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Process of Improving Software Engineering Predictability with Business Benefits

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Abstract:

A refined process to make software engineering predictable by associating bidding concept. This process helps in delivering software engineering products and solutions to customers with increased business values viz. customer satisfaction, better control over operating cost, profit margins and time to market.

This process greatly enriches decision making to enhance time to delivery, profit margin, knowledge sharing and keeping healthy collaboration among various geographically distributed teams within an organization.

Problem Solved:

The focus of most of the product software companies is to secure and sustain high returns and profitability of the business with customers. Based on the customer usage of product software, they frequently request product changes and enhancements for their needs. In order to keep a good balance between business growth and existing customer relationships, timely delivery and profitability of organization plays vital role.

For relatively large distributed R&D organization it is an important element to deliver customer requested functionality while maintaining optimal engineering cost. It is not easy and many times not possible with current methods of software engineering.

Companies also face issues in predicting the delivery of the software with the desired or requested functionalities from the customers by still generating higher return on investment.

One of the most common problems in large and geographically distributed product software development is uncertainty associated with timely completion of the projects/features/enhancements and to also keep the cost within the profitable margin. This significantly impacts the overall product business in multiple ways like

- Business financials or profit margins.
- Customer go-live plan related to requested enhancement (s)
- Customer experience, trust, etc.
- Time to market
- Future investment decision

Another problem the product companies frequently faces is the trade-off between time to market and required investment to build incremental functionality, generally does not offer any choice points. Therefore, many times the overall profitability becomes questionable and few of the projects/features/enhancements may get dropped due to cost overrun impacting business and customer satisfaction.

Prior Solutions:

Below are few of the different approaches mainly related to the prediction of software delivery with required functionality and also problems mentioned in the above sections.

a. Traditional methods of software engineering is centered around localized skills in distributed geographies irrespective of the time taken to implement the requested functionalities, in such cases sometimes the cost or schedule or both get impacted.

b. Few methods or process are based on data collectors, which gather data being generated by various tools within the organization, such as scheduling, defect tracking, requirements management and software quality tools. This data is constantly being collected, analyzed to predict the software delivery date. There are multiple problems with this as the prediction of software delivery keep on moving based on data getting collected, other problem is prediction can change anytime and lastly prediction can come quite late in the project execution.

c. Few other software delivery in which the project has been manually tracked on regular basis, but they are also unable to optimize software development cost and sometimes enforces a trade-off decision to choose between time to market or profit margin.

Description:

Product based companies keep getting enhancement or change request from existing or potential customers. Once the customers submit the request, it goes through evaluation process, once the product manager, solution architects, product architects, etc. approves the enhancement, the implementation timeline and cost is discussed and agreed with the requester.

Later the details of the enhancement request is communicated to software engineering team to plan the new software delivery within the agreed timeline and cost.

The cause for the associated uncertainty (or unpredictability) resulting into cost overrun, many times due to the choice of software engineering geography. This degree of uncertainty (or unpredictability) can be minimized by considering below proposed process during software development lifecycle.

This process is referred as Software Engineering Bid Process (SEBP). It solves the problem of business decision where to invest $ for customer requested features/ enhancements specifically in largely distributed programs. It represents ability to produce and deliver quality software in a predictable and economical fashion. Every team builds this factor based on what they commit and produce over period of time.

Software Engineering Bidding Process (SEBP) Overview: This process mainly works on the compiled list of customer and business requirements and based on that invitation is sent out to various engineering teams to collect the bids (effort and cost) estimates before the agreed bid closure date.

A team can choose whether or not to bid. However, a business decision is made based on available bids to select a geography or mixed geography and associated cost to deliver predictable results based on selected teams past credentials. Teams in different geographies may collaborate and submit joint bids, this enables healthy competitiveness among geographically distributed teams to bid for features based on skills and interests.

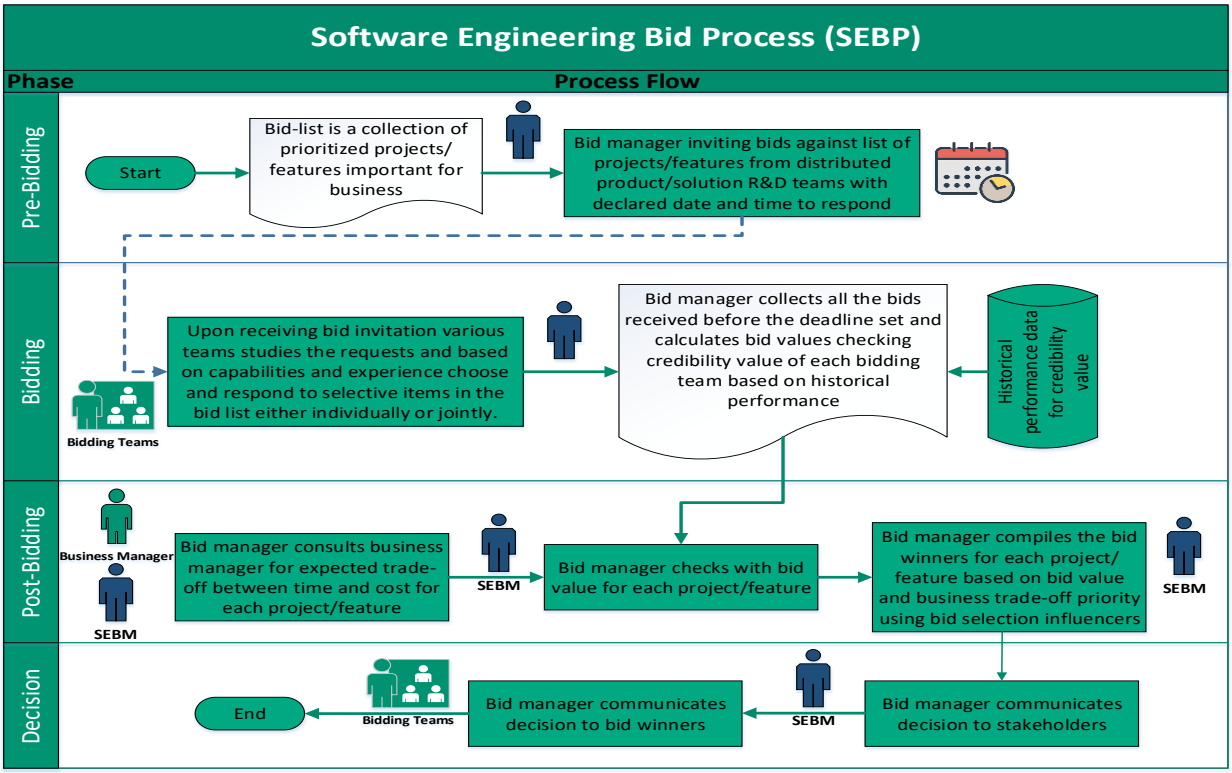
Actors: The main actors are bidding teams, bid manager and business manager.

Bidding Team: Software engineering teams expected to participate in bidding process are termed as bidding teams. Bidding teams assess the requirements and responds to SEBM on one or more or no-items based on technical capabilities and available resource capacity.

Bid Manager: This process has introduced a part time role, termed as Software Engineering Bid Manager (SEBM) to coordinate the entire bid process starting from compiling the bid-list (requirements) and also sends out communication to invite bids.

Business Manager: This role is the final decision maker for business profitability trade-off between time and cost. Bid Manager and Business Manager works together to arrive at final decision making for bid winner selection.

Process Flow:



SEBP Flow

On a regular interval basis (say once every quarter), bid manager (SEBM) collaborates with business manager and compiles customer requested functionality backlog (also called bid list) applicable for current bid period. SEBM sends communication to software engineering teams by specifying items in bid list and closure date with time for bid response.

Bidding teams may choose to respond individually or collectively or withhold from responding. SEBM waits for responses till the bid closure date to analyze all the bids.

The lower bid value indicates the advantage for business from cost, profit and profit margin point of view. However, selection out of bid value responses is also driven by **Bid Selection Influencers (BSI)** like proximity of team with geography of customer, organization promotion for collaboration expected from joint bids, effective and efficient utilization of resources etc. If there are no bidders, business may decide to reprioritize or enforce allocation based on bid selection influencers.

Based on business value guidance from business manager, SEBM chooses winners from the bidding teams.

There are two steps for communication:

1. In the first step, stakeholders (like Business Manager, Program Manager, site managers, etc.) are getting informed providing overall bid report summary. Intention of this communication is to prepare stakeholders about rational behind bid selection.

2. In the second step, winning bidding teams are announced and are informed to proceed for further planning.

This closes the bid process for the current cycle. SEBM then starts working for next period. Listed below key elements that are used in decision making. An illustrated example is also provided to explain the involved concepts.

Bid Selection Influencers (BSI): Following bid selection influencing factors are recommended and may be further customized based on nature and requirement of organizations. In certain cases as an exception a higher bid value team may be selected.

- Profit and profit margin
- Time to market
- Customer Loyalty
- Location of customer
- Collaboration across geographies
- Utilization of resources across teams

Raw Bid value (RBV) is a number that represents what it takes to build software products/features/enhancements. It is derived based on two basic parameters, effort claimed in the bid and effort cost of the bidding team.

$$RBV = (EST * CO)$$

Where,
RBV = Raw Bid Value
EST =Bid effort estimate in hours as per bid response
CO = Average $ cost per hour for the bid team

Effective Bid value (EBV) is a number adjusts raw bid value to another predictable number based on credibility value of bidding team. Since credibility value indicates overspend or underspend with respective to estimated effort, (1-CV) adjusts the EBV proportionately.

$$EBV = [RBV * (1-CV)]$$

Where,
EBV = Effective Bid Value
RBV = Raw Bid Value
CV = Credibility Value

Actual Value (AV) is a number that represents what it has taken to build software products/features/enhancements. It is derived based on two basic parameters, actual effort spent and cost of geography of the bidding team, this will be quite helpful in predicting the software delivery.

$$AV = ACT * CO$$

Where,
AV = Actual Value
ACT = Actual Effort Spent for bid items
CO = Average $ cost per hour for the bid team

Credibility Value (CV) is defined as historical mean of accuracy of estimates for successfully completed projects/features/enhancements. It also represents variance of actual effort spent from estimated effort.

The value of CV can be positive or negative. A negative value represents effort overspend whereas the positive value represents effort underspend.

At least one sample is required for calculations and if there is only one sample. An illustration is given below where CV is calculated based on average of last and current samples. Ideal value of CV is 0, indicating actual effort matches exactly estimated effort and means there is 100% predictability.

$$CV = EVG \div SCNT$$
$$EVG = [\sum ABS\ (EST - ACT)] \div EST$$

Where,
CV = Credibility Value
EVG = Effort accuracy average
SCNT = Sample count or Number of samples considered for EVG sum
ABS = Absolute value (without mathematical sign to indicate deviation of actual effort from estimated effort)
EST = Estimated Effort value in a sample
ACT = Actual Effort value of a sample pertaining to corresponding EST

As mentioned in Table 1, 'Last CV' is the value of CV from last bidding period, 'Current CV' is the value of CV calculated after bid items are completed and delivered and 'New CV' is the CV value based on 'Last CV' and 'Current CV'.

In this example, New CV = (Last CV + Current CV) / 2 will be used as 'Last CV' for next bid cycle processing.

Bid Cycle	1	2	3	4	5	6
Last CV	No history	-0.2	-0.15	0.03	0.21	0.26
Current CV	-0.2	-0.1	0.2	0.4	0.3	0.8
New CV	-0.2	-0.15	0.03	0.21	0.26	0.53

Table Credibility Value

Illustrated example:
Below bid cycle exercises will demonstrates how SEBP can be used for effective business advantage. In this use case, there are 2-geographically distributed software engineering teams. They choose to bid individually as well as jointly. Proposal 'A' is individual proposal from geography 'A'. Proposal 'B' is individual proposal from geography 'A'. Proposal 'AB' is mixed proposal from geography 'A' and 'B'. In proposal 'AB' the cost is average of geography 'A' and 'B'.

These teams decide to start practicing SEBP and choose 3-month period block for every new cycle of SEBP. Team also decides to use only two samples for credibility value (i.e. SCNT = 2) relying on last and current value of CV. SCNT can be other than 2 based on mutual agreement.

SEBM reviews the proposals in each cycle and decides based on business priorities which proposal suits most.

A. Bid Cycle-1:

At the start of the 1st bid cycle following parameters 'Last CV', and EBV will not be available to determine the best bid, in this case SEBM in discussion with Business Manager collectively reviews all the proposals and approves the bids depending on the EST, RBV and BSI (Bid Selection Influencer) and later communicates to respective stake-holders to take it forward.

Note: Bid team provides only EST, CO and RBV.

Parameter's (Start of 1st bid cycle)	Proposal 'A' (Geography 'A')	Proposal 'B' (Geography 'B')	Proposal 'AB' (Mixed)
Estimated Effort (EST)	200	100	150
Last CV	-	-	-
CO ($ cost per hour)	$15	$75	$45
RBV = Raw Bid Value = (EST * CO) **Example:** 200 * $15 for Proposal 'A'	3000	7500	6750
EBV = Effective Bid Value = RBV *(1 - CV)	-	-	-

Table Bid-Cycle-1-Start

For understanding this process let's consider all the 3 proposals got the go ahead with implementation of same bid item from the bid list, in reality for a given bid item there will be a single winner and for every item in the bid list, similar to table shown in **Table Bid-Cycle-1-Start**

Parameter's (End of 1st bid cycle)	Proposal 'A' (Geography 'A')	Proposal 'B' (Geography 'B')	Proposal 'AB' (Mixed)
Actual Effort (ACT)	250	90	180
Last CV	-	-	-
Current CV	-0.25	0.1	-0.20
New CV	-0.25	0.1	-0.20
EBV = Effective Bid Value = RBV * (1 - CV)	3750	6750	8100
AV = Actual Value = (ACT * CO)	3750	6750	8100

Table Bid-Cycle-1-End

Note: In the absence of 'Last CV', the 'New CV' will be same as 'Current CV'

Since this is the first sample as shown in Bid-Cycle-1-End, credibility value of teams is same as their accuracy of estimation. So their current CV is deviation of actual effort from estimated effort.

Analysis:
1. Proposal 'B' was fastest to produce results.
2. Proposal 'A' was cheapest to produce results.
3. Proposal 'AB' was moderate to product results.

SEBM will consider the CV of every Proposal and use it for next cycle. By using RBV and CV values the EBV is getting calculated, if this information was available prior to bid-cycle-1, SEBM would be able to predict actual value from bid response value. This data can be used for future, if time to market is critical the Proposal B team is the best and if cost is the main factor then Proposal A.

Now SEBM prepares for subsequent bid-cycle-2, using the bid-cycle-1 outcomes.

B. Bid-Cycle-2:

This is the second cycle for bidding and this time the 'Last CV' is available from bid-cycle-1-end table, the 'Last CV' of next bid cycle will be the 'New CV' of prior bid cycle for every proposals. Consider same teams bid's proposals will look like.

Parameter's (Start of 2nd bid cycle)	Proposal 'A' (Geography 'A')	Proposal 'B' (Geography 'B')	Proposal 'AB' (Mixed)
Estimated Effort (EST)	300	200	250
Last CV	-0.25	0.1	-0.2
CO ($ cost per hour)	$15	$75	$45
RBV = Raw Bid Value = (EST * CO)	4500	15000	11250
EBV = Effective Bid Value = RBV *(1 - CV)	5625	13500	13500

Table Bid-Cycle-2-Start

SEBM considers the 'Last CV' from previous bid cycle and EBV based on inputs (EST, CO, and RBV) provided by the bid teams, based on that SEBM can easily predict the cost and timeline for every proposal.
1. Proposal 'A' is the cheapest
2. If SEBM considers RBV for comparison the Proposal 'AB' would have better chance if cost and time to market both factor is considered
3. By using EBV the SEBM can predict each proposal. With that Proposal 'B' will take the precedence as 'B' and 'AB' have same EBV but proposal 'B' has less effort and hence can be completed early.

For understanding this process let's consider all the 3 proposals got the go ahead with implementation of same bid item from the bid list, in reality for a given bid item there will be a single winner and for every item in bid list, similar to table shown in **Table Bid-Cycle-2-Start**

Parameter's (End of 2nd bid cycle)	Proposal 'A' (Geography 'A')	Proposal 'B' (Geography 'B')	Proposal 'AB' (Mixed)
Actual Effort (ACT)	500	180	400
Last CV	-0.25	0.10	-0.20
Current CV	-0.67	0.10	-0.60
New CV	-0.46	0.10	-0.40
EBV = Effective Bid Value = RBV *(1 - CV)	6562.5	13500	15750
AV = Actual Value = (ACT * CO)	7500	13500	18000

Table Bid-Cycle-2-End

SEBM calculate the information shown in **Table Bid-Cycle-2-End,** he will also verify how accurate EBV prediction was. In this case Proposal 'B' EBV accurately matched AV but not for Proposal 'A' and 'AB'.

On analyzing the data one observation for proposal 'B', that there is no change in CV and hence EBV matched AV. SEBM can take a note of that and compare for proposals 'A' and 'B' and found it is changed and hence EBV was not accurate. With this SEBM can predict the cost and timeline based on the variance for Proposal 'A' and 'AB'

SEBM will consider the 'New CV' of every Proposal from Bid-Cycle-2-End table and use it as 'Last CV' in next cycle (Bid-Cycle-3-Start). Now SEBM has some historical data he can predict much better based on CV and can calculate EBV.

Now SEBM prepares for subsequent bid-cycle-3, using previous bid-cycle-2 learning.

C. Bid-Cycle-3:

This is the third bid cycle for bidding and there is last CV available for each proposals, which is an average of last two bid cycles and SEBM is better positioned to predict time and effort.

Parameter's (Start of 3rd bid cycle)	Proposal 'A' (Geography 'A')	Proposal 'B' (Geography 'B')	Proposal 'AB' (Mixed)
Estimated Effort (EST)	230	110	150
Last CV	-0.46	0.10	-0.40
CO ($ cost per hour)	$15	$75	$45
RBV = Raw Bid Value = (EST * CO)	3450	8250	6750
EBV = Effective Bid Value = RBV *(1 - CV)	5031	7425	9450

Table Bid-Cycle-3-Start

Looking at the above proposals, SEBM calculates EBV and uses it for accurate prediction in place of RBV:
From RBV chance of winning bid from higher to lower is
Proposal 'A' (3450) → Proposal 'AB' (6750) → Proposal 'B' (8250)

Based on EBV chance of winning bid from higher to lower is
Proposal 'A' (5031) → Proposal 'B' (7425) → Proposal 'AB' (9450)

If cost alone is the critical factor the bid will be won by Proposal 'A'
If time to market alone is the critical factor the bid will be won by Proposal 'B'
If time to market and cost both are critical factor the bid will be won by Proposal 'B'

Proposal 'AB' will have least chance if either time to market or cost is critical factor. For understanding this process let's consider all the 3 proposals got the go ahead with implementation of same bid item from the bid list, in reality for a given bid item there will be a single winner and for every item in bid list, similar to table shown in **Table Bid-Cycle-3-Start**

Parameter's (Start of 3rd bid cycle)	Proposal 'A' (Geography 'A')	Proposal 'B' (Geography 'B')	Proposal 'AB' (Mixed)
Actual Effort (ACT)	275	105	190
Last CV	-0.46	0.10	-0.40
Current CV	-0.20	0.05	-0.27
New CV	-0.33	0.07	-0.33
EBV = Effective Bid Value = RBV *(1 - CV)	4578	7650	9000
AV = Actual Value = (ACT * CO)	4125	7875	8550

Table Bid-Cycle-3-End

SEBM reviews the above information and take a note of bid-cycle-3 CV. SEBM checks how good was EBV prediction. In this case proposal 'B' EBV is very close to actual prediction accurately matched AV but not for proposal 'A' and 'AB'. SEBM also notes CV of teams for proposals 'A' and 'AB' changed and hence EBV was not accurate, but after few cycles the EBV for other will be able to predict cost and time with accuracy,

SEBM then takes bid cycle-3 CV (average of cycle-1 and cycle-2 CV) to validate if new CV would help in predicting EBV for next bid cycle. SEBM finds New CV is improving the approximation and should be considered during bid proposal processing.

Now SEBM prepares for subsequent bid cycles and the flow continues and prediction will getting close to actual.

Advantages

- ✓ Business gets choice points based on what is more important profitability or time to market or suitable trade-off for both
- ✓ Teams develop internal healthy competitive spirit, organization understand decision making process. Creating Subject Matter experts in bidding teams and filling up knowledge gaps in bidding teams
- ✓ Even though if specific team do not get a chance to implement the feature, it gets involved in understanding the feature and related estimation. This characteristics enhances global learning of team's intended choice toward any specific feature(s).
- ✓ Higher return on Investment by following the proposed process, most accurate and profit making decision(s) based on required trade-off between urgency of timeline and profit margin. Though this concept is presented for software engineering but can be used beyond this specific domain.
- ✓ Based on how Credibility Value becomes stable, business managers can rely on Effective Bid Value (EBV) rather than Raw Bid Value (RBV) and get a very close approximation of what would be Actual Value (AV). This helps in making correct decision and make a right judgment between cost & time for profitability and profit margin.