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Decision Support in Multi-Vendor Services Partner Negotiation

Mary E. Helander
IBM Research Division
Thomas J. Watson Research Center
P.O. Box 218
Yorktown Heights, NY 10598

Hua Ni, Paul M. Thompson, Leanne K. Viera
IBM Global Business Services

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Mary E. Helander[1], Hua Ni[2], Paul M. Thompson[2], Leanne K. Viera[2]

[1]IBM Research
[2]IBM Global Business Services

Abstract

In contract negotiations with professional services partners, asymmetry of information combines with a set of subtle and conflicting objectives that are not commonly found in other areas of applied operations research, in public or private sectors. This creates decision problems that are quite interesting from a modeling and business perspective. An effective solution approach includes an optimization-based methodology and a means of effectively transmitting usable information between potential partners. Use of this model has resulted in substantial cost savings and team composition improvements for a major consulting organization.

General Terms: Negotiation, Economics, Management, Revenue Management

Additional Key Words: resource allocation, linear programming, mixed integer programming, cost optimization, professional services, multi-vendor projects, pricing

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1. Introduction

In order to adequately address the diverse demands for technology and services that commonly occur in responding to a Request For Proposal (RFP) for large, public sector projects, bidding professional service enterprises often form teams that submit a joint tender. In this situation, the primary bidding enterprise (the "prime") is faced with two tasks: choosing suitable teaming partners, and allocating the project's work among these partners.

Two competing goals drive decisions for forming teams of partners and allocating project work among them. These are the desire to have the winning proposal, i.e. to win the project, and the desire of the prime and each teaming partner to maximize the benefit it will individually gain from doing so. While very similar in many respects, these two goals are profoundly different in focus and orientation. Indeed, if not managed correctly, the conflict inherent in them leads to suboptimal tendered bids, endangers the chance of winning and reduces the expected financial return for all partners. This situation is not found in other areas of operations research practice, in either industrial or public sectors.

When the prime is negotiating with other professional services organizations as potential teaming partners, there exists an asymmetry of information – the prime has first hand knowledge of all potential partners, while the potential teaming partners have very limited information about the other potential partners and about the prime. This information asymmetry, combined with the set of conflicting goals, creates decision problems that are quite interesting from a modeling and business perspective.

Negotiation among teaming partners, as a means to control the cost and subsequent offering price of a professional services bid, has not been addressed in the operations research, economics, or management literature. Furthermore, revenue management and pricing of professional services as a topic has only begun to appear; see for example Bona and Thompson [1], and Scardino, Young and Maurer [6]. With the area of services science evolving as a discipline, highly sophisticated mathematical approaches to professional services revenue management are being developed, such as those of Dube, Liu and Wynter [4], Hu, Ray and Singh [5] and Wardell, Wynter and Helander [7]. Due to the complexity of and competition within the professional services business, as well as increasing specialization through tools and assets, there is now a need for means to effectively price bids when services are offered by teaming partners.

This paper presents an effective solution approach to the multi-vendor services partner negotiation problem. This approach includes an optimization-based methodology based on the underlying mathematical structure of the decision problem. It also includes a means of effectively transmitting usable information between the prime and potential teaming partners. Use of this model has resulted in substantial cost savings and team composition improvements for a major world-wide consulting organization.

2. Harmonizing the Goals: Allocating Project Work Among Partners

The first goal, creating the winning proposal, involves two competing objectives: maximizing the value to bring to the client, and minimizing the cost of doing so. It also involves satisfying any constraints placed by the client on the winning team's proposal.

Typical reasons for forming partnering agreements include the following:

- client-specific constraints. For example, many US Government contracts require specified levels of inclusion of minority, women-owned, disadvantaged and small businesses
- to complement the primary team's capabilities through partner vendors' core competencies
- to gain access to unique expertise
- to extend the talent pool of highly qualified resources
- to achieve high quality delivery through diversity
- to leverage the cost differentials provided by partner vendors
- to share the cost of writing the proposal
- to share the risk of losing the proposal or failing to deliver project requirements

The second goal is the desire of the prime and each teaming partner to maximize the benefit it will individually gain from participating in the project. In most situations, each teaming partner desires to maximize its work share, its visibility, its revenue stream, and its profitability. Naturally, this puts each teaming partner at odds with the other partners and with the prime, and can lead to counter-productive behavior.

Harmonizing these conflicting goals is key to proposal success. In order to approach this, observe that a rational and economically motivated teaming partner or prime is willing to reduce its project-related revenue stream if and only if this is offset by an increase in the chance of winning the proposal sufficiently large to increase its overall expected return from participating in the proposal. In other words,

Lemma 1. A teaming partner or prime will prefer teaming arrangement j to teaming arrangement k if and only if

$$P_j R_j > P_k R_k$$

irrespective of the relative values of R_j and R_k,

where

- P_j = probability of the team winning the proposal under teaming arrangement j
- R_j = net present value (NPV) of the teaming partner's expected revenue stream from participating in the project under teaming arrangement j
- $P_j R_j$ = NPV of the teaming partner's expected revenue stream from participating in the proposal under teaming arrangement j.

Because of the power imbalance between the prime partner and other partners, the prime partner is in the unique position of being able to leverage the conflicting objectives of the other partners in order to maximize its own expected profitability. By using *Lemma 1* in a constructive manner, the prime may maximize the expected profitability of the tender and of each of the other partners [1], including itself. To achieve this, the prime partner leverages varying labor rates among partners for similar work, thereby lowering the cost of providing the required services. This translates into either directly increasing profitability, or else allows the team to tender a lower bid price, thereby increasing the chance of having the winning proposal.

3. Large Deal Pricing

Large deal pricing is typically very complex, yet is crucial to proposal success. The bid price needs to simultaneously satisfy the prime's profit margin objective and represent the best value for the client. Different vendors have different cost structures for the various labor categories, as well as different resource availabilities and throughput capacities. Moreover, partnering agreements may promise partners a specified portion of the business or positions, in exchange for their participation in the project or their agreement on a pricing structure for their services.

Creating a win-win situation for collaborating professional services partners is also vital to the success of a proposal. In order to create sufficient profit for this, several strategies are possible. First, one may increase the price. This is not always possible, since the proposal must be priced to win. Second, one may decrease total cost by reducing headcount. This is also not always possible, since adequate staffing is needed for delivery excellence. Third, one may decrease total cost by reducing headcount cost. This is possible, as long as each vendor including the prime has a satisfactory profit margin.

The pricing process commonly used by priming partners contains the following elements:

1. Services partners are identified, and agreements are put in place
2. Labor categories and roles are identified
3. RFP is sent to services partners, and hourly rates are solicited
4. ***Heuristic assignment of roles to services partners***
5. Labor costing is performed based on work estimates and rates
6. Labor costs are input to pricing tools

The heuristic assignment is often done through a spreadsheet model, with manual trial and error. A more rigorous approach to this assignment problem will result in significant cost savings, and has the additional benefit of supporting mutually-beneficial negotiation around labor pricing.

4. Pricing using Linear Programming

The pricing problem may be stated as the problem of determining the optimal mix of resources from the prime partner and the teaming partners that staffs all project positions and honors any negotiated agreements, given hourly rate bids from partners by labor category, and hourly costs for the prime's resources.

This problem may be formulated as a Linear Programming (LP) problem [2], which is easily solvable using standard commercial software packages. Inputs for this problem are (i) required FTEs by labor category, and (ii) vendor rates and capacity for each labor category. The objective is to minimize the total cost of providing the required services. Decision variables are the allocations of labor category FTEs for each vendor. Business rules and constraints include the requirements to staff all identified positions, to satisfy FTE-based and total-cost based minimum apportionments for teaming partners, and to satisfy pre-designated staffing positions.

The LP model may be stated as follows:

Let:

$N \equiv$ the number of vendors, indexed $i = 1, \ldots, N$ or $h = 1, \ldots, N$.

$M \equiv$ the number of uniquely rated labor categories, indexed $j = 1, \ldots, M$.

$r_{ij} \equiv$ the hourly rate for labor category j by vendor i, for $i = 1, \ldots, N$ and $j = 1, \ldots, M$.

$\rho_i \equiv$ the percent of total to be allocated to vendor i.

$\psi_i \equiv$ the percent of full time equivalents (FTEs) to be allocated to vendor i.

$\beta_j \equiv$ the minimum number of full time equivalents (FTEs) required for labor category j for $j = 1, \ldots, M$.

$x_{ij} \equiv$ the number of FTEs assigned to labor category j from vendor i, for $i = 1, \ldots, N$ and $j = 1, \ldots, M$.

$l_{ij} \equiv$ the lower bound for x_{ij}, for $i = 1, \ldots, N$ and $j = 1, \ldots, M$.

$u_{ij} \equiv$ the upper bound for x_{ij}, for $i = 1, \ldots, N$ and $j = 1, \ldots, M$.

Then a general form of the decision problem is:

Mimimize $\quad \sum_{i=1}^{N}\sum_{j=1}^{M} r_{ij}x_{ij}$ — Find a staffing allocation that minimizes total cost (1)

Subject to:

$$\sum_{i=1}^{N} x_{ij} \geq \beta_j \qquad j = 1, \ldots, M \tag{2}$$

Cover all needed FTEs

$$\frac{\sum_{j=1}^{M} r_{ij}x_{ij}}{\sum_{j=1}^{M}\sum_{h=1}^{N} r_{hj}x_{hj}} \geq \rho_i \qquad i = 1, \ldots, N \tag{3}$$

Each vendor gets a % (total)

$$\frac{\sum_{j=1}^{M} x_{ij}}{\sum_{j=1}^{M}\sum_{h=1}^{N} x_{hj}} \geq \psi_i \qquad i = 1, \ldots, N \tag{4}$$

Each vendor gets a % (FTEs)

$$l_{ij} \leq x_{ij} \leq u_{ij} \qquad i = 1, \ldots, N,\ j = 1, \ldots, M \tag{5}$$

Lower and upper bounds

Note that the mathematical formulation given by equations (1) through (5) may be adapted easily to other practical modeling formulations. For example, a mixed integer program may be desired when some or all of the resources must be designated in whole numbers. This is a potentially common situation, especially when one or more of the partners is a small vendor and requires that one or more people be committed full time to the project.

5. Model Input and Output

Samples of the kind of input required for the model appear in Figure 1.

Hourly Rates						
Labor Category	Vendor A	Vendor B	Vendor C	Vendor D	Vendor E	Vendor F
a	$220.46	$151.89	$178.74	$108.11	$157.56	
b	$121.27	$192.73	$205.22	$145.93	$119.00	
c	$111.13				$198.48	$158.30
d	$230.23	$144.02		$217.20	$114.25	$236.18
e	$170.29	$132.15	$201.19	$115.54	$214.24	$108.34
f	$73.36	$109.16	$178.83			$150.06
g	$207.50	$176.55	$100.73	$246.66		$116.79
h	$202.13	$170.70	$209.32	$110.48	$175.63	$136.74
i	$166.92	$118.06	$166.93	$107.80	$207.22	$111.11
j	$117.79		$182.77	$117.91	$212.06	
k	$184.21	$105.56			$174.10	$215.08
l	$111.71		$115.45		$158.91	$145.24
m	$115.30	$122.86	$145.84		$147.35	

Lower Bounds						
Labor Category	Vendor A	Vendor B	Vendor C	Vendor D	Vendor E	Vendor F
a	0.00	0.00	0.00	0.00	0.00	0.00
b	0.00	0.00	0.00	0.00	0.00	0.00
c	0.00	0.00	0.00	0.00	0.00	0.00
d	0.00	0.00	0.00	0.00	0.00	0.00
e	0.00	0.00	0.00	0.00	0.00	0.00
f	0.00	0.00	0.00	0.00	0.00	0.00
g	0.00	0.00	0.00	0.00	0.00	0.00
h	0.00	0.00	0.00	0.00	0.00	0.00
i	0.00	0.00	0.00	0.00	0.00	0.00
j	0.00	0.00	0.00	0.00	0.00	0.00
k	0.00	0.00	0.00	0.00	0.00	0.00
l	0.00	0.00	0.00	0.00	0.00	0.00
m	0.00	0.00	0.00	0.00	0.00	0.00

Labor Category		Total Required
a	>=	4
b	>=	5
c	>=	6
d	>=	7
e	>=	2
f	>=	3
g	>=	4
h	>=	5
i	>=	1
j	>=	2
k	>=	3
l	>=	4
m	>=	5
	Total	51

Target Revenue Allocation					
Vendor A	Vendor B	Vendor C	Vendor D	Vendor E	Vendor F
50.00%	10.00%	10.00%	10.00%	10.00%	10.00%

Figure 1. LP Model Sample Input

Samples of the kind of output that the model provides appear in Figure 2.

Assigned FTEs										
Labor Category	Vendor A	Vendor B	Vendor C	Vendor D	Vendor E	Vendor F	Total Assigned		Total Required	Delta
a	0.00	0.00	1.01	2.99	0.00	0.00	4.00	>=	4	0.00
b	5.00	0.00	0.00	0.00	0.00	0.00	5.00	>=	5	0.00
c	6.00	0.00	0.00	0.00	0.00	0.00	6.00	>=	6	0.00
d	0.04	1.85	0.00	0.00	5.11	0.00	7.00	>=	7	0.00
e	0.00	0.00	0.00	0.00	0.00	2.00	2.00	>=	2	0.00
f	3.00	0.00	0.00	0.00	0.00	0.00	3.00	>=	3	0.00
g	0.00	0.00	4.00	0.00	0.00	0.00	4.00	>=	4	0.00
h	0.77	0.00	0.00	2.36	0.00	1.87	5.00	>=	5	0.00
i	0.00	0.00	0.00	0.00	0.00	1.00	1.00	>=	1	0.00
j	2.00	0.00	0.00	0.00	0.00	0.00	2.00	>=	2	0.00
k	0.00	3.00	0.00	0.00	0.00	0.00	3.00	>=	3	0.00
l	4.00	0.00	0.00	0.00	0.00	0.00	4.00	>=	4	0.00
m	5.00	0.00	0.00	0.00	0.00	0.00	5.00	>=	5	0.00
								Total	51	

	Target Revenue Allocation						
	Vendor A	Vendor B	Vendor C	Vendor D	Vendor E	Vendor F	Total
Cost % Target	50.00%	10.00%	10.00%	10.00%	10.00%	10.00%	100.00%
Attained %	50.00%	10.00%	10.00%	10.00%	10.00%	10.00%	100.00%
Delta	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	

Figure 2. LP Model Output

6. Vendor Negotiation Using the LP Model

The LP model is particularly well-suited to supporting negotiations with vendor rates and contract terms, and to performing what-if analysis for hypothetical contract structures.

Output from the LP model includes the following: optimal total labor cost, allocations of labor category FTEs by vendor, and sensitivity analysis and what-if analysis information. The sensitivity analysis and quick re-optimization provides a quantitative basis for rate negotiation with partners. These allow the priming partner (the only partner with information regarding all teaming partners pricing and contract terms) to (i) identify the vendors and rates that have the most impact on the total cost, (ii) quantify cost-benefit tradeoff of contract terms, and (iii) reallocation the labor categories based on negotiated rate and contract changes.

This approach to multi-vendor services rate negotiation has provided very substantial results. For one large proposal, with a prime plus nine teaming partners, this method realized a reduction of 10~15% in bid pricing. For a second, very large proposal, with 44 labor categories, five proposal years, a priming partner plus 14 teaming partners, this model supported rapid evaluation of different mix strategies throughout the pricing process, significantly easing the burden of working the pricing process, and yielding a substantial but undocumented reduction in bid price.

7. Extensions

Several areas provide a natural extension of this work. Extending the model to support detailed work/task breakdown and planning – with further potential for cost improvements – would support a dynamic bidding process. For example, the priming partner could allow the rates given by a vendor to vary depending on the allocation percentage, etc.

A promising area of further work involves the tradeoff between risk and reward in the bidding process. For instance, the decision criterion might be an explicit function of the expected revenue from the proposal process and the risk of not having the winning proposal. This type of decision problem leads to a mean-risk stochastic optimization model, i.e., a model that optimizes expected revenues and risk simultaneously. An alternate approach is to incorporate probabilistic constraints in order to limit overall risk. Both types of risk-averse stochastic optimization models represent an improvement over pure, expectation based stochastic programs, at the expense of considerable complexity for both data and solution methodology.

Opportunities abound, but resistance to changing current pricing practices is high. Practitioners are comfortable using legacy pricing methods and processes that heavily rely on financial models and spreadsheet analysis. In addition, there are no hardened, easy-to-use tools that are general enough to address common pricing considerations and flexible enough for extension to specific, additional requirements.

8. Conclusion

This paper offers an approach to the multi-vendor services partner negotiation problem using conventional and readily available mathematical programming solution methodologies. It also offers an effective means of transmitting usable information between the prime and potential teaming partners. Application of the model has resulted in substantial cost savings and team composition improvements for a major world-wide consulting organization. This is an example of the fact that, in the practice of applied operations research, new developments that deploy existing and known mathematical techniques may be novel by virtue of a new domain. It is yet another illustration of how operations research practitioners need to be continuously vigilant and be willing to step out from conventionally understood roles and reach out to other areas. Being dedicated to every client's success is the key.

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