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Independent Audit of the ShotSpotter Accuracy, 2019-2022

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Executive Summary

According to a report from the Brookings Institution, 88 percent of gunshot incidents go unreported to police.¹ The ShotSpotter system is an acoustic gunshot detection service from SoundThinking that detects, locates, and alerts police to gunfire, including those incidents that otherwise would have gone unreported. ShotSpotter enables law enforcement agencies to provide a precise and rapid response to detected incidents. The system uses wireless sensors throughout a coverage area to capture loud, impulsive sounds that may be gunfire. The data are transmitted to a central cloud service that filters out sounds that are clearly not gunshots and provides a location determined by triangulation enabled by sensors. Trained SoundThinking employees, located across two ShotSpotter Incident Review Centers, listen to the pulses from the sensors that detected the incident audio with playback tools, analyze the visual waveforms to see if they match the typical pattern of gunfire, and either publish the incident as gunfire or dismiss it as non-gunfire. The entire process is intended to take less than 60 seconds from the time of the gunfire to the time law enforcement is alerted to allow for a timely law enforcement response.

SoundThinking claims that the ShotSpotter system is 97% accurate and has a false positive rate—the rate at which gunfire is detected when none occurred—of 0.5%. To determine the accuracy rate for its system, SoundThinking analyzes information from clients on possible errors, determines whether an error occurred, and catalogs any errors found. In 2021 and 2022, SoundThinking commissioned the Data Analytics practice of Edgeworth Economics (“Edgeworth Economics”) to conduct an independent audit of the 2019–2021 data and analyses that it uses to support its claims. Our audit of SoundThinking’s ShotSpotter data confirmed an accuracy rate of 97.69% for detecting, classifying, and publishing gunfire incidents from 2019 to 2021. This year, SoundThinking again commissioned Edgeworth Economics to conduct an additional independent audit of its 2022 data and analysis. Based on our analyses, our audit has yielded five important insights:

- In 2022, ShotSpotter’s accuracy at spotting gunfire was in line with prior years and above its claimed 97% accuracy threshold.

¹ <https://www.brookings.edu/research/the-geography-incidence-and-underreporting-of-gun-violence-new-evidence-using-shotspotter-data/>

- Specifically, ShotSpotter published 146,804, 233,966, 291,726, and 270,367 gunfire alerts to clients in 2019, 2020, 2021, and 2022 respectively.² For these years across all clients, our audit confirmed that based on client reports ShotSpotter correctly detected, classified, and published gunfire with 97.63% accuracy in 2022, which is in line with the 2019 to 2021 accuracy rate of 97.69%.
- In 2022, the ShotSpotter system published alerts of gunfire when clients subsequently indicated that none occurred 0.36% of the time, the same as occurred in aggregate from 2019 to 2021.
- Despite substantial variation in the intensity of reporting of potential errors across clients, ShotSpotter's accuracy rate does not appear to be sensitive to differences in clients' propensity to report potential errors.
- No single client exerts a disproportionate effect on ShotSpotter's overall error reporting rate such that the accuracy rate would change significantly.

This report discusses Edgeworth Economics' approach to auditing SoundThinking's data and analysis for its ShotSpotter system and our additional testing, intended to ensure the validity of our results.

² A small number of ShotSpotter accounts—six in 2019, 12 in 2020, eight in 2021, and seven in 2022—were for clients for which feedback was not expected. These included new clients, pilot programs, and clients who terminated their service, as well as some low volume clients. Excluding these accounts, there were 144,739 alerts in 2019, 229,359 alerts in 2020, 286,438 alerts in 2021, and 276,132 alerts in 2022 with an accuracy rate of 97.64% on average across the years.

SoundThinking Data Sources for ShotSpotter

Edgeworth Economics obtained data from SoundThinking for 2019 to 2022. We discussed the data available and ShotSpotter's error tracking and reporting process with SoundThinking personnel. Based on our discussions with SoundThinking personnel, we requested the following data:

- The number of published incidents sent to clients, by location;
- Potential errors identified by clients for investigation and ShotSpotter's conclusions regarding those potential errors; and
- Several samples of "Monthly Scorecards," which are documents sent to clients summarizing the activity detected and the error rates.

ShotSpotter data on published incidents are tracked in ShotSpotter's own systems. However, information on potential errors relies on clients reporting those potential errors for the ShotSpotter system to SoundThinking. When an error report comes in from a client, ShotSpotter creates a ticket, and the incident is reviewed. The conclusion of the review may result in one of several outcomes:

- A gunfire incident did not occur, but ShotSpotter published an alert for one—this is referred to as a "false positive;"
- A gunfire incident occurred, and ShotSpotter detected it, but an alert was not published for gunfire—this is referred to as a "false negative;"
- A gunfire incident occurred and was not detected by ShotSpotter—this is referred to as a "missed" incident;
- ShotSpotter failed to accurately identify the location of the gunfire to within 25 meters of the actual location—this is referred to as a "mislocated" incident; or
- The error report was incorrect, or the incident was one that ShotSpotter is not intended to detect, such as gunfire outside the coverage area, indoors, or of a small caliber weapon (i.e., less than 25mm).

We used these data to conduct our audit.

Edgeworth Economics Audit Results and Robustness Checks

First, Edgeworth conducted an analysis to ensure that the data were complete and accurate. Specifically, we compared the published incidents and errors detected in the Scorecards to those in the underlying data we received. Our analysis confirmed that the data appeared to be complete and accurate.

Once the data were validated, we reviewed the data and consolidated it into a format suitable for our analysis. Using these data, we independently calculated the accuracy across the categories ShotSpotter uses for its reporting. Our analysis confirmed that the accuracy rate across all ShotSpotter clients for 2019, 2020, 2021, and 2022 was 97.42%, 97.70%, 97.82%, and 97.63% respectively. Having audited and validated ShotSpotter's claims, we conducted additional analyses to confirm that these results are robust.

Since accuracy reporting depends on clients informing SoundThinking of potential errors for ShotSpotter, we tested whether differences in the intensity of reporting may have unduly influenced the reported accuracy. For example, if a client with a relatively high volume of published gunshot incidents rarely reports potential errors, then the reported accuracy rate may be higher than the actual rate. To test for this issue, we identified the areas where the intensity of reporting potential errors was at or below the 5th and 10th percentile of client reporting intensity. As shown in Table 1, if these clients are removed from the data entirely then the overall accuracy would decrease by less than 1%. Alternatively, assuming these clients with low reporting intensity all had the reporting intensity of the 10th percentile client and that all additional reports were erroneous ShotSpotter alerts, the overall accuracy rate would again decrease by less than 1%.³ Finally, we conducted statistical tests of the aggregate accuracy rates for ShotSpotter using different thresholds for inclusion of incidents based on the quality of feedback and number of incidents and issues and found the aggregate accuracy rate never differed significantly from 97%.

³ This analysis is conservative as it is only conducted on the more restrictive set of clients excluding those not providing or expected to provide feedback.

Table 1: **ShotSpotter Accuracy Rates
by Exclusion Threshold, 2019-2022**

ShotSpotter Alerts	Year	Client Feedback Rate Threshold		
		All Data	>5th Percentile	>10th Percentile
[a]	[b]	[c]	[d]	[e]
Excluding Selected Accounts	2019	97.39%	97.03%	96.65%
	2020	97.66%	97.26%	96.96%
	2021	97.79%	97.41%	97.26%
	2022	97.58%	97.42%	97.13%
All Data	2019	97.42%	97.40%	96.81%
	2020	97.70%	97.68%	97.68%
	2021	97.82%	97.71%	97.42%
	2022	97.63%	97.59%	97.29%

Note: Excluded accounts include new, pilot program, and service terminated clients as well as clients from which feedback was not expected.



About Edgeworth Economics

Edgeworth Economics is an economic and quantitative consulting firm that provides economic analysis and expert testimony for clients facing complex litigation, regulatory, and other challenges in the areas of antitrust, class certification, intellectual property, and labor and employment. Edgeworth's expert economists, statisticians, data analysts, and other professionals assist clients with innovative solutions rooted in the rigorous application of economic principles and hard data.

In our Data Analytics practice area, we provide economic and statistical data consulting to Fortune 500 companies across the globe, both through direct business consulting and in the context of litigation. Our professionals work with corporate leaders and outside counsel to identify fundamental questions that can be answered with the available data to foster strategic growth or minimize potential risks in all aspects of running a business, including sales, finance, and HR.

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