Innovate Memphis

Metro Alarms Research Report

2020

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BACKGROUND

Many businesses and residents within the City of Memphis opt to protect their property by installing an alarm system to notify authorities when a break-in, robbery, or fire occurs. These alarms provide a sense of security to residents, business owners, and property owners by summoning local police and fire agencies when a threat is detected.

Unfortunately, these detection systems are not perfect, and are subject to both system and user error. Thunder or power surges may cause a system error, household pets and pests can trigger motion sensors to set off an intruder alarm, or a staff member at a local business could incorrectly enter their disarm passcode. When these incidents occur, public resources are used to send police or fire personnel to the scene to respond to the incident. This dispatch leads to strain on City resources and creates a risk of delayed response times for real emergencies. Currently, over 99% of all alarms in Memphis are false alarms. Throughout this project, Innovate Memphis aimed to support the Metro Alarms office to deeply understand the problem and generate solutions that will help reduce incidents of false alarms from targeted property types, in turn reducing the burden on public safety personnel.

99% of all Memphis alarms are false alarms

STATE OF FALSE ALARMS

The Metro Alarms office is responsible for tracking false alarm occurrences in Memphis and charging a fee to alarm holders in an effort to offset the cost to the City. An analysis of the distribution of all alarm holders registered with Metro Alarms revealed several "hot spots" of alarm holders (Figure 1). There appears to be some correlation between alarm presence and neighborhood wealth, with Midtown and East Memphis having significantly more alarm holders than north and south Memphis. Note that inconsistencies in address data within Metro Alarm's data system, CryWolf, led to 70% of addresses being successfully geocoded.

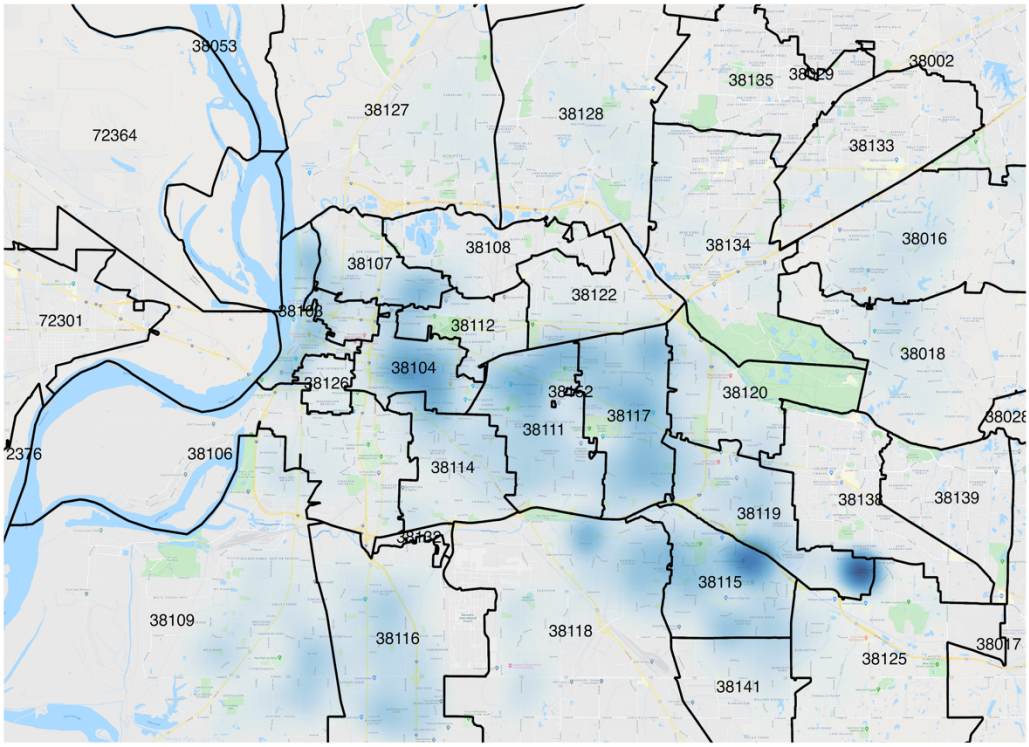


Figure 1: Distribution of all alarm holders in Memphis.

Over the last year (2/10/2019 - 2/10/2020) there were 26,229 false alarm incidents across 15,273 properties in Memphis, with a maximum of 63 False Alarms for one property. After two false alarms in one year, Metro Alarms will issue a fine to the alarm holder. A total of $1,184,670 was charged for all false alarm incidents over the past year, and over $800,000 (70%) of these charges have not yet been paid. Table 1 shows a breakdown of the total number of alarms and percent of charge not yet paid by property type for all alarms in 2019.

False alarm incidence by zip code is shown in Figure 2, with the industrial area in 38131 and 38132 having the highest incident rate (nearly 1 false alarm per alarm holder). A list of the top 7 zip codes can be found in Appendix 1A.

To quell the false alarm epidemic, it is important to determine the issues that are causing these false alarms. Older buildings could be a potential cause, as these buildings tend to have lower structural integrity and may be equipped with outdated alarm systems that are more prone to error and have not been properly maintained. To determine potential correlations, the average building age for each zip code was calculated using public data from the Shelby County Assessor's Office (Figure 3). Comparing false alarm incident rate with average building age, there does appear to be some correlation between zip codes with older buildings and zip codes with a high rate of false alarms.

Property Type	Alarm Count	% Not Paid
Single Family Home	10620	88.6
Storage Facility	984	61.7
Retail Store	672	67.4
Office - Low Rise	609	70.2
Fast Food	567	39.4
Religious	562	70.5
Strip Shopping Center	544	80.3
PUD Detached	502	91.8
Warehouse	393	47.8
Service Garage	376	77.9
Restaurant	346	66.8
Convenience Store	250	72.7
Day Care Center	238	73.9
Manufacturing Facility	206	41.8
Medical Office	206	71.9

Table 1: Total number of alarms and percent of fees not yet paid for all alarms in 2019. Property type breakdown comes from Shelby County Assessor Land Use data.

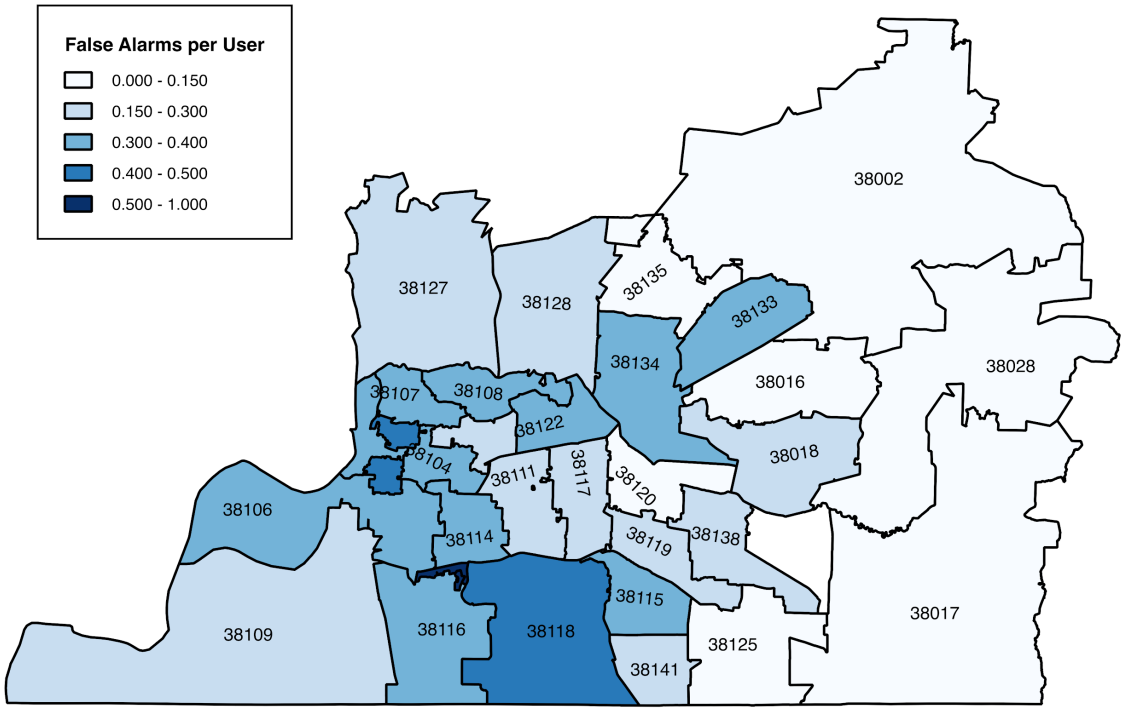


Figure 2: False alarm rate by zip code.

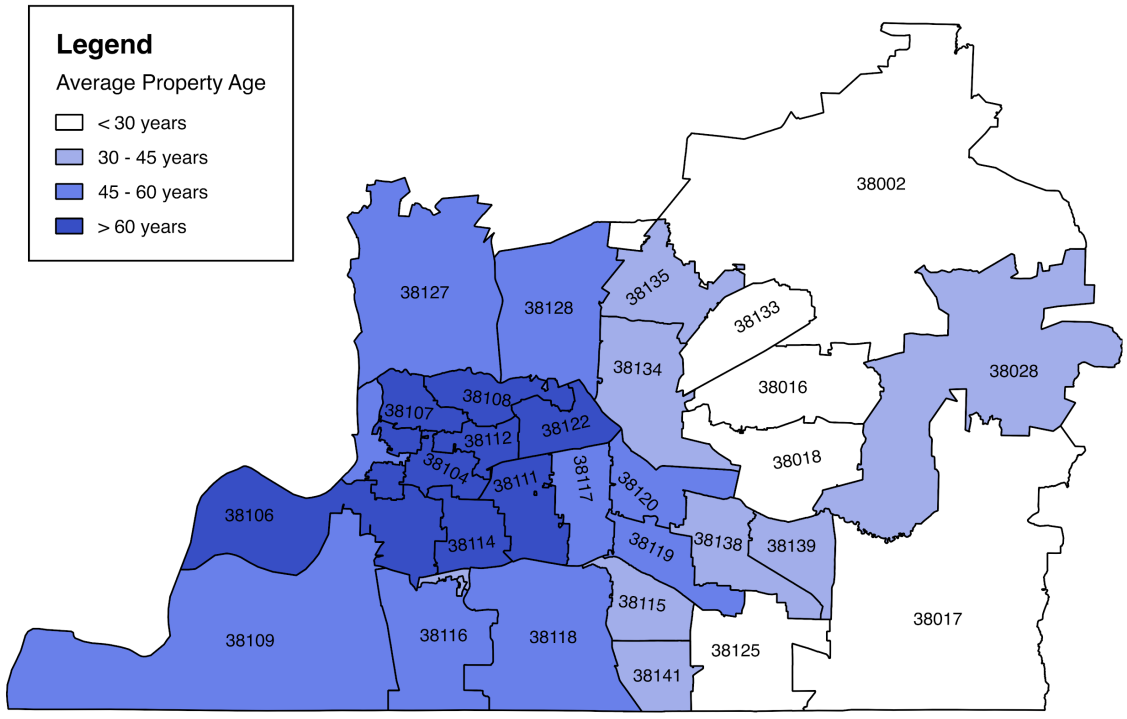


Figure 3: Average building age by zip code.

CHURCHES

Churches were identified by the Office of Metro Alarms as a target group due to their unique circumstances. Churches, unlike most commercial alarm holders, have many potential alarm users that tend to fall within an older demographic. In 2019, churches accounted for 2.2% of self-verify alarm holders, meaning they had 6 or more alarms during this time period. This may not seem like a drastic percentage, but churches are also only typically open 2 days per week, which makes these numbers more alarming. Metro Alarms also identified that the majority of false alarms for churches did not occur during their standard business hours.

In 2019, a number of Memphis churches had 6+ alarms, even though they are typically open 2 days a week

For all churches, a total of 494 alarms were reported during 2019, charging $23,740 of which $14,565 is still owed (61%). It is also important to note that churches were being explored as a potential pilot program for non-profit fee reduction programs during the time of our research. The Memphis area has 595 church alarm holders, and churches with 8 or more false alarm violations were chosen as a data sample for more in depth quantitative analyses. Of the 36 churches analyzed, 12 were also interviewed to gain a qualitative understanding of their false alarm experiences. The quantitative data gives a more objective overview to identify patterns and correlations in false alarm incidences, while the qualitative data allows us to more deeply understand how incidents arise. Data from two years (2018-2019) were used in this analysis. Figure 4 shows the distribution of all church alarm holders in Memphis (blue points), along with the 36 churches used in this analysis (red stars). Note that the churches analyzed (red stars) primarily occur in zip codes with older buildings on average.

We were first interested to know if alarms occur more frequently at any particular time of day, expecting that user issues, such as incorrectly entering a disarm code or improperly closing a door, would most frequently occur during opening and closing hours. The time of occurrence of each false alarm was classified as morning (6:00-12:00), afternoon (12:00-17:00), evening (17:00-21:00), or night (21:00-6:00), as well as opening (7:30-9:30) and closing (16:30-18:30) times for normal business hours. The rate of false alarms per hour are displayed in Figure 5, where opening and closing times and time of day classifications are mutually exclusive. This data shows that church alarms most frequently occur during evening hours, as well as closing time, while nighttime has the lowest rate of false alarms. This would

indicate a strong presence of human error in false alarms, given that the lowest false alarm rate occurs when the church is likely to be empty.

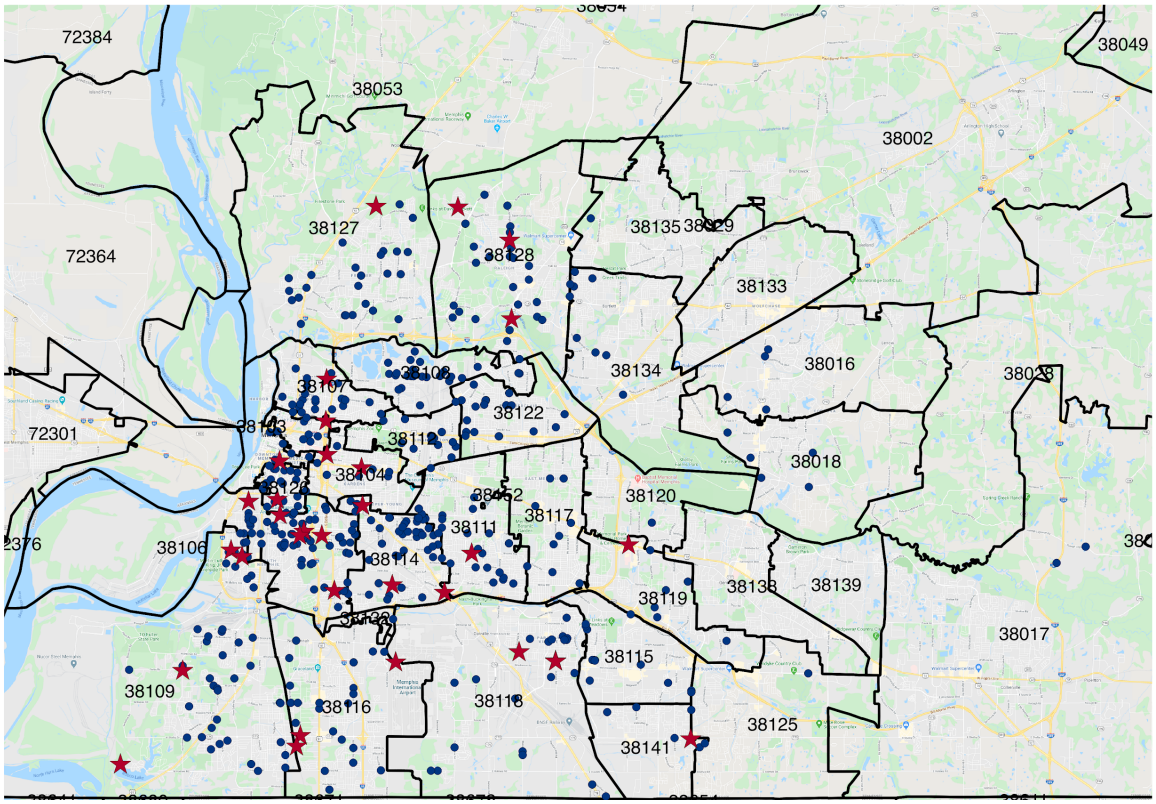


Figure 4: All church alarm holders in Memphis. Red stars identify the 36 churches used in this analysis.

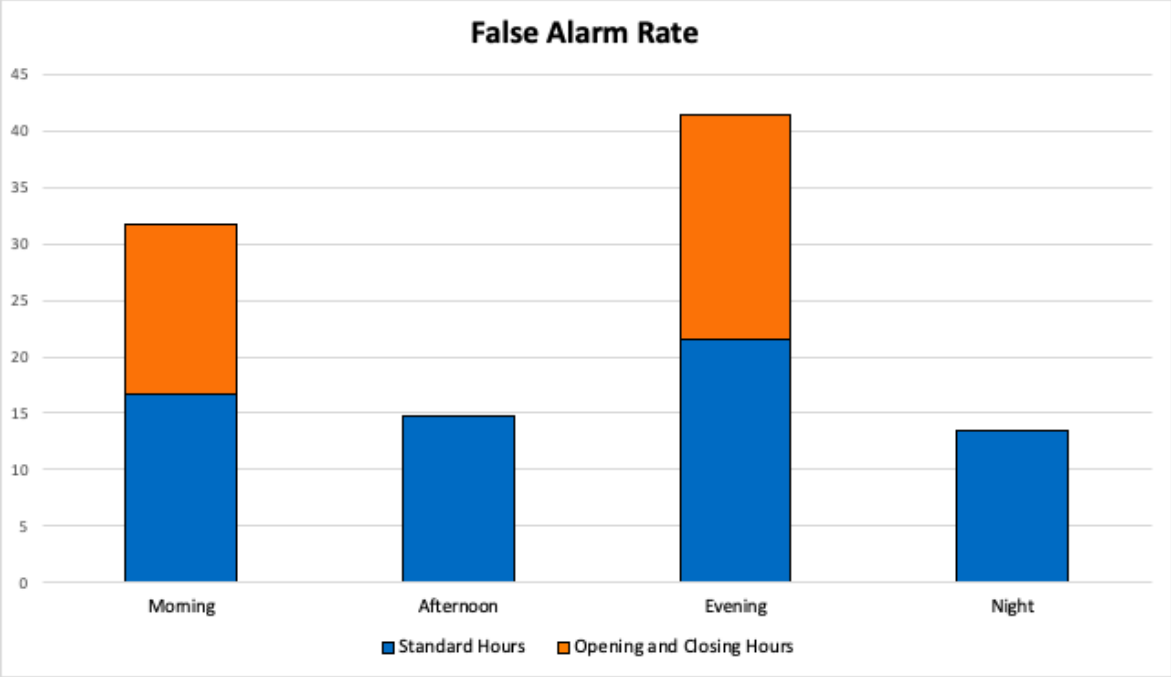


Figure 5: False alarm rate by time of day

System and User Errors

False alarms can be attributed to two main causes: user error vs. system error

This led to a new question: can we determine which false alarms were caused by human error and which were caused by errors within the system itself? This is an important question in how false alarms are targeted. Frequent user errors would indicate the need for improved training or contact with users, whereas system errors may require technical or diagnostic assistance from the alarm company.

Dispatch notes from the 911 call center were analyzed to classify each alarm as a system error or a user error. User errors could be identified by keywords, such as: a person or cleaning crew was on the property, an incorrect passcode was entered, or a silent alarm button was pushed. System errors were classified by notes indicating alarm malfunction or sensors falsely detecting motion or correlation with a storm incident in Memphis. This method allowed for 18% of alarms to be categorized as either a user or system error, and user errors are the predominant error type. The low success rate in categorizing alarm types stems from inconsistencies in reporting, but this analysis can still provide valuable insight into why false alarms occur. Figure 6 shows that user errors are especially prevalent in the morning, indicating that many users may struggle more with disarming the system than with arming it.

Alarm Type	Number
System	30
User	37
Not Categorized	308

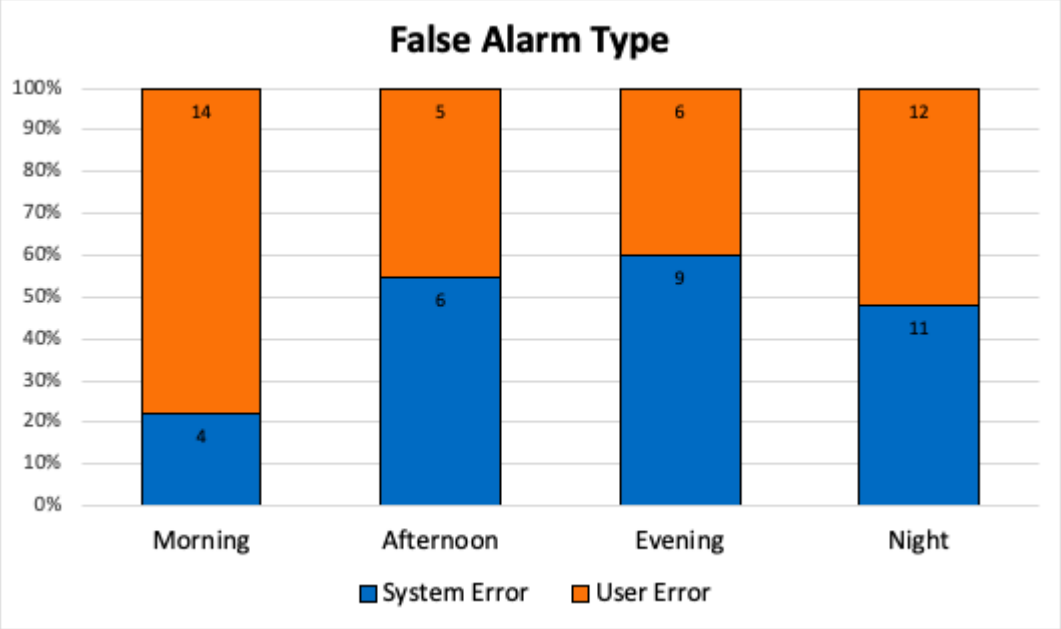


Figure 6: Comparing user and system error occurrence by time of day.

We are also interested in false alarms that were appealed by the alarm holder, which removes the fine if approved. Only 12 out of 375 false alarm incidents (3%) were successfully appealed by churches during this two-year period. The majority of these alarms (75%) were system errors, and almost half of the dispatch notes request that no officer visit the scene. This indicates that the user opted to self-verify and therefore should not have been charged for a false alarm. Using keywords in dispatch notes for system malfunctions, cancelled requests, weather issues, and other issues that may have qualified for an appeal, 34 alarm incidents were cited as potential appeals. Of these 34 incidents, 24% were successfully appealed. This could indicate that many alarm holders don't know about, understand, or have good experiences with the appeal system.

Lastly, companies with a high percentage of system errors as opposed to user errors may indicate faulty equipment, poor technical support, or low success in troubleshooting issues. For this reason, church alarms were analyzed to determine the frequency at which each company experienced system errors across all church alarms during this two-year period. Figure 7 shows that the majority of companies experience more user than system errors, but some companies are outliers for having significantly lower rates of system error. Companies with low rates of system error could be targeted as recommended companies to local alarm holders. The number of total account holders is also included for reference to company size.

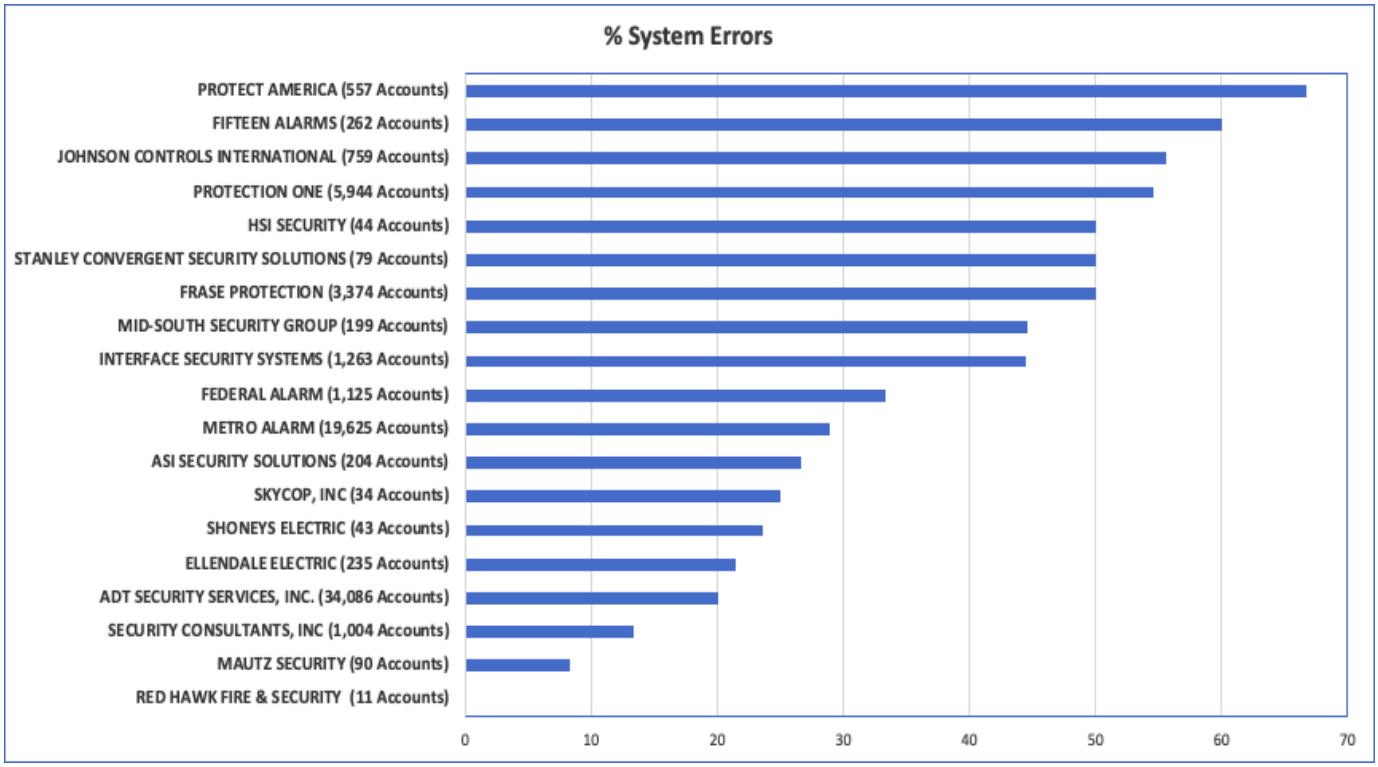


Figure 7: Percentage of all alarms that are system errors by alarm company.

Evaluation of Communication Trial

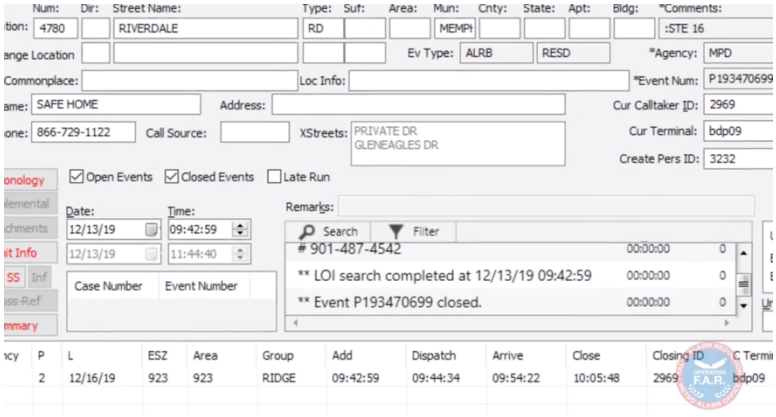
In late 2019, City Council approved changes to an ordinance to help modernize and strengthen alarm systems and incentivize alarm users to reduce incidents of false alarms. In anticipation of the ordinance going into effect on January 1, 2020, Metro Alarms and Innovate Memphis developed print mailers to help communicate the ordinance changes to the public.

Innovate and Metro Alarms worked together to test two alternative messages to communicate the new alarm ordinances to residents and encourage residents to access additional information. These messages were designed using the Behavioral Insight Team's EAST principles which stands for Easy, Attractive, Social and Timely. Messages were delivered via direct mail as a postcard-sized flier. Each flier contained a version-specific QR code and URL for accessing more information on the Metro Alarm Website, and listed 211 as an additional information resource.

This trial compared the following two message versions:

1. Version A – Deterrent Approach: Encourage residents to learn more in order to avoid new fees and penalties.

2. Version B – Civic/Social Approach: Encourage residents to learn more in order to help reduce the burden on public safety personnel.



The sample for this study includes all registered accounts in the Metro Alarms database, CryWolf, at the time of randomization (approximately 100,970). Randomization was performed at the address level, using a simple randomization procedure. To create the sampling frame, a list of all individual Metro Alarms accounts was generated from CryWolf. Addresses on this list were then randomly assigned to group A or B at a 1:1 ratio. These groups were provided to a mailing company, with Group A receiving letter version A (fines & penalties) and Group B receiving version B (support public safety personnel).

Results: Information Seeking Behavior

Given the randomization process, groups receiving letter versions A and B are assumed to be similar in demographic, socioeconomic, and other characteristics that may impact their natural predisposition to learn more about this ordinance change. Thus, any difference in information seeking behavior between groups may be attributed to the difference in verbiage in the letter. Figure 8 compares unique URL visits and unique QR scans between test groups. Letter type B, which appeals to civic duty and reducing public burden, saw an 83% increase in QR scans and a 354% increase in URL visits over letter type A. These results indicate that individuals are more likely to seek out information on how they can reduce public burden than how they can avoid fines and fees. This may inform future campaigns to reduce false alarms that appeal to civic duty instead of penalties.

Individuals are more likely to seek out information on how they can reduce public burden than how they can avoid fines and fees.

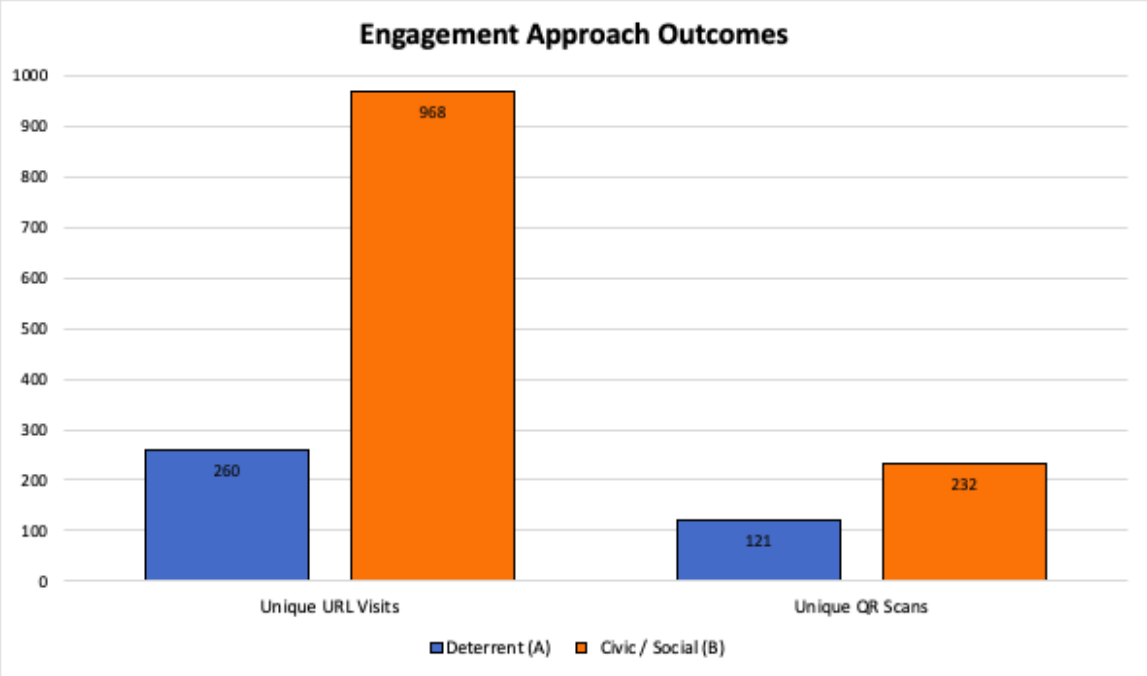


Figure 8: Total number of unique URL visits and QR scans by letter type received.

Residents who called 211 to inquire about the ordinance change were asked to provide their zip code. Each zip code within Shelby County received approximately the same number of type A and type B letters due to the randomization process (± 3%). This allows us to compare residents' predisposition to seek out more information about the ordinance change by location, disregarding the type of letter they received. Figure 9 shows the percentage of all alarm holders who called 211 seeking more information within two months of receiving the flyer. It appears that residents in South and North Memphis were more likely to call in for more information, while suburbs have a lower tendency to call in for more information. This also shows that areas with higher rates of poverty show a higher inclination to seek out information through 211.

These results are generated from a completely random assignment of letter types in a 1:1 ratio. Analyses by zip code show that almost all zip codes received less than 2% more of one letter type than the other, indicating that letter types were relatively evenly distributed geographically (Figure 1A). Those zip codes having greater than 2% variation in the letter type received also had few alarm holders in the area, with a maximum of 89 alarm holders in one zip code receiving 52.8% of a particular flyer verbiage (zip: 38132). This small number of alarm holders in a particular geographic area does not have a significant impact on results of the 100,000+ flyers mailed out. Thus, results can be attributed to our control measure, the type of flyer sent, as opposed to unsystematic variation in alarm holder demographics, income, property type, etc.

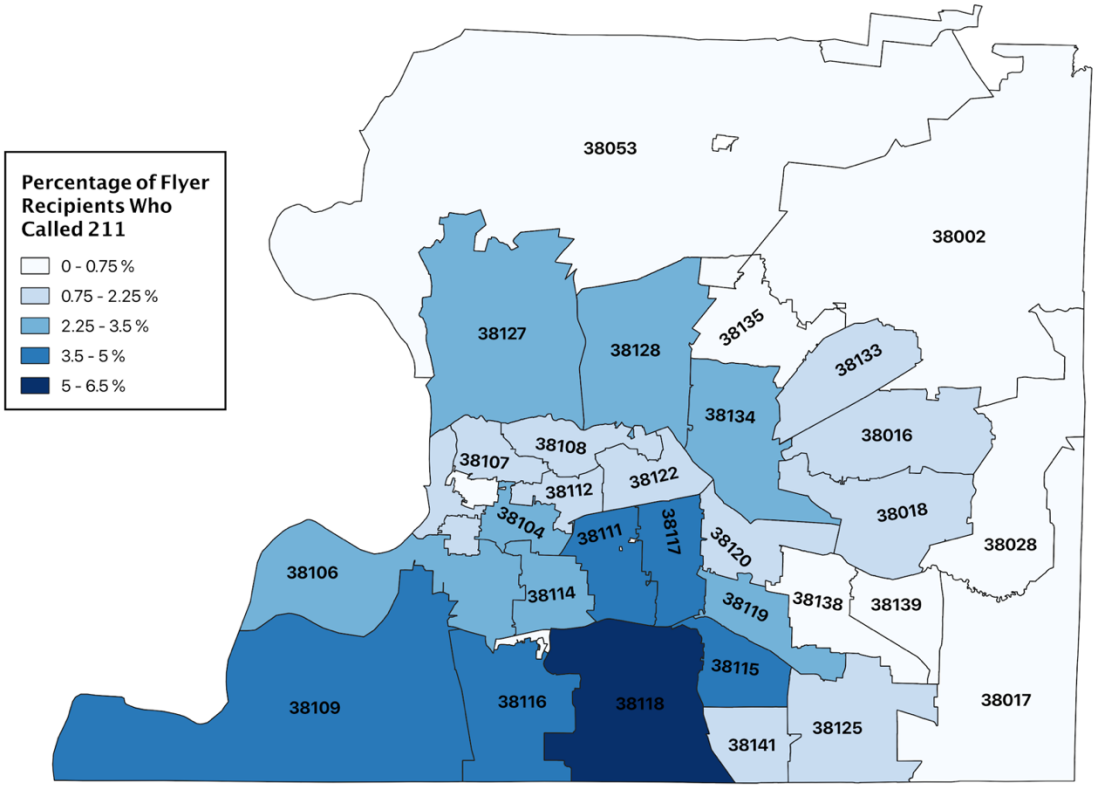


Figure 9: Percentage of all alarm holders who called 211 for more information on the ordinance change within two months of receiving the flyer.

Recommendations

While churches are a unique sample of alarm holders, the following recommendations may be applied to all commercial alarm holders in an effort to decrease false alarms in Memphis. However, a larger data sample with more varied businesses would provide a more accurate overview of the trends that may be contributing to false alarms.

1. Yearly overview data from 2019 alarms suggests that 70% of all fines issued by Metro Alarms have not yet been recouped. A more effective system for obtaining these charges should be developed so that alarm holders are being held accountable and city resources are being recouped.
2. Analyses indicated that only 24% of alarms that could have been appealed were successfully appealed. Metro Alarms may develop a guide to the appeal process and encourage alarm holders to pursue this process if they feel they have been unfairly charged. This may also improve Metro Alarm's rapport with Memphis residents.
3. User error appears to be the largest contributor of false alarms, which indicates a need for better training. Metro Alarms could host this training or develop a training guide for users to minimize their risk of user-caused false alarms.
4. Companies with low rates of system errors are more likely to have high quality equipment, troubleshooting, and maintenance than those with high rates of system errors. These companies may become "recommended providers" to minimize the occurrence of system-caused false alarms. Note that further analyses with a larger sample may be needed to generate a more robust list of the recommended alarm companies. However, this list is sufficient for churches as the sample group.

Follow Up & Next Steps
Ideation & Co-Creation

Findings from the quantitative and qualitative research were presented at an ideation workshop on March 6 with partners from Metro Alarms, Memphis Police and Fire Departments, and a representative from Dispatch. During this session, participants focused on solving false alarms recurrence in two categories: 1. System/technical issues (false alarms caused by faulty equipment) and 2. User errors (false alarms by an alarm user). Following that workshop, Innovate Memphis had an in-depth interview with Lieutenant Pannell, with the Memphis Fire Department.

We were able to generate 10 ideas for potential solutions across 3 main categories. At a high-level, opportunities were found to increase training on user best practices, build alarm company profiles and other customer-oriented education, and increase alarm company enforcement and accountability standards. Innovate Memphis will work with the Metro Alarms office to select from this menu of ideas, and identify ways to design, build and implement a final solution.

We were able to generate 11 ideas for potential solutions across 3 main categories.

Appendix

CryWolf Recommendations

Innovate Memphis was able to work with the CryWolf system at Metro Alarms in City Hall throughout this process. This system is difficult to work with and lacks many modern data tools that would make analyses more approachable, as well as automate certain tasks. Some straightforward recommendations include:

- Connect the CryWolf platform to Oracle or SQL to make large scale analyses more approachable. This could also enable data pushes to Office of Performance Management or nonprofit partners for analysis support. If this is not possible, new reports should be added that have more querying capabilities (e.g. All false alarm incidents for commercial alarm holders only).
- Connect with mapping service to verify addresses. Address data is currently prone to error, making analyses difficult and potentially causing errors in mailings, police visits to scene, etc.
- The platform should have the ability to export a spreadsheet that is consistently formatted. The current spreadsheets seem to come from a PDF converter that is largely inconsistent.
- Standardize a tagging method for successfully appealed alarms.
- Tag business type (church, school, small business, restaurant, etc) of alarm holders to make analyses more approachable and target high frequency business types.

Zip Code	Number of Alarm Users	False Alarms per User
38132	89	0.99
38131	31	0.97
38113	68	0.93
38101	16	0.56
38126	607	0.48
38105	521	0.48
38118	5,937	0.41

Table 1A: Zip codes with high false alarm incident rate

Company	Total Alarms	Churches Analyzed
6121 Metro Alarm	178	6
2213 Protection One	86	3
971 ADT Security Services	43	3
6004 Mid-South Security	171	2
105 Federal Alarm	21	2

Table 2A: Top alarm companies for churches analyzed

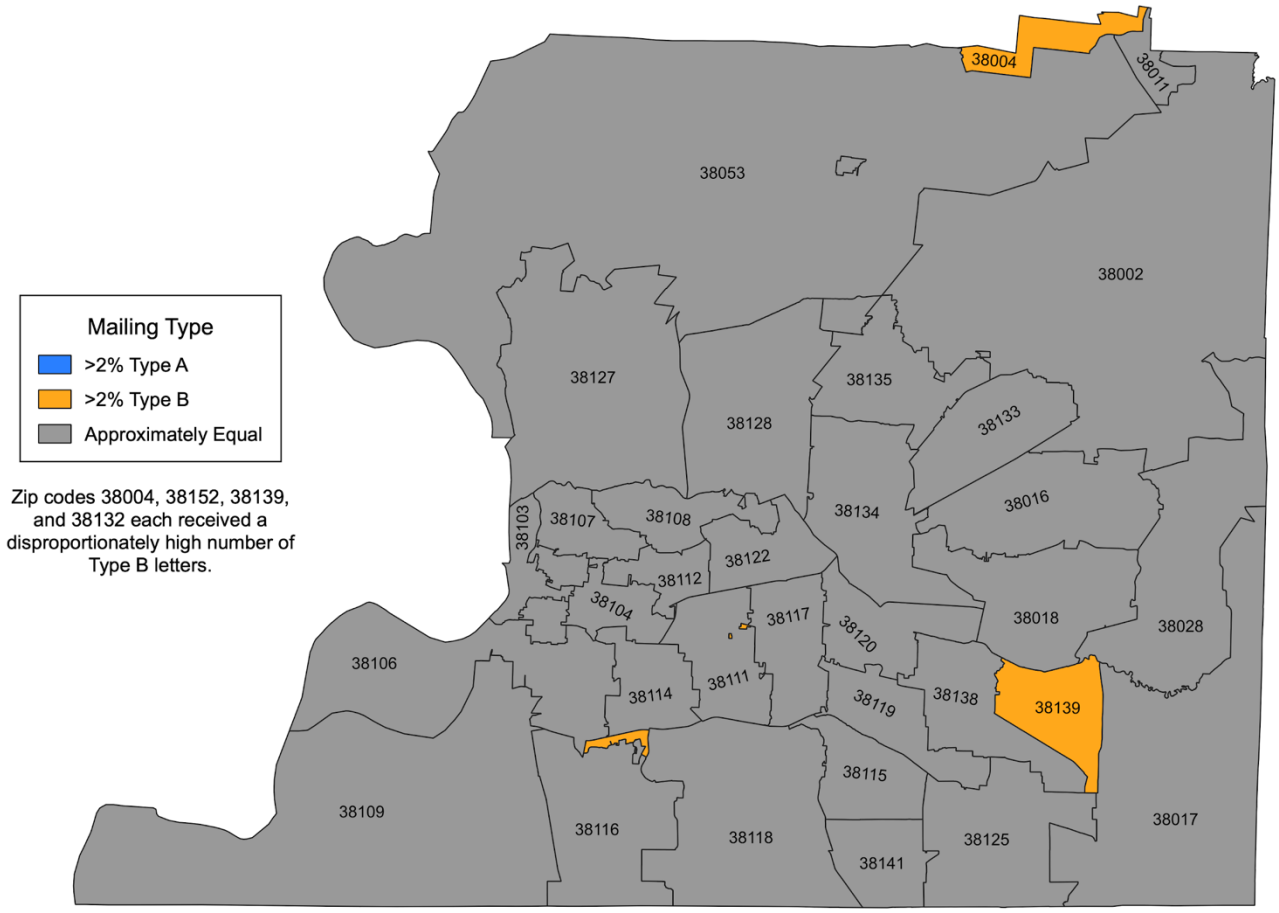


Figure 1A: Distribution of letter types across zip codes

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