An Analogy-Based Effort Estimation Approach for Mobile Application Development Projects

Andrè Nitze
University of Applied Science (HWR) Berlin
nitze@hwr-berlin.de

Andreas Schmietendorf
University of Applied Science (HWR) Berlin
schmietendorf@hwr-berlin.de

Reiner R. Dumke
Otto-von-Guericke Universität Magdeburg
reiner.dumke@ovgu.de

Reiner R. Dumke, University of Magdeburg
Agenda

1. Introduction
2. Background
3. Estimation of Mobile Development Projects
4. Estimation Model of Mobile Dev. Projects
5. Conclusions & Future Work

Reiner R. Dumke, University of Magdeburg
Many businesses are currently interested in attracting and retaining customers and improving the productivity of employees with a mobile application (app).

The mobility trend makes the mobile network traffic exceed the traffic of desktop devices and lets the amount of mobile subscriptions rise significantly even in emerging nations.
1. Introduction: Methodology

Effort Estimation Technologies

Software Estimation Techniques

Model-Based - SLIM, COCOMO, Checkpoint, SEER

Learning-Oriented - Neural, Case-based

Regression-Based - OLS, Robust

Expertise-Based - Delphi, Rule-Based

Dynamics-Based - Abdel-Hamid-Madnick

Composite - Bayesian - COCOMOII
Experience in COSMIC Adaptations

1. Introduction: Experience
2. Background: size & empiricism

Estimation based on Functional Size

Currently: the size is captured using a measure describing the functional extent of the software system as

- Lines of Code (LOC)
- user-centric story points of agile processes
- different types of function points
- etc.
2. Background: size & empiricism

Estimation based on Influential Factors

The influential factors (or constraints) are can modify the effort estimation to tailor it to the specific project parameters.

The biggest benefit of an algorithmic estimation lies in the objective traceability of the technique and the associated ability to automate it.

An analogy-based estimation shall be combined with a function point-based bottom-up estimation approach.
3. Estimation of Mobile Development Projects

Technological Characteristics of Apps

**Native apps:** most sophisticated way of development, (90% market share apps to be developed separately for iOS and Android).

**Web apps:** are based on web technologies like HTML, CSS and JavaScript and basically are mobile-optimized web sites.

**Hybrid apps:** are the link between the approaches described above (are based on web technologies and can be wrapped in native shells).
3. Estimation of Mobile Development Projects

Analogy: Complexity Categories of Apps

**Simple** (e.g. egg timer: no backend; standard components; minimal customization)

**Average** (e.g. car finder: access to external backend; more screens and menus; custom design)

**Complex** (e.g. online banking: own backend, business logic and components; middleware; custom controls and design)
3. Estimation of Mobile Development Projects

Analogy-Based Empirical Estimation Example

<table>
<thead>
<tr>
<th></th>
<th>Small app</th>
<th>Average app</th>
<th>Complex app</th>
</tr>
</thead>
<tbody>
<tr>
<td>min</td>
<td>€760</td>
<td>€2,450</td>
<td>€6,000</td>
</tr>
<tr>
<td>Ø</td>
<td>€16,500</td>
<td>€23,000</td>
<td>€79,000</td>
</tr>
<tr>
<td>max</td>
<td>€97,000</td>
<td>€105,000</td>
<td>€520,000</td>
</tr>
</tbody>
</table>

App development costs in Germany

Reiner R. Dumke, University of Magdeburg
A second way is to estimate the **size of individual app components** using existing function point-based techniques.

The basis could for example be the **COSMIC Function Points** method (COSMIC FP) whose suitability has been demonstrated for the estimation of mobile applications (see our paper).

To meet the aforementioned requirement of **simplicity in the estimation method**, the details of the calculation for the user should not be immediately visible.
3. Estimation of Mobile Development Projects

Component-Based Estimation Example

What do you charge for a simple / average / complex app?

- Concept: 2,644 €
- Frontend programming: 3,499 €
- Server-side programming: 2,677 €
- Marketing: 1,006 €
- Backend programming: 2,779 €
- Prototype: 2,220 €
- UI-Design: 2,008 €
- Project planning: 1,489 €
- Pilot: 1,043 €
- Testing: 1,671 €
- Documentation: 745 €
- Revision: 1,235 €
- Integrating feedback: 972 €
- Tracking: 977 €

Cost distribution of mobile application development in Germany

Reiner R. Dumke, University of Magdeburg
4. Estimation Model for Mobile Development Projects

Model Overview

Principles of Analogy

Influence Factors

Functional size Measurement

- Visual quality
- Landscape modes
- Device classes
- User database
- Complexity categories
- Component based
- Backend systems
- Bottom up estimation
- Empirical feedback loop

Simplicity

Screen measurement

Templates

User data base

User data base

Backend systems

Empirical feedback loop

Bottom up estimation

Simplicity

Screen measurement

Templates

User data base

Empirical feedback loop

Backend systems

Bottom up estimation

Simplicity

Screen measurement

Templates

User data base

Empirical feedback loop

Reiner R. Dumke, University of Magdeburg
4. Estimation Model for Mobile Development Projects

Functional Size Measurement Principles

**Basic measurement unit in apps:** one screen which usually covers one primary function to maintain the overview

**Simple and quick estimation:** provide templates for specific screen types

**Typical applications:** registration, simple lists, maps, data input and editing forms, static information etc. (can cover a large part of the functionality and the associated function points)
4. Estimation Model for Mobile Development Projects

Functional Templates

Templates for the rapid estimation of the functional size of mobile applications (login, geolocation, data manipulation)

Reiner R. Dumke, University of Magdeburg
4. Estimation Model for Mobile Development Projects

Tool-based FP-Based Estimation

Tool mockup for estimating the functional size of mobile applications

Reiner R. Dumke, University of Magdeburg
4. Estimation Model for Mobile Development Projects

Selection of Influence Factors (COCOMO)

- Novelty of the project
- Team cohesion
- Process maturity
- Architecture and risk treatment
- Development flexibility (compliance requirements and external interfaces)

COCOMO scaling factors

six-point ordinal scale and aggregated to the exponent of the effort
4. Estimation Model for Mobile Development Projects

Selection of Influence Factors (our approach)

- Visual quality
  (adjustment of UI components for reproduction of the corporate design, logo, etc.)
- Additional functions
  such as tracking, augmented reality etc.
- Novelty of the project
- Team cohesion
- Development flexibility
  (compliance requirements and external interfaces)
- Support for portrait and landscape modes
- Technological maturity of the platform
- Process maturity
- Architecture and risk treatment
- Number and type of backend systems
  (CMS, web site, ERP, CRM etc.)
- Number and type of supported platforms
- Type of supported device classes
  (tablet, smartphone, watches etc.)
Empirical Feedback Loop

*Feedback loop can be integrated into the process:* in order to strengthen the empirical foundation and thus to improve the accuracy of the estimator,

*Employing user data:* the estimates can be compared with the actual results and further insights into critical cost drivers.

*Refinement of the parameters:* the model could be optimized (manually) using the projects entered and the qualitative user feedback.
Conclusions

A method for cost estimation of app development projects has been developed which is aligned to the needs of technology decision-makers in small and mediumsized companies.

It provides a quick way to estimate the cost of app development projects of different parametrization.

This prototype could also serve as an experience database and thus allow for more precise estimates and the benchmarking of projects.
Future Research

A problem: the high level of market dynamics in the mobile space that brings ever new technologies,

App life cycle: contagious expenses for maintenance and support of the application which is not yet covered by the model.

Another open question: how additional empirical data can improve the estimation model.
COSMIC extensions

Thanks for your attention!

see: http://userpage.fu-berlin.de/~schmiete/