Guidelines for Software Development Effort Estimation

Dirk Basten and Ali Sunyaev
University of Cologne, Germany

An analysis of 32 accuracy factors yields a list of useful guidelines for improving software development effort estimation accuracy.

Inaccurate development effort estimation is one of the main problems that impact software projects. On average, the effort required to complete a project deviates 30 percent from the initial projection. Software experts don’t expect such estimates to be absolutely accurate, but the consequences of inaccurate predictions can be severe and even fatal.

For example, underestimating the development effort can lead to understaffing, cost and schedule overruns, and poor-quality software, while overestimates can result in inefficiency and wasted resources, as projects tend to expand to fit the estimated effort.

Although previous studies analyzing the reasons for estimation inaccuracy provide helpful insights, developers would greatly benefit from guidelines that simultaneously address the numerous potential influences on estimation accuracy.

Toward that end, we surveyed more than 50 empirical studies published since 1990 to identify factors generally affecting the accuracy of software development effort estimates. We didn’t consider specific estimation techniques, nor did we explore the reasons for deviations between estimates and actual results—for example, management removal of padding.

We first categorized factors affecting accuracy according to their role in development effort estimation in the project life cycle. These categories are the process, estimator, project, and context.

We then identified 32 factors, listed in Figure 1, that potentially improve or impede estimation accuracy—for example, use of historical data and lying, respectively. Not all of these factors can be controlled, at least in the short term. Nevertheless, knowledge about their influence will help professionals be aware of their impact.

Based on these factors, we developed a set of practical guidelines for each category.

PROCESS

Estimation process factors guide estimators’ work on both single-project and cross-project issues and thus should be addressed first.

To enable higher estimation accuracy

- ensure that accuracy is part of the estimator’s evaluation—such pressure will lead to more carefully conducted estimates;
- collect as much information about estimation tasks as possible—analogies with similar projects are helpful; and
- include adequate feedback sessions in the estimation process to improve the estimator’s performance.

ESTIMATOR

Estimators have different knowledge, skills, and behavior. These factors can’t be controlled through the estimation process.

To select an adequate estimator

- ensure that the estimator has the proper technical and managerial expertise to understand the task and its context;
• appoint professionals to estimate the task they develop themselves—both the estimate and the development will benefit from this choice;
• select an estimator who is willing to learn—otherwise, feedback sessions will have less value; and
• try to exclude candidates with a high general degree of optimism as well as optimism in the estimation process.

PROJECT

Project factors are inherent in the development task, such as complexity, or surround the estimation process, such as lying. Neither the design of the estimation process nor the estimator can influence these factors.

To enable the highest possible accuracy

• ensure requirements are as precise as possible to make project goals clearer—uncertainty, overlooked tasks, and irrelevant and misleading information will all diminish estimation accuracy;
• avoid anchors—estimators will unconsciously focus on an anchor and only subsequently alter the estimate; and
• split larger tasks into smaller ones, which can usually be estimated more accurately.

CONTEXT

It’s difficult to control external factors related to or determined by the client, such as the bidding process or the contract type.

With respect to the project environment

• communicate frequently with the client to obtain direct feedback;
• clearly state why the project is important—a high priority will influence the client to exert more diligence; and
• use your expert knowledge to support inexperienced clients and improve the accuracy of the requirements and thus the estimates.

IMPLICATIONS AND LIMITATIONS

Some estimation accuracy factors can only be controlled to a limited degree—for example, one party can’t dictate the contract type. Accordingly, simple knowledge of these factors isn’t sufficient to guarantee accurate estimates.

Nevertheless, our guidelines will

• sensitize software professionals to be cautious regarding diverse influences on the estimation process and thus have greater awareness of surrounding problems;
• serve as a starting point to develop checklists, thereby systematically eliminating reasons for inaccuracy;
• guide software professionals to a goal-oriented improvement of estimation accuracy—for example, by refining the estimation process using available resources if no experienced estimators are available; and
• improve the estimation process by controlling the various influences.

Because our guidelines are based on empirical studies, they can’t be generalized to all software development projects. Practitioners should always determine what specific factors they need to control in their own case. Moreover, it isn’t feasible...
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To control all factors on a project: the necessary resources probably aren’t available. Therefore, it’s important to perform a cost-benefit analysis of each potential controllable factor.

The findings we used to derive our guidelines weren’t distinct in every case. Each company should therefore review its own context and use our list of factors as a wrapper for project-specific checklists. For example, distinguishing between fixed-price and pay-per-hour contracts isn’t meaningful if a company usually executes the former. In such cases, it’s more reasonable to think about contract design within the context of fixed-price projects.

There seem to be no objective criteria for ordering the accuracy factors in a prioritized list. However, we believe that estimator experience is one of the most important factors in achieving development effort estimation accuracy. Expert estimation is the most often-used technique, and even the creation of meaningful estimation models relies on expert input. At the same time, it’s impractical to appoint the highest-qualified estimator on every project.

Although our research-driven guidelines can improve the software development estimation process and its result, users shouldn’t expect highly accurate estimates solely using them. Many companies have their own guidelines and shouldn’t ignore their knowledge and experience. In those cases, our guidelines should supplement existing processes.

Dirk Basten is a postdoctoral researcher in the Department of Information Systems and Systems Development at the University of Cologne, Germany. Contact him at basten@wiso.uni-koeln.de.

Ali Sunyaev is an assistant professor in the Department of Information Systems and Systems Development at the University of Cologne. Contact him at sunyaev@wiso.uni-koeln.de.

Editor: Mike Hinchey, Lero—The Irish Software Engineering Research Centre; mike.hinchey@lero.ie

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