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ECONOMIC COMPARISON OF THE RELATIVE COSTS AND EFFICIENCY OF USING THERMO FISHER SCIENTIFIC RAPIDHIT™ ID SYSTEM VERSUS TRADITIONAL DNA LABORATORY ANALYSIS

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Abstract

With the emergence of any new technology, economic questions arise regarding the efficacy of the new technology in comparison to existing analytical techniques. While the question of ultimate interest concerns the return on investment (ROI) of the new technology, that ROI requires both an evaluation of the net benefits of the technology and an examination of the costs to implement the technology. In this report, we examine the full-loaded cost structure of traditional DNA analysis using fiscal year 2021 data from Project FORESIGHT and compare the cost per sample with the price structure of the Thermo Fischer Scientific RapidHIT ID technology. The data indicates that a conservative comparison of the fully loaded costs for each technique leads to the conclusion that the RapidHIT ID technology is less expensive than traditional DNA analysis when sampling between 183 and 57,249 samples per year.

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Economic comparison of the relative costs and efficiency of using Thermo Fisher Scientific RapidHIT™ ID System versus traditional DNA laboratory analysis

The economic analysis in this report takes a conservative approach to a comparison of traditional forensic laboratory DNA analysis with the Thermo Fisher Scientific RapidHIT ID technology. The expenditures and efficiency data regarding traditional DNA analysis follows from Project FORESIGHT, a global source for forensic laboratory performance metrics.

Project FORESIGHT

"Project FORESIGHT is a business-guided self-evaluation of forensic science laboratories across the globe. The participating laboratories represent metro, regional, state, and national agencies (Houck et al, 2009)." The fiscal year 2021 analysis was derived from 196 crime laboratories or laboratory systems from six continents. Laboratories provide data on casework, expenditures, and personnel allocation. We construct a variety of business metrics from the submissions and tie the metrics to the strategic goals of the laboratories. The benchmark data includes metrics on productivity, cost-effectiveness, and timeliness, among other concerns.

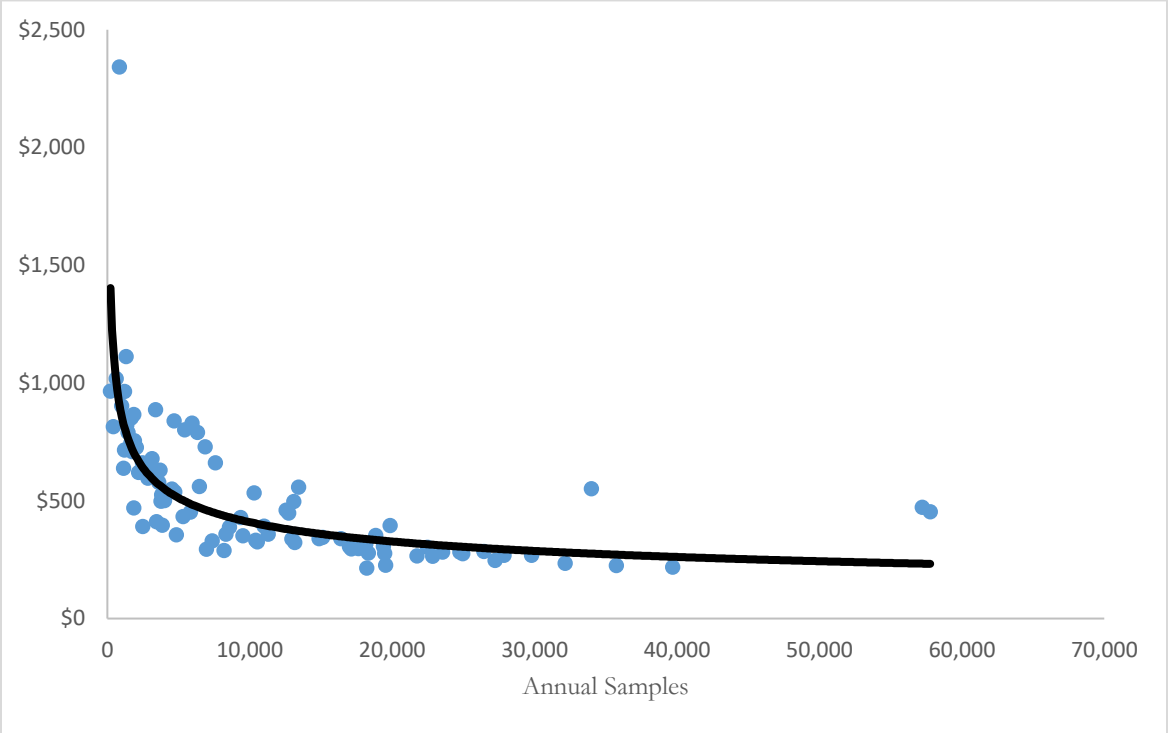
Some key trends highlighted in the FY2021 report include observations on DNA analysis over the prior eight years. Because of the growing importance of DNA analysis, demands upon laboratories to perform traditional DNA analysis has exploded. While analyst productivity has grown by 3.1% annually, the demand for examination of items has grown by 19.3% annually. The result is an annual growth in backlog by 27% and growth in turnaround time of 7.1% per year. The median turnaround time for DNA analysis through DNA database access has increased to nearly 200 days (Speaker, 2022).

Thermo Fischer Scientific RapidHIT™ ID System Comparison to Traditional DNA Analysis

First, consider the expenditures related to traditional DNA analysis. Using data on casework and expenditures submitted to Project FORESIGHT (Houck et al, 2009), the expected expense associated with an efficiently performed analysis of a DNA sample is determined. Unlike private sector laboratories that follow a profit-maximizing model, public sector forensic laboratories serve a jurisdiction, rather than a competitive market. Economic theory indicates that we should not expect such laboratories to achieve perfect economies of scale. However, we can estimate the cost per sample that is associated with efficient provision of DNA analysis for any level of annual samples analyzed. Using fiscal year 2021 submissions to Project FORESIGHT (Speaker, 2022), we plot the cost/sample from DNA analysis in Figure 1. The solid line is the estimated efficient cost/sample for alternative levels of activity for individual laboratories. The downward-sloped curve highlights the achievement of economies of scale (lower average cost) as the number of samples increases. The individual

laboratory expenditures submitted to Project FORESIGHT are fully-loaded laboratory expenditures including capital expenditures, costs of consumables, personnel expenditures, and all overhead charges. Project FORESIGHT follows the Internal Revenue Service treatment of laboratory equipment capital expenditures allocation over a five-year horizon with a fifth of the equipment capital expenditure included in the average cost for a given year.

Figure 1: Efficient Frontier Estimate for DNA Cost per Sample



The corresponding efficient cost to perform traditional DNA analysis depends upon a laboratory's annual samples processed. Table 1 indicates the expected cost for various numbers of annual samples analyzed.

Table 1: Efficient DNA Analysis Cost/Sample

Samples	Efficient Cost/Sample	Samples	Efficient Cost/Sample
100	$1,810	7,000	$459
200	$1,447	7,500	$449
300	$1,270	8,000	$440
400	$1,157	9,000	$423
500	$1,077	10,000	$409
750	$945	11,000	$397
1,000	$861	12,000	$386
1,250	$801	13,000	$376
1,500	$755	14,000	$367
1,750	$718	15,000	$359
2,000	$688	17,500	$342
2,500	$640	20,000	$327
3,000	$604	22,500	$315
3,500	$574	25,000	$304
4,000	$550	27,500	$295
4,500	$530	30,000	$287
5,000	$512	32,500	$280
5,500	$496	35,000	$273
6,000	$483	37,500	$267
6,500	$470	40,000	$262

The Thermo Fisher Scientific RapidHIT ID has direct costs, which also exhibit economies of scale. As with the Project FORESIGHT data, the expenditure for capital equipment is capitalized over a five-year period. Additionally, personnel expenditures are much lower. We use the FORESIGHT average personnel expenditure for a laboratory assistant/analyst to proxy the personnel expenditures for RapidHIT ID.[1]

Consider a comparison between the direct costs of Thermo Fisher RapidHIT ID technology and traditional DNA forensic laboratory analysis. There are significant economies of scale in evidence for each of these alternatives. For the Thermo Fisher Scientific instrument, the average cost declines with increased use of the technology as the fixed cost of the RapidHIT ID instrument is spread over greater sample runs. Similarly, the large capital expenditures in the traditional DNA laboratory require a high level of use to realize the efficiencies of scale economies.

[1] An individual carrying out general casework examinations or analytical tests under the instruction of a Reporting Scientist or Reporting Analyst and who is able to provide information to assist with the interpretation of the tests.

Figure 2: Cost/Sample Traditional DNA Analysis v RapidHIT ID

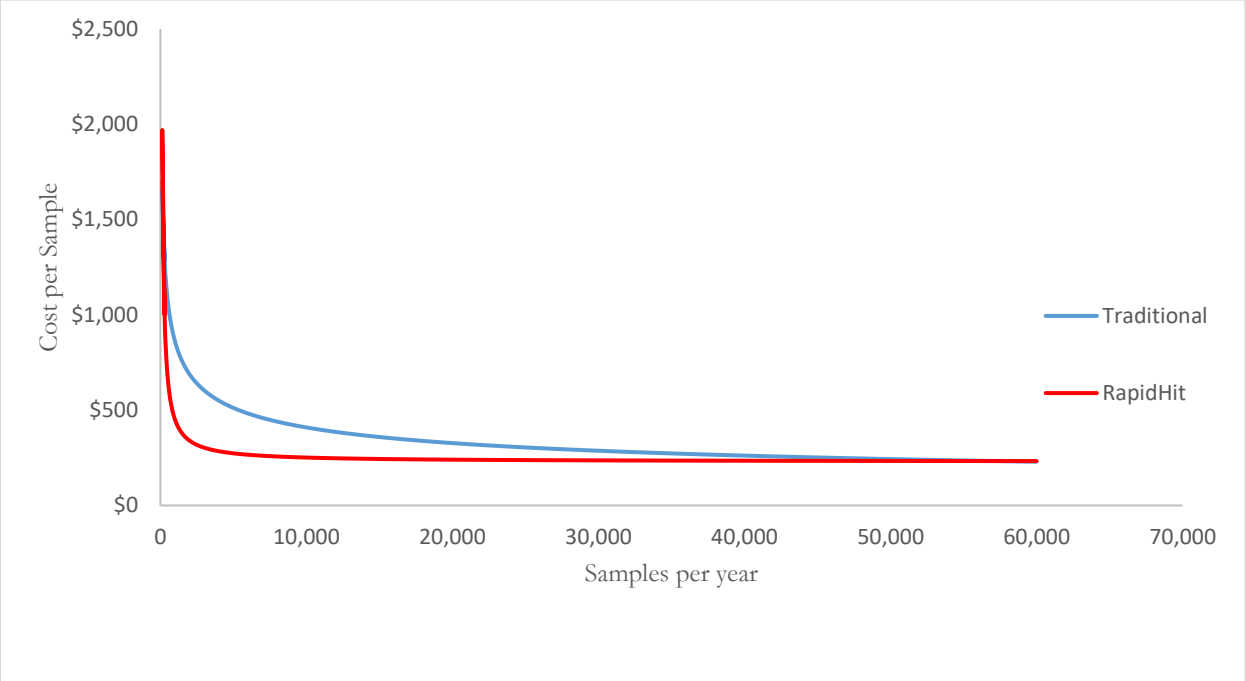
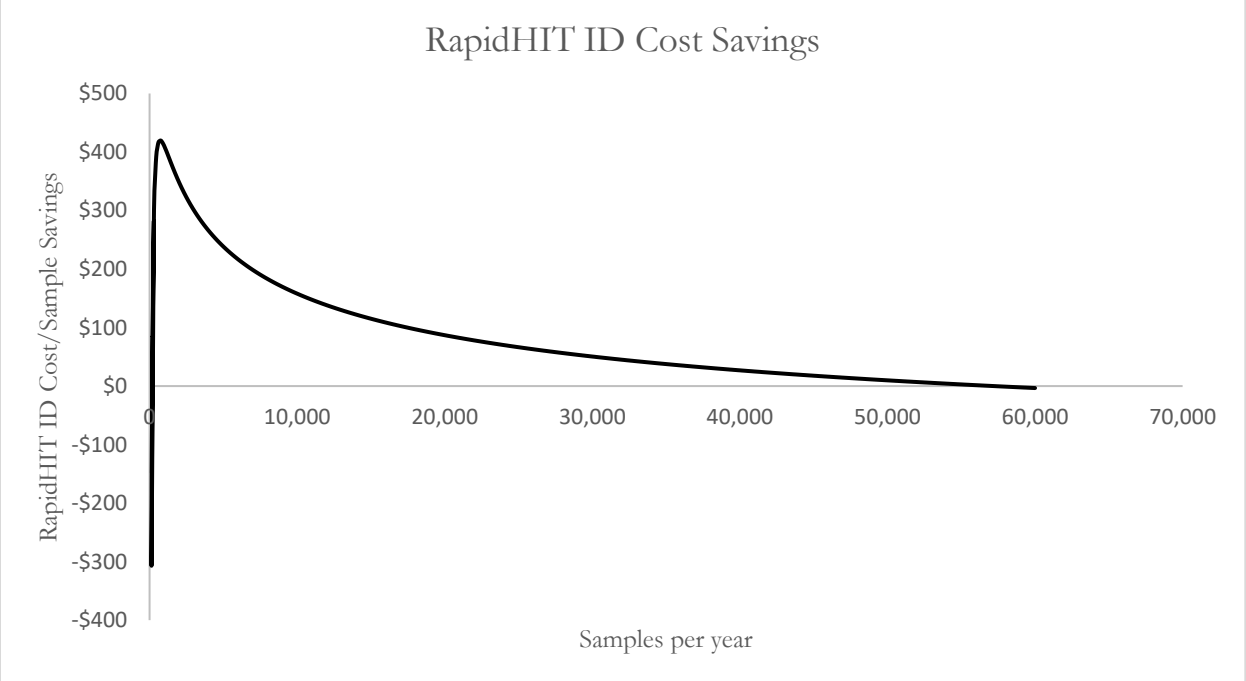


Figure 3: RapidHIT ID Cost Savings



Simply based upon the direct costs of each method, the Thermo Fisher Scientific RapidHIT ID analysis is less expensive than an efficient use of traditional DNA technology when the annual number of samples analyzed is between 183 and 57,249 samples per year with the greatest average cost differential ($419.66) at 750 annual samples.

However, these are just the direct costs from each analytical process. A comparison of the turnaround time from traditional DNA analysis and the Thermo Fisher Scientific RapidHIT ID analysis permits significant savings from costs avoided. Rapid identification of DNA avoids costs from justice delayed and subsequent crimes committed by recidivist offenders.

Indirect Costs Avoided

The growth in the demand for traditional DNA analysis has resulted in significant increases in turnaround time and backlogs. The FY 2021 Project FORESIGHT turnaround times are reproduced in Table 2. The combination of DNA Casework and entry into the DNA Database indicates that the middle fifty percent of laboratories complete their DNA analysis in 150 – 224 days.

Table 2: Turnaround Times by Investigative Area

Area of Investigation	25th percentile	Median	75th percentile
Blood Alcohol	22	28	37
Crime Scene Investigation	30	40	51
Digital evidence	24	75	149
DNA Casework	103	133	152
DNA Database	47	61	72
Document Examination	55	65	80
Drugs - Controlled Substances	57	70	86
Evidence Screening & Processing	26	40	47
Explosives	87	106	128
Fingerprints	54	69	82
Fingerprints Database (including IAFIS)	8	12	27
Fire analysis	68	102	126
Firearms and Ballistics	56	72	85
Firearms Database (including NIBIN)	5	7	25
Forensic Pathology	56	62	67
Gun Shot Residue (GSR)	80	92	110
Marks and Impressions	83	101	118
Serology/Biology	54	65	80
Toxicology ante mortem (excluding BAC)	51	66	77
Toxicology post mortem (excluding BAC)	67	81	90
Trace Evidence	168	204	242

Source: Speaker, P. J. (2022)

These cost estimates across a variety of sample sizes provides a foundation for the determination of ROI from the adoption of the Thermo Fisher Scientific RapidHIT ID technology. The cost savings alone may indicate which alternative methodology to employ. However, the argument in favor of any technique also requires a detailed examination of the net benefits associated with the time savings for identification. Several studies highlight the net benefits from time savings in the use of DNA analysis. The size of the savings is related to the type of crime avoided (DeLisi et al, 2010). The most violent crimes avoided yield the greatest net benefits (Anker et al, 2021; Wang & Wein, 2018).

Additionally, the contributions to the DNA database provide great cost savings (Doleac, 2017) with the savings reaching as high as $20,000 per addition to the database. Further evidence of savings are attributed by type of crime to the rates of recidivism with greatest gains from additions to the DNA database from young offenders of violent crimes (Anker et al, 2021).

Comments and Considerations

This report provides evidence that a conservative estimation of costs and benefits from DNA analysis indicates that the Thermo Fisher Scientific RapidHit ID System provides significant benefits over traditional DNA analysis for a wide range of annual samples analyzed. A more detailed examination of ROI should include an assessment of the crime characteristics for a jurisdiction and an estimate of the crimes avoided or negatively impacted in other ways using the techniques to provide the value of a statistical life (Aldy & Viscusi, 2008).

These additional considerations, among others, might be undertaken in a more in-depth analysis.

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