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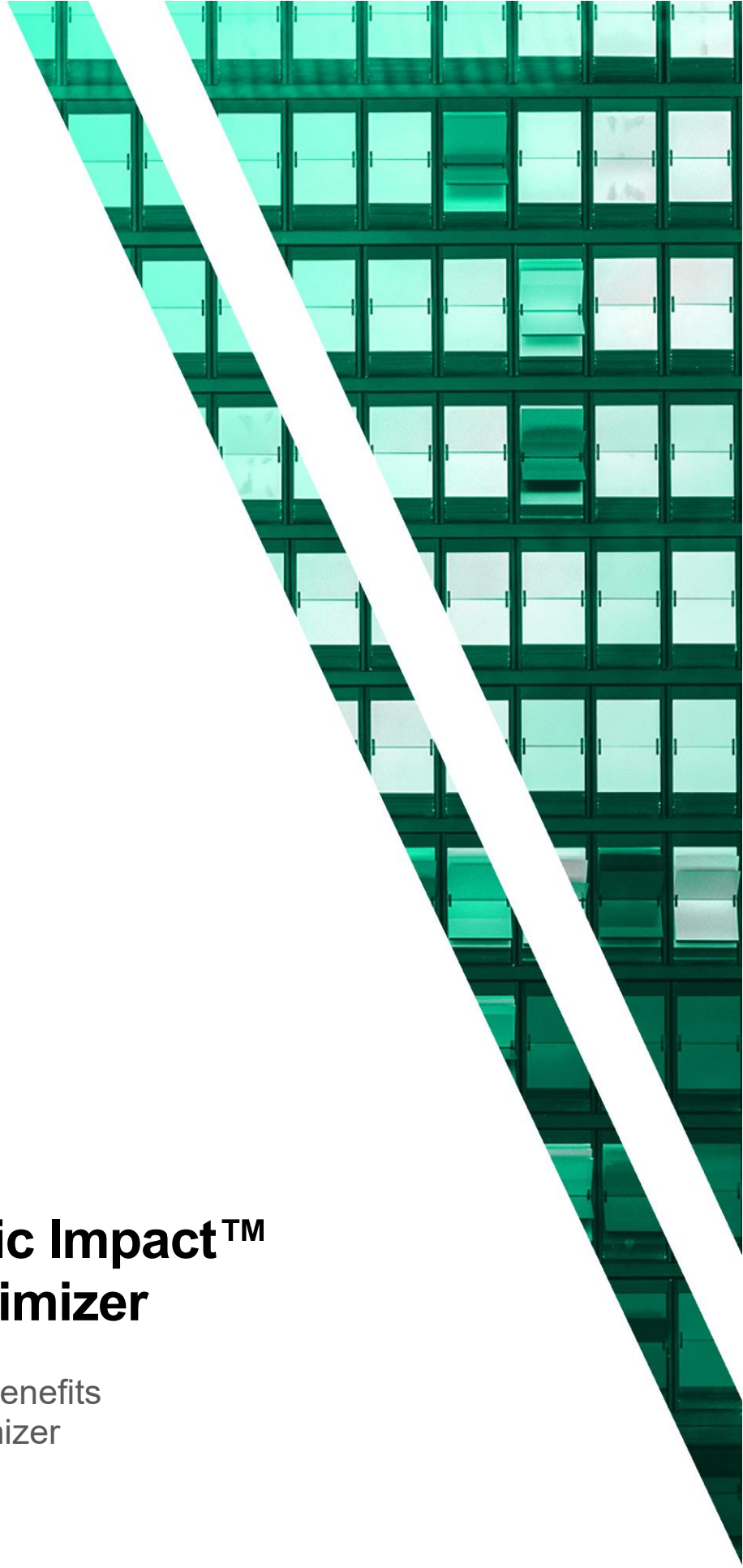

The Total Economic Impact™ Of The Gurobi Optimizer

Cost Savings And Business Benefits Enabled By The Gurobi Optimizer

SEPTEMBER 2022

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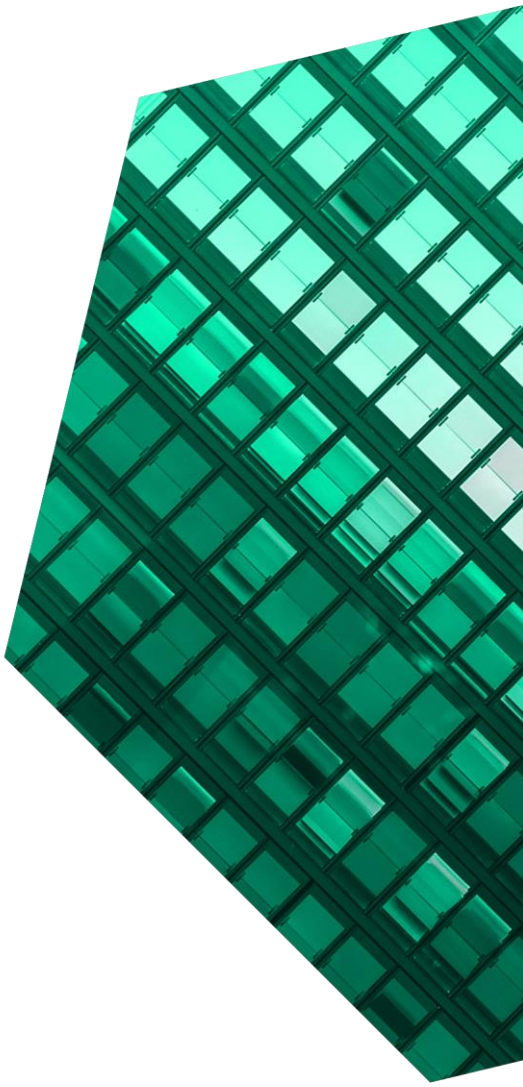

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Executive Summary

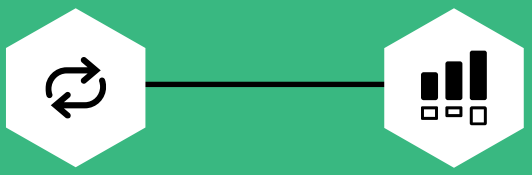
Enterprises of all sizes and in all industries have large, complex problems to solve where minutes or even seconds of failed or extra resources can lead to gross overspending or missed revenue opportunity. By embracing mathematical optimization, organizations can master the complexities of running a modern business and ultimately maximize profits while minimizing operational costs. The Gurobi Optimizer enables better business decision-making in less time, saving organizations millions or billions of dollars.

The Gurobi Optimizer is an extremely fast and powerful mathematical optimization (MO) solver capable of solving highly complex problems expressed in forms drawn from an array of mathematical disciplines, including linear programming, quadratic programming, quadratically constrained programming, and mixed-integer programming variants. Mathematical optimization is one of the decision intelligence technologies that work with other such advanced analytics specialties such as machine learning (ML). Gurobi enables users to state highly complex business problems as mathematical models and then it automatically generates optimal solutions in exceptionally fast times. The Gurobi Optimizer can be run in fully autonomous mode to generate real-time insights for automated processes. It also assists decision-making for recurring high-impact operational insights requiring immediate human-driven decisions.

Gurobi commissioned Forrester Consulting to conduct a Total Economic Impact™ (TEI) study and examine the potential return on investment (ROI) enterprises may realize by deploying the Gurobi Optimizer.[1] The purpose of this study is to provide readers with a framework to evaluate the potential financial impact of the Gurobi Optimizer on their organizations.

To better understand the benefits, costs, and risks associated with this investment, Forrester interviewed four representatives with experience using the Gurobi Optimizer. For the purposes of this study, Forrester aggregated the interviewees' experiences and combined the results into a single composite organization, that is a global organization with various revenue streams and business operations in several countries and revenues of $10 billion per year. The composite organization has an operations research function in place with several use cases employing mathematical optimization.

KEY STATISTICS



Return on investment (ROI)
518%

Net present value (NPV)
$3.60M

Prior to using the Gurobi Optimizer, the interviewees' organizations had established operations research teams using a variety of open-source solvers, other commercial solvers, and even spreadsheet-based optimization tools to manually solve business problems. However, these tools were not completely effective, unable to scale, unable to solve some problems with actionable time limits and, at times, delivered solutions that were suboptimal or simply wrong. To solve faster, some operations researchers resorted to simplifying or relaxing model constraints, going against best practices and yielding suboptimal

"The tool itself enables quick solves and fast development times to give us really quick proofs of concept that allow us to seek value faster than what another tool would provide."

Mine and process engineering systems lead, mining

solutions, and even this technique failed to solve certain complex problems within allowed timeframes.

The interviewees noted that after the investment in Gurobi, their organizations' operations researchers were able to solve problems several times faster than they were able to before. Gurobi was able to handle larger, more complex problems involving trillions of possible outcomes and deliver high-quality solutions within the time required for the specific problem. As a result, the organizations were able to generate additional revenue and save incremental operational costs through the enhanced mathematical optimization that Gurobi provided.

KEY FINDINGS

Quantified benefits. Three-year, risk-adjusted present value (PV) quantified benefits for the composite organization include:

- **Operational cost savings from MO-driven productivities.** After switching to the Gurobi Optimizer for several use cases focused on optimizing various aspects of its operations, the composite organization experiences performance improvements averaging 0.4%, saving it $3.9 million over three years.
- **Revenue uplift from MO-driven productivities.** The composite organization applies the Gurobi Optimizer to additional use cases focused on revenue optimization, which increases gross revenue by $3.7 million over three years and leads to a net margin increase of $169,300.
- **Savings from retiring previous commercial solver.** After adopting Gurobi, the composite organization retires its previous commercial solver, taking advantage of Gurobi's more-flexible licensing options to save money. The risk-adjusted savings over three years come to $221,600.

Unquantified benefits. Benefits that provide value for the composite organization but are not quantified in this study include:

- **Faster solving.** Minutes and even seconds of failed or extra resources provisioned can lead to gross overspending. With the Gurobi Optimizer, the composite organization solves problems faster, meets service level agreements for problems with actionable time limits, and reaches thresholds of optimality faster within set timeframes. Solving problems faster is the biggest benefit accruing to organizations and a key reason for selecting Gurobi.
- **Continuous improvement.** Gurobi is committed to continuous improvement of its products.

"The biggest improvement on my team was that the results were 10 times faster than before."

Lead, operations research, food delivery

“[Gurobi’s] vision is very clear. There is broad corporate alignment around that vision. We see this when we talk to different people at different locations and at different times.”

Chief technical lead, transportation

Performance in a number of areas, including presolve, heuristics, and MADlib — which is a standard industry benchmark for solving mixed integer problems — has improved over time. The composite organization anticipates further performance improvements and feature enhancements in future updates.

- **Operations research (OR) team productivities.** Faster solving enables OR teams to recalibrate and rerun models and explore more options in the process of delivering better solutions.
- **Strong technical support and account management.** The composite organization experiences Gurobi’s world-class, PhD-led technical support, and responsive account management. Gurobi Day events keep the composite organization closely connected with the broader community of Gurobi users.
- **OR team satisfaction.** The composite organization’s OR team enjoys working with the fast-solving Gurobi Optimizer as it makes their work more efficient and effective.
- **More robust than open-source solvers.** Interviewees said the Gurobi Optimizer is a stronger, more trustworthy product, with better features and fewer memory errors compared to open-source solvers. The composite organization does not need to worry about bugs in the Gurobi Optimizer the way it does when using open-source solvers.
- **Agile pricing and licensing model.** The composite organization takes advantage of Gurobi’s flexible approach to pricing and licensing, which allows it to easily scale up to add new projects without undue administrative burden.
- **Minimal vendor lock-in.** The composite organization easily switches among solvers with minimal effort. In addition, Gurobi’s development toolset supports both Python and .NET, providing more options to OR and data science teams responsible for modeling.
- **Breaking down silos.** The composite organization experiences improved coordination and communication as a result of applying optimization to use cases that span operations across different departments and lines of business. This gives rise to the development of a broad community of OR subject-matter experts within the organization, where different teams share approaches, best practices, and ideas for future projects.

“I can tell you how it improves the transparency of information [and] the transparency of decision making.”

Mine and process engineering systems lead, mining

Costs. Three-year, risk-adjusted PV costs for the composite organization include:

- **Gurobi licensing.** Gurobi's commercial license includes maintenance and access to Gurobi's world-class support for the term of the license agreement. Software updates are at no additional cost during the term of the license agreement. Pricing is based on various factors, including number of cores, number of applications, number of users (depending on usage type), usage, and license type. The risk-adjusted costs of licensing for the composite organization come to a NPV of nearly $625,700 over three years.
- **Deployment and ongoing maintenance.** The composite organization has staff skilled in mathematical optimization, and it does not require any additional training or professional services to set up and use the Gurobi Optimizer. As use cases are converted to Gurobi, some require adjustments to optimize performance, but this is a fairly trivial matter and does not take much time. Updates are issued on a quarterly basis and require an average of a day to install and test. The three-year risk-adjusted PV for the composite organization deployment and ongoing maintenance comes to $69,500.

The representative interviews and financial analysis found that a composite organization that already has a mathematical optimization solution in place before deploying Gurobi experiences benefits of $4.3 million over three years versus costs of $695,000, adding up to a net present value (NPV) of $3.6 million and an ROI of 518%. For organizations newly adopting mathematical optimization, the ROI will likely be significantly higher.

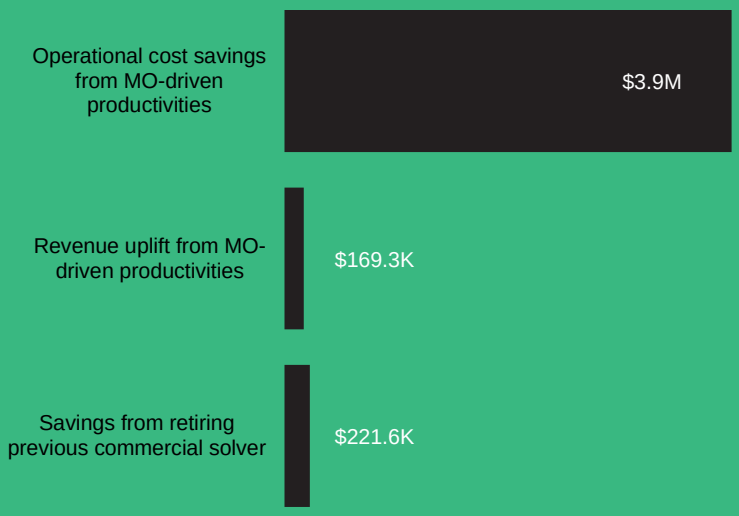
ROI
518%

BENEFITS PV
$4.3M

NPV
$3.6M

PAYBACK
<6 months

Benefits (Three-Year)



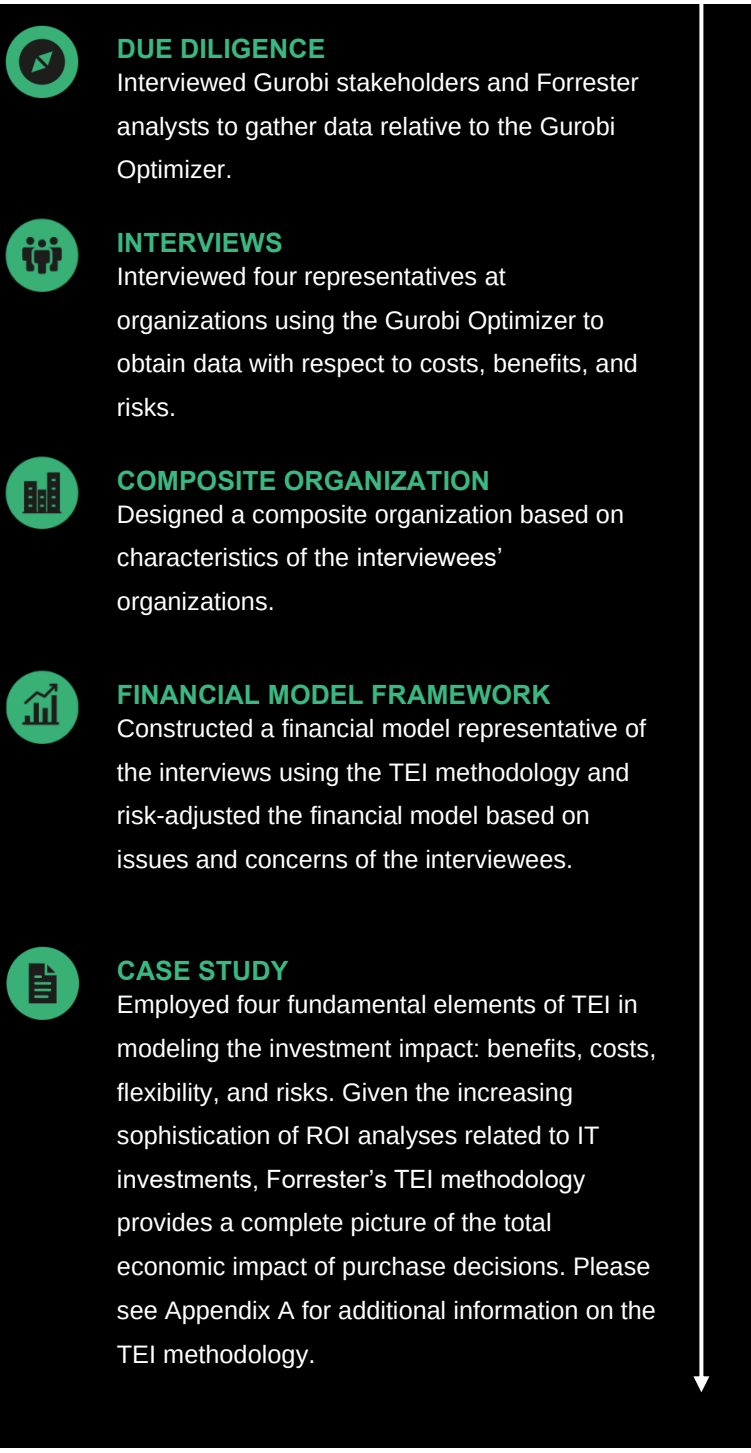
“Solving problems faster is the most important benefit we’re getting from Gurobi. Its performance is much better than other solvers we’ve used.”

— Lead, operations research, technology

TEI FRAMEWORK AND METHODOLOGY

From the information provided in the interviews, Forrester constructed a Total Economic Impact™ framework for those organizations considering an investment in the Gurobi Optimizer.

The objective of the framework is to identify the cost, benefit, flexibility, and risk factors that affect the investment decision. Forrester took a multistep approach to evaluate the impact that the Gurobi Optimizer can have on an organization.



DISCLOSURES

Readers should be aware of the following:

This study is commissioned by Gurobi and delivered by Forrester Consulting. It is not meant to be used as a competitive analysis.

Forrester makes no assumptions as to the potential ROI that other organizations will receive. Forrester strongly advises that readers use their own estimates within the framework provided in the study to determine the appropriateness of an investment in the Gurobi Optimizer.

Gurobi reviewed and provided feedback to Forrester, but Forrester maintains editorial control over the study and its findings and does not accept changes to the study that contradict Forrester's findings or obscure the meaning of the study.

Gurobi provided the customer names for the interviews but did not participate in the interviews.

The Gurobi Optimizer Customer Journey

Drivers leading to the Gurobi Optimizer investment

Interviews

Role	Industry	Geography	Revenue	OR Team Size
Lead, operations research	Food delivery	Global	$5B to $10B	7
Mine and process engineering systems lead	Mining	Global	$10B to $20B	7
Chief technical lead	Transportation	Global	$10B to $20B	50
Lead, operations research	Technology	Global	>$50B	40

KEY CHALLENGES

Prior to using the Gurobi Optimizer, the interviewees' organizations had established operations research teams using a variety of open-source solvers, other commercial solvers, and even spreadsheet-based optimization tools to manually solve business problems.

The interviewees noted how their organizations struggled with common challenges, including:

- **Inability to solve problems within actionable time limits.** Certain categories of data-driven insights are ephemeral. If enterprises fail to act on real-time insights for automated processes within a certain time frame, they are no longer actionable and the opportunity to change the course of the business outcome will pass. The windows for these can be measured in seconds or even subseconds. The same can be true for operational insights that involve human interaction but require solutions within hours or even minutes.

  The chief technical lead for the transportation company explained how critical speed is for decision-making relating to business operations in their industry. They said: "We had a major daily job that took around 5 to 10 minutes. The optimization is part of a sequence of events, so that 10-minute threshold is very important. There were times when the prior solver couldn't find the best solution in 10 minutes, while Gurobi always finds the best solution in less than 10 minutes and most of the time in 5 minutes."

  The lead of operations research for the food delivery company confirmed the importance of speed in decision-making for their organization's delivery operations. They said: "Our deliveries have latency constraints on them. We tried to relax the problem as much as possible so that we could find a solution in a reasonable time, but [we] had to manipulate the model in order to have it ready in that time. That's normally not best

"Gurobi is a fantastic MIP (mixed integer program) solver. MIPs are very, very important to us, and being able to solve them better is very important to us."

Lead, operations research, technology

"Before signing up for an unlimited contract, we checked that our heaviest workloads would perform well. It turns out that some of them were even faster to solve. That wasn't a requirement, but it was an added benefit that we were not expecting to be so high."

Chief technical lead, transportation

practice in operations research. With Gurobi, you can solve problems with fewer relaxations."

- **Inability to scale.** Several of the interviewees' organizations ran optimization models for operations in different markets around the world, each with their own unique inputs and constraints, which led to the need for a solver that could scale up to handle highly complex models on a global basis. The lead of operations research for the food delivery company explained that the open-source solver their organization previously used was not up to this task. They said: "When we started with some problems, we tried to model them in a global way, but there was no way to find a solution. It was impossible. While there are some tricks to simplify or relax the model in such a way that you can find solutions, they are globally not optimal anymore."
- **Manual processes yielded suboptimal or incorrect solutions.** One interviewee's organization previously relied on a spreadsheet-based optimization tool and manual processes for gathering inputs needed for supply-chain calculations before building its in-house OR capabilities. The mine and process engineering systems lead for the mining company said: "It was calling back and forth saying, 'This is what I got' [and] 'This is what I got.' [With our previous tool,] you're not really optimizing. You're just running calculations. What we observed at that point was that the solutions presented were oftentimes either nonoptimal or they were incorrect because they were reliant on a single point of failure to assess the optimal blend."
- **Other commercial solvers were not cost effective due to inflexible licensing and pricing models.** One of the interviewees discussed how moving optimization computations to virtual machines negatively impacted what their organization paid for its previous solver. The chief technical lead for the transportation company said: "We were using more VMs (virtual machines) than physical machines, and the pricing and billing was getting crazy with [the previous solution] in terms of the way [it was] counting CPU time. … The pricing became very hard to manage and very costly."

SOLUTION REQUIREMENTS/INVESTMENT OBJECTIVES

Interviewees said performance in terms of speed was typically the most important criteria for evaluating mathematical optimization solvers, but other evaluation criteria included:

- Reliability and scalability.
- Ability to handle heavy workloads.
- Having a flexible pricing and licensing model.

The lead of operations research at the food delivery company described how their organization made the business case for Gurobi. They said: "The original use of Gurobi was initiated by an OR analyst who joined the company fresh from university and had a strong background using Gurobi there. They had a quite difficult problem to solve and couldn't solve it with an open-source solver, so they petitioned the company to use Gurobi."

“We organized a test license and ran our model and found it was 10 times faster than our other solver, so the business case was very easy to make. That’s how it all started.”

Lead, operations research, food delivery

The lead of operations research at the technology company noted that their organization had a Gurobi license on a test machine used for benchmarking purposes for several years, but it became a more serious user as the performance of the solver improved over time. They said, “When we started working with Gurobi, it was just playing around inside our corporate environment [and] benchmarking things for less-secure applications.”

The chief technical lead at the transportation company said their organization began using Gurobi on some new projects and found it worked well and was less expensive. They also appreciated Gurobi’s relentless focus on continuous improvement. They said: “We liked Gurobi’s strategy, which was to provide a tool that was very efficient and [to] keep on improving it to make it even more efficient for complex computations. That was more of what we were looking for.”

COMPOSITE ORGANIZATION

Based on the interviews, Forrester constructed a TEI framework, a composite company, and an ROI analysis that illustrates the areas financially affected. The composite organization is representative of the four interviewees, and it is used to present the aggregate financial analysis in the next section. The composite organization has the following characteristics:

Description of composite. The composite is a global, multibillion-dollar organization with various revenue streams and business operations at locations around the world. The organization employs 10 full-time OR specialists who work on mathematical optimization projects. There are seven existing use cases for optimization: five focused on optimizing operational costs and two focused on optimizing revenue.

Deployment characteristics. After benchmarking a Gurobi test license on several of the existing use cases, the organization signs a three-year contract and transitions the rest of the use cases over to Gurobi. The OR team maintains the existing optimization use cases in Year 1 and deploys six additional use cases over the next two years: four cases focused on optimizing operational costs and two focused on optimizing revenue.

Key Assumptions

- **Global organization**
- **$10B in revenue**
- **Grows 3% annually**
- **10 OR specialists**
- **Seven existing use cases for optimization**

Analysis Of Benefits

Quantified benefit data as applied to the composite

Total Benefits						
Ref.	**Benefit**	**Year 1**	**Year 2**	**Year 3**	**Total**	**Present Value**
Atr	Operational cost savings from MO-driven productivities	$1,105,000	$1,593,410	$2,110,130	$4,808,540	$3,906,785
Btr	Revenue uplift from MO-driven productivities	$44,800	$69,216	$95,057	$209,073	$169,348
Ctr	Savings from retiring previous commercial solver	$85,000	$89,250	$93,925	$268,175	$221,600
	Total benefits (risk-adjusted)	$1,234,800	$1,751,876	$2,299,112	$5,285,788	$4,297,733

OPERATIONAL COST SAVINGS FROM MO-DRIVEN PRODUCTIVITIES

Evidence and data. Operations research can be used to help improve the productivity of organizations in many ways, including inventory control, production mix, resource allocation, maintenance planning, office assignment, workforce planning, and scheduling. A single successful use case can easily generate a home run for an organization, allowing it to more than recoup the cost of the Gurobi investment. The interviewed representatives described several use cases utilizing mathematical optimization to save operational costs in various ways. Improvements in performance ranged from 0.5% to as high as 5% depending on the operation and which solver, if any, was used prior to Gurobi.

- The lead of operations research at the technology company said their organization's initial use case was bin packing jobs in its data centers. They said: "Figuring out the most effective packing of these jobs and services in our data centers is something very important to us. We had rolled our own and started benchmarking solvers — commercial, open source, internal, [and] external — to figure out how we could do better, and Gurobi was the best." This interviewee estimated their organization achieved a 1% improvement in performance for a particular operation, saving many millions of dollars.
- The lead of operations research for the food delivery company related their organization's success applying optimization to menu planning, which is a core element of its market offerings and is performed weekly for a number of brands and sub-brands in diverse markets around the world. This was a combinatorically complex problem balancing one prime objective, to maximize customer satisfaction with menu selections, against another, to minimize the cost of that menu, subject to several constraints. Initially, the organization used an open-source solver to run the computations, and it achieved savings from 3% to 5% over manual methods, but it was unable to scale its modeling without relaxing constraints, which yielded suboptimal results. By switching to Gurobi, the organization was able to solve these problems in a global way and achieve incremental cost savings from 0.1% to 0.3%. This interviewee said: "The most gain you get is when you solve some problem with optimization in general. With Gurobi, you can come a little bit closer to the optimized solution."

- The same interviewee said their organization was using optimization in production planning as well as line-haul planning involving the loading and scheduling of delivery trucks for the most efficient route. For the production planning use case, the interviewee estimated their organization was able to speed up its production lines as much as 4% to 5% through optimization, although the interviewee was unable to quantify the cost savings from this improvement in performance.
- The mine and process engineering systems lead for the mining company described a use case centered around optimizing the scheduling and routing of haul trucks at the site. They said: "One of the biggest costs for our mines is the use and availability of haul trucks. That's the biggest cost. If you can shave down a second or two of a haul route, this is talking on the order of billions of dollars in aggregate." By combining machine learning from other tools with optimization powered by Gurobi, their organization was able to predict and optimize haul truck distances, shaving off valuable time and saving many millions of dollars.

Modeling and assumptions. Forrester assumes the following about the composite organization:

- The composite organization's operating costs are 65% of its revenue.
- The composite organization has five existing use cases focused on revenue optimization.
- The organization adds two use cases in Year 2 and two more use case in Year 3.
- Prior to using Gurobi, each use case generated operational cost savings of 1%.
- Gurobi improves operational cost savings for each use case by an additional 0.4%.

Risks. Organizational differences that may impact the financial benefit associated with operational cost savings from MO-driven productivities delivered by Gurobi include:

- The size and operating costs of the organization.
- Whether the organization already has a mathematical optimization solution in place prior to deploying Gurobi. For organizations newly adopting mathematical optimization, the ROI will likely be significantly higher.
- The organization's ability to effectively apply optimization to factors that contribute to operational costs.

Results. To account for these risks, Forrester adjusted this benefit downward by 15%, yielding a three-year, risk-adjusted total PV (discounted at 10%) of $3.9 million.

> **"Moving waste and/or coal is the most expensive thing at site. ... A couple seconds equates to millions of dollars in savings from haul truck usage and increased productivity because you are really optimizing how effective those trucks are being used when they're available."**
>
> *Mine and process engineering systems lead, mining*

Operational Cost Savings From MO-Driven Productivities					
Ref.	**Metric**	**Source**	**Year 1**	**Year 2**	**Year 3**
A1	Annual revenue	Composite	$10,000,000,000	$10,300,000,000	$10,609,000,000
A2	Cost of goods sold (percentage)	Composite	65%	65%	65%
A3	Operating costs	A1*A2	$6,500,000,000	$6,695,000,000	$6,895,850,000
A4	Operations affected by optimization (percentage)	Interviews	5%	7%	9%
A5	Operational cost savings from MO enabled by Gurobi (percentage)	Interviews	0.4%	0.4%	0.4%
At	Operational cost savings from MO-driven productivities	A3*A4*A5	$1,300,000	$1,874,600	$2,482,506
	Risk adjustment	↓15%			
Atr	Operational cost savings from MO-driven productivities (risk-adjusted)		$1,105,000	$1,593,410	$2,110,130
	Three-year total: $4,808,540			**Three-year present value: $3,906,785**	

REVENUE UPLIFT FROM MO-DRIVEN PRODUCTIVITIES

Evidence and data. Operations research can similarly be applied to financial and investment scenarios to optimize revenue including capital budgeting, cash management, revenue optimization, portfolio optimization, fund cloning, and bond management. While few of the use cases given by the interviewed representatives centered around revenue optimization, improvements in performance followed similar lines to those achieved for cost optimization.

- The chief technical lead at the transportation company noted multiple use cases for cost optimization, mostly around staff scheduling and fuel minimization. But they also described a major revenue optimization use case modifying the pricing categories for tickets on a daily basis. This interviewee said: “The revenue management tool opens and closes pricing for each seating class. It is a daily process that considers available seats on each [leg of the journey], as well as the interrelationships across [connections].”
- The mine and process engineering systems lead for the mining company described a use case for optimization that involved product blending on-site. Optimizing blends across business units to better meet customers’ needs positively impacted the organization’s ability to grow profitably. Previously, the organization used spreadsheets to set up schedules, collect customer information, and determine acceptable blend plans. This interviewee said: “From a process perspective, using [spreadsheets] would take the whole week

“We’ve been able to improve our total revenues by using optimization at the heart of the revenue management process. ... We know we are able to sell more tickets or obtain a better average unit price per ticket.”

Chief technical lead, transportation

to get a schedule set up [and] get all the integrations before you could even start blending. One of our goals was to reduce that time. [With Gurobi,] we went from a one-week exercise and reduced it to a day or two to get a suitable blend plan."

Modeling and assumptions. Forrester assumes the following about the composite organization:

- The composite organization's annual revenues are $10 billion and grow 3% annually with a net margin of 7%.
- The composite organization has two existing use cases focused on revenue optimization
- The organization adds a third use case in Year 2 and a fourth use case in Year 3.
- Prior to using Gurobi, each use case generated a revenue uplift of 1% of revenue.
- Gurobi improves revenue uplift for each use case by an additional 0.4%.

Risks. Organizational differences that may impact the financial benefit associated with revenue uplift from MO-driven productivities delivered by Gurobi include:

- The size of the organization in terms of revenue and net margin.
- Whether the organization already has a mathematical optimization solution in place prior to deploying Gurobi. For organizations newly adopting mathematical optimization, the ROI will likely be significantly higher.
- The organization's ability to effectively apply optimization to factors that contribute to revenue.

Results. To account for these risks, Forrester adjusted this benefit downward by 20%, yielding a three-year, risk-adjusted total PV of $169,300.

Revenue Uplift From MO-Driven Productivities

Ref.	Metric	Source	Year 1	Year 2	Year 3
B1	Annual revenue	Composite	$10,000,000,000	$10,300,000,000	$10,609,000,000
B2	Revenues affected by optimization (percentage)	Interviews	2%	3%	4%
B3	Revenue uplift from MO enabled by Gurobi (percentage)	Interviews	0.4%	0.4%	0.4%
B4	Revenue uplift from MO enabled by Gurobi (dollars)	B1*B2*B3	$800,000	$1,236,000	$1,697,440
B5	Net margin	Composite	7%	7%	7%
Bt	Revenue uplift from MO-driven productivities	B4*B5	$56,000	$86,520	$118,821
	Risk adjustment	↓20%			
Btr	Revenue uplift from MO-driven productivities (risk-adjusted)		$44,800	$69,216	$95,057
	Three-year total: $209,073			**Three-year present value: $169,348**	

SAVINGS FROM RETIRING PREVIOUS COMMERCIAL SOLVER

Evidence and data. Prior to adopting Gurobi, the interviewees' organizations used a variety of open-source solvers, other commercial solvers, and even spreadsheet-based optimization tools to manually solve business problems.

- The chief technical lead for the transportation company described how moving optimization computations to virtual machines negatively impacted what their organization was paying for its previous commercial solver, given the way compute time was calculated. According to this interviewee, pricing became very hard to manage and very costly. Gurobi's pricing model was more flexible and responsive to the organization's needs, which enabled it to cut its costs by more than half compared to its previous solver.

Modeling and assumptions. After switching to Gurobi and discontinuing the use of another commercial solver, the composite organization saves 50% of the cost of its Gurobi license.

Risks. Organizational differences that may impact the financial benefit associated with savings from retiring previous commercial solvers include the organization's use patterns as well as the licensing and pricing models of other commercial solvers.

Results. To account for these risks, Forrester adjusted this benefit downward by 15%, yielding a three-year, risk-adjusted total PV of $221,600.

> **"We use only [Gurobi], and we are confident in their strategy. Their pricing is clear, simple, and cheaper than our prior solution by over 50%, and their pricing model makes us more agile."**
>
> *Chief technical lead, transportation*

Savings From Retiring Previous Commercial Solver

Ref.	Metric	Source	Year 1	Year 2	Year 3
C1	Savings from retiring previous commercial solver	Interviews	$100,000	$105,000	$110,500
Ct	Savings from retiring previous commercial solver	C1	$100,000	$105,000	$110,500
	Risk adjustment	↓15%			
Ctr	Savings from retiring previous commercial solver (risk-adjusted)		$85,000	$89,250	$93,925
	Three-year total: $268,175		**Three-year present value: $221,600**		

UNQUANTIFIED BENEFITS

Interviewees mentioned the following additional benefits that their organizations experienced but were not able to quantify:

- **Faster solving.** Being able to solve problems faster was a critical factor for most of the interviewees' organizations and a key reason for selecting Gurobi. The lead of operations research at the technology firm explained: "There's a trade-off where the longer you search, the closer to optimality you're going to get. I can get to optimality, or I can get to within X% of optimality 20% to 50% faster. In general, we care about optimization problems that fall into that second class, where we're trying to solve problems faster."
- The same interviewee's organization used a number of commercial and open-source solvers, and the interviewee noted: "When people benchmark [their open-source solver] against Gurobi, Gurobi is better 99% of the time. And the average performance improvement is probably 20% to 50% faster in terms of solving problems."
- The lead of operations research at the food delivery company echoed this sentiment. They said: "It's really just the speed improvement for us. … In optimization, you can easily see if [a solution] is better or not. If you have 10 times faster, you could either run it longer if you have more time and have a solution that is closer to optimality. Now we can solve with fewer relaxations with Gurobi. It's still sometimes hard to find a solution in the given time. But, before, [we] may have [had] to make 20 changes and with Gurobi, [we make] maybe only three or four changes."
- The same interviewee explained how faster solving speed also made it possible to solve delivery-scheduling problems that couldn't be solved before due to actionable time limits. They said: "Probably they were solvable before, but it would have taken maybe 100 hours or 10 weeks. Gurobi was able to find a solution in a reasonable amount of time." Given that different use cases have differing objectives, solving for optimality with a longer time window versus solving to get at a less optimal solution faster, the interviewee said Gurobi's faster solving made it "feasible for us both ways."
- The mine and process engineering lead at the mining company confirmed Gurobi's performance time savings. They said: "We indirectly compare Gurobi with another tool that uses dynamic programming, and that optimization engine is on the order of days to solve. When we're looking at all the stuff that we have within Gurobi, we're looking at minutes — seconds in general [and] at most a couple of minutes."
- **Continuous improvement.** The interviewees recognized and approved of Gurobi's commitment to continuous improvement of their products' performance. The lead of operations research at the technology company said: "[Gurobi] has gotten better in every dimension. Its performance on MADlib, which is a standard industry benchmark for solving mixed integer problems, has gotten better and better. [Gurobi's] presolve has improved. Their heuristics have

"We've never had a problem with Gurobi performance. Performance hasn't really come up with Gurobi because it's never been a problem for Gurobi unlike other tools that other teams are using."

Mine and process engineering systems lead, mining

improved. It's been actually quite pleasantly surprising to see how much better Gurobi has gotten. I would say it has widened its lead over its competitors over the past six years."

- The mine and process engineering systems lead at the mining company supported this, saying: "For the initial use case I talked about, it took about 10 minutes to solve at the beginning for quadratic programming, and it's been reduced to within a minute or to 2 minutes. It's a dramatic performance improvement that we've observing."
- The same interviewee noted the quadratic bilinear programming initiatives that Gurobi is pursuing now. They said: "I would say [Gurobi is] one of the leaders in linear optimization solvers. This area of bilinear/quadratic programming is relatively new in their product, and [from] what we've seen, I would say from the past year and a half to two [years], is that [Gurobi has] a ruthless focus on performance improvements because that's one of the more challenging things to solve. We've been working with them, providing our models that we create internally to assist with their performance improvement objectives."
- **OR team productivities.** While interviewees said faster solving didn't reduce operations researchers' time, it enabled more value-added work. The lead of operations research at the food 'improvement on my team was that the results were 10 times faster than before. Maybe [before] [we] had 20 hours to wait for a solution, and now [we] have it in 2 hours. That's something that will change your whole way of working, how you formulate your model or what you try out in your next test. If you have to wait 20 hours, you are thinking much longer about what to do, and you are frustrated if it doesn't work. With 1- or 2-hour runs, you can do totally different things."
- The same interviewee said: "[My team] can calibrate its models better in terms of market needs. We did not change the delivery windows for our menus. They still had the planning time of two weeks. With or without Gurobi, it was two weeks. But now [the team is] able to run multiple iterations to calibrate the model."
- The mine and process engineering systems lead at the mining company confirmed the value of more time to explore options as a result of Gurobi's faster solving. They said: "If there's one thing [that encapsules] the value of Gurobi, it is the idea of allowing for optionality. We've always, in a sense, optimized for or created plans to meet a deadline. Now, because of Gurobi, we are not stuck on setting up data. We are using that same time to explore options, and that has provided tremendous value. [Before,] we didn't have time to look at alternatives. All that stuff that allows you to make a better decision, the tool indirectly or directly has allowed us to do."
- **Strong technical support and account relationships.** All of the interviewees praised Gurobi's strong technical service and support and their close account relationships. The chief technical lead for the transportation company characterized their organization's relationship with Gurobi as "quite transparent and simple." The lead of operations research for the technology company agreed, saying, "I've been very happy with the Gurobi relationship that we've had so far."

"There aren't that many people who are world class in combinatorial optimization, and Gurobi has a lot of them."

Lead, operations research, technology

“If there is something that Gurobi provides that other tools cannot or will not, it is that excellent engagement to work with us to improve and actually get the results that we are looking for. From experience, what they say they’ll do, they’ve done. That has really tremendously helped us in the solutions that we built.”

Mine and process engineering systems lead, mining

- The mine and process engineering systems lead at the mining company went further to note: “I polled my team before this, and if there’s one word to describe experience, it’s been ‘excellent.’ [Gurobi] is without a doubt the best vendor that we work with in terms of features. And the level of support and engagement that Gurobi provides us … allows us to have input in the direction of the tool. It’s been more than 10 years with working with the tool, and since the start to now, we have absolutely excellent communication with the people involved at Gurobi.”
- The lead of operations research for the food delivery company was also positive about their organization’s Gurobi partnership and the community found through attending Gurobi Day events. They said: “The people are quite nice. I think they are doing quite a good job on being attractive. I’ve met some technical people there, and they seem to be quite smart. [Gurobi] seems to be quite professional, and the product is connected with some community thinking. That’s a thing that I like from a technical perspective.”
- **OR team satisfaction.** The lead of operations research at the food delivery company noted the positive impact that working with Gurobi has had on their organization’s OR team. They said: “[The OR team members are] really happy and don’t want to switch back anymore, at least for the big problems. It’s the speed improvement for us and the 10 times work we would have done otherwise. Before, you had to run it over the whole day. You switch it on in the evening or at daytime, and the next day you have your results. That makes it something. It’s the speed improvement that brings something to the table.”
- **More robust than open-source solvers.** The lead of operations research at the technology company noted that Gurobi and other commercial solvers are more robust than open-source solvers. They said: “Because [the solver] is open source, we can look at the code, and we can see that it’s not that well-written. [It] has memory errors. And because of the way [it] is administered, it’s very hard to make changes to [it]. So it’s not the best experience. We do abstract out a lot of that by having this wrapper approach that allows us to swap in different solvers. But, ultimately, we don't trust [it] as much as we trust commercial solvers.”

“[Gurobi’s] more robust, but mostly it’s the best solver that’s out there for our purposes.”

Lead, operations research, technology

- **Agile pricing model.** Two interviewees pointed out how Gurobi's pricing model contributed to their organizations' agility. The chief technical lead at the transportation company said: "We can provision licenses in the same day. If you want to test anything for a new project, we have unlimited token servers, technically speaking, that can allow us to easily start a new project. Previously, we needed to pay for the license before getting it. It would take a month or more to go through our ordering process, the vendor's billing process, then our payment system. This saved our team time while expanding innovation toward creating new, valuable use cases."
- The lead of operations research for the technology company said their organization also had an agreement in place that enabled it to spin up Gurobi licenses on demand. They said: "It took some effort to put that in place. But we make good use of it, and we're happy with it."
- **Minimal vendor lock-in.** Most of the interviewees' organizations used a framework over the solver — an abstract layer that virtualizes the tool — making it easier to switch between solvers and reducing the possibility of vendor lock-in. The lead of operations research at the technology company said: "We have a uniform way of representing optimization problems, so the choice of the underlying solver is just a one-line code change. ... There's no kind of relearning that people have to do because people aren't using Gurobi directly here."
- The mine and process engineering systems lead at the mining company agreed, saying: "It's a fairly open developmental toolset. If you want to use Python, you can. Within the teams that I have worked with, there's two paths. One group uses Python for their constraint modeling or to access Gurobi, and another team uses .NET, and they both are quite supported by Gurobi. The literature and the guides … are valid for both cases. Gurobi is code-agnostic from that standpoint."
- **Breaking down silos.** While not specific to Gurobi, two of the interviewees discussed the impact that optimization had on improved coordination and communication between departments and enabled the breaking down of silos across their organizations. The lead of operations research at the food delivery company noted: "With the adoption of an optimization tool, we have created a global community where different teams from all around the world constantly share approaches, ideas, and best practices to enhance our product further."
- The mine and process engineering systems lead at the mining company described their organization's largest initiative so far — one still in development — to optimize across the entire supply chain their company spanned. They said: "There were separate initiatives that tried to tackle this, breaking down silos for financial optimization benefits. Groups within the organization would try to solve things on their own, but there never was an enterprise-level thinking for optimization [or] for advanced analytics."
- The same interviewee said: "The key driver was that it fed into the bigger group of 300 data scientists focused on optimization machine learning initiatives. That's what really kick-started this specific initiative: that there was buy-in from senior management to pursue these types of tools because they saw the benefit of it. We did proofs of concept for relatively low-hanging-fruit optimization use cases, like process improvements, and then slowly expanded the portfolio, and this eventually encompassed our supply-chain optimization tool. With the new paradigm shift, the mines will have visibility of what customers are demanding, and they can optimize at the source of how much they need to

produce in order to fulfill that demand. The expected benefits are in the millions."

FLEXIBILITY

The value of flexibility is unique to each customer. There are multiple scenarios in which a customer might implement the Gurobi Optimizer and later realize additional uses and business opportunities, including:

- **Future initiatives.** All of the interviewees spoke of future initiatives, including projects centered around sustainability. The lead of operations research at the technology company mentioned experimenting with energy-grid optimization, while the mine and process engineering systems lead at the mining company spoke of a drive to reduce consumables used in their production plants. The latter said: "Cost is the main driver, but we also want to be stewards of the environment, too. So another key driver is to reduce our carbon footprint. Reducing waste has tangible net benefits from both a financial perspective and an environmental perspective."
- Interviewees described their processes for initiating new projects. The chief technical lead at the transportation company said: "Sometimes we propose new ideas to our internal customers, telling them we might be able to improve a process by, say, 1% to 5%, depending on the topic, thanks to optimization. We have three or four new project per year. Thirty percent of time is spent on new projects, [and] 70% of time is working on existing projects, adding constraints, or shaping the existing constraints based on business learnings or changes."
- The lead of operations research at the food delivery company also noted their organization's active involvement in developing new projects. They said: "When we have the capacity, we are jumping into the problems. But it could also be that people are coming to us and say, 'Hey, we have here a problem. Can you help? We heard that you are doing something with math and algorithms. Can you help us?' If it's a computational problem, then it's on us, and we are trying to help them."
- The same interviewee added: "[Thanks to Gurobi,] we scaled up somehow so we could do more of what we did. We also had more time to think about other types of optimization problems. Before, maybe one analyst could handle maybe three markets. Now they can handle five markets. Before, they were only looking into menu planning. Now they have time to look into production or logistics planning. For menu planning especially, we did more to improve the quality of the solutions itself, running multiple iterations. That was the biggest change I would say. Before, you could have maybe one trial in a day. Now you can have five or six trials in a day."
- The lead of operations research at the technology company said leads on new projects come from the business. They said: "Word of mouth is part of it. If someone knows they have an integer optimization problem or a linear programming problem or a constraint programming problem, [it's] very easy to find. My team acts as a consulting body and gives them advice on how to model and solve their problem."

"Our approach was to try out small cases, build knowledge of what it takes, utilize the tool, and ultimately see benefits quickly or not, with the idea of failing fast or succeeding fast."

Mine and process engineering systems lead, mining

- **Advanced analytics.** Even though mathematical optimization is an older science, relatively speaking, interviewees view it as every bit as exciting as other decision intelligence or advanced analytics specialties such as ML. The mine and process engineering systems lead at the mining company said: "We as an organization are really pushing the advanced analytics front. We have a program to utilize what we have and build on top of that in order to fully enter the realm of applying all types of technology to solve our current mining challenges. One of the cornerstones of that is optimization and machine learning, and Gurobi fits a big picture into that."
- The lead of operations research at the technology company confirmed how the field of optimization is continually changing. They said: "We are constantly trying to add to our optimization framework the ability to use more advanced features of solvers. Things like callbacks and incrementalism that Gurobi and other first-tier solvers support. It's not something we were able to do two years ago using our interface layer. As Gurobi and other commercial solvers add more advanced features, we are continually evaluating them and figuring out whether we want to support them from our framework."
- **Interplay between MO and ML.** The interviewees had interesting views on the interplay between mathematical optimization and machine learning. For example, the lead of operations research at the technology company said they frequently saw ML and MO working harmoniously together. They said: "Often, ML generates the input to an optimization problem. ML is about thinking and OR is about acting, and you need to think before you can act. Often, we'll have a ML phase that goes on before we construct the problem and hand it off to Gurobi to solve. And you can have a nice virtuous feedback loop as well, where if you are trying to figure out how to think, it helps to have seen the results of past actions."
- The chief technical lead at the transportation company said: "Most of the time, they are working on different projects, but some projects need both competencies to solve the decision-making problem that we need to solve. Machine learning people are building models, and the outputs of the models are then inputs for the optimization engineers to do that job. Once or twice, reinforcement learning approaches were compared to optimization approaches, but optimization was still better."
- The mine and process engineering systems lead at the mining company acknowledged their organization was further behind on machine learning, but they noted some promising results linking optimization to machine learning to both predict and prescribe how best to operate a plant. They said: "Prescriptive analytics is something that we have more knowledge of and more data in order to make better decisions. The realm of machine learning and AIs is emerging, but in order to get to that stage, the foundation needs to be improved. From an optimization standpoint, we are more mature to use those prescriptive analytics areas."
- The lead of operations research at the food processing company said operations research was the more valuable art. They said: "With machine learning, you are looking into the future based on historical information. If, due to the [COVID-19] pandemic, historical information is not really accurate anymore for the future because the whole world changed due to this disruptive thing, then your models are not really helping you so much anymore."

Flexibility would also be quantified when evaluated as part of a specific project (described in more detail in Appendix A).

Analysis Of Costs

Quantified cost data as applied to the composite

Total Costs							
Ref.	**Cost**	**Initial**	**Year 1**	**Year 2**	**Year 3**	**Total**	**Present Value**
Dtr	Gurobi licensing	$0	$240,000	$252,000	$265,200	$757,200	$625,695
Etr	Deployment and ongoing maintenance	$64,559	$1,218	$2,436	$2,436	$70,648	$69,509
	Total costs (risk-adjusted)	$64,559	$241,218	$254,436	$267,636	$827,848	$695,204

GUROBI LICENSING

Evidence and data. Gurobi offers prospective customers two options for experiencing the Optimizer at no cost, which most of the interviewees' organizations took advantage of.

One is a free, time-unlimited trial license of a feature-restricted version of the Optimizer that's limited to 2,000 variables and 2,000 constraints. Another is a free 30-day evaluation license of the fully featured Optimizer.

Gurobi's commercial licenses, which all of the interviewees' organizations eventually signed up for, includes maintenance and access to Gurobi's world-class support for the term of the license agreement and is available both on-premises and in the cloud. Pricing is based on various factors, such as the number of cores, number of applications, number of users (depending on usage type), usage, and license type. Initial and expert training can be ordered separately.

For added flexibility and agility, customers may negotiate additional contracts that allow them to spin up additional licenses on demand.

Modeling and assumptions. Forrester assumes the following about the composite organization:

- The composite signs up for a commercial license with a three-year commitment. The implementation starts with seven use cases in Year 1, and it expands to add three more use cases in Year 2 and to three more use cases in Year 3.
- Based on pricing provided by Gurobi for this scenario, the annual recurring license fees are $200,000 in Year 1, $210,000 in Year 2, and $221,000 in Year 3.
- Pricing may vary. Contact Gurobi for additional details.

Risks. Organizational differences that may impact the costs associated with Gurobi licensing include:

- The size and scale of deployment.
- The license type.
- Global licensing agreements and other volume discounts.

Results. To account for these risks, Forrester adjusted this cost upward by 20%, yielding a three-year, risk-adjusted total PV (discounted at 10%) of nearly $625,700.

Gurobi Licensing						
Ref.	**Metric**	**Source**	**Initial**	**Year 1**	**Year 2**	**Year 3**
D1	Gurobi licensing	Gurobi		$200,000	$210,000	$221,000
Dt	Gurobi licensing	D1		$200,000	$210,000	$221,000
	Risk adjustment	↑20%				
Dtr	Gurobi licensing (risk-adjusted)		$0	$240,000	$252,000	$265,200
	Three-year total: $757,200			**Three-year present value: $625,695**		

DEPLOYMENT AND ONGOING MAINTENANCE

Evidence and data. The interviewees' organizations had staff skilled in mathematical optimization and did not require additional training or professional services in order to set up and use the Gurobi Optimizer. Most of the organizations used connective interfaces that enabled solvers to be easily swapped in and out. While existing use cases required conversion from the previous solvers to Gurobi, most interviewees characterized this as a trivial matter involving adjustments here and there to optimize performance. Ongoing maintenance was also minimal with one major update and three minor updates delivered on a quarterly basis throughout the year.

- The chief technical lead at the transportation company described the transition to Gurobi as quite easy. They said: "We had 15 to 20 use cases that needed to be converted before we could retire our previous solution. Some use cases were done in a few days while others took around a month. We spread things out and were done in less than a year. Performance was pretty good from the start. There were only a few projects that required tuning to improve performance to the level we thought we could achieve — not necessarily required performance levels."
- The lead of operations research at the food delivery company confirmed Gurobi was easy to set up. The interviewee explained that they considered their company to be technically savvy with a lot of engineers. They said: "We had a specific back-end engineer who's very experienced and, for him, the feedback was [that Gurobi] was very, very easy to deploy. The basic stuff was done in a day. There were a couple more days for back-end work to set it up for us in a specific way, but it was running on the first day."
- The mine and process engineering systems lead at the mining company explained that their organization initially used an interface that

"The transition to Gurobi was quite easy. We modified the layout a bit to do what was very specific to Gurobi, but it was centralized in a piece of code. Afterwards, everybody just had to use their already existing code, and everything was working fine. We basically ran a test, and it was done."

Chief technical lead, transportation

allowed it to change the optimization engine underneath. When that tool was sunset by the vendor supporting it, the organization utilized Gurobi's guides to set up a direct interface.

- The lead of operations research for the technology company said their organization took a more measured approach to deployment and updates, given that optimization involved its data centers, which needed an extra layer of security around them. They said: "It took a couple person years of work to move over to Gurobi, but that's not Gurobi's fault. That was internal to our company."
- Discussing their organization's cautious approach to updates, the same interviewee explained: "We always lag Gurobi. They'll come out with a new release and say, 'This is so much better than the previous release that's out there.' We won't immediately roll it out, but [we] do our own testing on our internal benchmarks so that we can become convinced there won't be significant regressions. We're very conservative when it comes to adopting new versions of Gurobi — no shade to Gurobi there."

Modeling and assumptions. Forrester assumes the following about the composite organization:

- The organization spends an average of 8 hours per use case to migrate seven existing use cases to Gurobi.
- Gurobi releases one major and three minor updates per year on a quarterly basis.
- The organization spends 8 hours per update to install and test updates.

Risks. Organizational differences that may impact the costs associated with deployment and ongoing maintenance include:

- The organization and state of optimization projects prior to deploying Gurobi.
- The efficiency of the OR team deploying and maintaining the Gurobi Optimizer.

Results. To account for these risks, Forrester adjusted this cost upward by 15%, yielding a three-year, risk-adjusted total PV of $69,500.

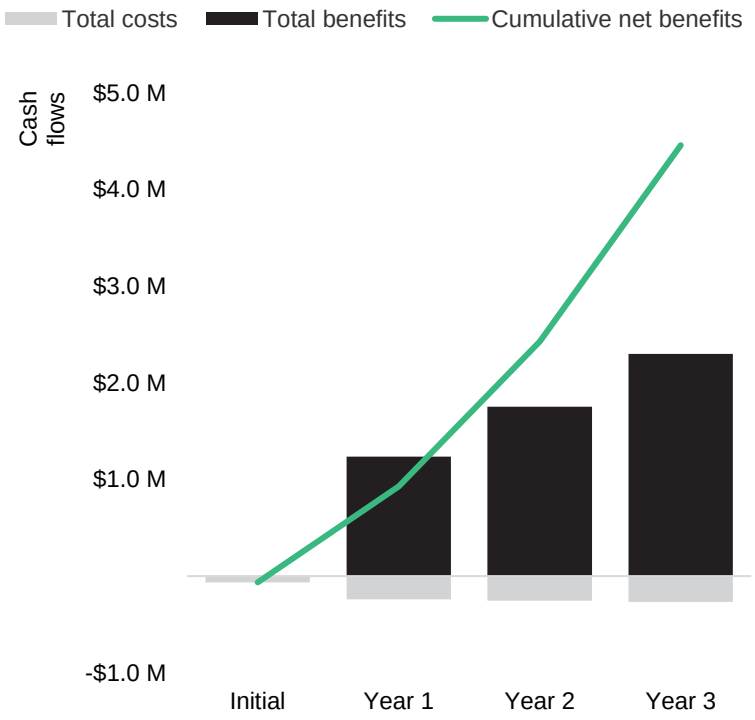
Deployment And Ongoing Maintenance

Ref.	Metric	Source	Initial	Year 1	Year 2	Year 3
E1	Time to deploy Gurobi (hours)	Interviews	8			
E2	Number of existing use cases migrated	Interviews	7			
E3	Time spent migrating existing use cases (average hours per use case)	Interviews	120			
E4	Subtotal: Time spent on deployment and migration (hours)	E1+(E2*E3)	848			
E5	Number of updates per year	Gurobi		2	4	4
E6	Time spent on updates (average hours per update)	Interviews		8	8	8
E7	Subtotal: Time spent on updates (hours)	E5*E6		16	32	32
E8	Fully burdened hourly compensation for operations research staff	TEI standard	$66.20	$66.20	$66.20	$66.20
Et	Deployment and ongoing maintenance	(E4+E7)*E8	$56,138	$1,059	$2,118	$2,118
	Risk adjustment	↑15%				
Etr	Deployment and ongoing maintenance (risk-adjusted)		$64,559	$1,218	$2,436	$2,436
	Three-year total: $70,648		**Three-year present value: $69,509**			

Financial Summary

CONSOLIDATED THREE-YEAR RISK-ADJUSTED METRICS

Cash Flow Chart (Risk-Adjusted)



The financial results calculated in the Benefits and Costs sections can be used to determine the ROI, NPV, and payback period for the composite organization's investment. Forrester assumes a yearly discount rate of 10% for this analysis.

These risk-adjusted ROI, NPV, and payback period values are determined by applying risk-adjustment factors to the unadjusted results in each Benefit and Cost section.

Cash Flow Analysis (Risk-Adjusted Estimates)

	Initial	Year 1	Year 2	Year 3	Total	Present Value
Total costs	($64,559)	($241,218)	($254,436)	($267,636)	($827,848)	($695,204)
Total benefits	$0	$1,234,800	$1,751,876	$2,299,112	$5,285,788	$4,297,733
Net benefits	($64,559)	$993,582	$1,497,440	$2,031,476	$4,457,940	$3,602,529
ROI						518%
Payback period (months)						<6

Appendix A: Total Economic Impact

Total Economic Impact is a methodology developed by Forrester Research that enhances a company's technology decision-making processes and assists vendors in communicating the value proposition of their products and services to clients. The TEI methodology helps companies demonstrate, justify, and realize the tangible value of IT initiatives to both senior management and other key business stakeholders.

TOTAL ECONOMIC IMPACT APPROACH

Benefits represent the value delivered to the business by the product. The TEI methodology places equal weight on the measure of benefits and the measure of costs, allowing for a full examination of the effect of the technology on the entire organization.

Costs consider all expenses necessary to deliver the proposed value, or benefits, of the product. The cost category within TEI captures incremental costs over the existing environment for ongoing costs associated with the solution.

Flexibility represents the strategic value that can be obtained for some future additional investment building on top of the initial investment already made. Having the ability to capture that benefit has a PV that can be estimated.

Risks measure the uncertainty of benefit and cost estimates given: 1) the likelihood that estimates will meet original projections and 2) the likelihood that estimates will be tracked over time. TEI risk factors are based on "triangular distribution."

The initial investment column contains costs incurred at "time 0" or at the beginning of Year 1 that are not discounted. All other cash flows are discounted using the discount rate at the end of the year. PV calculations are calculated for each total cost and benefit estimate. NPV calculations in the summary tables are the sum of the initial investment and the discounted cash flows in each year. Sums and present value calculations of the Total Benefits, Total Costs, and Cash Flow tables may not exactly add up, as some rounding may occur.

PRESENT VALUE (PV)

The present or current value of (discounted) cost and benefit estimates given at an interest rate (the discount rate). The PV of costs and benefits feed into the total NPV of cash flows.

NET PRESENT VALUE (NPV)

The present or current value of (discounted) future net cash flows given an interest rate (the discount rate). A positive project NPV normally indicates that the investment should be made unless other projects have higher NPVs.

RETURN ON INVESTMENT (ROI)

A project's expected return in percentage terms. ROI is calculated by dividing net benefits (benefits less costs) by costs.

DISCOUNT RATE

The interest rate used in cash flow analysis to take into account the time value of money. Organizations typically use discount rates between 8% and 16%.

PAYBACK PERIOD

The breakeven point for an investment. This is the point in time at which net benefits (benefits minus costs) equal initial investment or cost.

Appendix B: Supplemental Material

Related Forrester Research

“Specialized Infrastructure Is Creating New Industry Insights,” Forrester Research, Inc., September 28, 2021

“Navigate Trump-Era Uncertainty With The Compass Of Customer Obsession,” Forrester Research, Inc., June 8, 2017

“Prescriptive Analytics: The Black Belt Of Digital Decisions,” Forrester Research, Inc., January 10, 2017

“Applying Advanced Analytics To Your Supply Chain,” Forrester Research, Inc., October 12, 2016

“Perishable Insights — Stop Wasting Money On Unactionable Analytics,” Forrester Research, Inc., August 11, 2016

Appendix C: Endnotes

[1] Total Economic Impact is a methodology developed by Forrester Research that enhances a company’s technology decision-making processes and assists vendors in communicating the value proposition of their products and services to clients. The TEI methodology helps companies demonstrate, justify, and realize the tangible value of IT initiatives to both senior management and other key business stakeholders.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