartphone apps allow services to be available at the touch of a button and

are generally considered to be more convenient than online forms or phone-call-based solutions (Vividus Marketing, 2017).

The City of New York manages their non-emergency complaints through both an online submission form and a mobile app (Noise Complaint Form - 311). To submit a complaint, the user enters the time, date, and location of the street noise. The system checks the location information to ensure the location exists before the user can submit the complaint. Users aren't required to enter contact information on the form, making it possible for them to submit noise complaints anonymously. If a user is submitting a complaint for recurring problems, the form provides the option to make note of other dates and times when the problem occurred. The municipality also makes all their complaints available to the public through an online database, where users can check on the status of their complaints and see what steps have been taken to address the disturbance.

Between the winter of 2013 and fall of 2014, more than 140,000 noise complaints were submitted in New York City, with 52,000 of them being related to loud music and partying (Wellington, 2015). City data analysts examine these data to discover what hours and times of the year have the highest complaint frequency, the rate at which complaints are resolved, and how these features vary between the five boroughs of the city (Owen, 2017). An online database makes all of the data recorded from their complaint submission forms available to the public. New York City's chief data analytics officer said that making these data available to the public "is a powerful way to give New York City residents a sense of who they are, what they're doing and how they're doing it, as well as the strengths of their neighborhood so that they can work together to address quality of life issues" (Howard, 2017). The data collected through the online submission form has inspired local politicians to enact new legislation related to noise regulations. In November of 2014, Margaret Chin, a councilmember from lower Manhattan, introduced a bill that would require the Department of Environmental Protection to begin collecting noise samples throughout the city to improve noise regulations (Wellington, 2015).

A wide variety of data can be collected from reported submissions, and municipalities have the option to choose what information they would like to receive. Municipalities can also collect these data to analyze characteristics of noise complaints, like time, frequency, and location. The complaint submission forms vary depending on the municipality, and while some are effective, like New York City's 311 form, others including Copenhagen's noise complaint form need

improvement. Copenhagen's municipal complaint submission form is similar to New York's, but Copenhagen's noise complaint form doesn't allow for audio submissions, and neglects all submissions related to street noise (København Kommune, 2018).

The public can also file complaints pertaining to noise and other nuisances with mobile applications. The Noise App is a United Kingdom-based mobile application that allows users to document noise complaints from their smartphones (The Noise App, 2018). Organizations including local municipalities, enforcement agencies, and housing providers can subscribe to Noise App's services to receive these complaints, making the service free for the end user. If there is no organization to send a complaint to, the user has the ability to create a "personal diary" of noise complaints. This log is stored locally on the phone, and the users are required to pay a small fee for each recording they wish to save in their personal journal. The app includes some noteworthy features, including the ability to record noise intensity, track GPS location, and express personal comments or feelings regarding the problems experienced. The app offers a more personalized approach than the typical online submission forms, which could help make the end users feel like their voices and opinions are being heard and validated.

SeeClickFix is another example of a mobile application that allows users to submit complaints (SeeClickFix Inc., 2018). Although this app is not associated with noise complaints, it has some noteworthy features. The app is typically used for submitting complaints about community facilities problems, like potholes in the streets or trash on the sidewalks. The app allows the user to take a picture of a problem, record the location, and provide a brief description of the problem. The complaint is then sent to the municipality to handle and posted to a forum where users can see and *upvote* other complaints that have been submitted. The app also allows all users to see a map that shows where complaints have been submitted. Municipalities in the United States utilize SeeClickFix to improve the response time between complaint submission and the time it takes them to act upon the request. By assembling all critical information in a single location, cities can better control how these problems are addressed.

Finally, Amsterdam allows residents of certain parts of the city to file reports through either an online form or mobile app about any kind of nuisance they encounter. This report goes directly to a community officer, who delegates it to the appropriate response team (O'Sullivan, 2016). According to Amsterdam's Night Mayor, area residents have claimed the app has "changed their lives," making it significantly more convenient to notify municipal authorities of any problems.

The municipality also uses the noise complaints to collect data and improve their nightlife management strategies. These data give them insight into how they can most effectively allocate city resources, especially when they receive a number of noise complaints from similar areas (Scruggs, 2017).

2.4. Summary of Background

After analyzing the current situation and looking into solutions that have been effective in cities similar to Copenhagen, it is clear that the city's public officials do not have adequate data on the problem to make the necessary changes to its regulations and improve the way the nightlife noise disturbances are handled. Many of the residents of Nørre Kvarter are unhappy with the frequent nightlife disturbances, and are asking for change (Flibbert et al., 2017). Reporting mechanisms, like New York City's 311 Complaint Form, or "The Noise App" in England, can provide critical data to municipalities and help municipalities to determine the most effective way of addressing noise disturbances.

3. Methods

The goal of our team's project was to provide Miljøpunkt Indre By & Christianshavn with a tool to collect noise complaint data in inner city Copenhagen, specifically in Nørre Kvarter. The data collected by this tool will help promote initiatives to improve Copenhagen's noise regulations. These data can also provide important insight into the city's nightlife problem to all interested stakeholders. Our team provided Miljøpunkt Indre By & Christianshavn with our data collection tool, a prototype web app. We made the data that the tool collected, available through a user-friendly online database along with advice on how these data could be utilized most effectively to improve nightlife noise management strategies within the city.

In order to accomplish this goal, our team completed the following objectives:

- Identified the authorities invested in the nightlife noise problem and the data they believe are useful.
- Identified potential users of a noise complaint application and their motivations to use it.
- Discovered technical considerations in the development and implementation processes.
- Developed a prototype noise disturbance reporting app for testing and data collection.

3.1. Determining Application Features & Desired Data

Before developing the prototype application, we talked to people invested in the noise problem to determine who our stakeholders were and to gain a better understanding of their perspective on the noise problem to frame our potential solution. We interviewed eleven representatives from different groups of stakeholders to gain their opinions on what features to include in the prototype, and what data they believed would be important to collect through the app.

3.1.1. Presenting to Local Committees

In an initial effort to raise awareness of our project, we presented our project proposal to both the Noise Network and the Indre By Lokaludvalg (Inner City Local Committee, consisting of members from the municipality and representatives from each district of the city). Our sponsor helped set up these initial presentations, which allowed us to introduce our project and build

connections with people invested in the nightlife noise problem. After our presentation to the Noise Network, we conducted a short survey which asked them about the features they would like to be included in our app and how the collected data can help them in their efforts [Appendix B].

3.1.2. Determining Miljøpunkt's Desired Data

We conducted an initial semi-structured interview with Marianne Spang Bech, the Center Leader of Miljøpunkt Indre By & Christianshavn, to better understand her expectations for our project [Appendix C]. This interview helped direct us in the process of developing the app and gave us a better understanding of the project's stakeholders.

3.1.3. Gathering the Residents' Perspectives

The residents of Indre By will be the primary users of this application's complaint submission process. Thus, it was crucial that we understood their opinions on the nightlife noise problem and the creation of this tool. We interviewed six residents of Indre By, including the chairmen of two residents' associations, to gain insight into the nightlife noise problem and to identify features that should be included in our app. We informed the interviewees of how noise complaint systems are used in other cities around the world and how the data collected from this app can be used to help resolve the noise issues in Copenhagen. Two or four members of the team conducted each of the semi-structured interviews, with one or two members leading the conversation and one member recording answers. Center Leader Spang Bech helped us contact the Nørre Kvarter Beboerforening and Noise Network to organize the interviews.

One of the six residents we interviewed was Mr. Søren Rud, the chairman of the Nørre Kvarter Beboerforening (NKBF). In this interview, we gained his insight on the nightlife noise problem and how a noise complaint app can benefit the community. As the head of the NKBF, Søren Rud's perspective was one that reflected the views of the residents he represents [Appendix D]. We also interviewed Mr. Hugo Madsen, the chairman of Strøget Beboerforening (the neighborhood adjacent to Nørre Kvarter). Mr. Madsen provided us with a plethora of information on the structure of the noise complaint system and how he and his neighbors have been affected by the nightlife noise problem [Appendix E]. The other four residents we interviewed were members of the Noise Network; they provided us with their perspectives on the nightlife noise problem [Appendices F & G].

3.1.4. Understanding the Perspectives of the Public Officials

We conducted two interviews with public officials to understand how administrators within the municipality view the nightlife noise problem and how they think it could be improved. We also aimed to gain their perspective on the creation of the noise complaint app and wanted to discuss how the data collected through an app like ours could be used to gain deeper insight on the nightlife noise problem. Center Leader Spang Bech helped us set up an interview with Mr. Martin Gyldstrand, a project leader in the Culture and Leisure Committee of Copenhagen (KFF) and developer of the city's nightlife management plan. We discussed the city's current nightlife management efforts, how liquor licenses are issued, and the feasibility of implementing an app for submitting noise complaints within the city. During the interview, we also informed Mr. Gyldstrand of ways that the City of New York uses the data collected through their 311 app to improve nightlife management and discussed how similar efforts could be implemented in Copenhagen. In this interview, two team members asked the questions, while the other two took notes and an audio recording of Mr. Gyldstrand's responses [Appendix H].

We also interviewed Søren Nielsen, head of the Noise Unit, and his IT consultant. In this interview, we looked to gain their perspective on the nightlife noise problem and a better understanding of how members of the Noise Guard would utilize a tool like this. All four team members conducted this interview, with two asking the questions and two recording the responses through audio recording and note taking [Appendix I].

3.1.5. Understanding the Perspectives of Local Authorities

In order to gain a full understanding of the nightlife noise problems and how the police currently address them, we interviewed Mr. Jakob Vilner, the Vice Police Chief of Copenhagen. Mr. Vilner is in charge of the police response to nightlife incidents and helped develop the *trygt natteliv* (safe nightlife) project for Copenhagen. This semi-structured interview allowed us to gain an understanding of the current nightlife noise management system and how the data collected from this app can help the police gain a deeper understanding of the nightlife noise problem. All four members conducted this interview, with two asking the questions and two recording the answers [Appendix J].

3.2. Planning the Prototype Application

After conducting our interviews with project stakeholders, we used the feedback we received to construct a blueprint for our app’s features and user experience. This required our team to design a preliminary layout of the application that included every essential feature of the prototype app.

3.2.1. Analyzing the Interviews

Once we had spoken to representatives from each of the stakeholder groups, we analyzed the interview and survey results to understand how the end users hope to use this application and identify their most requested features. We identified common patterns in the data set and compared the answers given by each group of stakeholders. We also identified what data the app could collect and how the receiving parties wanted to view the data. Analyzing the interview and survey responses allowed us to determine which data were pertinent to collect through our app.

3.2.2. Storyboarding the Application

Once we determined the desired features for the prototype application, we developed a storyboard/wireframe of how the app would look. Storyboarding is a common engineering and design technique that helps developers quickly model how the final product should function (Rouse, 2013). We made a mockup of the preliminary application design using Google Slides and Google Draw to model the user interface and user experience for the app. We drew inspiration from some of the apps we researched in the preliminary stages of our project, including New York City’s 311 complaint app. Once completed, we presented the storyboard to Center Leader Spang Bech for feedback.

3.3. Developing a Prototype Application

We developed the prototype application in multiple iterations, following a scaled-down version of the Agile Scrum software development methodology. The Agile methodology is a software development approach in which work is done in quick, focused iterations (Learn About Scrum, 2018). The development phase begins by creating a product backlog—a wish list of all major software components required to build the app. Each larger iteration, known as a “sprint,”

focused on one specific component of the software. Each sprint contained smaller daily iterations that focused on developing and configuring the component until completion.

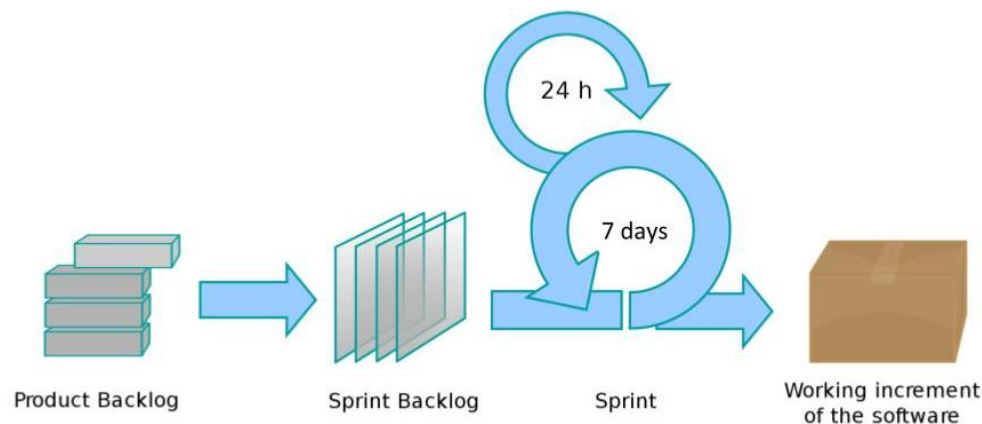


Figure 4: Diagram of a Sprint Iteration [Lakeworks, 2009]

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3.3.1. Making Application Design Decisions

In order to maintain the longevity and accessibility of our app, we had to make several key software design decisions. First, we decided to design the tool as a web application, which allowed us to develop the app for both iOS and Android operating systems simultaneously. We made this decision to appeal to the largest possible audience and minimize future maintenance on the backend of the system. Suggestions from the EU's Internet Handbook also helped inform this decision (European Commission, 2016). We chose the app's programming languages based on industry standards; the backend was developed using Python with Django and the frontend was built with HTML and Vue.js (a JavaScript framework). We chose these languages and frameworks based on their prevalence in modern web app development. To ensure that the future owner(s) of this app have a full understanding of how it was developed, we documented all of our decision-making processes in an attached document [Appendix K].

3.3.2. Producing the Prototype

The initial prototype of our app contained the basic set of features that we believed were required to demonstrate its potential. These basic functional requirements included the ability to collect the time, location and category of a complaint. These are the three core pieces of data collected by other noise complaint apps. At this stage, we prioritized functionality over user

friendliness to ensure that the required features of our app worked. We also developed a basic user interface that sends data to a centralized cloud database to make the data accessible to all stakeholders interested in the receiving the data.

We engineered the application's backend infrastructure in parallel with our stakeholder interviews (as described in section 3.1). The backend of the program refers to the portion of the code that the end-user does not see or interact with. This includes the database setup, data transfer, and information routing. We also developed the frontend of the system in parallel with our interviews and surveys, so that once we decided what needed to be included, we were ready to incorporate it into the app. The frontend of the app refers to the interface that the user interacts with, and the user experience model [Appendix K].

3.3.3. Receiving Feedback on the Prototype System

The final iteration of our application involved gathering user feedback and making minor changes to the app based on the feedback we received. Due to time constraints we were unable to make any major changes to the app. We collected feedback on the initial prototype of the app through a Google survey. We focused our survey questions on identifying functionality preferences of the end users and collecting feedback on the usability of the user interface [Appendix L]. The survey was shared on the Miljøpunkt website and distributed through the Nørre Kvarter Beboerforening and Noise Network. The feedback we received helped us determine how usable the app was, the prospective users' interest in using this app, and what features the users would like to see incorporated into future versions of this app.

3.3.4. Delivering the Prototype

Upon the conclusion of the development period, we installed our web app on to a server located at Miljøpunkt. Our team developed a set of recommendations for Miljøpunkt that contained suggestions on how to move forward with the app including potential improvements for the app, and ideas for how this app can be integrated throughout the city of Copenhagen. We paired our recommendations with a guide that explained how the app was developed, information on how to access the database of noise complaint data, and instructions on how to maintain the system.

4. Findings

Through interviews conducted with our stakeholders, our project team identified the shortcomings in Copenhagen's current nightlife noise management resources, determined the necessary features of our data collection tool, and developed a prototype app that allows users to submit noise complaints to a database. This chapter presents the knowledge gained during our research which informed the decisions we made while developing the prototype app. This chapter also includes our team's analysis of the feedback we received from the app's prospective users, members of the local residents' associations, and public officials involved with the nightlife noise problem. This chapter is divided into two sections:

1. Understanding the Stakeholders' Expectations and Perspectives
2. Designing the App and its Functional Requirements

4.1. Understanding the Stakeholders' Expectations and Perspectives

Our team conducted interviews with public officials from the municipality, the Copenhagen Police, members of the Noise Network, and representatives from local resident associations. These interviews allowed us to identify the shortcomings within the current noise management system and helped us develop an accurate layout of the system's key contributors.

Finding #1: The current nightlife noise management system of inner city Copenhagen is complex and poorly conveyed to the public.

Summary of Evidence:

While conducting research into the structure of Copenhagen's nightlife management resources, we found that there was no single source that thoroughly described the noise management system. Through interviews with Martin Gyldstrand (Project Leader of the Nightlife Plan), Søren Nielsen (Head of the Noise Unit), and Hugo Madsen (Chairman of the Strøget Beboerforening), we pieced together our understanding of how the city manages noise generated by the nightlife scene.

Mr. Madsen informed us about the different municipal bodies that are involved managing noise complaints and how they interact with each other [Appendix E]. He informed us that the noise problem is under the jurisdiction of two departments within Copenhagen’s Municipality: the Department of Technology and Environment (TMF) and the Department of Culture and Leisure (KFF). Mr. Madsen detailed that within the TMF are the Centers for Traffic and City Life and Environment Protection under which the Noise Unit operates. He provided us with a rough sketch illustrating the system and we worked with him to make this into an electronic graphic [Figure 5]. During our time with Mr. Madsen, we discovered the municipal complaint resource structure was far more complex than we had initially believed.

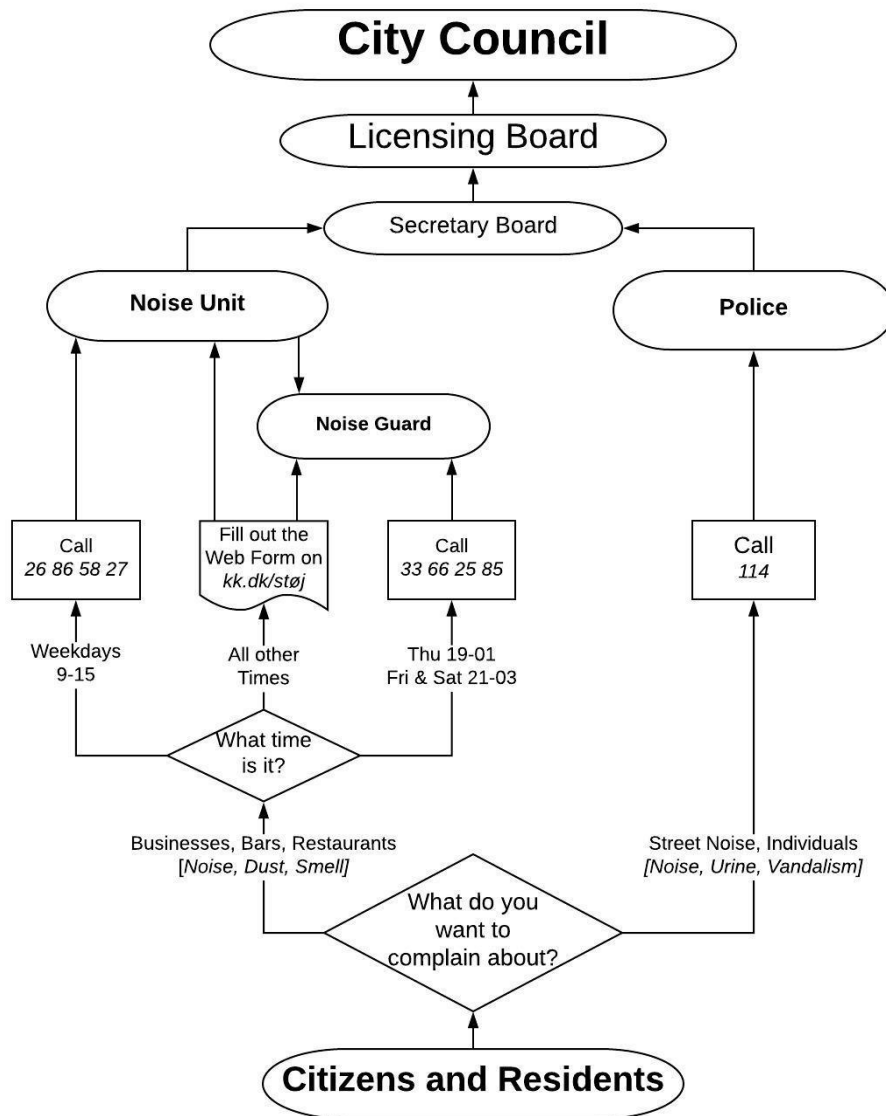


Figure 5: Map of Stakeholders and the Noise Complaint System

Mr. Nielsen informed us that both the Noise Unit and Noise Guard are responsible for regulating commercial establishments and ensuring that they follow the strict guidelines on noise prevention set forth by the municipality. He stated that both organizations, while considered to be “authorities” by the city, have no direct authority to impose consequences [Appendix I]. If they wish to impose sanctions on an establishment that is not following the regulations, they must request assistance from the police. The Noise Unit and Noise Guard can only manage incidents involving noise coming from bars and restaurants; they do not have the authority to regulate noise from other sources like private celebrations and street noise—which are two of the largest contributors to the noise problem.

Mr. Nielsen also explained the process of issuing liquor licenses and said that the Licensing Board, which is partially under the KFF and partially under the City Council, receives input from the Secretary Board, the KFF, and the TMF. All liquor license applications pass through the Secretary Board, which may convey this information to the Licensing Board as described by Mr. Madsen. He explained that the processes of passing information from the Secretary Board to the Licensing Board and awarding licenses are rather secretive. This results in confusion as to whose input is being considered when a license is being issued, especially with regards to the voices of concerned citizens and their opinions on the distribution of liquor licenses in their neighborhoods.

Analysis:

Copenhagen’s nightlife noise management system is complex and has several different bodies responsible for making key decisions. Interviews with representatives from both the TMF and KFF revealed that they are aware of the limitations they are bound to by the current legislation and structure of the noise management system. Additionally, the municipal bodies that comprise the nightlife noise management system do not share a central database for noise complaints. This results in each organization having only a partial understanding of the nightlife noise problem.

Representatives of both the TMF and KFF noted that many of the punitive measures that can be taken against non-compliant bars and restaurants are not within their jurisdiction but are instead the responsibility of the police. Mr. Vilner, Vice Police Chief, clarified that the police do not have the resources to address all of these issues as they prioritize issues like terror, violence, and drugs.

Finding #2: The current noise disturbance reporting mechanisms are unclear to residents and obstruct data collection.

Summary of Evidence:

Interviews with Hugo Madsen, Søren Nielsen, and inner city residents informed our understanding of the current complaint system. Mr. Madsen described the process of contacting the noise management resources and explained the challenges with the current system. The foundation of the complaint system, as illustrated in Figure 5, is composed of the residents and citizens. The residents and citizens are the ones who are most affected by the nightlife noise problems and are the source of the majority of noise complaints. Residents trying to complain about noise must navigate this complex system to determine whom they need to contact. If the noise is coming from bars, restaurants, or other businesses, the residents have three methods of submitting their complaints depending on the time of day. If the disturbance occurs during the workday, they should contact the Noise Unit to submit their report. If the noise disturbance occurs at night within a specific timeframe (see Figure 5), the resident should contact the Noise Guard. If necessary, a Noise Guard representative will come to the scene, measure the noise levels, and enforce the rules on-scene to the best of their ability (i.e. close open windows, ask the establishment to turn down the music, etc.). Figure 6 provides a graphical representation of both the bars' and restaurants' hours of operation and the hours in which the Noise Group and Noise Unit operate. Although establishments in Indre By have different hours of operation, the hours represented in Figure 6 reflect common hours of operation, as well as the resident testimonials from interviews. We determined the common hours by reviewing fifty local establishments' pages on Yelp and Google Maps. Some of the establishments in the area, like 7-Eleven and Netto make alcohol available for purchase twenty-four hours a day, seven days a week, however these were not incorporated into the average. Some bars remain open until six in the morning, however that is a minority of establishments. Other bars and pubs close earlier in the night, with the most common hours of operation displayed in the graphic. The operating hours for the Noise Unit and Noise Guard were found on the municipal reporting page.

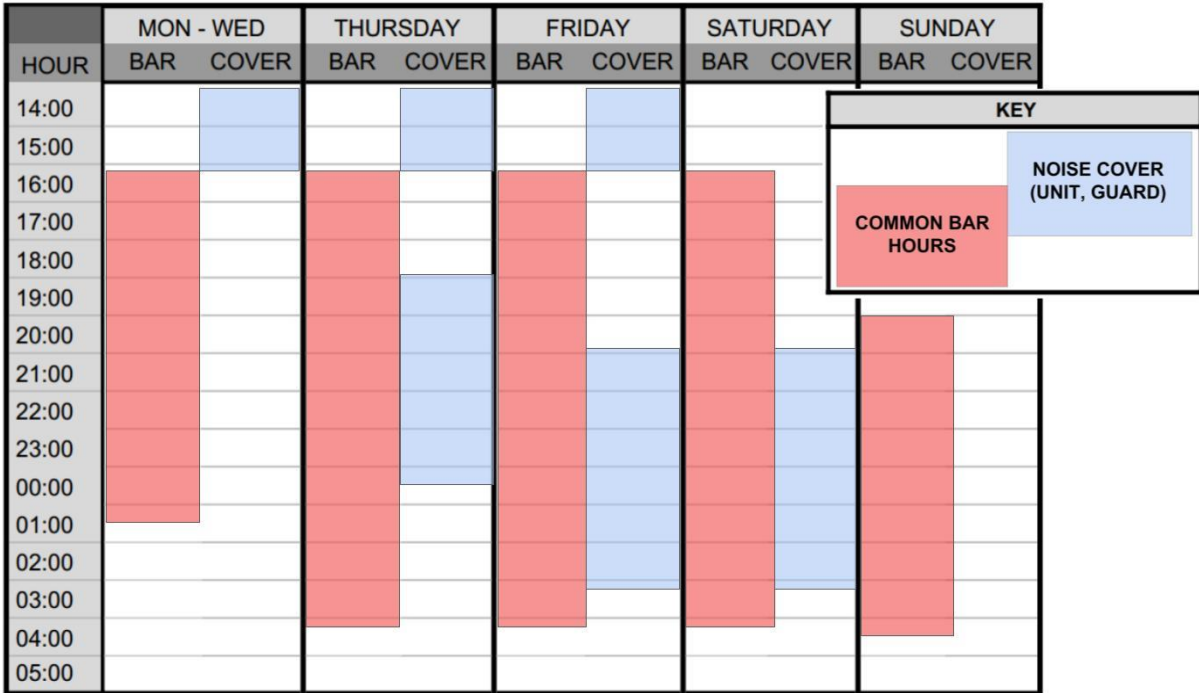


Figure 6: Noise Unit & Noise Guard Operating Hours Compared to Bar Hours of Operation

Mr. Nielsen informed us that many of the complaints the Noise Unit receives fall outside of their jurisdiction because residents are unsure who the correct authority is. If the complaint is within the Noise Unit’s jurisdiction, they will address it when the appropriate resources are available. The Noise Unit does not always address these complaints due to the lack of available resources and because the source of the noise often disappears before they can arrive. Additionally, they do not operate during some early morning hours when many bars are still open (see Figure 6). Limited resources and operating hours often leave the residents to rely on the online form (shown below in Figure 7) and the already-busy police for help. The form itself is divided into four sections: contact information, location of problem, type of problem, and other information. Each section asks for detailed information about the resident and/or the incident they are reporting and contains a specific list of categories a resident can submit complaints on. Before submitting, the form asks for users to answer a simple math question in order to prove they are not an internet bot and prevent spam.

Indgiv klage over støj-, lugt- eller støvgener fra virksomhed

Dine kontaktoplysninger

Navn*	<input type="text" value="Indtast navn"/>
Adresse:	<input type="text" value="Indtast adresse"/>
Husnummer:	<input type="text" value="Indtast husnummer"/>
Postnummer:	<input type="text" value="Indtast postnummer"/>
By:	<input type="text" value="Indtast by"/>
Telefon:	<input type="text" value="Indtast telefonnummer"/>
E-mail*	<input type="text" value="Indtast E-mail"/>
Trafkes bedst:	<input type="text" value="Indtast hvornår du trafikes bedst"/>

Hvor er problemet?

Firmanavn*	<input type="text" value="Indtast firmanavn"/>
Adresse*	<input type="text" value="Indtast adresse"/>
Husnummer*	<input type="text" value="Vælg først vejnavn"/>
Postnummer:	<input type="text"/>
By:	<input type="text"/>
Åbningstider:	<input type="text" value="Firmaets åbningstider"/>

Hvad er problemet?*

Støj

- Andre støjgener (Ikke byggeplads)
- Musikstøj fra arrangement (ikke restaurationer)
- Musikstøj fra restaurations
- Musikstøj grundet åbne døre/vinduer
- Støj fra byggeplads (ikke Metro)
- Støj fra facaderenovering
- Støj fra varelevering (Byggeplads)
- Støj fra varelevering (Detailhandel)
- Støj fra ventilation eller lignende
- Støjende arbejde udenfor tilladte tidsrum (Byggeplads)

Lugt

- Andre lugtgener
- Lugt fra brændeovn
- Lugt fra madtilberedning
- Lugt fra tobaksrøg

Støv

- Andre støvgener
- Støv fra byggeplads
- Støv fra facaderenovering

Udeservering

- Udendørsservering efter kl. 24

Øvrigt?

Kommentarer*

Beskriv det du vil klage over

Vedhæft filer

No file chosen

Indtast svaret på følgende regnestykke: 9 + 2

Figure 7: Noise Unit complaint form, frm kk.dk/støj

The Noise Unit receives the responses to the online complaint form, and delegates responsibilities to the Noise Guard, who will address the complaint during their regular hours. This form does not accept complaints on sources out of the Noise Unit's jurisdiction, such as street noise or private events.

The police are the only group with the authority to handle complaints about private events or street noise. In an interview with Jakob Vilner, Copenhagen's Vice Police Chief, we learned that the police record specific information when a resident reports a noise disturbance. This information includes the location, time, nature of the disturbance, and the caller's Danish Personal Identification number (CPR-nummer) to verify their identity. All of these data are recorded in a case log system and the complaint is assigned a case number. The complaint will be addressed if the appropriate resources are available; however, Mr. Vilner explained that the police cannot address the issue when there are not sufficient resources available. Furthermore, they lack the

resources to record some details of the complaint into their system at times; in such a situation, only the case number is recorded [Appendix J].

Analysis:

The largest problem with the noise complaint process is that information on the correct methods of submitting complaints is not readily available to the public. Having different resources at different times of day, or days of the week can quickly become confusing and residents looking to take action against noise disturbances are often unable to contact the relevant authorities. We interviewed six residents of inner city Copenhagen who all explained that the current system was too complicated. This claim was further supported by the fact that three of the residents we interviewed shared stories of incidents in which they had accidentally contacted the wrong authority and were not redirected to the appropriate one.

Finding #3: Limited resources means police reaction to nightlife noise incidents is rarely immediate.

Summary of Evidence:

We asked residents for their opinions on the current nightlife management system and how they report the nightlife noise disturbances they experience. All six of the interviewed residents expressed their discontent with the current system and shared instances when they had called the police and were told that nothing could be done about the incident. The residents also described times they submitted complaints to the municipality and never received any sort of confirmation that the complaint had been addressed.

In our interview with Mr. Jakob Vilner, we learned that the police record every complaint they receive into their own system. Mr. Vilner also noted that the police are often spread too thin to address these types of complaints and only allocate resources when they can. He also mentioned that the police are reluctant to administer disciplinary action to the troublesome partygoers; in most cases they will remind an individual of their responsibilities and ask them to quiet down. Mr. Vilner said that the police are not trying to make enemies with the nightlife crowd and want people to have a good time but will take action if necessary [Appendix J].

Analysis:

Residents report noise disturbances hoping that the authorities take action. However, the police often don't take immediate action due to higher priority issues and a lack of resources. If the residents want more immediate action and the police can't spare the additional resources, then another solution is needed to address this problem.

Finding #4: A lack of response from the current nightlife noise management system, paired with a complicated complaint submission process, has discouraged residents from submitting complaints.

Summary of Evidence:

In the six interviews we had with residents of inner-city Copenhagen, they expressed that they and their fellow residents have become discouraged with how the authorities handle complaints. Residents claimed that they did not “feel validated” in their complaints, largely due to a lack of responses received from the authorities [Appendix F]. With no perceived response to their complaints, the residents felt ignored and undervalued. To some residents, the act of submitting a complaint through the current system is a futile effort. Three of the six residents also recalled times when they were told by the authorities and their peers to “just move out” and “live somewhere else” if they were bothered by the noise in the streets. One resident shared stories of times when they and their fellow residents were compelled to sleep in their kitchens or bathrooms because of the noise being produced outside their bedroom windows. One of the residents claimed that her loss of sleep was negatively affecting her personal health. This resident explained that she joined the Noise Network seeking psychological help in the form of a support network [Appendix F]. After hearing these testimonials, it was evident that the residents desire to have their voices heard and want the authorities to respond to their complaints.

It should be noted that the responses received during our interviews on this topic are biased. The residents we interviewed are noise activists in the area who have strong connections to the noise problem. Many of these residents mentioned that their neighbors have given up on complaining and now rely on the activists to share their voices and opinions. Despite this bias, each of the six residents we interviewed expressed an overall sentiment that the noise affects the majority of people living in the area. This notion is supported by data collected by a previous WPI IQP team, who found that thirty of the thirty-six people they surveyed indicated that the noise problem was at least a moderate disturbance to them (Flibbert et al., 2017).

Analysis:

The current complaint submission process makes many of the residents feel as though the authorities are not listening to them and provides them with no confirmation on whether their complaints were addressed or not. This lack of communication is discouraging residents from pushing for action. An improved complaint system needs to provide users with a sense of validation, which relies on the response they receive from the appropriate authorities.

4.2. Designing the App and its Functional Requirements

Our team interviewed public officials from the municipality, the Copenhagen Police, and specialists in data and applications to understand the technical and security requirements of a data collection system. We also interviewed members of residents' associations, members of the Noise Network, and prospective users to determine what they would like to have included in a noise disturbance reporting application. Finally, we conducted interviews with prospective recipients of the collected data, like public officials and the police, to investigate how they could use the data to improve their understanding of the nightlife noise problem. Weighing the desires of the stakeholders and understanding the regulations for data storage in the EU allowed us to follow legal restrictions, tailor the app's design to the prospective users, and satisfy requirements for effective use.

Finding #5: Important noise complaint data includes category, time, and location.

Summary of Evidence:

In our interview with the head of the Noise Unit and their IT consultant, we learned how they collect and use the noise complaints they receive. They both explained that only the location, time, and type of disturbance are useful in addressing complaints. However, their online complaint form also collects non-pertinent data, like comments, audio, and pictures. The IT consultant explained that these data are subjective and do not assist the Noise Guard, but they do make the user feel more acknowledged and validated during the submission process [Appendix I].

Analysis:

When the authorities or public officials are dealing with a noise complaint, they often only need minimal information—just enough to identify what the problem is and where/when it’s occurring. Evidence like images, audio recordings, or noise level readings are not pertinent as there is no way to verify the quality and validity of the evidence; the authorities would require a second, verifiable source like a surveillance camera to confirm the incident. This extra evidence would also require large amounts of storage space in a database and, according to the Noise Guard’s IT consultant, these data are typically not worth the resources they require. In order to best suit all parties, it makes sense to include the ability to provide this extra evidence in the app. However, the authorities and public officials should not be required to include these data in their own operations.

Finding #6: The Copenhagen Police have to follow strict data security standards, set by the European Commission and the Municipality, which restricts their use of data from external sources.

Summary of Evidence:

In our discussion with Mr. Vilner, we asked if the police would be interested in receiving the data our app collects. While he expressed interest in having access to the data analysis, he said that laws and restrictions set in place by both the local municipality and the European Commission prevented them from accepting our data into their system. He said this was partially due to police regulations, which prevented them from using unverifiable information in their operations. However, the police were also restricted by European Commission regulations on data privacy—specifically regarding the collecting and sharing of data that may contain personally identifiable information (European Commission, 2018). The legal implications, in Mr. Vilner’s view, were greater than the value our data would bring to their existing operations.

Analysis:

The Copenhagen Police and Municipality have shown interest in our app and its potential. However, it appears that any solution directly involving the police must be built by an approved developer and has to follow a strict set of design and data security guidelines. Our team doesn’t have the capabilities or resources to fulfill these requirements, but we can showcase the value of our data analysis and visualizations.

Finding #7: Simple data analysis can provide nuanced insight into the inner workings of Copenhagen’s nightlife.

Summary of Evidence:

Though representatives from both the police and municipality claim to have their own systems for recording the complaints they receive, they were still interested in viewing the data that our prototype app collects. Both authorities mentioned that these data could help them gain a deeper understanding of the nightlife problem. Data analysis and visualization, similar to what is employed in New York’s 311 app, creates visual representations of the collected data in a concise and intuitive manner. Both the police and city officials have also expressed interest in this feature, which can provide a more comprehensive understanding of the nightlife situation. Additionally, a visual representation of the data can identify geographical areas of concern and help authorities prioritize the use of their resources. Simple data analysis can also help noise activist groups like the Noise Network put together stronger, more convincing arguments to present to the authorities and strengthen the dialogue between these groups.

In our interview with Mr. Martin Gyldstrand of the KFF, we discussed how the municipality could use additional nightlife data. Mr. Gyldstrand said he could see how such an app could help both the police and the municipality better identify priorities within their night noise management strategy. He explained that “a complaint is not just a complaint, but also an opportunity for deeper analysis and better understanding” [Appendix H]. Mr. Gyldstrand also explained that it is important for nightlife management to be able to identify why the complaint occurred and how it can be prevented in the future.

To test the visualization capabilities of our application, we intended to use the data submitted through the test period as the basis for a heat map. Sixteen users created accounts and submitted a total of twelve noise reports during the application’s test period, which we conducted over a five-day span. These complaints, while examples of the types of data our tool can collect, were insufficient in quantity for analysis. To generate a larger dataset, we needed to consider the parameters upon which noise occurrences depend and design a simulation with them [Appendix M]. We used these simulated data to build timelapses, heatmaps, and other visual representations that show stakeholders the app’s potential impact.

Our simulation considered the time of day on weekdays and weekends, frequency of four different categories of noise complaint (bar, construction, street, private) based on four different

periods of the day (daytime, nighttime, peak bar hours, and the period in which most bars close), and the difference between residential and commercial parts of the neighborhood. No actual noise complaint data are available to the public, so we were forced to make a realistic simulation using educated guesses. We selected a time frame covering five weeks because we wanted a dataset that spanned multiple weekends. Given the parameters, this simulation generated 8500 individual data points (representing each resident submitting one or two noise complaints every week) and superimposed them on a map of the area in the form of a density bar graph or time-lapsed heatmap (Figures 8 and 9).

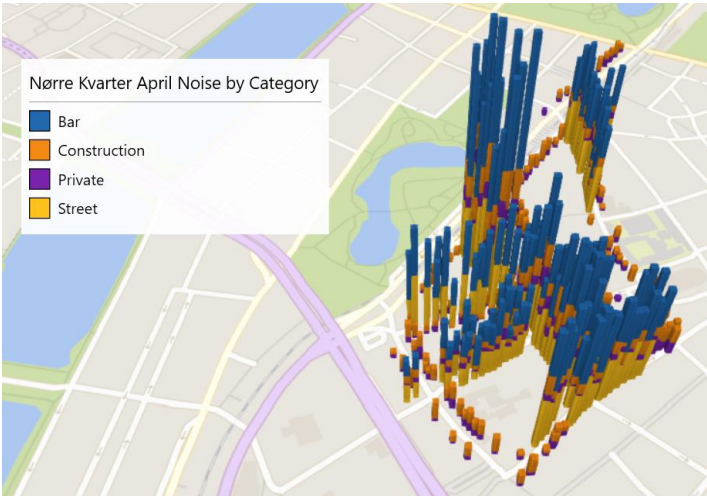


Figure 8: Example of a density bar graph highlighting noise complaint concentration by category.

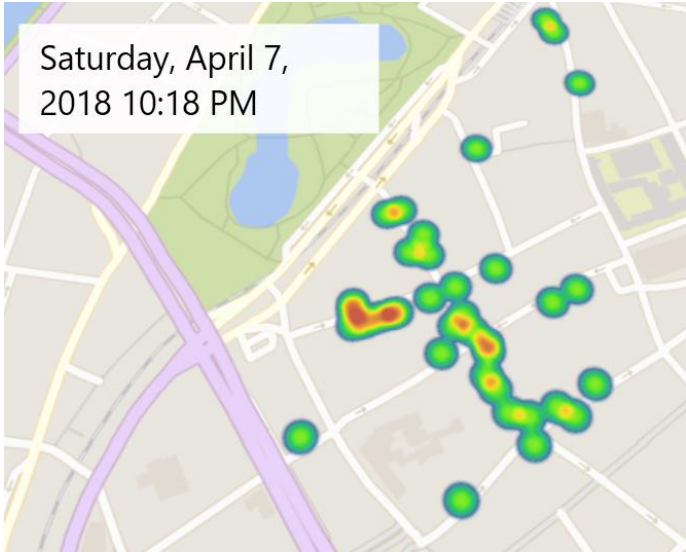


Figure 9: Example of a time-lapsed heatmap highlighting noise complaint concentration over time.

The idea of sharing data between different organizations is something that sparked Center Leader Spang Bech's idea for the development of a noise complaint app. She recalled a time when she was part of a project where the municipality crowdsourced data about a poisonous and invasive plant species in the city for removal purposes. This information not only helped authorities deter the invasive species, but also helped educate the public on the problems and reasons behind the plant's movement which prompted further action on the issue [Appendix C]. The municipality expanded this idea into an app known as "Giv Et Praj", which translates to "Give a Hint." This app deals with vandalism and repair complaints and provides a live map feed of the status and location of requests. Ms. Spang Bech explained how she envisioned a similar approach being taken for noise.

However, the Noise Guard's IT consultant raised an important concern regarding the publicity of the data collected by this app: any open-ended information collected (comments, audio, images) could potentially risk accidental disclosure of private data. These data need to be secured for legal purposes because someone may submit potentially compromising information about themselves or someone else. This can even extend to location data. If published data show a high volume of complaints in close proximity to a single bar, the analysis turns into a public statement that identifies that bar as a problem. A similar statement can be made about publishing the exact location of where a noise complaint was filed. It could unintentionally single out and expose households to retaliation from the groups affected by the noise complaints, such as the owners of bars and restaurants, and the nightlife crowd themselves. Therefore, it is important to ensure that no piece of published data is detrimental to any one individual or business.

Analysis:

Authorities like the Police and Noise Guard showed interest in utilizing analysis and visualizations from the data our application collects to improve their nightlife management strategies. To showcase the potential of our app's analytics and visualizations, we created a simulation to generate example complaints based on realistic constraints. These constraints accounted for time of day, day of week, density of alcohol-selling venues, and the different complaint categories. The example visuals we generated utilize both basic data analytics and more complex methods to provide additional context on the nightlife noise problem.

Finding #8: According to prospective users, a successful noise complaint app should be simple, easy to use, and provide deeper insight into the nightlife noise problem.

Summary of Evidence:

In our Noise Network survey, seven of the eight respondents mentioned that the current complaint system is inconvenient and difficult to use [Appendix B]. Long and complicated complaint forms can deter citizens from submitting reports, so a noise complaint submission form should be quick and straightforward to fill out. This sentiment was echoed by a Danish app developer we spoke to, who stressed the importance of developing a user-friendly interface that anyone can navigate. He also mentioned that we cannot expect users to spend anything but a minimal amount of time when filing a complaint, especially when the majority of noise complaints will be submitted during the late hours of the night [Appendix G].

After completing the application's testing period, we analyzed the responses received from the survey we provided to the test users. The app was made available through our sponsor's website and a link to the web app was delivered to approximately 250 people via email. The survey contained technical questions on topics such as device type and browser used, as well as subjective questions about their individual experiences using the application [Appendix L].

Test users felt our prototype app, while easy to use, could have a more intuitive noise report submission process. They believed that we should be clearer in explaining the details of the submission, process of registering, and meaning behind complaint labels. Additionally, the users expressed interest in an option to submit supplemental media like pictures and audio. After submitting a complaint through our system, two users suggested that we provide feedback on where the information goes and when they can expect a response. They also wanted the ability to view their and others' submitted complaints. The prototype app was designed as a minimum viable product that collects only the data essential for analysis purposes (category, time, and location).

One user thought that the buttons could be in a more convenient location, which would allow for more intuitive navigation through the app. One user echoed a point we found in earlier interviews—that residents want to know what their submissions are used for and if there is a response. Another suggestion was to better explain the complaint categories, since they may not be self-explanatory [Appendix N].

Analysis:

Our app's testing period had a positive overall response. We reached a total user base of sixteen people during our test period and received six complete responses on our feedback survey. According to the users who filled out the survey, our app was easy to use. However, we have no measure of the number of people who attempted to use the app but couldn't and gave up. Thus, we cannot derive a meaningful conclusion about the usability of our app beyond the limited scope of feedback we received.

5. Conclusions and Recommendations

Through interviews conducted with our stakeholders, our team identified the shortcomings in Copenhagen's current nightlife noise management resources, identified the necessary features of an effective data collection tool, and developed a prototype app that is able to collect noise disturbance data.

5.1. Summary of Findings

Finding #1: The current nightlife noise management system of inner city Copenhagen is complex and poorly conveyed to the public.

Researching the nightlife noise management system unveiled a complex structure that is difficult to navigate and doesn't provide direct feedback to those who are submitting complaints. The different municipal groups operate within their own specific jurisdiction, and do not coordinate data communication nor effectively redirect misguided users.

Finding #2: The current noise disturbance reporting mechanisms are unclear to residents and obstruct data collection.

During interviews with the residents of inner city Copenhagen, we repeatedly found that they had misconceptions about how the city's nightlife management system works. Residents have a difficult time identifying the authority they're supposed to report a noise complaint to, as different organizations accept different complaints at different times. This often leads to residents submitting complaints to the improper authority and those reports not being properly addressed.

Finding #3: Limited resources means police reaction to nightlife noise incidents is rarely immediate.

Residents who complain say they rarely see a response from the police. If the police come, it's typically after the disturbance has already subsided. Our interview with Mr. Vilner, Vice Chief of the Copenhagen Police, revealed that the police are unable to address every complaint they receive because they prioritize more pressing issues like terrorism, violence, and drugs.

Finding #4: A lack of response from the current nightlife noise management system, paired with a complicated complaint submission process, has discouraged residents from submitting complaints.

During our interviews, residents explained that they felt ignored by city officials when voicing their concerns over the noise problem. The residents' discontent with the current system, combined with a lack of police response and a complicated submission/reporting process, discourages residents from remaining engaged in the process and continuing to report noise disturbances.

Finding #5: Important noise complaint data includes category, time, and location.

Interviews with Noise Guard and Copenhagen Police management revealed that the type of disturbance, when a disturbance occurred, and where it happened is all the information necessary for them to take action—everything else is supplemental.

Finding #6: The Copenhagen Police have to follow strict data security standards, set by the European Commission and the Municipality, which restricts their use of data from external sources.

In talking to Vice Chief Vilner, we learned that that laws and restrictions set in place by both the local municipality and the European Commission prevent them from accepting our data into their system or making their data available to the public.

Finding #7: Simple data analysis can provide nuanced insight into the inner workings of Copenhagen's nightlife.

The police and city officials can gain a better understanding of how much the nightlife scene impacts the local quality of life through simple analysis of the data collected through our prototype app. The police and city officials also showed interest in visualizing these data through media like heat maps and timelines.

Finding #8: According to prospective users, a successful noise complaint app should be simple, easy to use, and provide deeper insight into the nightlife noise problem.

In our interviews with residents, they explained that they do not want to navigate through a complicated form to submit a complaint if they are awoken in the middle of the night. Thus, app designs must be simple and allow users to quickly submit their data and promptly return to sleep.

5.2. Recommendations

From the findings listed above, our team was able to draw conclusions on how to implement our solution efficiently and ways the police and municipality can incorporate the idea of a noise complaint app into existing efforts to manage nightlife noise. Our recommendations fall into two categories: addressing the nightlife noise problem directly and further enhancing the data collection tool and data analysis.

5.2.1. Recommendations to Address Nightlife Noise Problem

Recommendation #1: The Copenhagen Police utilize the data collected by the app to improve the allocation of nightlife management resources.

Explanation:

With a deeper understanding of the trends in nightlife disturbances, the police would be able to prioritize and concentrate resources on specific areas at peak times. This could enable the police to address sources of noise before they bother residents. This does not address their lack of resources, however it would result in them being used more efficiently.

Recommendation #2: City officials utilize the collected data to influence their decision making processes when issuing liquor licenses in active nightlife areas.

Explanation:

All eleven of our interviewees cited the availability and abundance of alcohol as a significant contributor to the nightlife noise problem. In many of those discussions, they also expressed their discontent with the way liquor licenses are issued. We recommend that city officials, including those in the KFF and TMF, utilize the data collected through our app to identify localized patterns of noise disturbances before issuing licenses to any new bars or restaurants in an area. If city officials considered these data before awarding liquor licenses, this would give the residents an indirect yet powerful voice in how their community is shaped. This also allows the public officials in the municipality to gain a deeper understanding of how residents are affected by the patrons of the businesses around them, and should consider this when allowing potentially noisy businesses to open in residential neighborhoods.

Recommendation #3: We encourage Miljøpunkt Indre By & Christianshavn and the Noise Network to promote the use of this app to increase data collection.

Explanation:

Our data collection system is dependent on two core factors: the number of people using the app and the amount of data collected. The larger the audience this app is able to reach, the more people are likely to use it. More people using the app increases the sample size, which generally leads to a more representative data set. If all of the data can be attributed to a small number of users, the data effectively becomes useless because it does not create an accurate representation of the problem as whole, but instead reflects the perspective of a few individuals. We encourage noise activist groups to promote the use of this app throughout Copenhagen through social media and local publications, to grow its user base.

5.2.2. Recommendations for Continued Development

Recommendation #4: We encourage Miljøpunkt Indre By & Christianshavn and the Noise Network promote the development of a comprehensive noise complaint app.

Explanation:

Although our team was unable to develop a finished product that incorporates every requested feature, we were able to pique the interest of the primary stakeholders of this project. Based on our research and findings, we came up with four reasons why a system like this should be implemented in Copenhagen.

1) Centralized data collection promotes communication between relevant authorities.

Collecting data in a centralized manner, whereby all complaints are going to the same location and can be accessed by all relevant authorities, can help promote cooperation between the Copenhagen Police, the Noise Unit/Noise Guard, and the Municipality. Such a system will encourage communication between these groups and help all influential stakeholders work together to assess and address the nightlife noise situation. As more data enter the centralized database, all parties would be able to see how complaints are being addressed and propose improvements to how the city manages its nightlife. When legislative changes are needed, all parties will have access to the same information that could influence the legislature. This would

minimize the amount of time spent sharing data between authorities and give everyone the same view of the nightlife situation.

2) Ease and accessibility allows for quick, convenient complaint submission.

As illustrated in our Findings chapter, the current mechanisms for reporting noise disturbances are complex and difficult to navigate. Currently, the difficulty of submitting a complaint operates as a filter, discouraging residents from submitting complaints which they believe are not worth the time to submit or the frustration experienced when submitting. This results in only high-priority complaints being submitted, where the disturbance is more annoying than the submission process. An app that minimizes this process by allowing users to submit complaints quickly through a simple form would greatly improve this process and likely result in a more representative set of nightlife noise complaints. It is important to note that making the submission process easier might also produce an over-representative set of noise complaints, as the ease of submitting complaints might prompt residents to also report smaller noise disturbances that don't require a response from the authorities.

3) A streamlined complaint submission process can automatically direct complaints to the proper authorities and has the potential to facilitate a unified response system.

Due to the complex nature of Copenhagen's noise complaint system, each of the authorities responsible for managing nightlife noise inevitably receives complaints that fall within another authority's jurisdiction. In many cases, they contact the other authority and notify them; however, this wastes time and resources that could be better allocated elsewhere. A comprehensive application could automatically handle the process of notifying the correct authorities, while still making the complaint information available to all parties. This app could also act as a conduit for responses to these complaints—where the handling authority (the Copenhagen Police, the Noise Guard, or the Noise Unit) could provide a response to the filed complaint, and the user could view and keep a record of it along with the responses they've received for other complaints.

- 4) **Centralized data collection allows for analysis and visualization, which can illustrate the situation in a comprehensive manner and help the authorities better manage the nightlife scene.**

This app, if properly promoted by the municipality and other organizations, could effectively become a “Big Data” system where many sources are sending data to one easily-accessible repository. The type of data—temporal, geospatial, and categorical—is primed for data analytics if collected in large quantity. More specifically, these data lend themselves to representation in heatmaps, time lapses, and timelines that can illustrate the changing landscape of the nightlife noise problems in inner city Copenhagen both over time and in real time.

Recommendation #5: We recommend the future developer of this app implements additional features to the prototype app.

Explanation: In our surveys and interviews, prospective users have provided us with feedback on additional features that they would like to see in future iterations of our app. We did not have the time nor the resources to include these features in the final version of our prototype. We recommend adding the following to the app:

- 1) Official Complaint Response System
- 2) Auto-Detect Location
- 3) Audio & Media Uploading
- 4) Improved Mobile Functionality
- 5) Improved User Account Features
- 6) Quick Submission
- 7) Open Source Data
- 8) Complaint Threads
- 9) Noise Complaint Tags
- 10) Virtual Marketplace Availability
- 11) Handicap Accessibility

- 1) **Official Complaint Response System:** When we asked the Noise Network about what features they believe our app should have, they requested a way to see what the police have done in response to a complaint. Thus, we recommend that the future manager of this app work with the Copenhagen Police to integrate some sort of response system. Designing

and developing an official complaint response system would require close work with the Copenhagen Police Department and København Kommune to set up the workflow systems that enable officers to respond to the complaints submitted through the app. Additionally, the police would have to allocate additional time or resources to respond to these complaints.

- 2) **Auto-Detect Location:** By using modern geolocation services, we can automatically detect the location the noise complaint is being submitted from. This is an essential part of the “quick reporting” feature and making the app convenient to use. This feature requires the web app to be hosted on a website with a Secure Sockets Layer (SSL) digital certificate that secures an encrypted connection between a user’s device and the server. We were unable to meet the data security protocol requirements to receive an SSL certificate because we did not have adequate access to the server our app was hosted on.
- 3) **Audio & Media Uploading:** This feature was frequently requested by prospective users during interviews and in surveys. We opted to exclude this feature from the final prototype because we lacked the time to get it working properly on every operating system. Even though the local authorities would not use these data, we recommend adding this feature to accommodate the wishes of the user base. As more image and audio data are collected, the database will grow quickly and eventually need more storage space. We recommend that the future developer of this application uses an elastic storage service that automatically allocates additional storage space when needed.
- 4) **Improved Mobile Functionality:** The final prototype of the app is not optimized for use on mobile devices, as we lacked adequate testing resources. The web app is fully functional and optimized for use on web browsers on personal computers, but is not as fluid and organized on mobile devices as we had hoped it would be. With more time and resources, the app can be optimized for use on mobile devices. This is essential to its success, as we believe that most complaints will be submitted through the app during the late hours of the night when people are woken up by the disturbances they experience. These people will

most likely reach for their phones to report this disturbance because it will likely be close by.

- 5) **Improved User Account Features:** The future developer of the app should implement extended account features to improve its usability. We decided not to collect any identifying personal data (email, phone number, etc.) in our prototype app because we were unable to implement proper data encryption. Assuming that proper security features are eventually implemented, we recommend that future iterations of this app allow users to register their email and phone numbers which could be used for password recovery and account authentication features. We would also recommend implementing a feature that allows users to view a history of their past submissions, as this feature was heavily requested in the feedback we received during our testing period.
- 6) **Quick Submission:** “Quick” submission would enable sending a complaint in as few as two button presses. This would be useful for users who are woken up in the middle of the night and do not have the patience to navigate through multiple menus. We were unable to implement this feature because GPS-based tracking was restricted on the web app without data transfer encryption.
- 7) **Open Source Data:** A core feature of New York City’s 311 complaint system is that all complaints are compiled into an open source data set. This allows any interested parties to perform data analysis on the city’s complaints. The 311 complaint app makes all data available to the public through an online database, allowing users to see all the complaints that have been submitted in the city, the status of those complaints, and the resolution details. This gives users insight into the management of their communities and the ability to see how their complaints have been handled. Implementing a system like this would require significant understanding of legal implications beforehand, but would be greatly beneficial to the overall success of this system. While making the data open source was a requested feature during the test period of our app, there are risks associated with publicizing submissions.

- 8) Complaint Threads:** A complaint thread system would allow users to confirm the complaints of others nearby, rather than submitting their own for the same incident. This would organize complaints and verify that the disturbance affects multiple users. For example, a noise complaint that has been confirmed by three other users would help validate the complaint and express the severity of the disturbance. A similar feature is utilized by the “SeeClickFix” app, which allows users to *upvote* or *like* other public facilities-related complaints/requests that have been submitted in the area. The more *upvotes/likes* a complaint has, the more visible the complaint will be to authorities.
- 9) Noise Complaint Tags:** Residents have recommended that we add categories for trash collection and noisy party busses. Rather than expanding our current list of categories, we suggest adding an optional “tagging” system. This system would still require the user to specify a broader complaint category, but then further identify the type of complaint using more specific “tags.” This feature would also add the ability to search complaints by their tag in the database and would offer local authorities a more descriptive look into the noise complaints without having to read through individual user comments within the complaint.
- 10) Virtual Marketplace Availability:** To maximize the reach of our app, it should be made available on the most popular app distribution platforms: the Apple App Store and the Google Play Store. Making the app available on these virtual marketplaces allows users to download the app to their phones quickly and easily, leaving it just a tap away whenever they want to use it.
- 11) Improved Technological Accessibility:** During an interview with one resident, they suggested that we should integrate features that increase the technological accessibility of this app. These features could include: colorblind modes, the ability to increase font size, and potentially features that would assist visually impaired users by providing compatibility with screen readers. Although these features are not essential to the overall success of the app, they would help make this accessible to all potential users.

Recommendation #6: The future developer create additional data analytics and visualization tools to best represent collected data.

Explanation:

Our interviews with stakeholders repeatedly confirmed that data analytics and visualization tools would make it much easier to understand the nightlife noise situation as a whole. These tools could include heatmaps of inner city Copenhagen showing the density of submitted complaints, timelines that show the number of complaints submitted on any given day or at a specific time, and tables showing additional useful analysis of the data. A well-designed and developed data visualization and analytics dashboard would provide an easy way to view the nightlife noise situation in inner city Copenhagen and determine if the situation is improving—or getting worse—over time. Without it, interested stakeholders would have to crawl through Comma-Separated Value (CSV) files filled with data and perform their own analyses manually. Several tools that can perform these types of data analysis and visualization include: Microsoft Excel, which has a surprisingly robust data analysis package; Tableau, a professional software that includes strong geospatial and temporal data analysis; and R, a powerful programming-based statistics and data analysis software.

Recommendation #7: The Copenhagen Police and Municipality work together to develop an app that streamlines the noise complaint process.

Explanation:

We strongly recommend that the Copenhagen Police and municipality work together to develop an app that streamlines the noise complaint process into one system. The implementation of a professionally designed noise complaint system could provide both authorities with access to all the submitted data, and initiate the dialogue between these two authorities about making improvements to the nightlife noise problem. Although we were successful in gathering the interest of the police and municipality they were unwilling to take over a system like the one we developed for two reasons. First, both of these bodies already have their own data collection systems. Second, acquiring a system like ours would come with many data security requirements and legal obligations. Mr. Vilner, Vice Chief of the Copenhagen Police explained that they are not in a position to take on a system like this because they would be required to respond to and follow up on every complaint they receive, which they do not have the resources to do. However, in order

for a noise complaint app to reach its full potential, the police and municipality must work together develop an integrated system that streamlines the data it collects and has the appropriate feedback channels built-in.

A simpler solution would just require the municipality to add noise complaints to their “Give et praj” app, which already allows users to report facilities-related problems, much like that of the NYC 311 app. Considering that noise is the number one type of complaint submitted through the NYC 311 system, it would make sense for the Copenhagen Municipality to add this feature to their already existing app (Cook, 2017). The addition of a feature like this could be used to help provide the evidence for the need of a dedicated noise complaint application. The prototype app we developed functions both as a research tool, and as a working data collection system that can be used until this system is expanded, or a new system has been developed following our recommendations.

5.3. Technology and Society

Throughout the process of researching and completing this project, we learned many valuable lessons. The key ones follow:

- 1. Before you can develop a proper solution to a societal problem, you must immerse yourselves in the problem to gain a deeper understanding of the issue.**

No matter how much research you do, it is impossible to obtain a full understanding of the problem unless you experience it firsthand. Following our pre-project preparation, our team felt that we had a solid understanding of the problem. However, once we arrived in Copenhagen and began interviewing the problem’s stakeholders, we quickly discovered that the problem was much larger and more complex than we had previously thought. By immersing ourselves in the situation and talking to people with different experiences and perspectives, we were able to gain a deeper understanding of the problem and use it to design a stronger solution.

- 2. Understand the differences and disagreements within the community you are working in and accommodate for the biases they introduce to your research.**

In talking to the various stakeholders involved with Copenhagen’s nightlife noise problem, we discovered that the topic was fairly divisive. The residents, city officials, and police all had

different experiences and perspectives of the situation, and all had bias in their beliefs that reflected these differences. All parties had disagreements about what was important in addressing the issues and how to go about solving the problem. For example, the residents feel like the municipality and police could be doing a better job of controlling the nightlife noise, whereas the authorities feel as if their responses to complaints are sufficient. Our team was not in a position to determine which party is “correct” without slanting our own bias in one group’s direction; taking one party’s side destroys the objectivity of our reporting. These differences made it crucial to frame our recommendations in objective and diplomatic language as they’ll have impact within all circles of the community.

This situation occurred again when we had to decide whether to omit certain features in the prototype versions of our app. The idea of implementing a feature that would allow users to upload video, audio, and decibel recordings in our app was something that came up a number of times in our interviews and surveys with residents. In interviews with the Noise Guard and the Copenhagen Police, we learned that validating such information is time consuming and unnecessary. To approach this disagreement, we looked at the issue from both perspectives. Residents wanted to prove the severity of the conditions through visual and audio media. However, the authorities would be the one validating the data, and deemed it unnecessary for practical applications. In the end, we decided to develop the prototypes of the app without the feature due to limited time and resources, and suggested that this feature be added in future versions of the app.

3. Participatory research and co-creative design is an effective way to approach a social problem with an engineering solution in mind.

Participatory research gives the community (and its stakeholders) a hand in identifying the root of the problem and provides a more in-depth perspective of the situation. In our preparation for this project, we had difficulty finding a lot of the information we deemed necessary to frame the nightlife noise problem. Upon arrival, we worked with our sponsor to reach out to those who are invested in the problem—the residents and city officials. Their motivations for wanting this problem to be addressed (for the residents: being able to get a good night’s sleep; for the city officials: having happy constituents) gave them reason to help by participating in our research with

us. This was particularly helpful in determining the structure of the current nightlife noise management system, where we had several residents helping outline it with us.

Co-creative design gives the community control over their problems and encourages them to contribute to a solution. During our app's development and design process, we sent an invitation to try the initial prototype to everyone who had expressed interest in our project: residents, city officials, police, and local businesses. This invitation included a request for feedback on the app—specifically regarding its layout, ease-of-use, and available features. Since we invited feedback from people who were motivated to help improve our solution, they were more than willing to try it out and provide advice and ideas.

4. Keep the end-goal in sight and know when to cut corners.

As we learned more about the problem at hand, the scope of our project quickly grew well beyond what our team was comfortable with. While we came in with the intention of developing a prototype app to allow residents to report noise disturbances, interviews with stakeholders expanded our list of potential features and shifted our focus away from the problem at hand and more towards the development of the app. Eventually, our team realized that the time limit of the project would prevent us from delivering a fully-developed application that allows users to submit noise complaints directly to the Copenhagen Police and municipality.

After several weeks of exceptionally-long workdays, it seemed like our goal was still just as far away as it was when we had started. At this point, we reflected on our initial goal and realized that we had lost focus of our purpose in the project: to survey the situation, understand the perspectives of all major stakeholders, and develop a tool that modeled a basic approach to solving the problem. We had focused entirely on finding and implementing a solution that maximized quality without considering whether we actually had sufficient time to do so. Often times, when assessing a situation and developing a solution with a deadline, you are forced to find a balance between quality of research/design and overall productivity. Too much focus on the former will lead to a lack of work/life balance and inevitably overworking oneself, whereas too much focus on the latter will lead to a quickly-developed but likely inadequate solution.

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7. Appendices

Appendix A: Stakeholder Maps

Figure A.1: Complete Stakeholder Map.

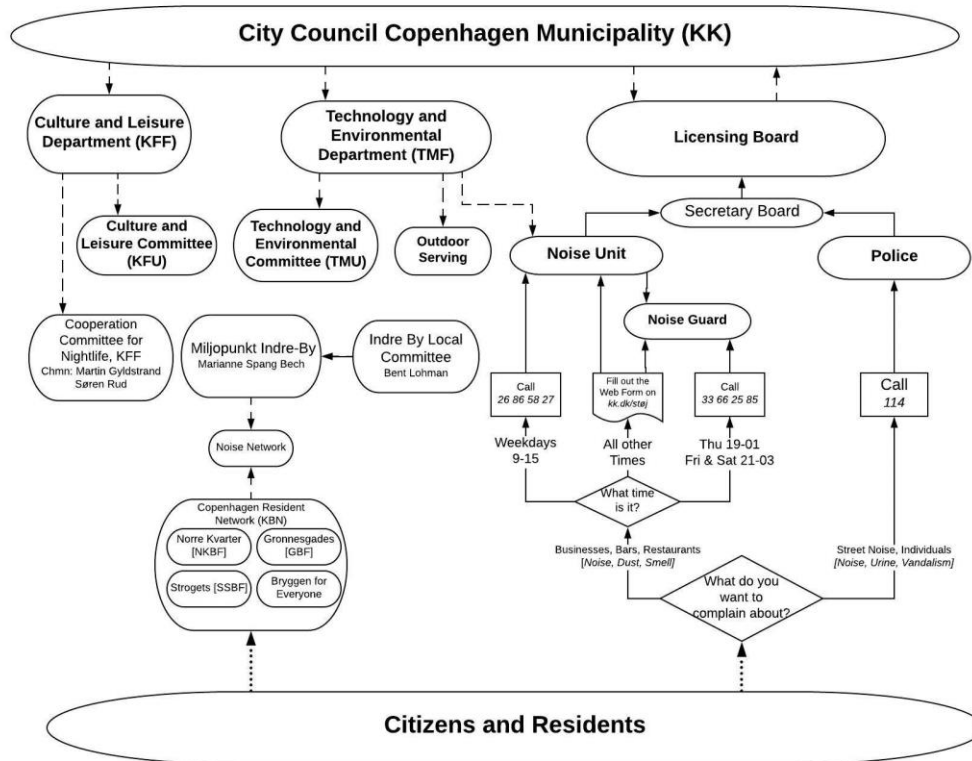


Figure A.2: Map of Resident Involvement

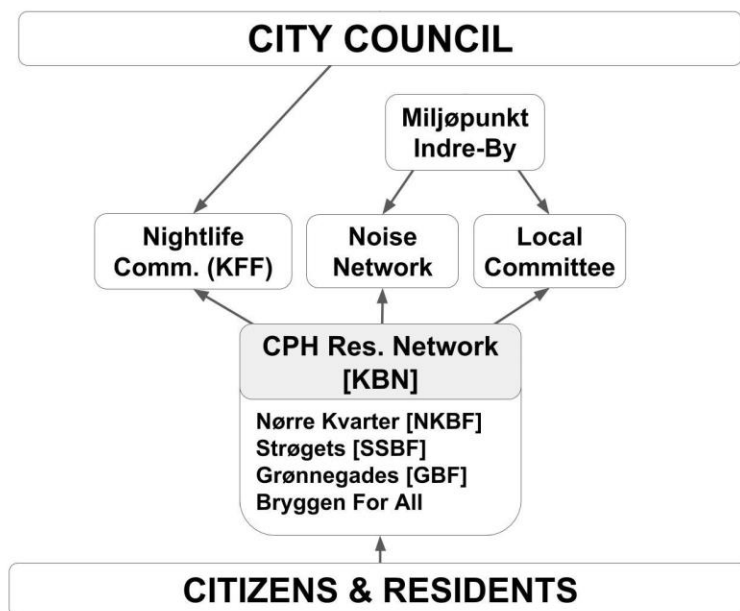


Figure A.3: Complaint Reporting Path.

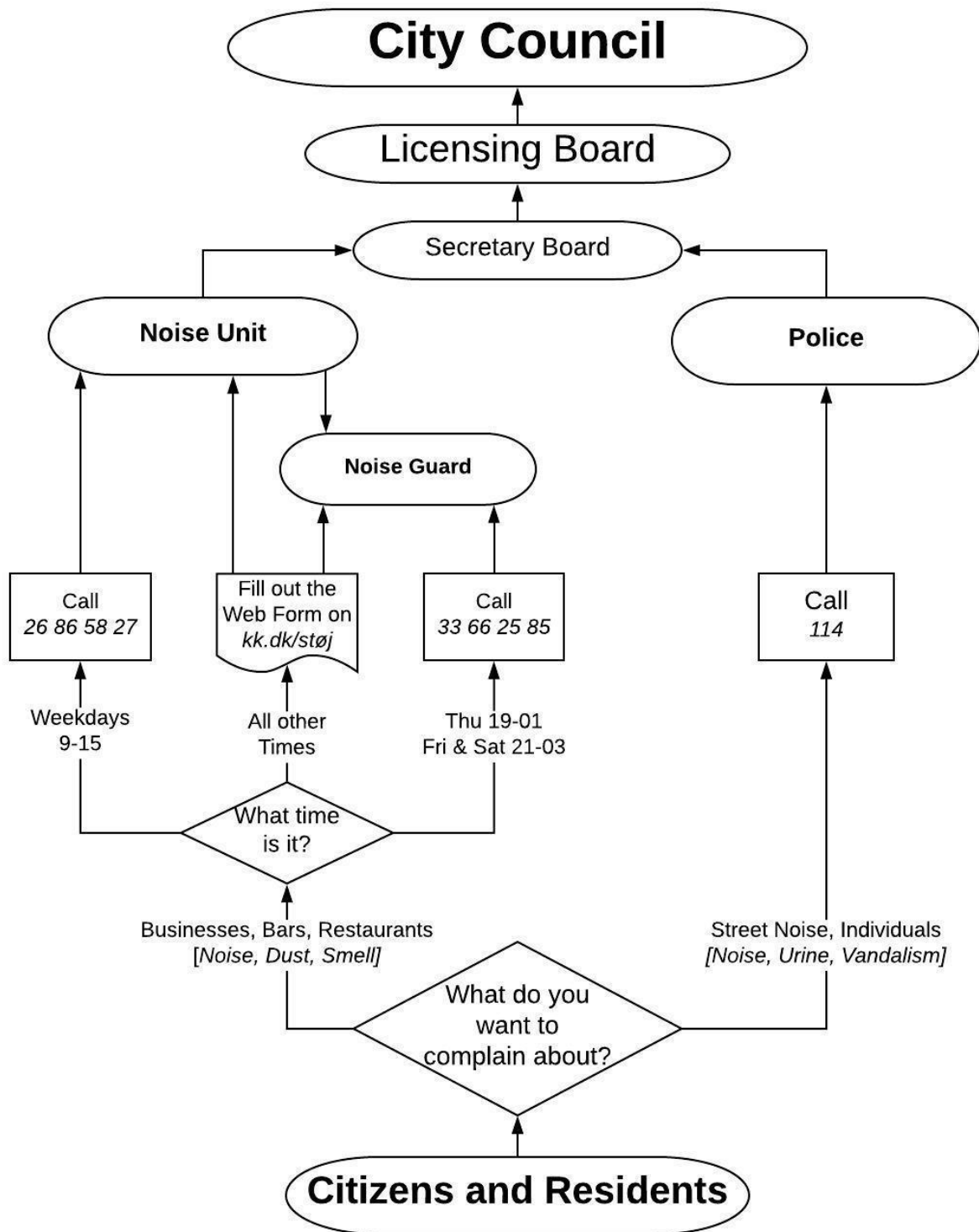
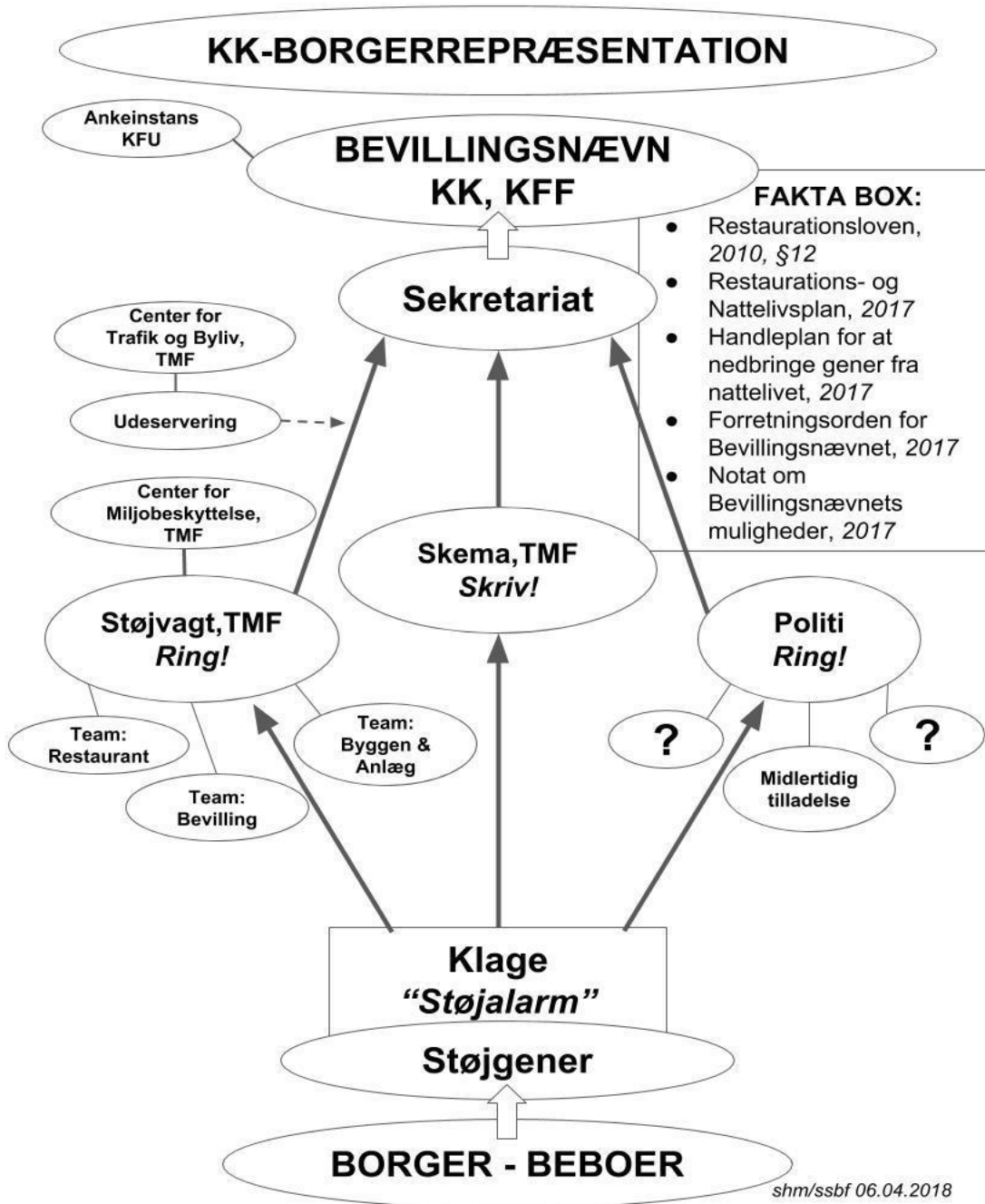


Figure A.4: Danish Stakeholder Map, made with the help of Hugo Madsen [Appendix E].



Appendix B: Noise Network Survey Answers

March 19, 2018

Questions:

1. **What aspects of the current noise complaint system can be improved?**
2. **What features would you like to see in a noise complaint submission app?**
3. **What would be a good way to promote this app to area residents?**
4. **Would access to any noise disturbance information help you in your efforts within the Noise Network?**

Answers:

Question 1	The largest problem is that people do not know where and how to complain!
Question 2	Easy to use, at 'official' events that it is possible to see the permission, document noise (pictures, video, sound) and send a complaint to relevant authority
Question 3	?
Question 4	Yes? And in my work at 'lokaludvalget' [local committee] in Nørrebro
Comments	I live in the part of Copenhagen named Nørrebro—not the inner city—but the problems with the nightlife is expanded to us over there.

Question 1	To actually be heard. Complaints need to be focused registration at complaints. So 1. Focus 2. Registration 3. Consequences
Question 2	Easy availability, DB noise measurement. Different categories: noise from neighbor, street noise (people), music
Question 3	Download from official webpage (miljø + teknik)(Kommune)
Question 4	Like NYC311 so everybody can see statistics

Question 1	Easier way from the individual to the police and town hall.
Question 2	?
Question 3	Local papers amongst other things.
Question 4	Yes

Question 1	Registration. Transparency.
Question 2	Fulfill all legal requests to a complaint[?]
Question 3	Local paper, lokal udvalg
Question 4	Knowledge about noise

Question 1	Signs and police involvement (more resources to the police), authorities such as guards visible in parks and nightlife streets to make party people behave with respect for local residents and stop noisy and messy behavior (urinating in the streets, leaving garbage, etc.) and with authority to fine people for unacceptable behavior, improved registration with authorities of complaints from citizens.
Question 2	dB level and indication of nuisance level (for instance: impossibility to sleep, babies crying, pulsating bass that make it impossible to relax). contact information to the authorities, the app must be "open source", and it must be applicable to computers for people who do not have a smartphone
Question 3	Through local newspapers, local media (local radio and tv), meetings for residents, advertisements in local culture houses, cafés, libraries
Question 4	Absolutely yes!

Question 1	Almost all: More transparency, access to data, easy to use (hardly anyone complains that I know of- too difficult, especially nighttime). You can define yourself what noise is. Today it is hard to complaint about "party-in-the-streets"- None because no one finds themselves responsible and so no one receives complaints.
Question 2	?
Question 3	Flyers- Neighbor knock-on-doors? Sure you have better ideas than I do. Important that is marketed with the IMPROVEMENTS (as people have given up complaints)
Question 4	Always good to know more

Question 1	All kinds of noise will have to be included
Question 2	Direct and reliable access to the relevant authorities
Question 3	?
Question 4	Certainly. The main problem is: who among the authorities will listen?

Question 1	24/7, 365 Access to complain. Open source so all can see complaints filed/registered. All complaints to be saved indefinitely by authorities (min. 10 years)
Question 2	Ease of access and use; possibly by iPhone/Android or online by computer. Classification of type of noise (garbage collection vs. drunk rowdy behavior, etc.). Able to view the data and withdraw it according to category of noise.
Question 3	Local Newspapers, posters in the area sponsored by city officials (emphasizing collaborative effort to post cards distributed in bars, bistros, etc.)
Question 4	Definitely! Necessary to motivate city officials to act. Information on how other cities already approach solving problems of nighttime noise is also useful and inspirational—both for the Noise Network and city officials.

Appendix C: Interview with Marianne Spang Bech

Center Leader at Miljøpunkt

March 12, 2018

1. What expectations did Miljøpunkt have for this app before we arrived?

a. What are the current expectations for the application?

Two years ago, Ms. Spang Bech had an idea about compiling all of the complaints for the noise group and noise network, and simplifying the data collection process both for the network and municipality. She had the idea from work, and the municipality, where there was a lot of data about invasive plant species that made people sick on contact- so they crowdsourced the information. There needed to be a platform to report the plants, and compile that information in one place. They expanded the application to signs and graffiti and anything's possible. The noise network liked the idea, and wanted to move forward with it. She expressed that this needed to be an app to help make the end data recipient more qualified in management of the noise.

b. Have Miljøpunkt's expectations for this app changed due to our research and presentation?

Ms. Spang Bech told us they hadn't changed; "Actually, [she] was very pleased about [our] background information." She felt the preparation that our group did was good because it was a way to show others we're not the first who attempted to create an app like this. Being the first is hard, but there was already proof of concept and we were building off prior examples.

c. In what ways have the expectations changed?

They haven't.

d. What is your dream for this app, if it could be perfect, ignoring constraints?

Ms. Spang Bech told us to keep it simple. She said it shouldn't have 10 pages of data entry that a user has to navigate through. It had to be easy to use and easy to use the data it compiles. She told us "I dream of simple" and that this app should help compile a more complete view of the issue, which will enable authorities to use resources better.

2. What features do you believe are necessary in this application

a. What types of data do you think will be the best to collect?

Ms. Spang Bech wanted a "Do you have another complaint?" page after user submits complaint, which leads them back to the main page, or redirects them to the reporting page again. She also told us to make sure the reported location is where the noise is, not necessarily where the user lives. We learned we should consider asking users for contact info, but weigh that against anonymity. She told us we needed to verify the data. If we couldn't verify through the application, then the bars and restaurants wouldn't take the data to be valid. If we decided the user should submit complaints anonymously, then she said there needs to be some verification, either over the phone or online.

Ms. Spang Bech suggested that our app might need to require things like the user's name so we can ensure it's a valid source of information. She also said it would also help in identifying repeat-complainers, so it can be addressed as to why they are repeatedly complaining.

b. What else can our app achieve which would be beneficial for Miljøpunkt?

Ms. Spang Bech had this vision of a “Super cool app” that should modular. She said the app should be a generic reporting mechanism, and that switching out noise with something else would enable the app to address other issues, not just noise.

c. What data do you think residents want to submit (complaints)?

She told us that they want to be asked more questions about the nature and source of the noise. Ms. Spang Bech suggested we ask police “what are the problems with their complaints?” and “How could we help improve that data?”

d. What does Miljøpunkt intend to do with the collected data?

Ms. Spang Bech informed us that the data was not for Miljøpunkt. The data needed to go to the police and municipality. She suggested that if we used Excel, we could export to nearly every system (excel data storage). She told us that one of Miljøpunkt’s interns found a program to use (that was free for the first time) that can collect reports, and export the data. Ms. Spang Bech said this app was a better option than the municipality’s complaint system, where users need to “click... click... click... click...” through a lot of areas of submission. We learned Miljøpunkt planned to store the information in a database on a server at Miljøpunkt. Ms. Spang Bech suggested that from these data we can generate maps and visual descriptions of the app.

e. Do you have an idea of what format you’d like to view and receive the data?

Ms. Spang Bech said that if we wanted people to use the app, it needed to be simple and if we wanted the data to be useful, it needed to be in an excel spreadsheet.

3. What social impact do you think this app can have?

a. Why do you think this app is capable of making this social impact?

Ms. Spang Bech was unsure. She thought it might not have an impact on the social scene. We learned the original idea was to be able to accommodate the people complaining, and to use the data to help regulate the noise. That was our scope, if there is an effect that comes about because of this working, it will take time. She said she’ll need to evaluate after the summer, to see if there was a social impact. Ms. Spang Bech warned us that it would be a big job to work with the complaints the way people complain today, using technology like phones and online forms, since there was no way to compare or prioritize where resources are used. She envisioned the data from the app can help them with that and that it might even be useful in a way the Municipality didn’t even realize yet. She believes the data could help the Municipality see a way to get a head of the problem.

b. Can you think of negative social impact this app may have?

She also expressed that there’s the possibility for misuse. She thought users could intentionally submit false reports, and to counter that we would need to take steps to prevent misuse, like pulling the users’ phone numbers from phones directly, to verify their IDs, or have a login, and store that data based on submission).

4. At what stage of development do you expect this to be at the end of the project?

a. What kind of product do you expect? How far in the development phase?

Ms. Spang Bech thought it should be working, and in the phases of being tested by the end of the project.

b. Do you anticipate this app existing in the long term, and thus needing long term maintenance?

Ms. Spang Bech said she would love for this to be something that everyone could use, but there was already an app for the municipality. She wondered how long it would be before the municipality switches to the application complaint process. She said she would love to have a download link on the Miljøpunkt homepage, for people to use when they feel they're not being heard.

c. Is there a target release time for this application?

She told us that we should have the application ready to test and collect data at least a weekend before we leave, so there's time for test data to be collected during peak noise and bar hours.

5. Is there room for the expansion of this application to other districts?

She already answered this in question in 2a-b; Yes

a. Where else can this be implemented?

Ms. Spang Bech thought it can be implemented in other municipalities, as well as other fields of complaints from noise to things like odors, street repairs, and invasive plants.

b. Is this general enough to be adapted to other districts?

She thought it should be, and that was our goal.

Appendix D: Interview with Søren Rud

Chairman of the Norre Kvarter Resident Association [NKBF]

April 10, 2018

1. What is your opinion on the nightlife noise in Nørre Kvarter?

Mr. Rud said it has been escalating for the last 10 years. He felt it is way too over the top, with far too many bars, and the bars are far too noisy. He had been living there for 45 years. He said it had always been lively, but nothing compared to present levels.

2. What do you believe the greatest contributor to this issue is?

Mr. Rud told us he thinks the bars are the largest contributor. He said the bar owners blame the public, but it's the bars who really cause the problem. He explained that there are 5 or 6 streets, like Vestergade, where most of the noise is, and those streets have a lot of bars. From his experience, he saw that the streets with no bars have no noise.

a. Why do you believe this issue persists?

He thought the bar owners don't take responsibility for the problem and instead blame the public.

b. What are the barriers to reducing the nightlife noise problem?

Mr. Rud said he believes money is the biggest barrier. He said the nightlife industry is a huge business and the bar owners don't want to change anything because it makes them money.

3. What is the mission of the Nørre Kvarter Beboerforening? (I.e. Why was it created, and what does it do?)

It exists to make it a nice and secure area for everyone to live, and to take care of the area, citizens, and the houses. It's one of the oldest areas in Copenhagen, and it is a unique area since all the houses are from the same period in the late 1700s (18th century).

4. How would you describe the residents of the area? Demographics, typical behavior?

We learned that the area used to be a rough until the end of the 70s, with a lot of prostitution, and the bars were not for the young people. Mr. Rud told us there was fighting, and it was bad for young people. He said now there are a lot more bars, 50-60 compared to the 6-10 left over from before. He explained that residents are usually co-owners on their homes, or have partial ownership, and still a lot of tenants without any kind of ownership. He told us that tenants pay monthly rent and En-part buy a share of the house. He said if you were going to buy it it'd be millions, so en-part is a cheaper option. He recalled in the 70s, when it was still very cheap to live there, the houses were run down. He had an apartment that had a roof that would leak in many places when it would rain, and there were rats on the fourth floor. He said it was very run down, and a lot of artists and musicians wanted space for their practice or studio. When the artists and photographers moved in, attracted by cheap housing, it wasn't a nice area, but after they moved in there started to be this sentiment of "wow this is a nice area". Mr. Rud said many of the Danish rock stars we're living there at one point. He explained that when lawyers and

advertising firms wanted houses for offices, he and his fellow residents started the resident association to work against them moving in- and they succeeded. They demonstrated in acts of civil disobedience, and they bought shares in the companies that didn't want to preserve these buildings as residential spaces and in 5 years they succeeded in saving 10 houses which contained many families, and many of them were still living there. He told us they bought shares to be able to attend shareholder meetings in the hope to make the company change their policy and save the apartments. Mr. Rud told us that many of the people still know each other and take care of each other's children, or cats and dogs- that's the foundation of the area. He also said they have a lot of American students because of DIS, a study-abroad organization with centers nearby, so the area is a huge mixture. He told us it's often referred to as "a hipster area, only hipsters are going there", but that's not true. It's a huge mixture of workers, student, artists, nurses and everything.

He said that the resident associations won the houses back in the 80s and 90s, and up through the 2000s it was okay, but 10 years ago they found out that people who lived there for a while were moving out not just because of the noise, but because of the pissing in the nighttime too. Mr. Rud said the resident association was still complaining, and the association tries to take over communication and correspond with city hall on behalf of the residents.

a. How tech savvy are the residents? Are they comfortable with an application?

Mr. Rud said that only one member of the association does not use a computer, and that they used to have two but one of them died, so using a computer is not a problem. He also said he's not such a big app user himself, but was comfortable with a reporting app.

b. Do you think the not-so-big app users will prefer this over the existing veins of complaining

Yes, Mr. Rud thinks it's better than the form and calling.

5. Do the residents often complain? How often do they complain about the noise?

Mr. Rud expressed that was a very broad question. He said the residents complain very often. He understand that when you've complained many times to the police, and nothing happens, you resort to just plugging your ears or going to the countryside if you have the option. He told us "many people have given up" complaining.

a. Through what mediums are they complaining?

He said they use every avenue for complaining. They have the noise guard from the TMF, and you can call a number to contact them but only on Thursday, Friday and Saturday, and only till 3 in the morning (on Thursday is only until 1AM) but there are bars that are many open later, until 5 AM, and some until 11 am. Residents complain through a mix of calling on the phone, submitting the official complaint form, emailing town hall, and calling the police.

6. What do you think could provide effective insight into the nightlife noise problem?

Mr. Rud was aware of our work on the app, which he thought could be helpful. He said in the beginning an efficient approach was he took was a tour around the area and made

a list of all the bars, including all the places like Netto and stores to buy alcohol in the night. He submitted the list, containing over 70 places to buy alcohol during the night that are nearby, and the town hall was surprised. He didn't even know they had this many. Mr. Rud said documentation is important since only 2 people of the Borgerrepræsentationen live in Indre By (Inner City). He believes you have to visit and see it with your own eyes to understand the problem.

7. Would a data collection tool be an effective asset in mitigating the noise?

Mr. Rud thought this can be effective at helping people understand the issue.

a. How do you think this data collection tool can be useful?

Mr. Rud thinks the problem lies in getting through to the city hall. He expressed that this problem is a mixture of both the TMF and KFF, and communicating data to both is important since it provides insight to the issue. He thinks that our app can provide those data. He thought it's important to document when the bars are violating the rules, about serving outside after midnight for example, or open doors and windows. He also thought it would also be nice if you could report a sighting of a dangerous event, like seeing someone with a knife.

8. How impactful do you think the creation of this app will be?

He thought it depends on where the data is sent. Whether the licensing board are presented with the complaints—which they don't always receive, if it's going to city hall and if it can be sent to the relevant organizations, since they are seeking information too. Mr. Rud thought it would be good to know what could be sent through the app, and where it's going.

9. What Other Categories could we collect reports on?

Mr. Rud told us there is always noise in the city center. The noise is generated from the bars, the garbage collection, the guys with leaf blowers blowing cigarette butts off the sidewalk into the streets, and deliveries for restaurants. He said there are rules regulating this type of noise, such as deliver to businesses shouldn't occur between 22:00 and 7:00. There could be an "other" category for types of noise like this.

10. Should our application redirect users to the existing form, or accept complaints on the same types of noise?

Mr. Rud thinks using an application is easy, especially compared to the existing form which is complex and discourages use in the middle of the night. He said we should test the application, because if city hall accepts our application and the data it provides it could replace the form. In order to achieve this, city hall would need to see who uses the app and who submits complaints. *Will city hall be able to see who submits complaints?*

No, complaints will remain anonymous for now

Then the form is still necessary since you still need people to fill out complaints with their personal information so the complaints are connected to an individual.

Appendix E: Interview with Hugo Madsen

Chairman of the Strøget Beboerforening [SSBF]

March 26, 2018

Prior to beginning the interview we explained the consent form, obtained written consent for his participation in the interview and to have his name associated with answers, and verbal consent to record the interview for the purpose of accurately representing his answers.

1. What is your opinion on the nightlife noise problems in Stræderne and Strøget?

Hugo Madsen is a citizen, resident, and chairman of a resident association in Inner City Copenhagen, specifically in the smaller section of the inner city called the Middle Age City, where the houses are very old. He told us there's an important distinction between residents and citizens. A resident lives in the area 24/7, but that's not the case with citizens. He said many citizens come from outside the area, but residents actually have to deal with the noise.

Hugo provided us with a quick sketch which gave us insight into how the different groups are connected, and illustrated many of his points. He expressed that he is not very computer proficient and it could be useful to develop a digital map. Brent worked with Hugo to develop his sketch into [Fig. 1, Appendix A]

At the top of the map is the City Council (Borgerrepræsentation). At the bottom of the map are the Citizens (Borger) and Residents (Beboer), who experiences the noise whose lives are affected. Hugo said they can't deal with the problem themselves, since they're "old farts" and cannot convince drunk young people in the street to act differently.

2. Do the residents often complain about noise? Through what mediums are they complaining?

He explained the three reporting mechanisms, to submit the form on the Copenhagen Municipal Page, and the other two are to call the Noise Guard/Patrol, or the Police.

Hugo said the Noise Patrol sometimes do not come because of "restricted resources". The Noise Patrol may or may not show up, and if they do they can only make measurements on the decibels with equipment. He expressed that often when the Noise Patrol arrives, the noise is no longer there since it takes time for them to arrive and the disturbance is likely temporary. He also informed us that they can take measurements but they don't have the authority to actually do anything since they're "Civil servants", and after they leave they have to report to their Unit.

Mr. Madsen told us the form online is also an option and when the Noise Guard arrives they also have to make a report for the form. He said the last option is to call the police and "often they do not come because they do not have the resources".

a. What aspects of the current noise complaint system can be improved?

Mr. Madsen expressed one of the biggest shortcomings of the form is there is no immediate effect. Additionally, users cannot complain about the "party in the street". He has been living there for 30+ years, and he's used to the noise, and used to not being able to

complain about the street. When he asked why the form cannot address street noise, he received the response that the noise guard cannot address the street, and that it's a police issue.

Mr. Madsen thinks information needs to be passed up to higher authorities from the noise guard, the unit, and the police. We learned there is a licensing committee (bevillingsnaevn), made up of 8 or so people, who represent different interests, and they made decisions on the applications for licenses. They take into account have there been any complaints in this area. If there aren't, or if they haven't been recorded, or if they haven't been passed to the licensing board, they cannot consider them when making their decision. Mr. Madsen said the police and noise guard/unit are not coordinated with each other, so the passing of information is not as efficient as it can be.

We also learned the Licensing board meets monthly, and at the last meeting there were 30-40 applications, complete with all the proper documentation. Mr. Madsen expressed the board cannot read all the documentation for every application, so they have a Secretary Staff or Secretary Board, who will process the documentation and information from the lower authorities. He is curious what information do they receive and how much is passed on, since it's not clear but reasonably it isn't everything- information is lost in the transfer. He told us the focus on the secretary board and licensing board is because both of them are secret meetings, since they contain private data on the applicants.

Mr. Madsen explained the residents cannot react to license applicants until too late because they don't know who is applying until after they apply and almost after they receive the license. This can be improved so the residents can react to changes in their neighborhood before there's nothing that can be done about it.

3. Do you believe nightlife noise to be a major problem in Copenhagen?

a. What do you believe the greatest contributor to this issue is?

Taking a top down perspective, Mr. Madsen believes the cause of the noise is that people are noisy and they gather. Why do they gather? He thinks this is because there's a lot of bars and restaurants, and that attracts people from the nearby area and the suburbs all around Copenhagen.

b. Why do you believe this issue persists?

Mr. Madsen attributes the problem to the authorities continued issuing of licenses to bars, enabling them to remain open until as late as 5 in the morning.

c. What are the barriers to reducing the nightlife noise problem?

Our application is most similar to the existing online form, and Mr. Madsen highlights that it needs to be accepted by the authorities. He expressed the existing three avenues for complaints are insufficient since they are not coordinated.

He said the largest barrier behind the app being accepted is that people give up. If they don't feel they're being taken seriously they give up making those complaints and it may be difficult for some people to use a computer. Technology and indifference are two obstacles

preventing people from submitting complaints, and so the correct information isn't recorded and communicated.

He also explained that people expect immediate action when they call authorities “come and help me, I'm in trouble” and there isn't immediate action.

4. How would you describe the area?

Mr. Madsen directed us to look out of his window to look at the nearby hostel. He explained that it used to be offices for a nearby university. It was then turned into a hostel, which has a large capacity and is usually full of young people. On the weekend they have a good time and enjoy themselves. They have heaters outside so people congregate outside. People also step outside to smoke. He pointed out another venue down the street which has many concerts at once, and makes a lot of noise.

Mr. Madsen explained a lot of people are already here, and it attracts other young people to come and “have a nice party”. Dormitories and hostels attract people to come because there are accommodations. He told us that a house down the street is for sale, since the residents have given up trying to live in the area because it's so noisy, but it's hard to find a buyer because of the noise.

He expressed his concern that Copenhagen is becoming too much of a tourist city, that it may be very busy but if all of the residents leave it will only be a tourist area. He said many people are renting their houses as Airbnb's and leaving the area, and that attracts more young people and tourists to the area. This compounds, driving more residents away.

5. How would you describe the residents of the area? Demographic break up, ages, etc.

He wasn't really sure. He explained that to have a flat in the inner city is considered fancy, and it attracts a lot of wealthy people and younger people, not really families. He said the older residents like himself are a “dying race”. The prices for the flats are expensive, and many of the residents wouldn't be able to afford them today, but they moved into the flats 30+ years ago when they were affordable.

6. As Chairman of the Strøget Beboerforening, what are you looking to improve in the area?

Mr. Madsen said his primary goal is to improve the quality of life for the residents, which has been under attack by the noise from the bars and increased traffic on small streets. Both generate a lot of money, and people try to figure out how to make money in the area, but because the area is small the bars and roads are getting more crowded and noisier. He told us the tourist industry, which is good, brings a lot of people but creates an issue with more transport needed in the city.

7. You mentioned the licensing process and that you're unsure what exactly happens, can you elaborate?

He said that isn't public known, but he wonder if permissions are being given when there's a lot of complaints and problems in the area. He's curious why they give the licenses? One explanation he thought of is that when the police act, it's on a singular incident, and the actual problem is a lot larger. They might just consider the specific incidents instead of the greater context. The larger context is the concentration of bars and clubs in such a small area.

He informed us that in the general law for Bars and Restaurants, paragraph number 12, it says the authorities need to consider the entire area and larger context. However, authorities may only be concerned with their specific department and jurisdiction and ignore the big picture when addressing if issuing a license is feasible. The residents experience the problems and the larger problem in general; noise from traffic and music and people.

8. Do you think there is a way to more accurately communicate the larger problem to the authorities?

Yes, however he doesn't believe this is a technical problem in communicating, it's a political problem. It's a question of political awareness, especially at the top of the map [Figure 1, Appn. A]. He believes they need to take the current problems seriously, and change how they process information and the regulations within their departments. He said they need a broader total view, about what is really going on.

It is worth nothing that Hugo informed us about the new metro station opening next year which will only increase the amount of people coming into the area.

Additionally, from our interviews with residents, northern citizens of the quarter are seeing the bars and restaurants moving more north and expanding the noisy district.

We informed Hugo on what we hope to achieve with the application: to give the residents a voice in the noise problem. We recognize the three avenues for complaints and that none are meeting the resident's expectations. Through interviews with the TMF and KFF we found the reaction to complaints is not immediate, and that beside the police there's no management strategy for street noise. We hoped our app can pinpoint the noisiest and most problematic areas, so the police can allocate more resources to the area, similar to how NYC's 311 app is used.

9. What features would you want available in/data collected through our app?

Hugo said he would like a response, since currently there's no response through the complaint system. It would be helpful to know if they did anything, what was the result, did they have any action, and how was my complaint processed. He wants to have feedback in addition to wanting a response.

He also suggested implementing a decibel meter in the application, and we discussed the various issues with the validity of those recordings, such as being unsure on where the readings are taken and how they can be inaccurate.

Appendix F: Interview with Morten Vesely and Cleo Weisser

Two Residents of Nørre Kvarter

April 3, 2018

Prior to beginning the interview we explained the consent form, obtained written consent for their participation in the interview and to have their names associated with answers. Additionally, the interviewees have reviewed the text below and approve the answers as they appear.

1. How long have you lived in Copenhagen?

Morten [M]: 40 years right here in Nørre Kvarter. Longer in Copenhagen: since '68

Cleo [C]: 36 years in different areas around Copenhagen

2. What made you become involved with the Noise Network?

C: The noise is frustrating and annoying. It is frustrating that nothing is being done about the noise issues. It helps psychologically to be working with others on this issue. The noise situation seems to be continuously getting worse, and it seems like no one is interested in stopping it. We understand that we are a minority here as downtown residents, but nevertheless an important minority that keeps the area alive, safe and sound, we think. The appropriate authorities are not finding middle ground with the residents here: "Too old and complaining about everything", it goes.

You get sick from the noise. People can't sleep and are becoming irritable. There are kids living in these houses as well, and it has an effect on them. We want an attractive neighborhood, not just to pass by, visit or stay in, but to live in for years.

In our neighborhood there are very narrow streets and old houses. Noise is louder in 4th floor than at street level and the buildings themselves are not soundproof. And noise is worse in summer when you would like to have an open window.

Even within the area, solidarity regarding noise issues is a bit difficult. There is much airBnB, subletting and short term living, e.g. much moving in and out, and people nowadays tend not to stay when getting families etc. Add to that that people living in the courtyards or "just around the corner" might not be affected at all by night-life noise. And other areas in Copenhagen not yet affected by nightlife noise tend not to be interested before they are themselves affected.

The current nightlife plan is not addressing the majority of aspects of the night-life noise as we experience them. The ultra-short version is that they've focused more on waste clean-up (always very noisy) and having more bouncers (often themselves noisy).

So it useful to have a noise forum and platform.

3. How has the nightlife noise problem evolved in your time here in Copenhagen?

M: The noise problem has changed and the activities in the town have changed drastically within the past 6-8 years. The level of partying has increased as the amount of bars

has increased. Lots of bars are open all night long now, it did not used to be that way, a majority would close at 1 or 2 in the morning (which is a manageable problem). It is a misunderstanding when politicians claim that this area has always been like today. I have lived here for 40 years and know what I'm talking about and that that was not so. It was very hard to obtain a late-night-license contrary to today.

The behavior also used to be quite different. There used to be police supervising in the streets. This is not happening anymore. Police have been moved to other places to take care of "terror and gang violence"

C: There used to be a few places in the neighborhood open until 5 AM, and there were police patrolling the area, but not anymore. The police just drive by because they have other things to do, even when noise is streaming out from bars in the morning. The area has always had nightlife, until 1-2 AM, but now it goes all throughout the night. I have repeatedly been told to "move out" if I can't take it, but who is going to move in here? We all need sleep. Sublet apartments and Airbnb's are doing well in the area, so here are lots of people around who don't care that much about the noise and don't feel too much responsibility about what's going on in the neighborhood. Often they contribute to the noise problem themselves for the same reasons. "Feel like a dinosaur left here, nobody takes notice of the people who actually live here".

If a shopkeeper can get a night license the propriety owner can raise the rent by 200-300%, because hardly any other small-business than bars can pay that type of money for small-size premises that are prevalent here. So what we see is an evil circle where regular shops are closing and bars are opening. Besides the high rent level, day shops are threatened by the shut-down-by-day- shops (namely bars), because the area doesn't attract customers because of the now reduced amount of "interesting" shops. And, of course, because of the competition from internet shopping. Small business without alcohol or involved is really having hard times. And the alcohol license policy doesn't help them.

a. What are the biggest contributors to the problem?

M: "When the municipality issues a liquor license to one bar, they have to give a license to all the others, they claim". Even in a residential area. So apparently they issue one night license after the other, knowing about the consequences but not willing to do anything about it: Their version is that it is not their responsibility. No limits until an area is absolutely full of bars and problems. Then they – maybe – will put a local stop to the issuing. And then continue the practice in another area, which is soon bound to suffer from the same problems as the amount of nightlife rises.

C: The Municipality knows the police don't have the resources to manage people in the streets. Even so they have issued and keep issuing late-night-licenses. With the massive amount of bars, the streets naturally have become an extended dance floor as people are hopping from bar to bar. The proximity of bars makes it hard to tell which ones are causing the problem. When there were fewer you were able to easily identify which bars were not taking care of their

patrons. The Municipality also does not acknowledge complaints as valid, or usable, since they claim residents are biased against specific bars.

4. What have your experiences in the Noise Network been like?

M: The Municipality claim to want citizens' involvement and dialogue but it seems that they do not want to take our complaints seriously and not want to address our real-life problems, namely noise. The noise network has no authority and it is very difficult to get through to the higher levels. However, the municipality is sensitive to negative publicity (the press), so maybe there is a possibility there...

C: It helps a little psychologically because you feel very alone and powerless against the noise problem, so it helps to share and deal with other affected people. There has been more focus as of lately, article writing/network, in relation to noise. But generally there is a lot of talking, and not much action. If twenty night-open bars pop up in a residential area, obviously problems with sleep and life quality will arise, and the municipality should be listening to the residents and look out for us instead of treating us as grumblers.

When politicians some years ago after personally having experienced the noise in Noerre Kvarter during night, wanted to address the night-license issue (which in our specific area is the main problem), bar owners threatened with a lawsuit, and at the same time the Municipality's lawyer made a report that basically said that they/the Bevillingsnaevn could not stop issuing night licenses once they had given one. If one can get one, everybody shall be able to. Ever since, the politicians are scared of approaching the issue. Understandable, but we see it as they are much concerned about bar owners' rights and little about residents', tourists' and other groups' rights and life quality.

A specific problem also is the "Bevillingsnaevn" which issues the (night) alcohol licenses. An impenetrable and not-transparent organ in the sense that you never know what is going on at their meetings until months later in scanty minutes when licenses already are given (and in reality never are withdrawn again). Members are also subject to confidentiality regarding what goes on there. In fact conditions like residence area, denseness of bars, schools etc should influence the issuing, but it is not possible to get insight if and how these considerations in fact are taken. Police also participate in meetings, and their main contribution apparently is that they are having "no comment" on this or that license even though they themselves say that they have given up on controlling the night life situation in downtown. In spite of its lack of transparency, Bevillingsnaevnet, including the police's role there, has been and is essential to the shaping of the direction of the city. Police, politicians and the various departments of the Municipality blame each other and continuously pass the buck. And we feel lost.

5. What data would you like to see collected by our app?

C: Focus on the things that the Municipality does not acknowledge. "If there are no complaints, because you can't submit complaints, that doesn't mean there isn't a problem". Make it transparent as to what the issues are. Police don't respond in time to make complaints

valid. Street noise, noise from private properties - terraces and balconies. This is an issue especially with the amount of Airbnb's in the area because people come in for a few nights and throw parties and feel no responsibility towards neighbors. The noise from the Municipality's "morning-after" cleaning in the streets. The Noise Guard only work until 3 AM. Between 3-8 AM, a period with serious noise problems here, there is therefore no one to call except the police who seldom have time or interest. Most people don't feel like making complaints in the middle of the night, or step outside to try and dispel the noise themselves. People need a method of complaining that will allow their voices to be heard. Many people have stopped complaining because nothing has been done about the issue. They are complaining in a private setting, and don't do it publically without some sort of campaign. The app needs promoting because people have lost faith in complaining (the system as well as the actions (not) taken as a consequence).

Making it easy to complain, and maybe so you don't have to fill in so much in the night. Making it OK to complain about noise –just as political correct and natural as complaining about discrimination in night-life. Making the life and the life quality (aspects of it anyway) of the residents visible.

6. What features would you like to see available in the app for data collection?

M: Acknowledging that a complaint has been received. They never confirm that reports have been received, no acknowledgement afterwards.

C: Make it easy to complain and possible to register complaints: For visibility and in order to bring noise issues into focus and the political agenda. The complaint process should be more transparent so you can follow the complaint. By making it possible for everybody to see the complaints that are submitted (and what actions are taken), people and authorities might be more committed. It might not prompt action, but it would be good just to record. "Let's have another tool". In the end it is dependent on who sees these complaints (and what actions they are willing to respond with).

7. How do you think the Noise Network can benefit from the data collected by this app?

M: Modern entertainment is strangely always surrounded and defined by noise. So a noise-app could definitely be useful. I repeatedly go outside at 6 AM to observe what is happening in my street, and record the findings (music coming out from bars, shouting guest- and shouting bouncers - in front of bars, bar customers urinating, vomiting or dealing and taking drugs in front of our house and thereafter returning to "their" bars etc. etc.) . Higher authorities (politicians, police) don't consider these regular observations as valid records. Politicians and police do however not live in the downtown area and neither come here on a frequent and regular basis. So it would be good with a coordination of observations like mine to define the experienced noise problems.

C: “We can always use the data”. We share this noise problem with the rest of Europe so we will be able to compare data which is useful. It is a goal for the municipality that public urban space is used as much as possible. I’m not against this apparently positive and democratic priority, but The Municipality as well as all of us will have to deal with the fact that noise is not very democratic: when you open up for noise everywhere and at any time, people who don’t want noise or for instance want sleep during night have no alternatives: Naturally noise overrules silence. It will cost money – and maybe popularity in the short term – to regulate noise but I think it’s worth it and necessary. And a health issue.

Appendix G: Interview with Resident and App Developer

Member of Noise Network and App Developer

March 26, 2018

Prior to beginning the interview we explained the consent form, obtained written consent for their participation in the interview

1. How long have you lived in Copenhagen?

Noise Network Member [NN]: 50 years

App Developer [AD]: 38 years.

Questions For Member of Noise Network:

2. What made you become involved with the Noise Network?

She was incredibly bothered by the noise. It was disturbing her work life, and she was unable to sleep most nights. She started a network to raise awareness in the neighborhood on the noise disturbances that were generated from festivities in the park outside her door.

3. What have your experiences in the Noise Network been like?

She said they've been frustrating. She told us the people who are involved are engaged and interested. She feels it's a waste of time when talking to the police, municipality and public officials, because they are not listening to the voices of the citizens, and have already determined the outcomes.

4. How has the nightlife noise problem evolved in your time here in Copenhagen?

a. What are the biggest contributors to the problem?

She said the problem is the drinking culture of the youth, and that has gotten much worse over the years. The residents are just asking for reasonable levels of noise, and not a constant party. She thinks alcohol is a major issue here, and it is what fuels the noise problem.

She said TMF now has preapproved organized events including festivals and sports events, which has helped reduce the amount of noise generated in the park. In the park, half of it is private and extremely restrictive on what happens on that side. That side of the park is in the wealthier area. The Noise Network is asking for the same restrictions to be implemented on the public half of the park. The idea of an open air music scene in the park was once pitched to the city. This proposed area of the park was to be covered and have access to free electricity. This idea was struck down by the residents of the area due to the amount of noise the residents believed would be generated from this scene. Frank Jensen, the mayor of Copenhagen, shut this idea down in spite of the old mayors of the TMF and KFF having full support of this issue.

5. What data would you like to see collected by our app?

She said she would like to see Location, some way to validate the data, and type of noise (ambient, spontaneous vs ongoing noise).

6. What features would you like to see available in the app for data collection?

The ability to get accurate decibel recordings. This is convincing evidence, but is very subjective and needs to be recorded in specific ways for it to be valid data.

7. How do you think the Noise Network can use the data collected by this app?

She said if the noise network has the hard data to present to public officials, they will have the necessary information to stand their case. They are looking for neutral data to present to politicians, and an ombudsman can be brought in if they are unwilling to acknowledge this data. They just need a vessel to collect this data. She told us that the NKBF was on the verge of filing a lawsuit against the Mayor for abusing his power and not addressing the noise network.

Questions For App Developer:

1. What kind of experience do you have with app development?

He worked to develop an app for identifying the handicap accessibility of different buildings around the city of Copenhagen. This users of this app go on it and place a pin on a map of where the building is, and record any features that may make it inaccessible to handicapped patrons. For example, if there are only steps leading up to cafe, and no ramp available.

2. Do you have any suggestions on how we can approach the design/layout of the app?

He suggested we make it so there is minimal effort on the user's side because if people are woken up in the middle of the night, they are going to want a quick reporting mechanism.

3. We're having trouble ensuring that someone will continue this project once we leave. Do you know anyone who would be interested in contributing?

He mentioned that insurance companies may be interested since they have large IT departments and care about the health of their clients.

4. Do you have any experience writing a "Terms of Service" agreement? Do you have any suggestions on how we can approach making our own?

He told us that Terms of service templates should be available online for EU.

5. How can we market this solution? We need to make sure people see and use this in order to collect effective amounts of data.

He suggested public newspapers, possibly having a QR code on posters around the city.

6. Do you have any other tips or helpful information we could benefit from?

He said to use open street maps over google map since Google can be very expensive in the long run and OpenMaps has the safe features. He also said there are problems with geolocation here—sometimes geolocation will place people on the wrong sides of buildings. He advised we should suggest their location to people, but let them change it if it's inaccurate. He said we can consider accessibility for blind people in using this app in the future. He also told us the data needs to be hosted in AWS because of European Data Protection Legislation.

Appendix H: Interview with Martin Gyldstrand

Special Consultant from the KFF, and Project Leader for the Nightlife Plan

March 20, 2018

Let the record state that Martin willingly provided written consent to participation in this interview, as well as having his name associated with answers. Additionally, he verbally consented to having this meeting recorded and was aware of the presence of the recording device.

Reissman: We just want to make sure we were on the same page in the understanding of the current situation of the nightlife. **Would you be able to give us a brief overview of the (restaurant and night plan) you were talking about, and how successful that effort has been?**

Gyldstrand: It's very difficult to get consensus on this issue, and it's difficult to get common ground on the tools on how to deal with the issues, but I think the plan has been very good and we are working very directly at implementing the plan. If you look at the citizens perspective in very harmed areas- areas that have intense nightlife- then they would say there has not been done enough, but we have been working very effectively to make sure to clean effectively, and follow up on the restaurants, but it will always be difficult when there's a lot of people in a small place, and as long as the restaurants are upholding the laws and the things they have to do, then it's difficult to shut down places, which is what some of the citizens want- want fewer restaurants- and that's an aim that is difficult, and maybe not desirable for some politicians. I don't know if I answered the question.

Reissman: Yeah, I think that [answers how] you're trying to address these issues.

Currently, **when these issues arise with restaurants and other noise sources [sources of noise disturbances] in these tight, dense communities, how are they addressed? What does the "Restaurant and Night Plan" do to address a restaurant that is too loud, or a group of people generating noise?**

Gyldstrand: The first thing is we have a [Noise Guard]. They will react immediately and go out and measure the noise, or the smell or whatever it is, and they will, for instance have music from open windows or something like that, they will go in and regulate that.

Reissman: **And they have the authority to regulate?**

Gyldstrand: Yeah, yeah. That's right. The problem is, they don't have the authority to regulate on the street. They have a very strict mandate on regulating the restaurants itself, but the problem is most of the noise comes from people standing in the street smoking, or just going from one place to another, or going home in mass bunches at 5 o'clock in the morning when the places close, and that, the noise guard cannot regulate. That's a police task, if it's too much, and the police is very busy with other things than people singing songs on the way home. But that's very annoying for the citizens, and we acknowledge that. But it's very difficult, very hard, for the municipality to do something about that end of the problem.

Reissman: You said the police address the nightlife noise not in the restaurants, on the street. **What are the other resources available?**

Gyldstrand: [The police] also control the restaurants. Only the police can close down a restaurant completely. Then the noise guard would need to call the police, then if there's something really bad going on, and the police will have to [address it]. The noise guard can impose restrictions, but it cannot make any force. The police can make things really happen.

Reissman: **When addressing the people in the streets, are there any resources besides the police that can help with [that effort]? Or is it only the police?**

Gyldstrand: It is only the police that can do that. We are trying to. We have a pilot project starting up, that is about getting more presence. Some kind of corps, volunteer corps, that can say to people calm down or direct people in certain ways and so on, but it has only “soft power”, you know, it's not [the] police. We're trying to do that in collaboration with the [Roskilde festival], because they have a lot of experience with controlling crowds and so on. In the summertime, it's really crowd control in that area. And we are also trying to strategically develop other areas of the city where people can go and be encouraged restaurants and other actors to use different parts of the city. Because it's very concentrated, if you look at the data, it's very concentrated. [There are] huge parts of the city that are quiet, too quiet, and [those parts] need something to grow, and restaurants and cafes and so can help do that. That's why we also have a spreading out strategy. Also because we are having more and more and more people and more and more tourists and if [they] all go to the same places around here, [the problem] is going to be even worse than it is today.

Cyr: **Besides the Norre Kvarter area, are there other areas of concern within the city of Copenhagen?**

Gyldstrand: Yes, there is Gothersgade, it's on the corner of Kongens Nytorv If you know, if you go. It's also notorious for nightlife. And we have Nyhavn, there are a lot of bars there, but its elderly and not that, its doesn't bring the same harassment, it's quieter.

Reissman: **Do you think for the residents living in these areas, you said they can call the police, do [the residents] have adequate resources to deal with this problem. If the residents would like to report [complaints], do they have a way?**

Gyldstrand: Yes, yes yes

Reissman: **How?**

Gyldstrand: Well, they can call 114, and it will register. At least it will register somewhere, but I don't know where and how and what the response is when it's somebody calling from an apartment. [if they get a call saying] “I have this guy down here, peeing on my wall” or something, they will probably register it, but they can't, they don't have the resources to go and arrest the guy. I don't want to comment on how the police works, they have to answer for themselves, but they handle violence and gangs and so on as first priority, and harm to health first, and then all the rest. And that's why I think the citizens feel helpless in some way concerning that end of the problem, some citizens do at least.

Reissman: **Do you think there's something the municipality can do to make them feel less helpless?**

Gyldstrand: We are trying our best to get a voice to their concern, were trying very hard, because were also interested in bringing down the [harmful effects]. But I'm sure an effective app will be, could be a solution. Also because if it can- when we register a noise, and this is also for the police, we have a certain system, that just registers, but we have difficulties automatically, in real time basis, to see where is going on and when and how much. It's more the people in the street reacting. But maybe, if there [is an automatic system], we will have more knowledge on when and how.

Reissman: On that topic, of that specific information- you're saying the when and how and the where- what data would be beneficial for the municipality to know about this issue. **If you could know anything about how much or where, or anything, what would you want to know?**

Gyldstrand: Then we can center or focus the resources on the hot spots, where there is a lot of harmful effects.

Reissman: **What specific information? Would you know where, or when, etc.?**

Gyldstrand: When, where, what it is exactly that the citizen is experiencing, with what is going on exactly, maybe some sort of categorization, and we also have to make some kind of discussion about expectations.

Reissman: So with that information, **is there a way that would be best [for you] to see it?** A spreadsheet, a list, a map, any specific way you'd want to see it to prioritize it

Gyldstrand: I don't know, maybe that's a little too detailed for me to answer exactly- it's the noise guard that gets all the complaints. Actually imp sitting with a transcript of how their complaints are, in excel, and it has the when and the where and so on, on a list down, but it's an extract, and it has a lot. Maybe an app could do it on a day to day basis and do different data analysis [on-the-spot]. I think [the noise guard] is working on something like that. If they go out there, it would be good to have a laptop or smartphone or anything that would be automatically registered, and I think they are going out and writing it down on a sheet, on a piece of paper, and when they arrive back they will type it into the computer.

Reissman: So to automate that process?

Gyldstrand: Yes, to automate that would be great for them. But that's on the noise guard, and that's, I guess also for the citizens, that would be great.

Cyr: **At this point in time do you feel as though the lack of data on the nightlife noise issue, is inhibiting the effectiveness of a solution, at this point? Is there a lack of data on the issue that is holding back effectiveness?**

Gyldstrand: I think the data should be refined and be easier to use, but we already know what's going on, we know where the problems is. It's not like we are completely in the dark, we know but it would be very helpful to get solid data on a regular basis to see if it's going up or going down and when and where and so on. But it's very, if you look at it, I can send you the excel transcripts if you want to, and it's like one person can make 20 clicks on one issue and some people don't make any complaints. It's difficult to see where actually the harm is but we can see who and when and where people feel that it's too much.

Reissman: **if we could provide you with this information in an easier format, with the trends, is it going up or is it going down, how much the [KFF] react?**

Gyldstrand: They could [get] a more nuanced insight on the when and where, especially if there are certain new areas that will develop into problems.

Reissman: **Could this nuanced insight guide future action? With what would this insight help the KFF?**

Gyldstrand: If there is a huge increase in one areas, they could ask for resources to bring it down in some way, either powering up the Noise Guard if that's the issue or make focused clean up or they could call for that there is no activity in the area, cultural activities or festivals, or they could try to block further restaurants to establish in the area. It's very difficult for the municipalities to say that a certain restaurant should close down, that's not in our power. That's the judge decision. Just to [clarify] the judicial things are very important in this respect, on how and where, who does what and when within the legal framework. And that's been, I have been trying around this table, we've been talking about this a long time with the citizens- they think the municipality should do more, just close it down. That's not how it works.

Reissman: It seems like there's a bit of a disconnect-

Gyldstrand: A disconnect in expectations, yeah. A very great one yeah. They put it all in one pot. [They say] “There is a guy with a pizza, there’s a guy making loud noises, and there a guy…” and its different compartments, the municipality cannot come and correct all what they see. And they think it's the municipality because they see grant the licenses and been historically to the bars (licensing committee), but there is a gap in expectations for sure.

Reissman: So if the residents are reporting these things, and they’re not always 100% accurate, because it’s subjective, what could be a part of these reports to validate them? If you wanted to see this information, how would the municipality know that these are legitimate reports and not just-

Gyldstrand: I think every, what I’m trying to do with this transcript, I think every complaint is a valid, should be seen as a valid complaint in itself, in what the citizens feels, but that doesn't mean we can use it judicially, then we have to, with objective tools and so on, validate that what the citizens saying is correct, then we can use the complaint. If it’s legal what's going on, sometimes it's just annoying. And it is annoying, to live, sometimes to live in the middle of the city. It is, I understand.

Reissman: You said, if you had these complaints, [the noise guard] can go out and see if they are valid. **What do you mean by checking they’re legitimate?**

Gyldstrand: The noise guard has to, if its concerning a bar with open doors, and they come and say “yeah you have open doors”, and that's a complaint, then there will be some kind of sanction and report on that specific—If the noise guard come up on the doors are closed and the windows are closed when they come, then it is a complaint, but you cannot- it’s not a legitimate complaint, in the sense that it is not something we positively can add on. But it’s still a complaint, what the citizen experienced is real, and then we could make two data sets. [One] that says this is ALL of it, this is all of what we got and had registered and when and how. That gives one picture of how all [of] it plays out. Then there's the picture, how much have we been able to react and how much has been has been trespassers that the municipality and the police can act on. I guess, that would be the ideal.

Reissman: The noise guard would have to go out and make sure it's something you can deal with. **Do you think there would a way in the report to say “oh the doors are open”, and get evidence of that, so that way every complaint, you don’t need a noise guard to check every single one, to have the validity in the report itself?**

Gyldstrand: Like a picture?

Reissman: Exactly, something like that

Gyldstrand: Probably, they might. I'm not sure about that, but that would be a guess, it could. Also, a good tool for the noise guard is- what was the issue when the complaint was filed.

Cyr: So our project team is looking to develop an app, that will allow the people or Copenhagen to submit noise complaints, where they'll be collected in a database and analyzed to develop different heat maps and time lapses of where the biggest noise complaints are and when they happen-

Gyldstrand: And also on a map maybe so you can visualize where it is red and yeah. Interesting that's great

Cyr: Particularly relating to street noise because as far as we know there aren't any other ways of handling the noise within the streets besides the police. **Is the data collected by this app, is that something the municipality would be interested in?**

Gyldstrand: I’m sure, I’m sure. I would very much like to pass it forward, that information that would be very interesting to see

Cyr: With this app, if people are complaining and just submitting noise complaints on their phones with it, do you see it having an effect on the local business in the area, or is that something that's already kind of being handled by the noise guard?

Gyldstrand: I hope so. One of greatest effort is to make dialogue and cooperation between the citizens and restaurant owners, because that would be the easiest way, and the best way and in the spirit of the city. If there's a problem the restaurants should also want to handle that problem. For instance, people standing outside their restaurants and so on, and I know that most restaurant owners want to cooperate, we can see that. As something new, as part of [The Night Plan], when we renew the licenses, we ask them "could you think of any voluntary initiatives to bring down the harmful effects of your business, especially in the night", and then they propose different things, and we write it in their letter of admittance or letter of authority to run a business. And I'm certain that if a restaurant is aware that their restaurant is in the highlight, that we have focus on it, then [the owners] will be more likely to act on it, if they have a chance to do so.

Cyr: Do you feel like this would be an effective way of having the citizens voice their opinions on the noise disturbances they are experiencing?

Gyldstrand: I hope so, I really hope so. I think that you should- have you contacted Søren Rud also? You interviewed him?

Cyr: We haven't interviewed him yet but were planning to.

Gyldstrand: Maybe he would be the best person to answer that. I hope he will.

Cyr: Throughout all of our background research, we looked into how other cities have managed their nightlife noise problems. One of them that stood out in particular is New York City, and how they've used their complaint form which they have available through an app, it's called their 311 system. And what they've done is they've taken all of those complaints that have been submitted through the app-

We needed to switch rooms

Cyr: To pick up where I left off, so New York City takes the complaints that they receive through the app, to then compile them all in one place and develop maps of areas of greatest concern with the nightlife noise, so they can use their resources in the most effective manner they can. They also make all of this information available to the public through an online database. So essentially if you were to submit a noise complaint, you could then go online, see your complaint in their system, and they provide information on if it's been followed up on or not. They do preface this by saying we might not get to it right away, and when the available resources are there, we will look into the issue. **Do you feel like a similar type of solution would be helpful?**

Gyldstrand: That sounds great, that sounds absolutely great. That sounds absolutely great. That would also, if it could be open like that, and people can go in and see their complaint, and there is a connection to how we react on this end, then the citizens would feel that their voice is better heard- not that it's not heard now, but they would actually see it because now we react every time if they call, we will react at-the-spot, [the noise guard] will come out, it's nothing like we won't look into it, it's not like that, but if it's online I guess the citizens would actually feel more comfortable with it, because what I've heard is a few times they feel like they send a complaint, and then it just gone, it's just disappeared. They don't know where it's gone and to whom and what happened to it, so they feel apathy. That would be very good if they could actually themselves go in. Maybe they will also, on the other side, if [one person] have made 20 complaints, that would also be highlighted. [If they] make 20 complaints about the same issue, we cannot do something about that person down there, or your neighbor. Because that's also, some people think because your neighbor is complaining, is making noise, it must be the

municipality. There's a cultural change also. People are getting more annoyed by others, feeling more unrest by noise, and it's a paradox because it is part of being in a city, there's noise. Anyway, that was sidetrack.

Cyr: On the topic of noise complaints, do you feel [-,] **demographically, is it only the older people complaining, or are there younger people complaining as well?**

Gyldstrand: also young people complain, and there are some who have been living in the city for a long time and they see it develop and they think it's getting more and more intense with the nightlife, but in Norre Kvarter, it has been intense at least for 25 years, I think 40 years, 40 years, it has been a street and an area that's been lively, but maybe it's more intense now. And people living there for a long time, they get older and the crowd gets younger, and there is a growing gap. There are also people moving in, and they might get shocked. Maybe when they bought their apartment it was 3 o'clock on a Sunday, and then they don't realize there is [this scene], but most people know where the area is. It's not only elderly, it's also younger people. But I see, there is a lot of the same names. I'm not saying some people are more likely to complain, but it's a fact that we see that a big portion of the complaints are concentrated on a few [people]

Reissman: **Is that something that this information should be associated with, so that way you can associate the complaints with who submitted them?** Either by name, or-

Gyldstrand: Or by area, right? And also by name but maybe that shouldn't be public. I don't know about the technical things about that, if there are some issues that I haven't thought of. But in principle, it would be great for all parts, or parties, to have a total transparency, so that people can go in and everybody can view what's going on. Also the restaurants and so on, and I'm thinking about if people should have their names.

Reissman: Because what I'm hearing is that you want to see if one name or [phone] number submits 20 complaints of the same thing

Gyldstrand: If that was the case, and the neighbor doesn't complain, and the guy living under doesn't complain, and the guy over doesn't complain, and the one in the middle has 20 complaints, maybe we should go in and try to— maybe there's something wrong with that particular, what's wrong with that particular address, and try to maybe talk to the person that is suffering. I mean there is a lot of things that can influence. A complaint is not just a complaint, it's also to analyze, but it's very good to have the data so you know where you have to make a deeper analysis of something. If you have it in the data, that's kind of very aimed, we could possibly, by a dialogue, make the citizen feel heard and so on. That's not to say that we can fix it for everybody, because that's probably not possible, but it would be better than today.

Cyr: **So we don't have any other questions for you, do you have any questions for us?**

Gyldstrand: No, not really. I think it's very interesting with the app. So are you technicians, is it gonna work?, Do you know how to program and so on?

Underhill: So Mike and I have a lot of experience building apps, and were going to walk [Brent and Chris] through the process as well.

Gyldstrand: Oh! Okay great

Underhill: We hope it will turn out well, we're pretty ambitious,

Taylor: Our project only takes place until the end of April, so we're hoping by the end of that to have a working prototype, so we can show what this complaint system can do.

Gyldstrand: *That's great, how do you integrate it with, do you integrate with Google maps? How do you view [the data]?*

Underhill: Were planning on having a way where we could, maybe like a website or something that you could go to, where you can view maybe a plot of the data over google maps, so you could see this particular street has a lot of complaints, at this time of night. That sort of thing. Were still assessing how we wanted to show the data and we have some pretty cool ideas I think.

Gyldstrand: It's also very interesting to see, of course when the complaints are coming during the day and at night, but also season wise, on a monthly basis, because certain areas are very prone to get complaints in the summertime, and in the wintertime [it's not nearly as bad]. For instance, Islandsbrygge over here, and we have a lot of complaints there in the summertime, people like camp, and transport portable devices as well

Cyr: That's something that New York City has done, they've looked at it as they year goes on by month, and see where they can be most effective at each time, because obviously when the weather's warmer there's probably going to be more activity outside, in the streets, because when it's zero degrees Celsius no one really wants to be outside.

Gyldstrand: and sometimes you can't really imagine the patterns before you see them in the data, and then its "Whoa! Look at that! Okay!", that corresponds to our data experience, so there must be something good. So good work!

Appendix I: Interview with Søren Nielsen and IT Consultant

Head of the Noise Unit and IT consultant

March 22, 2018

1. How do you, and the Noise Guard view the noise the Copenhagen?

Søren Nielsen sees that Copenhagen has been growing, the nightlife scene has been growing, and there has been an influx of people to the area, especially in the inner city. He explained this creates an increase in noise in the inner city, much of which is generated from people walking around and the restaurants in the city. The city can regulate all of the bars and what happens inside them, but it's not the mission of the noise guard to regulate the "Party in the street", it's the mission of the police.

2. Is the noise from the party in the streets and from the bars of an acceptable level?

While there are regulations defining what is the acceptable limit, noise is a subjective issue. For some people its fine, and for some "it's a living hell to live above the bars". He can understand that if someone lives above a bar, and the noise is preventing them from sleeping, they would think the noise is unacceptable.

3. What are some of the contributors to people thinking it is unacceptably noisy?

Mr. Nielsen told us he thinks change prompts reaction. He said there were areas without many bars, and then they became areas with a lot of bars. He gave an example of street that was full of antique shops, which then had a lot of bars open, and he believes that is what causes people to react. When residents moved in thinking it was one kind of area, and it changes, then they react. Mr. Nielsen talked about some streets that have been loud, bar streets for a while, and the people who move in knew that's what it was, so they expected it and are more okay with living with the noise.

4. What would someone expect on one of the noisy streets?

He said they would expect that there is a level of noise. He talked about Gothersgade as an example. He said it's the biggest party street, the Noise Unit have one or two complaints per year from that area.

The IT consultant informed us that the additional construction of the new Metro station adds to the noise level. Construction has regulations on when they can make noise, but citizens have expressed there is increased construction recently. Mr. Nielsen told us that they receive "at least as many complaints from construction" as they "do about night life".

5. Due to the two sided nature of this issue, would an effective solution address the residents or the noise management?

Mr. Nielsen expressed that addressing both sides is necessary. The authorities can help to manage the noise and diminish it to a certain level but this may not be enough to make the residents happy. He said some of the best solutions come from residents talking together. They

can come up with a solutions that benefits the residents and the bars. He thought this was especially true with noise in the streets, since it's not in the Noise Guard's jurisdiction. He said a good doorman or bouncer can help to mitigate the noise in the street better than the Noise Guard can.

6. What is the main objective of the Noise Guard and Unit?

Mr. Nielsen explained the Noise Guard tries to prevent the noise upfront. When people get new alcohol permits, the Noise Guard will check the restaurant to make sure they're not creating too much noise and following the regulations in place. They get thousands of complaints filed to them. He also said they often meet to document the noise levels themselves, so they can find if the complaints they receive describe the problem accurately.

a. What is the Noise Guard capable of doing? (Authority)

Mr. Nielsen informed us that the Noise guard focuses only on company noise- noise generated from businesses. They will tell businesses to follow the regulations, but if the businesses don't comply then the Noise Guard will have to pass the issue to the police, who will address the problem through the legal system. They can regulate concerts and clubs, but they can't regulate the people, especially in the street. They can't do anything about private parties. Mr. Nielsen said if there's a problem with alcohol permits, that's not the noise guard's jurisdiction. They cannot regulate businesses being open too late or serving to underage people.

b. If the Noise Guard and TMF aren't associated with alcohol licensing, who is?

Mr. Nielsen said that's the responsibility of The KFF. They have a secretary board and there are politicians on the licensing board. It's very tightly regulated on whose perspectives the board can consider. "It's difficult to say no to an alcohol permit if there's a restaurant nearby with a permit." However, the TMF will look at venues before license approval and tell the approval board what they think.

7. Do all involved stakeholders-groups have a sufficient understanding of the nightlife issue?

Mr. Nielsen told us he thinks the problem is very local and concentrated around the inner-city. There are some people who think there isn't enough going on outside of that area and they would like more noise, and there are people who are very frustrated because there's too much noise.

He said he thinks anyone who would go to the inner city at 3 am on the weekends would be surprised with how wild and noisy it is, since they don't really understand the extent of the noise. He also told us this wasn't the case 20-25 years ago, but now the area is a lot louder and drunker than people expect.

The IT Consultant told us about their effort using GPS to track trash and cleanup efforts, and how they've seen an increase in how often the street cleaners need to come, an increase in how much litter there is, and logically an increase in people creating the litter. The increase in

people cause this noise, and now the young people have more money to spend at more venues. He also said transportation infrastructure also allows people to travel to the inner city for the night, resulting in larger crowds from outside the area.

8. Would it be beneficial to the Noise Guard and its efforts to have access to data on the areas more prone to noise, and the most likely to have disturbances?

Mr. Nielsen expressed that he believes the Noise Guard is adequately equipped with an understanding of the nightlife issue. After working with the issue so long, they know where to make their rounds and the areas of high interest. They understand which restaurants and bars listen to the Noise Guard when they tell them to follow the regulations, and which ones will be a problem. He also said that the police don't always have the resources to address the noise, since they prioritize gangs and drugs.

We presented Mr. Nielsen with background on our research into applications like NYC's 311 app, and how apps have been used elsewhere. Our application is aimed to give a voice to the residents on the noise problem.

9. Would a data collection tool be an effective asset in mitigating the noise?

Mr. Nielsen said that depends on whether it will get the police more active. People are frustrated about which authority handles what noise, and contacting the correct authorities can be difficult. He told us that there are forums for the discussion of the issues, and knowledge is always good. However, he said the noise guard probably cannot use the data/app themselves.

The IT consultant explained that if this application sorts the complaints by type it may be useful. For example if someone submits a complaint about a private event, the noise guard can then say thank you for the complaint and inform the resident that's under police jurisdiction, directing them to the correct authority. This may lower the barrier for the police to react—if they could just press a button to see where the nearest complaint is that would help. We need to be sorting users' complaints and then directing them to complain to the right authority.

a. What other kind of information could be collected in this type of application?

Mr. Nielsen said he thought the police could use prioritization dependent on how important addressing the issue is: is this affecting a lot of people, or is this just a one-time smaller thing? If it's a recurring issue, it would likely be prioritized over temporary disturbances.

10. Do you think this data collection tool will appeal to citizens of all ages?

Mr. Nielsen thinks that some of the people complaining to the Noise Guard would opt to use an application over calling in, and it's more appealing to young people. He's also concerned that in making the complaint process so easy and fast, that it may double or triple the number of complaints the Noise Unit receives.

The IT consultant told us that if you increase the friction, the difficulty in reporting, it can result in reports mostly coming from people who really have a noise problem/really mean it,

instead of people who are just momentarily annoyed. Decreasing friction too much can result in too many low-priority complaints, making it harder to identify and address the high-priority ones from the people who are actually upset and bothered.

Also, Mr. Nielsen explained the people who complaint are concerned and have a problem, but there are many people who have a problem who don't complain. He told us that if you're a citizen and you haven't complained the last 10 times, when there's one more compliant than you can tolerate you're not very patient and just want it to be addressed.

a. Is there any information lacking from the reports the Noise Guard receives

Mr. Nielsen said the Noise Guard tries to get people to say where the problem is, but this isn't always accurate. They have a form on the internet on which people can choose which kind of complaint it is, which is good for statistics but sometimes people don't know what category they're choosing means. Under the category "music from concerts", Mr. Nielsen estimates only 1 out of every 10 is actually from a concert. The rest are from clubs or bars, or music in the street. There's also a text box for comments, but the IT consultant told us it's hard to pinpoint where the noise is coming from, especially from inside ones apartment so reported location is inaccurate. Mr. Nielsen said people typically complain before they go to bed, and between 3am and 5am is when the least complaints are. Part of this may be due to the difficulty of submitting and that residents don't want to go through the process when they're trying to go back to sleep.

Appendix J: Interview with Jakob Vilner

Deputy Inspector of the Copenhagen Police

April 13, 2018

The team reviewed the consent form with Jakob, explained the purpose of recording interview, received verbal consent to record, and Jakob signed the consent form to participate in the interview.

1. What is your official title?

Jakob Vilner told us he's the "*Vicepolitiinspektør*", the Chief of the local police in Copenhagen. Ms. Spang Bech corrected his translation to Vice Police Chief, however the literal translation of *Vicepolitiinspektør* is Deputy Inspector. Mr. Vilner added "Deputy Chief Superintendent, in English in a way- Chief of the local police in Copenhagen"

2. What is your involvement with the nightlife noise problems in Indre By?

Mr. Vilner told us of his involvement in a project called *trygt natteliv*- meaning safe nightlife. He explained it is a police effort to manage whatever happens in the nightlife on Thursday, Friday and Saturday, during most weeks/months of the year. They aim to provide safety and be a presence as police to provide protection.

a. Why those days in particular?

He explained that those days are covered specifically "since the most riots and most noise occurs those days- Thursday, Friday and Saturday". Mr. Vilner said the police effort is there from 9 or 10 in the evening all through the night. The "normal" police drive around in the white cars all day. Mr. Vilner's group is a special effort for nightlife, different from the "normal" police.

3. How do the police receive noise complaints?

He said they receive tons of complaints on music noise—lots of music from restaurants, discotheques and private parties. The police can regulate establishments to close their windows or give them a fine for not following regulations. Mr. Vilner told us the police do not regulate how much noise happens on the streets unless it's dangerous to the people around them.

a. Aside from giving fines what else can the police do?

Mr. Vilner said they can arrest people, but specifically for noise if people are being too loud the police can give them a fine, and prefer this over arresting people. He said someone needs to be very noisy and behaving very badly to deserve the fine. He explained that the police try to regulate by being "the good cops"—they ask people to be quieter, to give reminders rather than fines when they can, because they want it to be a good experience. They're not there to be bullies. He told us that if people fight in the street they'll get a fine or be arrested but that's not under the noise specific effort.

4. Are most of the complaints you receive about people singing and shouting in the streets?

Mr. Vilner informed us that the police commonly hear that when people move around on the streets they make a lot of noise. The restaurants and the discotheques also can generate noise, since patrons go outside into the street to smoke, because they cannot smoke inside. He said it can get quite loud for people living above the discotheques since noise gets louder when it echoes between buildings. His perspective is that the people are loud because they are in a good mood and there's music. He told us the police don't regulate the street noise unless it's "very very" noisy, since it's not illegal to stand on the street and sing and talk loudly to each other or go outside the discotheques smoking.

a. How would you respond if someone called in a complaint about loud people outside?

He said that they would go there and ask them to quiet down, go back inside when they're done smoking, or if they don't have a reason to be there to go move somewhere else.

5. How many officers are available to handle complaints like there, on an average night, specifically in Indre By?

Mr. Vilner told us this is dependent on the time of the year. There can be as many as 12 (groups of threes or pairs), and on colder weeks when the bars are less active, as few as 9 or 6.

6. How do the police prioritize their resources to address these complaints among other responsibilities?

He said that depends on what else the police have to do. They put Life and Health problems on top, "If there's other things going on like Violence or drugs, [the police] prioritize that"

7. What aspects of the nightlife noise problem are hardest to address?

Mr. Vilner said the hardest part is that people would like to have a good time, in the streets, especially when it's warm outside. They go into the streets, not just the discotheques. They can buy alcohol in grocery stores or the 7-Eleven, and they can drink it in the street and they can bring their own music. The Police also want people to have a good time in Copenhagen. It's difficult because the people who want to have fun can be the problem.

8. Is there a mechanism for recording all complaints that are submitted?

We learned that every time a call comes in to 114 or 112 (although people don't use 112 for noise) the police notice that. They record that complaint and it goes to the dispatch room for radio communication, and Mr. Vilner said it's kept track of. If someone reports a complaint they keep track of that, and if they respond to the complaint they also keep track of the response. They have two systems—one where they direct cars around and another in a file database. They log the file, assign it a Journal Number (similar to case number), and enter it in the database.

9. Do you feel as though there are enough resources available to effectively address the nightlife noise problems throughout Copenhagen, specifically in the inner city and in the summer?

Mr. Vilner said that's subjective. He informed us that the police made an effort to bring down violence in Inner City and it has been a success- they actually brought down violence. However, defining is considered enough is hard to do objectively. He said everyone has the right to sing at night, but if the police wanted to end that it would take many more resources. Mr. Vilner believes they put enough effort in, and told us that the police partner with many groups like security guards and discotheques, and the Municipality and street workers, to help manage nightlife noise. For example they worked with the Municipality to address young people congregating around the McDonalds late at night.

10. Does the existing file system the police have direct resources to geographic areas of high concern?

Mr. Vilner told us that yes, it does. The police analyze the data very closely, however their analysis is centered around violence not noise. Coincidentally, the areas of highest violence with people in the streets are the same areas as the discotheques and the restaurants and the cafes.

a. Is it helpful to have access to that kind of data/analysis?

Yes, he said they use it for "intelligent policing". He explained they make a report every quarter for where the problems are and what can be done about. They're working on a special project in one of the areas- the Municipality wants to see how it will work with video cameras or closing the street down, and they work very closely with that effort. "Stuff like that has two sides", since closing the street to traffic means more people will be in the street.

Our team explained the details of the system we were developing. It would allow residents to submit reports on noise disturbances to our database, which over time and applying the right analytics could highlight patterns in the nightlife scene, primarily noise. We had been modeling it after similar existing systems like New York City's 311 system. We provided a brief explanation on how NYC's 311 works and how it helps by identifying when/where noise complaints usually arise.

11. "Do you think the police would be interested in seeing the data collected from the [app we developed]?"

Mr. Vilner replied "Oh yeah we would like to see the data of course".

12. It seems our file systems are similar in data storage and analytics. Our system hopefully allows for direct user submission, without having to go through calling one in. Maybe by having access to this database would be beneficial, in addition to their already existing database on official reports and system would help with understanding the big picture.

Mr. Vilner agreed but told us we needed to emphasize that the police would not have direct access to this database. “If you want the police to respond to it, then they you have to call the police. We would like to see the results but we cannot have access to it or stuff like that, because then we’ll have to respond to it. But they’ll have to call us if they want us to respond to it, you point that out to people using the app.” Our app is a database, not a complaint system. If users want a response they still need to call 114.

13. Is there anything your file system does not collect that our application could, that you'd like to see?

He explained to us that if the police receive a complaint, they assign it a journal number which is an inconvenient identifier for them to use. They might write down the type of noise when they go to address the complaint, but usually they don't mark down what kind of noise it is if they're busy. Mr. Vilner thought “It could be nice to show if it’s people in the street or people standing outside the discotheques”- In other words, the category. He said the police have a very good understanding of where the noise is but not the type, so it could be good to show if it is from people driving through, people in the street or people going home. Their system stores only what the police operator enters when they receive a call. Our system can find out what the people find annoying.

14. What features do you think would be beneficial to include in the app we’re developing?

He said that relies on the abilities of our app. Typically the police just register noise in general, not the type of noise, and the Police could use more information on the type of noise, and trends in the categories.

15. Since our project team is only here until the end of April, we are looking for someone to continue the work that we’ve started. Do you think the police would be interested in expanding upon and developing the system we've already started? *Right now our system was live and it exists and is functional in its most basic form, so it wouldn't be developing it from scratch, there is already something that exists.*

Mr. Vilner informed us that he doesn't have the authority to give us a concrete answer, since he's not ranked highly enough, but he told us “I’m sure my bosses would like to see something from you, and write to them ‘are you interested?’ and they will look into it”. Mr. Vilner provided us with contact information for higher ranking officials, and directed us online to find the email for the Police secretary as well as a secure online submission box, as well as his contact information.

Mike shows Mr. Vilner what we have developed so far, including category selection and the redirection to the Noise Guard. We want to collect data but also educate people on where to submit complaints. The subcategories allow for specific breakdown by type. Additionally, our location data tells us where it is. The goal is to create something similar to the NYC 311 App. We hope to enable data analysis so people can see the evolution of the noise problem over the week and over time.

To which Mr. Vilner responded that he thinks the interesting part is denoting what kind of noise the complaint is about and how it's annoying people, because then you can determine the cause. He's interested in seeing if it's just music or people in the street or are they just walking through. There's different kind of noise in different places and that's something the police would like to see.

16. Do you think data analytics on the data we collect can inform decisions on where the patrol is assigned, to focus on geographical areas of highest concern?

He said that it can, but that it would probably look like the system and results the police already have. They've worked with data analytics for intelligent policing, and they implement similar tactics to determine where/when they have to be around areas of higher violence. For example, there is a lot of violence around Nørreport station around 2 am, coinciding with the last train home, so they assigned resources there and then. They also experience high violence on Gothersgade around 2-5 am, so they direct most of the police there. Another example he gave is Vestergade, where there's a lot of noise too. Mr. Vilner expects the analysis our system creates to look similar to those the police already have access to. By having a second database, ours may uncover areas of concern the police had previously been unaware of and the two can be cross checked against each other.

17. Do you have any questions for us?

Mr. Vilner didn't have any question for our team, but he thinks this is an interesting problem, which is why the police work with it a lot. He informed us that he sits on the group in the Municipality which deals with nightlife, and they know that this is a big problem that is very annoying to those who live there. He also mentioned the party busses are "interesting" and operate in between different regulations.

Ms. Spang Bech discusses how this app is not just for data submission and collection, it's an educational guide to inform people how to get to the correct authority. From the application they can be redirected to call or go to the online form. This will hopefully result in the users who call the police knowing they've contacted the correct authority, and the police receiving less complaints that should be directed elsewhere.

18. Do the police ever receive calls for issues outside of their jurisdiction for noise regulation?

He told us the available resources dictate what is possible for the police. If they have patrol to go to where a complaint was reported, then they will go and address the noise. If the resources are being used elsewhere, on higher priority issues, then they can't go to the area to address the issue, and they'll just register the complaint.

19. Representatives from the Noise guard had said they frequently receive complaints that should go to the police, do you experience this as well?

He told us that when someone calls the police, they will inquire about what specifically is the problem. If it's something like open windows, they can address it themselves, but they also can call the noise patrol since the police have the noise patrol's direct number. If it's something like restaurants which is a noise patrol issue rather than a police issue, Mr. Vilner thinks they will call the noise patrol instead of redirecting the citizen to call the noise patrol themselves. They'll record information about the issue and then notify the noise patrol.

20. Who regulates the people outside smoking? The noise guard?

Mr. Vilner told us the police regulate smoking, since it takes place in the street. The patrons can't bring alcohol from the discotheques outside but even smoking can cause noise. It's also tough for the officers to tell if people are outside just to smoke, or if they're hanging out having a party in the streets.

Ms. Spang Bech suggested Mr. Viner advise on the distinctions between police and noise patrol jurisdiction. Mr. Vilner said he was informed, however the noise patrol understands the issue better since they work with noise every day. She also suggested that in the future the police may have interest in different categories, such as construction noise, and that this application may provide access to that data. Additionally since there is already a specific form for that through the municipality, our application can redirect users to the correct avenue for that complaint.

21. How useful do you think somebody attaching a picture, video or recording would be when assessing a complaint?

Mr. Vilner told us he sees it providing "not very much" help. "It's just a moment cut out of the big picture. You have to be there to see how much noise it will make and how annoying is it. You have to get the big picture to know. Just filming someone screaming and shouting wouldn't give anything"

22. Do members of the municipality and city officials have access to your data?

He explained that no one has access to police data unless explicitly requested. This is due to privacy protection regulations since the police records who calls, their social security number, and address.

23. Open discussion on security and privacy concerns.

Ms. Spang Bech explained that there is no legal issue with publicizing information such as location, although bar owners may not like complaints being reported on their address, whether they're inside or outside. The city already has a site which publicizes all complaints about essentially everything but noise, and the data is easily accessible so there is a precedent for this kind of data publication and no actual problem with making the noise data public. However, our system needs to prioritize keeping personal data private to comply with security laws.

To complain about other things such as garbage, Ms. Spang Bech informed us that users do not need to disclose their identity so anonymous reporting is possible, but we should be collecting an identifier to help validate complaints and track unique user submissions. There is an issue with passing the identity of users to the police, since Mr. Vilner told us that would essentially constitute a complaint and the police would need to file a report and address that, which they are not interested in. They are however, interested in the big picture through data analysis. Mr. Vilner said a system like this could be of use to the police, but they would need to look into the feasibility further. This can help begin the conversation of collaboration between the municipality, police, and data collection systems.

He told us the police cannot allow outside systems to have access to the police database due to security laws. There are strict laws about databases communication in order to protect individuals' privacy. Two databases cannot be combined without being positive there is no legal issue. Mr. Vilner even cited that the police cannot combine their automotive and criminal databases when pulling someone over. Mr. Vilner is not familiar enough with the law to advise, however he suggested the police's lawyers could help.

Even with these strict data laws, conveying data analytics denoting the big picture would be allowed. The issue arises with any personal data, such as phone number, personal address, and name.

Appendix K: Application Design Decisions

Frontend and Backend

In software engineering, the term “backend” is used to refer to the piece of the software that directly interacts with the database (or “data access layer”). Users of the software generally do not directly interact with this part of the system; they interact with the “frontend,” which contains the user interface and other user-driven functionality. The frontend then sends a request to the backend (or occasionally to some “middleware” between the two, used to pre-process the data or bear some other functionality), and the backend attempts to satisfy that request—whether it’s to send data back to the frontend, store some data in the database, modify something in the database, or delete something in the database. If the backend cannot satisfy this request (due to some error or another), it will send an error message back to the frontend.

Backend: Platform

At the beginning of our application design process, we established that using a REST (REpresentational State Transfer) backend framework would be the best approach. The REST framework facilitates the transfer of data between the app and a centralized database. This approach allowed us to collect data from any number of apps being used simultaneously, transmit that data over the internet via HTTP (HyperText Transfer Protocol), and collect it in one common location in a quick and simple manner. The use of a REST framework also allowed us to build a web-based API (Application Programming Interface), giving stakeholders who are interested in the data a way to directly query the database.

To implement this REST API, we considered two industry-standard platforms: Node.js (a JavaScript framework) and Django (a Python framework). Researching their differences led to the following conclusions:

- Node.js is newer, but less mature (well-supported) than Django
- Django is used more frequently in large-scale projects
- Django has a package called the Django Rest Framework, designed for quick development of simple REST APIs
- Python, the programming language Django uses, has many separate code “packages” that contain pre-built functionality
 - JavaScript also has this, but they’re not as well documented
- Django automatically handles the creation and maintenance of a database (SQLite, by default)

Given the benefits/drawbacks between the two, we decided to proceed with Django as the foundation for our REST API. Alongside Django, we used the following Python packages:

- The Django Rest Framework, which includes functionality that makes developing a REST API as quick and painless as possible.
- Django CORS Headers, which enables the sharing of resources (data) between the backend and the frontend.
- Django Filter, which makes filtering data from the database significantly more simple.
- Django Rest Framework Filters, which extends Django Filter and includes specialized filters for specific data types.
- Pillow, which enables the storage of images within Django's constructed database.
- Virtualenv, which keeps the Python program isolated in its own virtual container, away from any external influences. This is particularly critical when the program might be developed or deployed on multiple computers, which may have different settings/configurations.

Backend: Complaint Model

Designing the Complaint model, or what information would be stored in the database to represent a user-submitted complaint, closely followed the process of interviewing stakeholders to determine the pertinent information to collect. The original model contained a simple set of data that we assumed would be required in a noise complaint: the timestamp of the submission (time/date), the location of the incident (longitude/latitude), a categorization of the complaint, and any comments the user might have about the incident.

Eventually, this list was expanded to include subcategories, images, audio, and the user's account ID. We decided to store images and audio using JPEG and AAC compression respectively, both of which offered the greatest compression/quality ratio available and minimized the amount of storage space our app's server would require.

After consulting with the Noise Group and Copenhagen Police, we decided to restrict the list of complaint categories to just four: "Bar/Restaurant," "Construction," "Street Noise," and "Private Celebration". Each category then had an associated sub-category, which was limited to: "Loud Music/Party," "Loud Talking/Shouting," and "Banging/Pounding." We made the "Comments," "Images," and "Audio" fields optional in complaint submissions, then eventually eliminated "Images" and "Audio" as they required more time to implement on the frontend than the value we thought they brought to our prototype app.

Backend: User Account Implementation

To ensure the validity of user-submitted complaints, we decided to require users to create accounts before submitting noise complaints. This allowed us to tie each complaint back to an individual user and created a foundation for system abuse monitoring, if it were to be implemented in the future. It also allowed us to delegate permissions to individual users, such that a user associated with the police or the municipality could have access to parts of the system that the residents don't (like data analytics, for example).

Django comes with a default user account model, which includes a username, password, first and last names, email address, groups, and permissions. We only required a first name, last name, username, and password in the prototype of our app. This was to minimize the amount of personal information we collected in our database; we didn't want to be responsible for ensuring that the personal data of our users was secure, as the app was still in its early developmental stages.

In the future, it would make sense to also require an email address. If the authorities wanted to follow up on a noise disturbance, or the user were to forget their password, their email address would be an effective means of contact.

Backend: API Design and Development

With the backend's foundation in place, we then began designing and implementing the API through which our data could be accessed. The API serves two purposes:

1. It allows for direct communication between the frontend and backend of the app.
2. It allows for stakeholders (who are interested in the app's dataset) to directly query the database without formally requesting the data from the app's development team.

Communication with the API is done through HTTP method requests (e.g. GET, POST, PUT, and DELETE), which include the instructions and data required for the backend to complete the requested operation. Designing the API iteratively followed the process of answering the question "What data would the application need to save, modify, delete, or request from the database?" This process resulted in the following list of endpoints (or access points for anyone using the API) as a base for the API's development phase:

1. Sending a complaint to the system
2. Getting a list of all complaints in the system
3. Getting an individual complaint (by complaint ID)
4. Creating a user account
5. Getting a list of users in the system
6. Getting an individual user (by user ID)

Additional endpoints will be required in future iterations of the application as some basic ones were left out of the prototype due to time constraints. These endpoints should include:

1. Removing a complaint from the system
2. Removing a user from the system
3. Modifying a user account (with updated user information)

The API was also designed with security and authorization in mind. Every call to an API endpoint required an authentication token that's unique to the user's account. An authentication request should be made prior to any of the above calls to an endpoint to validate the user's credentials and ensure they have permission to perform the operation contained within the endpoint. This authentication request requires the user's username and password be sent to the API; if the user credentials are valid, the API will return an authentication token that gives the account access to every API endpoint that they have adequate permissions to use.

Developing the API required the creation of Django Views and Serializers. Django Views control the HTTP method requests made to the API, acting as an arbiter for how data enters and exits the database. Django Serializers process the data that's being requested from the database and return it in a consistent format. We opted to return this data in JSON (JavaScript Object Notation) format, which is open-standard, an industry standard, and human-readable. Together, Django Views and Serializers work to process any requests made to the API and how information comes back to the user.

Backend: Filtering Data

Being able to request complaints by ID or the set of all complaints from the database is nice, but it severely limits the usefulness of the dataset if analysts have to know the IDs of specific complaints or crawl through the entire dataset just to see information on complaints they're interested in. Thus, it makes sense to allow users to query the database with more specific criteria. Django Filters can take in these requests, automatically search the database based on the specified criterion, and return a list of results that fits what the user is looking for. We built a filter for the Complaint model, which allows users to filter these complaints based on:

- The person who submitted the complaint
- The date/time (timestamp) the complaint was submitted
- The complaint's category and sub-category
- The complaint's location (latitude and longitude)

Of note: The timestamp, latitude, and longitude are all filtered within a provided range. This means that users can select a range of dates/times, latitudes, and longitudes within which they'd like to view complaints.

Backend: Documentation

The documentation for the backend consists of a setup guide and an API reference, and is contained within the README.md file in the project's GitHub repository.

The setup guide contains a list of the code's requirements and dependencies. It also has initial configuration information, database management information, and instructions on running the server.

The API reference contains every endpoint request that the backend is configured to handle. Each of these endpoint requests contains a description of what it does, the API URL that gives the user access to it, the HTTP request method required to access it, and authentication/permissions requirements. It also contains examples of what information should be included in the request's headers, any constraints on the data contained within the request, the expected response if the request is successful, and an example of the content the request returns.

Frontend: Platform

The first design decision related to the front end of the app was the web framework we were going to use. A web framework is a platform of pre-existing code that provides built-in functionality of many tasks that would otherwise have to be written manually. The largest deciding factor when choosing a web framework is whether your website will be multi-paged or single-paged.

A single page website is one that is encompassed in a single page URL. Page content will change based on user interaction, but it will never require a page refresh. Multi-page applications on the other hand, are large and enough that they require page refreshes and redirection.

To decide on the web page type, we outlined all the wanted features the web page types offered and ranked them. The web page type with the highest score would be the one we choose.

Web page Type (Preferred functionality is **bolded**)

	Weight	Single-Page	Multi-Page
Functionality:	3	Single-Functionality	Multi-functionality
Resources:	3	Limited data rendering	Database rendering
Response:	2	Quick response (No Refreshing)	Frequent Page Refreshes
Score		5	0

Criteria Description:

Single-Functionality: Our app only serves one purpose, to submit a noise complaint. Using a multi-page approach may overcomplicate things.

Limited Data Rendering: Our app is not going to dynamically render pages of database data. (i.e. Wikipedia, Facebook, etc.)

Quick Response: Our website needs to have a quick response time to feel like an app. This means that most clicks should not result in a page refresh.

Multi paged applications are meant for larger, database rendering applications. Our application is not about database rendering, but rather database populating. Therefore, a single-page application is the most logical approach here.

Now that we had decided on a web page type, it was time to examine the frameworks we could use. Our research led us to the three most popular web app frameworks: Angular, React, and Vue. We used the same approach as web page type to decide on our framework.

Framework Decision

	Weight	Angular	React	Vue
Usage License:	3	MIT	MIT	MIT
Website Type:	3	Single-paged	Multi-paged	Single-paged
Audience:	2	Large Company	Large Company	Small Company
Libraries Incl:	2	Library Heavy	Flexible	Flexible
Web Lang:	2	HTML, JS, CSS	Javascript Heavy	HTML, JS, CSS
Satisfaction:	1	65%	92%	89%
Awareness:	1	100%	100%	23%
Maturity:	1	8 Years	5 Years	4 Years
Score		10	7	13

Percentages were collected from a 2017 Stackoverflow.com survey

Criteria Description:

Usage License: The framework must be free for commercial use if this app is to go public.

Website Type: Since we had already decided on a website type, this criteria was ranked very high. However, React ranked high in other criteria which is why we left it in here for consideration.

Web Languages: A traditional website uses HTML, CSS, and Javascript (JS) together. The HTML outlines what's on the page, Javascript makes it interactive, and CSS makes it look appealing. React relies on Javascript to serve all 3 purposes. This is useful in websites with a lot of extended functionality, changing interfaces, and data to display. However, in simple applications it can create unnecessary complexities.

Libraries Included: Library heavy frameworks can cause unnecessary complexity in simple applications. Flexible libraries allow you to install only the libraries you need. This makes the learning process simpler and shrinks the code size.

Satisfaction: The IQP project is demanding and we do not have the time to be frustrated with our code.

Awareness: We are more likely to find support for the framework if it is more well-known. It is also easier to find other developers to maintain our work once we finish the project.

Audience: Our small development team requires a framework designed for small teams. Frameworks for large companies can assume your team has the resources to rewrite or design many system by hand.

Maturity: How old the framework is. An older framework has been tested for longer and is therefore more stable.

We decided on going with Vue because of the advantages over the other two frameworks. Overall, Vue seemed like the simplest of the three, making it the perfect choice for developing the prototype in the short 5 week span.

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Frontend: Design

In order to create an app that looked more appealing to the user, we needed to use a design language in our app. We decided that the design language needed to be simple to implement and familiar to interact with. This is what led us to Material design. Material is a design language developed by Google. It is comprised of simple colors and shapes to simplify the user interface. It is an industry standard and used in most Google products as well as the Android Operating system.

Frontend: Maps

Every noise complaint needs a location attached to it. There are three ways that this can be accomplished. Via GPS, address search, or by dragging a pin on a map. GPS was our first implementation, but we soon found out that these features are unavailable until our website utilized data transfer encryption. Users could input their address but that could still lead to inaccurate location. Map selection was therefore necessary so that users could select and confirm that the location was correct. There were two map libraries for us to choose from: Google Maps and Leaflet. Similar to the web framework, we ranked the features each library offered and chose the highest scoring one.

	Rank	Google Maps	Leaflet
Interactive Map	3	Yes	Yes
Address Search	2	Yes	Yes (Requires 3rd party plugin)
Usage Limits	2	25,000 Loads/Day	Unlimited
API Key	1	Yes	No
Score		5	6

Criteria Description:

Interactive Map: This feature is necessary and both services offer it.

Address Search: Integrated address search makes it easier for users to locate their location on the map. They might know their address, but not necessarily that exact location on the map.

Google has this feature built in but Leaflet requires a 3rd party plugin to use.

Usage Limits: Scalability is important for our application. While the 25,000 map loads a day offered by Google may be reasonable to expect at the launch of the app, we cannot risk having our application break down in the future if it becomes more popular. Leaflet offers unlimited map loads which is much safer for the long term.

API Key: Google requires an API key to access their map. While they key is free, it requires being manual reactivation each year. This is an added layer of maintenance that we should not leave future project owners with.

It was a close decision, but Leaflet seemed like the better option to use. It was not as complete or well-known as Google maps but it did not require having an account or API key to use.

Frontend: Documentation

The documentation for the front-end consists of a setup guide and a high-level design document. The setup guide is located in a `readme.md` file in the source code and the design document is located in a formal manual.

The design document describes how the source code works together and how it can be improved. It can be used by future developers who are looking to improve the program or add features like more languages or complaint categories. It can be located (permanent link to come—will be addressed for the next version of this document)

Hosting

To conduct a testing period for our prototype web app, we had to make it available on the internet to potential users. This required us to find a hosting platform for both the frontend and backend to run on. Our sponsor had a hosting provider, but they weren't responsive when we initially tried to contact them. Additionally, the workflow required to deploy new versions of the application to their servers when we made updates was inefficient; every time we wanted to make changes to the code they required us to call them, wait for support, remotely connect to their server, and then make the necessary changes while they watched us work. This meant that deploying our new code could be a 30-minute to 1-hour long process every time we wanted to update our app, and restricted us to working solely within the provider's operating hours.

Hosting: Amazon Web Services (AWS)

To speed up the development and testing process, we decided to use a separate hosting platform for our web app. AWS is the go-to hosting service provider of the IT industry and makes it easy to quickly build and deploy projects of any scale on their servers. Additionally, AWS offers a "Free Tier" that negates the costs of hosting small, simple applications—perfect for our prototype web app!

Configuring hosting was fairly complicated, despite the abundance of documentation Amazon makes available to developers. The first step was to provision an Amazon Elastic Compute Cloud (EC2) server for our app to run on. We decided on configuring one of their "t2.micro" server instances, which contained more than enough computing power and storage space for our purposes. We chose to provision this server at their Frankfurt, Germany location to best comply with EU data regulations (which requires additional security measures on all EU-based data platforms). We also configured a "security group" for the server, which controls who can access what on our server, to forward all traffic to our application EC2 instances allow developers to access the server via Secure Shell (SSH). This provides complete control over the server through a secured terminal; thus, all setup and configuration must be done via command line.

To maximize the productivity of the development process, we also opted to configure automatic code deployment through GitHub and AWS CodeDeploy. GitHub, the centralized repository we host our code in, allows us to push our code directly to AWS CodeDeploy every time we push changes to the code in the repository. AWS CodeDeploy will then take this code and automatically deployment process (setup and configuration) on the EC2 instance. This improves the development workflow significantly, as developers no longer have to connect to the EC2 instance and manually pull and deploy the updated code—something that can take an extra 5-10 minutes every time a change is made.

This added some extra steps to the development process upfront—specifically requiring the inclusion of an *appspec.yml* file in both the backend and frontend with CodeDeploy’s deployment instructions. We also had to include scripts to automate each step of the deployment process. These scripts contained sets of commands that, when run, completed the process of setting up and configuring the app. The frontend and backend utilized the following scripts:

- *clean_instance.sh*, which removed the old code before the new code was installed.
- *install_os_dependancies.sh*, which re-installed anything the server needed to configure the app.
- *install_python_dependencies.sh* or *install_nodejs_dependencies.sh*, which re-installed everything required to run the code.
- *start_application.sh*, which configured the code for the startup process.
- *runserver.sh*, which ran the code.
- *stop_application.sh*, which stopped the code from running if the server needed to do so.
- The backend also used *migrate.sh*, which set up and configured the app’s database.

To keep the server running, we utilized a Node.js package called Forever. Forever simply takes a specified script and keeps it running until either something goes wrong or the administrator tells it to stop. We used Forever in the *start_application.sh* script, to perpetually run *runserver.sh* and keep the app online.

Hosting: Making the App Available on Miljøpunkt’s Site

Once the app was hosted on AWS, we could access and use it through an IP address that was automatically generated for our server. However, we didn’t think that a complicated string of numbers would be the most effective way to distribute our app. Thus, we decided to make our app available on our sponsor’s website as well. The Miljøpunkt Indre By & Christianshavn website was developed using WordPress, which is designed to use pre-structured pages to represent site content. More specifically, WordPress is not designed to host web apps. In order to make the app available on the website, we had to create a new “News” post and link the app in an HTML “iframe” within the body of that post. The “iframe,” or inline frame, allows content from another location on the internet to be embedded in a page. By embedding our web app in

Miljøpunkt's news posting, potential users simply had to navigate to our sponsor's website rather than a difficult-to-remember IP address.

Hosting: Moving to A-one

We wanted to ensure that our app was completely under the control of our sponsor before the conclusion of our project. This required us to move the app from AWS to our sponsor's hosting provider, A-one. As mentioned previously, doing so required a call to their support line where we waited for support to be available. Then we were given temporary access to the server, where we had to manually install and deploy both the frontend and the backend while the support technician watched. Their platform was running Windows Server 2008 R2, which provided significant compatibility problems in trying to move our code from the newer, UNIX-based AWS server.

Security

Our app will be collecting user-submitted data, which opens up a potential scenario in which the users identify themselves in their noise complaints. Users, as well as the noise sources which they are reporting, do not want this information to be public. This makes it our responsibility to keep it safe. To avoid a potential data breach, our software must be designed with security in mind. We are also required to comply with the European Commission's regulations on data collection and data storage. Many of these regulations can be covered with a "Terms of Service" agreement, available to users in our app, and by storing our data with a European-based server hosting provider using dual-encryption security. The European Commission also recommends the development of a web app over the development of an app that is coded specifically for a particular platform or operating system. This is because a web app is cheaper to develop, easier to maintain, and accessible on multiple platforms (European Commission, 2016).

Appendix L: Test Group Google Survey Responses

Total Responses = 6

April 17, 2018

Did you use the app on a Computer or a Smartphone?

6 users reported Computer

What web browser did you access the app with?

3 users reported Google Chrome

1 users reported Firefox

1 users reported Internet Explorer

1 users reported Microsoft Edge

How easy was the app to use (on a scale from 1 being difficult, to 5 being very easy)

1 user reported a 3

3 users reported a 4

2 users reported a 5

How comfortable are you with using an app like this? (on a scale from 1 being very uncomfortable to 5 being very comfortable)

1 user reported a 2

5 users reported a 5

Which features of this app did you like the most? (Check all that apply)

2 users selected "Category of Noise"

2 users selected "Finding Location by Street Address"

4 users selected "Finding Location by moving the pin on the Map"

2 users selected "Comments Section"

Did you experience problems using any of these features? (Check all that apply)

4 users selected "No problems with any of the features"

2 users selected "Finding location by moving the pin on the map"

0 users selected "Category of Noise", "Finding Location by street address" and "Comments section"

Do you think an option to upload pictures and audio would be useful?

6 users responded Yes

0 users responded No

Would you use this app to submit noise complaints in the future? If you answered no to the previous question, why not?

4 users responded Yes

2 users responded No, and their additional responses are below.

Response No.	Comments: Key points of information in bold .
1	I would call the police right away if it was really bad . Otherwise I would just try to ignore the noise .
2	I would have said " maybe " had it been possible. It depends who uses the result— is it the police or the municipality who will act upon it now, or is it just for statistical purposes? If the latter , I probably wouldn't use it.

Would you encourage friends and neighbors to use this app?

4 users responded Yes

2 users responded No

What should the name of this app be?

3 users responded Stop Støj

1 user responded CPH Noise

1 user responded Københavenerappen or KBH Støjklager

1 user responded Støj Alarm

How can we further improve the app?

Response No.	Comments: Key points of information in bold .
1	When I had moved the pin, and found my location, I didn't know what to do. It took a while to realize that I had to scroll down and choose next —it would have been easier if that button was in the top .
2	Step 2— The applicable categories —fx. Street Noise, Private Celebration etc. are good . However, I am thinking that there maybe should be an open category , for people the fill in themselves. In order not to restrict the types of complaints to a very fixed categories .
3	Although I've now updated my iPhone, the app still cannot use on the iPhone. It seems that login info might be different according to which device is used. On the iPhone I don't even get past the login process. The message that either my username either/or my password is/are wrong keeps popping up. In my opinion it is essential that the same login info must work on any and all devices used (computer, iPhone, iPad, android, etc.).

Additional Comments

Response No.	Comments: Key points of information in bold .
1	<p>When I had registered and created my user, I ended up on a completely different site and didn't know how to get back to create the complaint. I had to open the mail where the link was, and click on it again. That's a barrier.</p> <p>I also don't understand the categories, why are they important? I ended up just clicking on one, not sure whether it as the one intended for my purpose. And whether it made any difference what I chose.</p> <p>Lastly, I didn't receive a confirmation and couldn't see my complaint afterwards. It would have been helpful to see the complaints reported within the last say 12 hours in the same area—so that I could see if other people are bothered by the same event.</p>
2	<p>At your presentation in Miljøpunkt you spoke about the app being open source so that people could see what complaints that had been submitted. That feature I think would be very useful.</p> <p>Also I think that the app should be in iOS and Android app-stores if at all possible. To promote the spreading of the app. Great job!</p>
3	great initiative
4	When I just tried to use the app on my computer (6 pm Tuesday), I couldn't log in either --- perhaps the test site is already closed??

Appendix M: Simulation Matrices

Platform

Following the development of our prototype application, we determined that we needed more data to represent the analytics and visualization potential of our system. Given the small amount of time remaining in the project, we needed to quickly develop something that could generate large amounts of realistic data. These data would then be used to show what kinds of analysis and visualization can be done on the information our system collects. We used Python to build the data generation system, as the language is designed for quick application development.

Weighting

A complaint contains four important pieces of data: the category of complaint, the sub-category, the time/date, and the location. For the purpose of obtaining a strong and varied simulated dataset, we wanted to include a large number of complaints with varied categories and with dates/times covering a month or two. We included a varied location as well, focusing on the nightlife-heavy Nørre Kvarter district. It's important to note that these breakdowns/estimations were almost entirely "educated guesses," as actual noise complaint data/distribution is not publicly available. We adjusted the weights to obtain a realistic dataset while still maintaining reasonable distributions.

To keep the dataset as realistic as possible, we had to weight the distribution of complaints more heavily over periods of time where there's more nightlife action. Additionally, we weighed certain categories of noise differently throughout the day; logically, more construction-related noise would occur during the day and more bar or street noise would occur during the night. Similarly, significantly fewer noise complaints are likely to be filed during the day, as most people are awake and at work. Far more nighttime noise complaints are likely to be submitted during the weekend (Thursday, Friday, Saturday), as nightlife activity peaks during these days. These weight/percentage breakdowns in Tables A, B, and E below.

We also had to account for the different types of noise occurring in different areas. In our investigation of Nørre Kvarter, we discovered two distinct settings: purely residential and residential with a heavy distribution of nightlife businesses. We categorized these settings by street and street address, then weighted the distribution of bar/restaurant and street noise heavier in the commercialized areas, and construction and private noise heavier in residential areas. The breakdown of street/area categorization can be found in Table I, and the weight/percentage breakdown is located in Table C below.

Finally, we had to consider the breakdown of noise complaint sub-categories with regards to the primary category. We weighted each sub-category by the type of noise its primary category was most likely to produce. This breakdown is located in Table D below.

After taking every weight into account, the data generation tool would create a specified number of complaints, over a specified period of time. These data automatically export as a CSV, ready for analysis and visualization.

Visualization

Once we had a realistic data set to work with, we wanted to showcase different kinds of potential analysis and visualization. We could have done this programmatically using the PyLab Python package, R, or D3.js. However, Microsoft Excel's 3D Maps feature provided exactly the solution we were looking for, and required no code. Using 3D Maps, we created a model of the noise complaints by category, superimposed on a map of Nørre Kvarter (see Figure 1). We also created a time-lapse heatmap visualization, showing the density of the noise complaints at any period of time in the day (see Figure 2 for the simulated distribution on a Saturday night).

Figure M.1: Example noise complaints by category in Nørre Kvarter, for the entire simulated period.

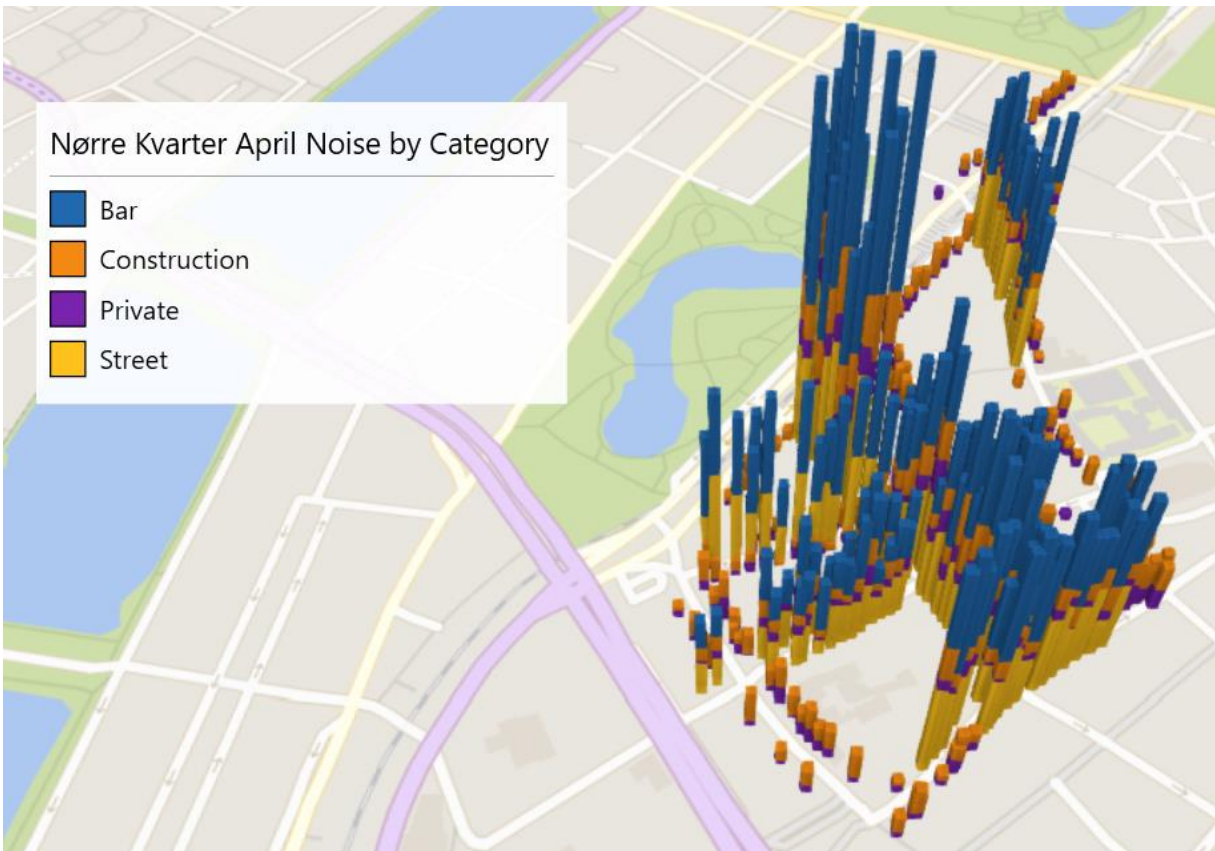


Figure M.2: Example noise complaint density on a peak Saturday evening in Nørre Kvarter. Colorized areas indicate that a noise complaint has been filed for that location within the previous hour. Warmer colors indicate a higher density of noise complaints.

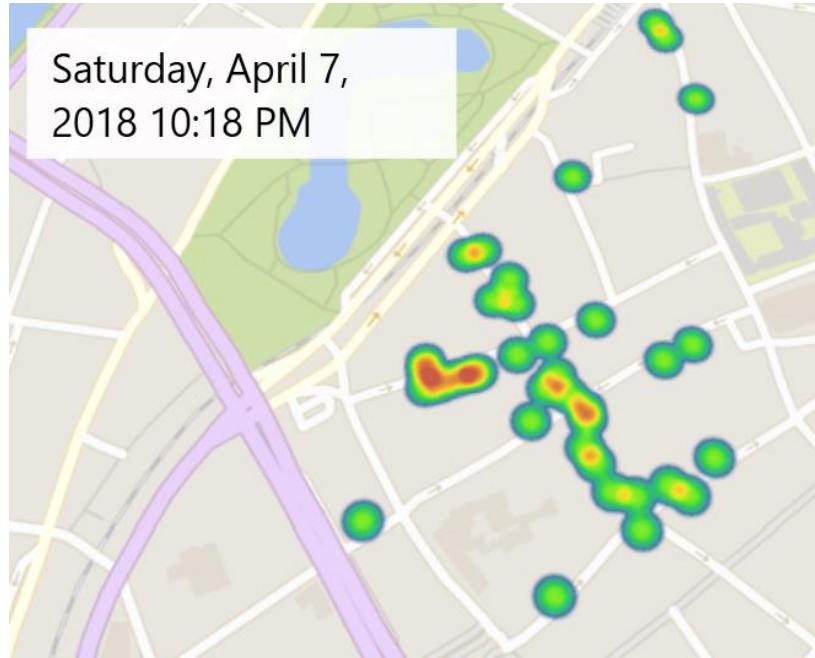


Figure M.3: Example average noise complaint count per hour on an average weekend day.

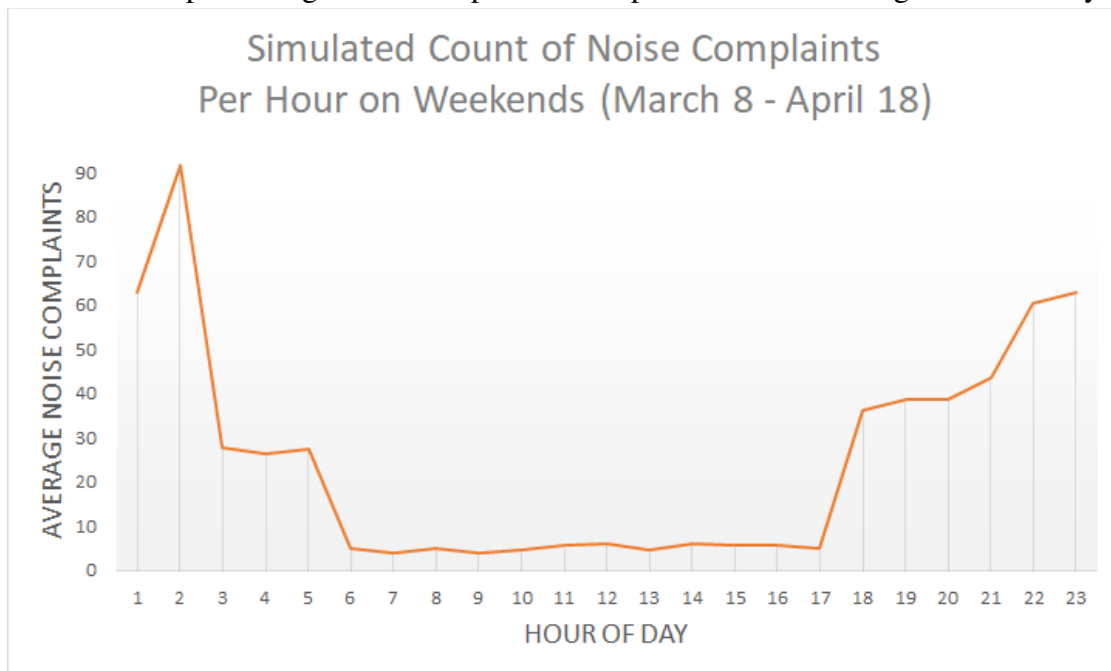


Table A: Weighting of total complaints, weekday vs. weekend.

	% Total
Weekday	20
Weekend	80

Table B: Time breakdown of periods of the day,
Percent breakdown of complaints per time of day weekday vs. weekend,
Percent breakdown of time of day per complaint category.

	Time	Week	Weekend	Bars	Cons.	Street	Private
Day	6-18	5	15	0	80	5	0
Night	18-22	40	15	15	20	10	35
Peak	22-2	50	35	50	0	35	65
Close	2-6	5	35	35	0	50	0

Table C: Percent breakdown of complaint category vs weekday/weekend and by location.

	Weekday	Weekend	Location
Bars	25	35	Commercial
Construction	35	15	Residential
Street	30	40	Both
Private	10	10	Residential

Table D: Percent breakdown of noise type per complaint category.

	Music/Gen. Noise	Talking	Banging
Bars	40	60	0
Construction	50	0	50
Street	40	50	10
Private	70	20	10

Table E: Number of complaints by weekday vs. weekend.

TOTAL COMPLAINTS	8500		
Weekday	1700	Weekend	6800

Table F: Percent breakdown of time of day per complaint category.

	Day	Night	Peak	Close
	8-18	18-22	22-2	2-6
Bars	0	15	50	35
Construction	80	20	0	0
Street	5	10	35	50
Private	0	35	65	0

Table G: Number of weekday/weekend complaints by time of day.

Weekday	1700	Weekend	6800
Day	85	Day	1020
Night	680	Night	1020
Peak	850	Peak	2380
Close	85	Close	2380

Table H: Numbered breakdown of weekday/weekend noise by complaint category.

Weekday	1700	Weekend	6800
Bars	425	Bars	2380
Construction	595	Construction	1020
Street	510	Street	2720
Private	170	Private	680

Table I: Street address ranges and commercial address ranges.

Commercial Sections of Streets in Nørre Kvarter								
Street Name	Address Range		Commercial Range 1		Range 2		Range 3	
Nørre Voldgade	2	60	2	6	18	22	56	60
Sankt Peters Strade	1	53	29	53				
Stuðiestræde	1	49	6	49				
Gammeltoiv	8	18	8	18				
Vestergade	1	39	1	26				
Sankt Petri Passage								
Nørregade	2	53	2	4	23	53		
Larslejsstræde	1	19						
Teglårdstræde	2	17	2	17				
Larsbjørnstræde	2	25	2	25				
Vester Voldgade	2	37	0	2				

Appendix N: Application Layout and Text

Figure N.1: Welcome Page

Stop Støj LANGUAGE: EN

MENU SUBMIT A COMPLAINT ABOUT

Welcome!

Welcome to the Stop Støj App! This app serves two purposes: to help inform people about Copenhagen's noise complaint process and to collect nightlife noise complaint data. These data will be used to build a model of the nightlife noise issues in inner city Copenhagen. This model can provide valuable nightlife insight to the police and city officials, potentially improving nightlife management processes and living conditions.

The app will walk you through the process of submitting a noise report. This report will be filed with Miljøpunkt Indre By & Christianshavn for data analysis and advocacy purposes. Upon submission, the app will direct you towards the proper authority and automatically give you contact information so you can request immediate action on the incident.

Disclaimer

Please refrain from submitting any personal information in a report as we cannot currently guarantee that the data will remain completely secured.

[Please read our Terms of Service here](#)
[Cookie Policy](#)
[Privacy Policy](#)

Figure N.2: About Page

Stop Støj LANGUAGE: EN

MENU SUBMIT A COMPLAINT ABOUT

About

This app was developed for the purpose of collecting data on noise disturbances throughout the city of Copenhagen. Each report submitted through this app will be entered into a database that will help create a deeper understanding of the nightlife noise problem in Copenhagen. We hope that the data collected by this app will help raise awareness of the nightlife noise problem, and provide evidence to promote changes in the way that noise complaints are handled.

Developed By:

Christopher Cyr, Brent Reissman, Michael Taylor and Chad Underhill, from the Worcester Polytechnic Institute under the guidance and supervision of Centerleader Marianne Spang Bech from Miljøpunkt Indre By and Christianshavn

Figure N.3: Begin Complaint Submission Page

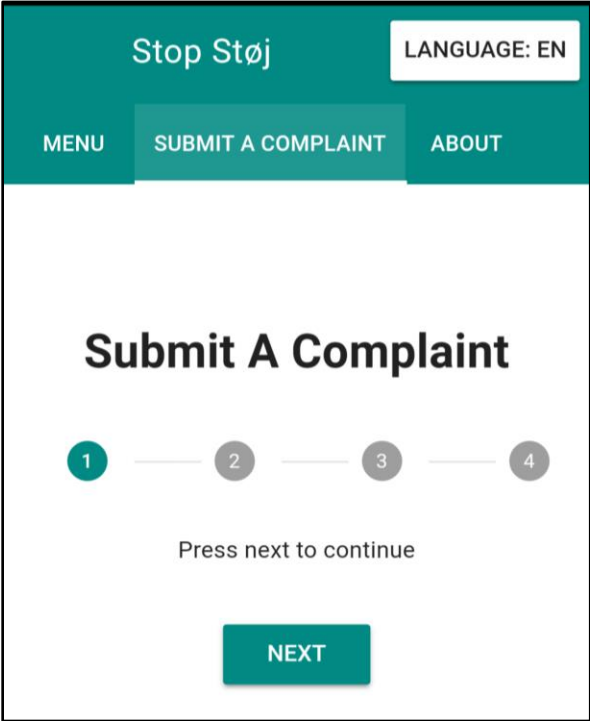


Figure N.4: Step 2, Select Complaint Category

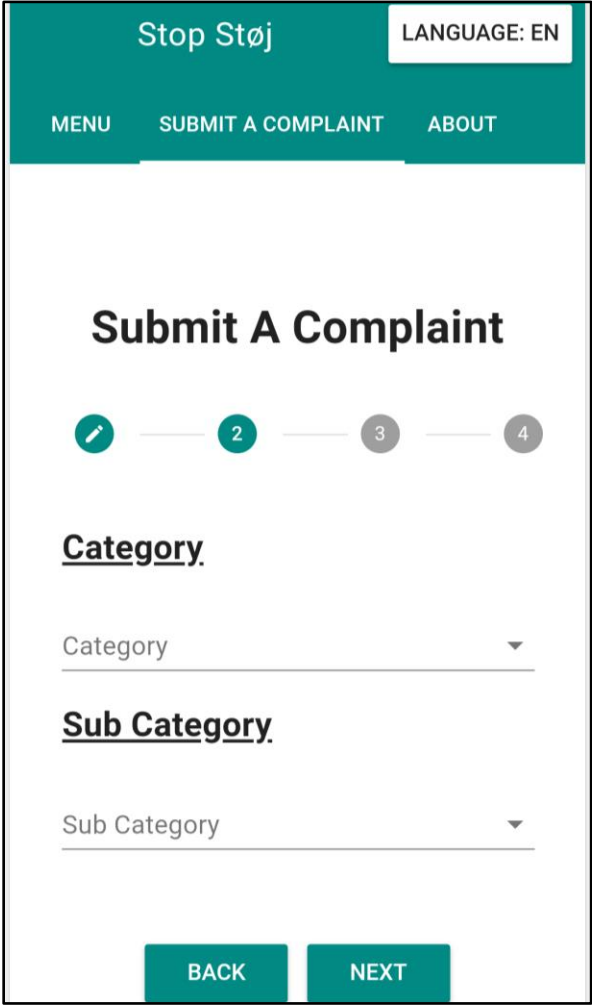


Figure N.5: Category Dropdown Menu

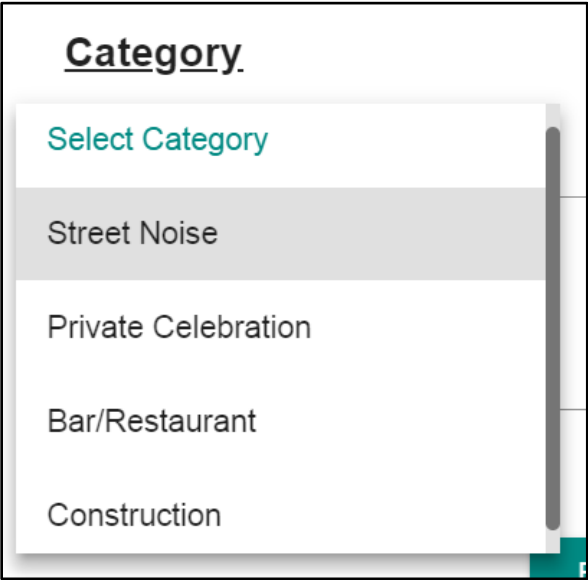


Figure N.6: Sub-Category Dropdown Menu

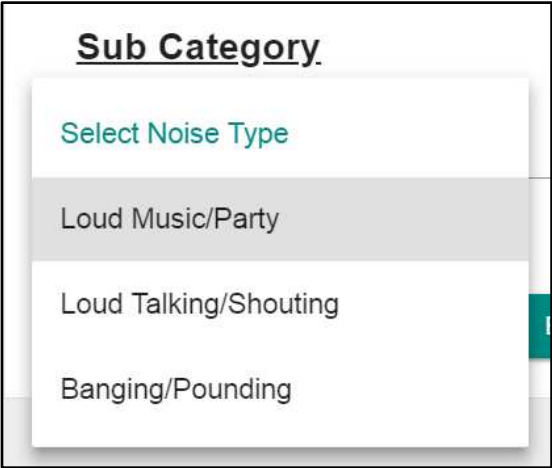


Figure N.7: Step 3, Select Location

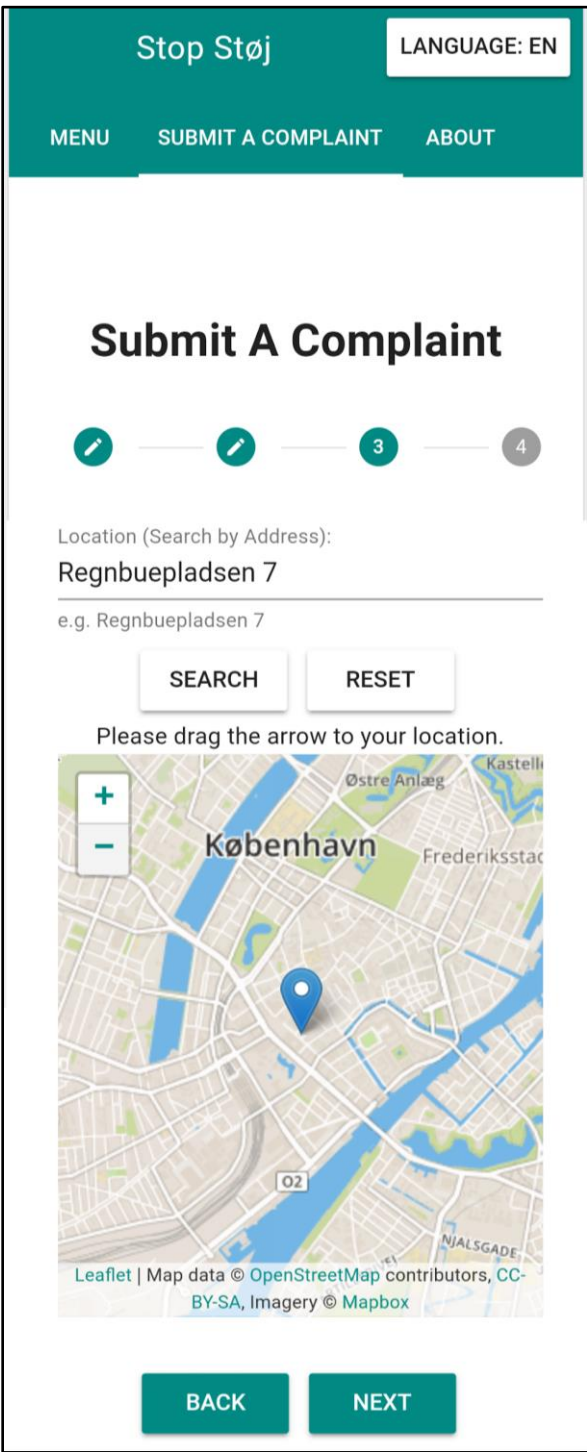


Figure N.8: Step 4, Add a Comment

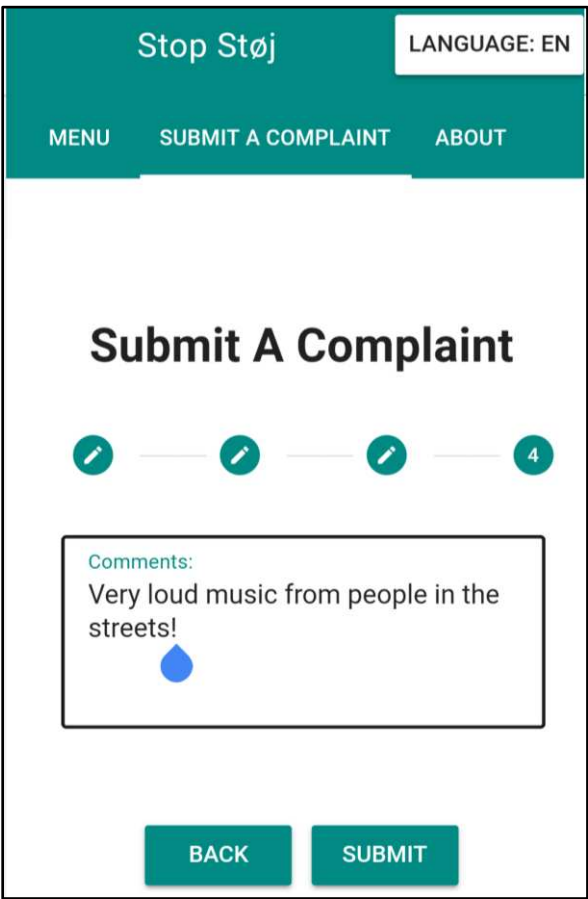


Figure N.9: Post-Submission Page

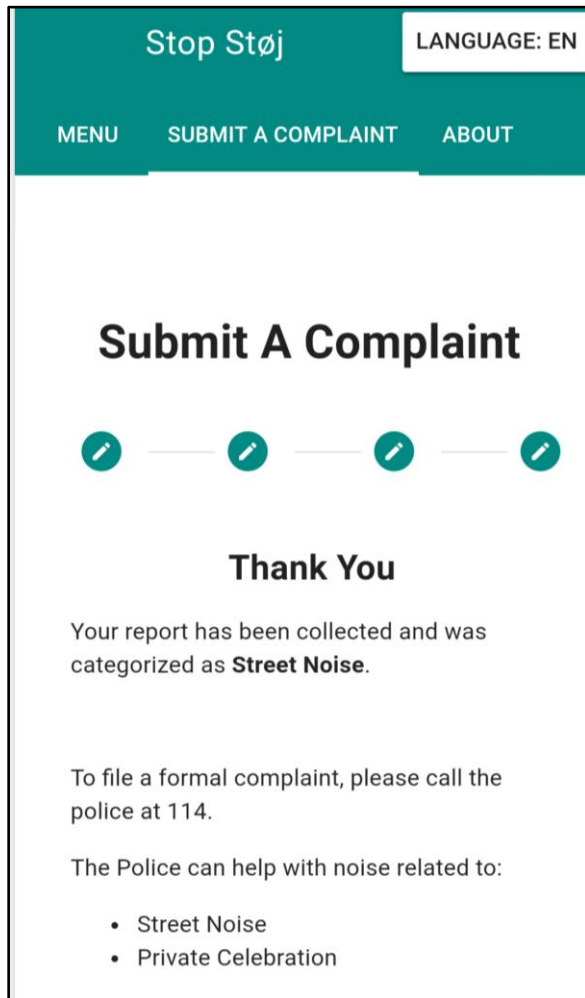


Figure N.10: Danish Translation Feature



Appendix O: Consent Form

To Whom It May Concern:

We are a team of university students from Worcester Polytechnic Institute in the United States. We are working on a project that aims to help improve nightlife noise regulations in inner-city Copenhagen. Our team is looking to develop a mobile app that will allow citizens of Copenhagen to submit noise complaints.

To fully understand this issue, we would like to interview you about your experiences and perspective on the nightlife noise issue. This interview process is entirely voluntary. You do not need to participate in the interview, and you may skip any question you do not want to answer without providing a reason for doing so. This interview should take approximately 15 minutes, but you are under no obligation to stay for the entirety of the interview.

If you are interested in participating in this interview, please read the following:

This interview is a part of our research into the nightlife scene of inner city Copenhagen, and will be used to gain a better understanding of local perspectives on the nightlife noise problems. This research will be used to guide the development of a noise complaint application for the residents of Copenhagen. The insight gained from these interviews will enable us to better design the application for potential users of the application potential users of the application and the receiving audiences of the data. This interview will also include a brief discussion on the feasibility of a mobile application that can record noise complaints, the use of data collected by this application, and how these data may be used most effectively.

The findings of this research will be published in an academic journal by the George C. Gordon Library at Worcester Polytechnic Institute. No personally identifiable information will be included in this publication without explicit permission from the participant. Individual responses may be included, if the participant explicitly consents.

Before we begin this interview, please ask our team if you have any further questions about this project or the interview process. If you have any questions at any time during the interview process, we are happy to answer them and encourage you to ask. You can also contact us with additional questions after the interview by email at noise-d18@wpi.edu.

If you willingly consent to participating in this interview, and acknowledge the information presented above, sign your name below indicating your consent to participate.

Name	Signature	Date
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If, following this interview, you consent to the publication of your name, individual responses, and association of your identity with your recorded responses in the published report, sign your name below indicating your explicit consent.

Name	Signature	Date
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Appendix P: Potential Groups for Continued App Development

Due to our team being unable to finish the development of the app, we have produced a list of potential groups to continue development and expansion of our system. The following are listed in no particular order of importance:

- 1) København Kommune & Copenhagen Police
- 2) Computer science students from the Danish Technical University (DTU)
- 3) Professional App Development Team

- 1) **København Kommune & Copenhagen Police:** All noise complaints that are made are directed towards these two authorities. Both of these groups have expressed interest in utilizing the data collected by the system we developed, and the potential it has to further inform their management of nighttime noise disturbances. If these two organizations work in collaboration to combine their complaint systems and develop a single unified system, they are capable of centralizing the data for both organizations to use, streamlining the noise complaint process, and making both of their existing systems more organized and efficient. The København Kommune already has a system called “Give et Praj” that is used for reporting various objects and facilities that need to be fixed within the municipality’s jurisdiction such as repairing potholes in the roads or fixing road signs that have been vandalized. It may be practical for the municipality to expand on this existing data collection application by adding an option to begin collecting noise complaints. This would help them obtain more data on the noise problem by utilizing an already existing system, which would allow them to determine whether or not it would be worthwhile to develop a separate app for this system. The Copenhagen Police should also be a part of this process because each group is responsible for different types of noise complaints. Involving all relevant authorities results in an application which successfully delivers data to the correct recipient. This eliminates the gap in jurisdiction that currently renders many complaints unable to be addressed. A fully developed noise complaint app can also provide both authorities with all the necessary data and analytics to gain a deeper insight on the nightlife problem informing them on how they can utilize their resources to manage the nightlife noise problem better.

- 2) **Computer Science students from the Danish Technical University (DTU):** A team of technical university students would allow for the low-cost continuation of the complaint collection system that our app established. Such a project could build on our existing app to analyze trends related to noise disturbances throughout the year. A team of students specializing in computer science, data security, and data analysis would be capable of continuing this project, due to the security and programming a project like this entails. Our project team has constructed a system that meets the barebone requirements of a public data collection tool, and we have put together a list of suggested features to be added to the app in future development. Such a project would still rely heavily on app usage which, as we discovered, relies heavily on a response from an authority. The team of technical students would also need to continue the dialogue with the police and municipality about providing these authorities with access to the data this app collects and incorporating it into the already existing systems used by the authorities.
- 3) **Professional App Development Team:** Our team highly suggests having this app further developed by a professional development team to produce a polished and fully functioning product that can be used by the people of Copenhagen. Our team lacked the available resources that are required to ensure that all the data collected by this app would remain secure. Additionally, our team was not able to obtain a license for approval to upload our prototype of the app we developed onto the Apple App Store, and Google Play Store. The EU Commissions also has strict regulations on data security, which is essential to the success of this app. A professional app development team would be able to acquire a Secure Socket Layer (SSL) certificate that would allow for secure data transfer, the implementation of features within the app such as auto-detection of location and increased secure storage of confidential information that is entered into the system. A professional app development team would also be able to deploy a production level product using industry standard technology that our team did not have access to during the timeframe of our project. A full-fledged data collection system would also provide stronger evidence for why the municipality and police should collaborate on a system like this. A completed and well-polished app would also be more appealing to prospective users and would be easier to publicize if available on a virtual marketplace like Apple's App Store.