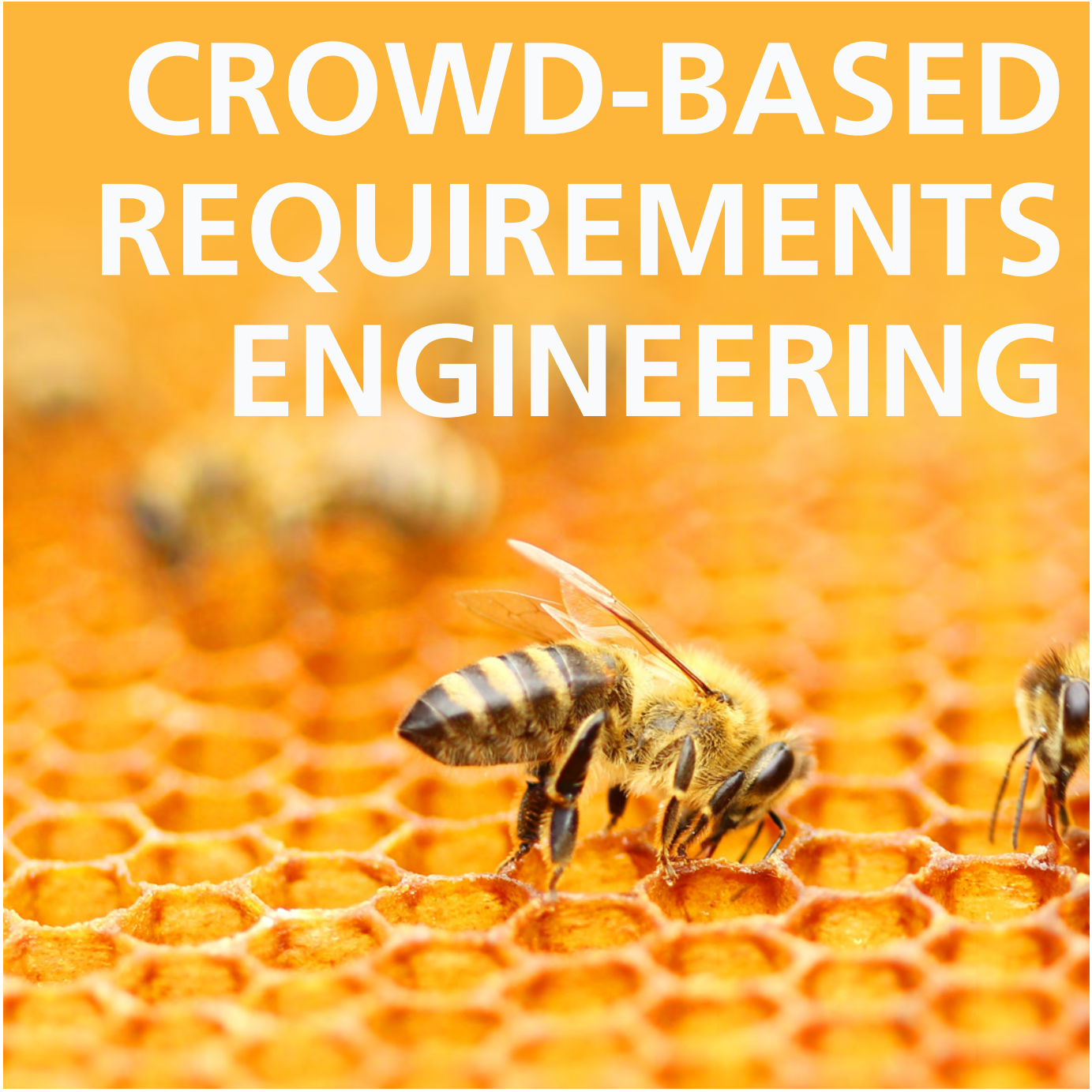


CROWD-BASED REQUIREMENTS ENGINEERING





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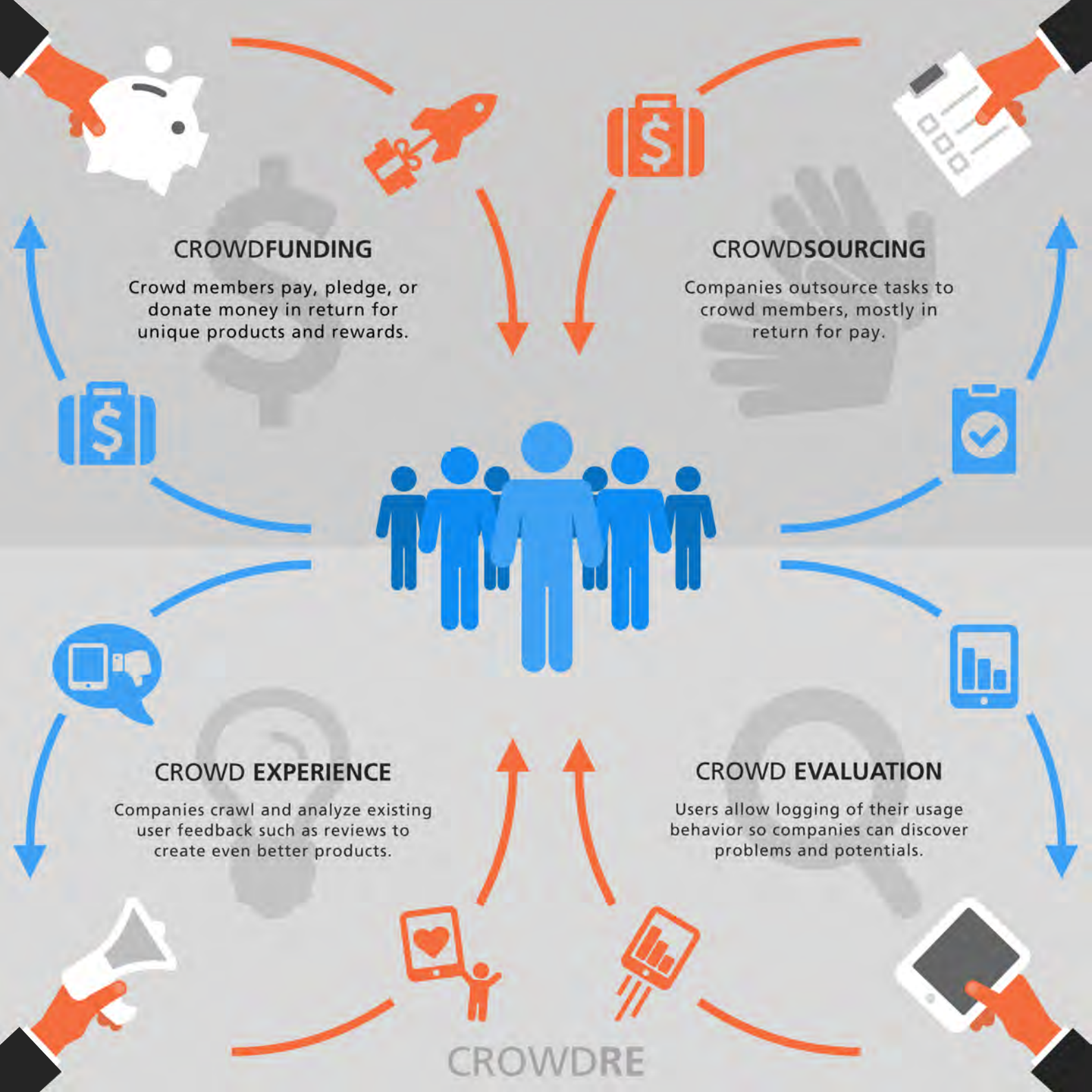
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PRETTY CROWDED?!

Today, every product has a “crowd”; a very large, heterogeneous, and physically divided pool of stakeholders who interact with each other online. Knowing how to manage this crowd means being able to channel and unleash the power of literally everybody, and gives you a market advantage over all those competitors who fail to recognize this potential.

This crowd is not the queue at the supermarket check-out, nor the tight squeeze on the morning commuter train. What we see as your crowd goes way beyond that. Think, for example, of **crowdfunding**. Here, the crowd voluntarily pays money to support an initiative they like through a platform (such as Kickstarter) that lists these initiatives. That way, startups gather seed capital, small businesses raise the development costs of an innovative new product and even secure a minimal number of sales, and good causes reach interest groups to raise donations for a specific project.

Businesses increasingly outsource tasks to the crowd, which is known as **crowdsourcing**. These tasks can range from very simple ones such as categorizing pictures or filling out a questionnaire in return for a small fee (like on Amazon Mechanical Turk), to creatively complex tasks such as proposing a solution to a problem scenario or submitting visual designs (such as Threadless). For these more complex tasks, usually only

the crowd member with the best idea receives a reward. In some cases, such as on Wikipedia, the crowd contributes without receiving compensation.

By using a product, the crowd gathers hands-on experience with that product. Crowd members often share this **crowd experience** through review portals or feedback channels, allowing product developers to understand what the crowd likes and dislikes about it, or what they miss. Based on this, they can improve the product, resulting in a better customer experience. Similarly, in the case of software, product developers can evaluate and analyze how the crowd uses the product through **crowd evaluation**. To draw conclusions about bottlenecks and other problems, specific aspects of the user’s interaction with the product are recorded or measured, after which an analysis aims at identifying problem patterns in the usage.

On the next few pages, we will show you how you can tap into the crowd’s immense potential in order to develop better products. The solutions from the Fraunhofer Institute for Experimental Software Engineering (Fraunhofer IESE) that will support you in this endeavor are in perfect harmony with existing requirements engineering (RE) practices. Although we will be using an app development company as an example (see page 7), these solutions can be applied in virtually every domain.



CUSTOMIZING AT A NEW LEVEL

You have a great product that provides the solution to a need that many people have. *But how can they become happier with it? What needs or ideas may have been overlooked or may still be unclear so far? And is it possible to expand your market to other potential users?* The answers to all these questions are out there!

A product can never be successful if one does not have the consuming market in mind. *Who will buy and use your product? How does your product help the user achieve his or her goals? Does the product fulfill your customer's expectations?* These are only a few of the questions that need to be answered before developing even the simplest of products. Without a **broad and deep understanding of who the product is intended for**, the risk of market failure increases.

Interviews, questionnaires, and workshops are just some of the most popular and proven **techniques** used to understand what the market wants and needs. Combined with creativity techniques, they can be used in many settings to gather opinions, wishes, and requirements in great detail. However, these techniques are especially suited for settings with smaller numbers of stakeholders. For example, focus groups are typically performed with six to eight participants, and it is impractical to perform more than just a handful of interviews because conducting and processing them is time- and cost-intensive.

But perhaps you have already passed the stage where conducting merely a few interviews sufficed. To understand **all your stakeholders** on every continent, traditional RE methods will soon reach their limit. You know your customers don't all think alike, so you need to find out across a much wider range what they think both individually and collectively. This will allow you to further develop your product or service, to better meet their expectations, and to appeal to potential new customers. But how can you obtain such knowledge from a hundred, a thousand, or even a million people? And how can you single out those individuals with that one valuable comment that holds the solution to a problem faced by many?

It seems that a **new approach** that complements existing RE practices is necessary. One that can gather information from many people, which cannot be done manually. We will need dedicated tools and techniques that help to perform this work effortlessly, that have a **high cost-value ratio** by helping you gain much insight with minimal effort, and that save valuable time in preparing, performing, and processing the wishes and needs of your customers. Fraunhofer IESE's "**crowd-based**" approach is such an approach that helps you understand your customers even better.



JUST ASK

Perhaps you recognize yourself in the following example, regardless of your professional domain.

A successful app development company has several apps in its portfolio. As these apps provide very effective and intuitive solutions to everyday problems, most of them have become immensely popular. The number of downloads is overwhelming, as is the **number of reviews** in which users praise and criticize the apps or ask for functionality that is currently not available. All of this information on crowd experience provides vital input for management decisions regarding some of their most pressing issues.

The business philosophy has always been to develop apps that improve the quality of life of their users. But **why are some apps less popular?** What keeps these apps from catching on? And who would buy them? Moreover, lately there have not been any viable ideas for new apps to be developed. **Which creative ideas for new apps** do users have?

For apps for which competing products are more successful, what can the business learn from **what its competitors do differently (in terms of being creative)?** How can the company get ahead of the competition by being the first to introduce new features and by quickly and adequately responding to its customers' wishes and

needs? Competitors also offer certain apps that the company itself has not yet developed. This means that based on user reviews of those apps, the company could identify **what users miss** in the other apps, and to subsequently develop a new app that better meets the customers' expectations in order to help them secure a competitive position in this market segment.

Manually assessing feedback from a user base with thousands of users is a daunting and costly activity. Instead, an automated way to exploit their feedback becomes necessary to **identify and address issues** quickly, and add new and improved functionality ahead of the competition. Texts including bug reports, complaints, feature requests, praise, and quality requirements can be analyzed through automation. Additionally analyzing crowd evaluation data will enable even better insights into the way users work with the app and into the issues they encounter on the way. This way, a company could use the crowd to its advantage.

What about your business? Have you identified your crowd, i.e., all the users and potential users of your products? Do you have the means to understand this crowd? Are those means capable of growing along with the crowd, and conversely, are these means using the crowd's potential to help your business grow?



POWERFUL CROWDS

Imagine a single user expressing his or her thoughts, for example by writing a review of your product. Does the opinion of this user reflect the opinion of other users? If not, what do they like or dislike instead?

A crowd is different from an individual. A crowd is a large group of **hundreds to millions** of people with a common interest. Each crowd has **group interactions**, which is why a concert audience is much more excited about the music they are listening to than an individual alone would be. These interactions also occur online among your users. As a result, what a crowd produces does not come from standalone individuals, but is the product of many interactions, which are more useful for your business than you might expect!

The crowd is very active in voicing wishes, ideas, criticism, and demands. The app development company in our example learned that **the users will tell** them what they like or dislike, what works for them and what does not. Furthermore, they respond to each other to confirm or deny that this reflects their opinion. This shared knowledge is no secret; it is available online, and it would be a waste not to use it! It is natural for management to involve the customer's opinion in their decisions, and automation can provide the necessary optimization. We really need the crowd and the information they provide.

The crowd consists of people, and **people are different**. They use your product in different ways, and communicate differently. Some crowd members are vocal about their opinion, some can be persuaded to give their opinion, while others remain quiet. Such individual differences must be regarded to obtain a balanced impression of what the crowd wants. Traditional RE techniques such as focus groups are not capable of achieving this, although they play an important role in gaining a deeper understanding of the requirements. **Crowd experience and crowd evaluation techniques** will help to mitigate the effects of interpersonal differences.

The crowd can be persuaded to contribute more and in different ways using **motivational instruments**. Concepts such as **crowdfunding** and **crowdsourcing**, which we discussed earlier, show that crowd members can be motivated to pay money to support an initiative, or to do work in return for payment. When they are also motivated to provide feedback, the crowd can help guide important management decisions, from visionary decisions down to implementation decisions. With a **deep understanding** of what the crowd as a whole thinks, what improvements they would like to see, and what could be possible future developments and investments, management can reduce its "blind spot" and base many decisions on a **representative sample** rather than on the opinion of a handful of stakeholders.



INFORMATION OVERLOAD?

Despite the increasing popularity of audio- and video-based platforms and means of communication, the Internet is still essentially a **text-based medium** where people primarily communicate through written language. Reviews, reports, books, chats, emails, protocols, and even transcripts are all text-based means of storing, sharing, and communicating content. This has several benefits. Browsing and searching through texts is easier than in other media, just as making annotations or replying to specific portions. Text can often be modified without difficulty, also enabling collaborative efforts. And texts can be stored in larger quantities because of their smaller file sizes.

The consequence of the text-based nature of the Internet is that people will often **report on their experience with your product or service** in writing. They may write you an email, send a message through social media or post a report in your bug tracker, or disclose their crowd experience in an app store review. Your own company may be making use of text-based storage, too, such as saving protocols of customer communications in a CRM system. Crowd members may have various reasons for writing something about your product or service. They may feel socially obligated to report an issue, or they may pursue their own personal gain by having the issue resolved. Some feedback mechanisms provide gamification elements or help boost one's status.

Once the number of people expressing their opinion about your product or service runs into the thousands and beyond, you have access to a great deal of potentially **highly valuable text-based data**. These data are there and can be freely used to further the development of your product or service. But how do you handle this feedback? If one or more persons are given the task of manually processing these data, can they draw parallels and objectively prioritize issues that should be addressed? Without tool support to gather, aggregate, and analyze these data, properly handling all natural language data provided by a crowd becomes an infeasible task.

For such settings, **crowd experience analysis** offers a suitable solution. An efficient and recurring analysis of online reviews could help management make informed decisions, within acceptable time and cost boundaries, and at a high level of quality, as such decisions are **based on statistical evidence** and allow prioritizing the current main needs and trends. Not only does this support the company's **growth**, but it can also assist in helping the company **diversify** their portfolio strategically, **specialize** in their areas of strength, and **personalize** their service to users. The benefits of automating this step and improving the business results hence very quickly lead to a break-even point after the initial investment.



BIG CROWDS NEED BIG DATA

Each product or service has an **intended use**. But do users really use the product in this way? Are there ways to optimize the workflow, is it already as good as can be, or is there a persistent problem for which users have found a workaround? Perhaps some users use the product for something entirely different? In that case, your product might even be marketed for this new purpose! But when you want to physically observe your users in their actual use context, time and budget only allow you to obtain such findings from a handful of people. This is why more and more organizations turn to **crowd evaluation techniques** to improve their products.

Crowd evaluation involves monitoring the way your product is being used by users who have given their consent. Due to privacy restrictions and because not all information is relevant, only certain behavioral and context data are recorded. Combining these data allows you to derive and visualize the **actual usage of the product** in order to identify non-verbalized wishes and to uncover ideas based on **usage patterns** that deviate from what was expected. This may reveal issues that require addressing, new uses for the product, and opportunities for optimization. This information is what you need to plan your future product development.

As the amount of data generated by the crowd is ever increasing, and because the interrelationships among these data are not always clear, different means of analysis are needed. The concept of **“Big Data”** comes into play when traditional technologies can no longer analyze data within an acceptable timeframe and budget or provide meaningful results at a sufficient level of quality. Big Data technologies can significantly scale up data processing and consume and manage resources within acceptable boundaries by relinquishing some technical properties (such as consistent database structures).

Big Data is often needlessly applied in contexts where traditional technologies would suffice, leading to poor results and causing many to question its added value. But for analyzing and comparing crowd evaluation and crowd experience data, these technologies provide **true benefits**. A crowd produces large amounts of data that are all very different in nature. App store reviews have a different structure and language than bug reports, and log file data of an app have a different structure and different parameters than those of an embedded system. Since competition is high in many domains, the data need to be processed quickly to identify problems, trends, and innovations early. The concept of Big Data is indispensable for performing this kind of requirements elicitation with the crowd.



MAKE THEM SPEAK WITH ONE VOICE

The analysis of many crowd experience and/or crowd evaluation data requires automation. Most data collection and analysis tools only partially answer the question of what the crowd wants, and include only specific types of feedback from certain portions of the crowd. Because they do not integrate information from several sources, it is uncertain whether the findings are complimentary or contradictory. Moreover, the results are usually not validated but left for the analyst to interpret.

Fraunhofer IESE not only provides a **methodological approach** that supports traditional RE techniques by obtaining knowledge and information from a broad pool of stakeholders, but also offers a variety of tool-based services. We are taking a “crowd-based” approach in which the crowd provides the basis for **answering your questions** in real time, at acceptable costs, and at a quality high enough to guide important management decisions. You will get many results, coming from many people.

How does this work? First, the **sources** from which data are extracted must be selected. Taking the case of our app development company as an example, the crowd experience data relevant to their situation are mainly found in app stores, which can be expanded with monitoring mechanisms to obtain crowd evaluation data. This

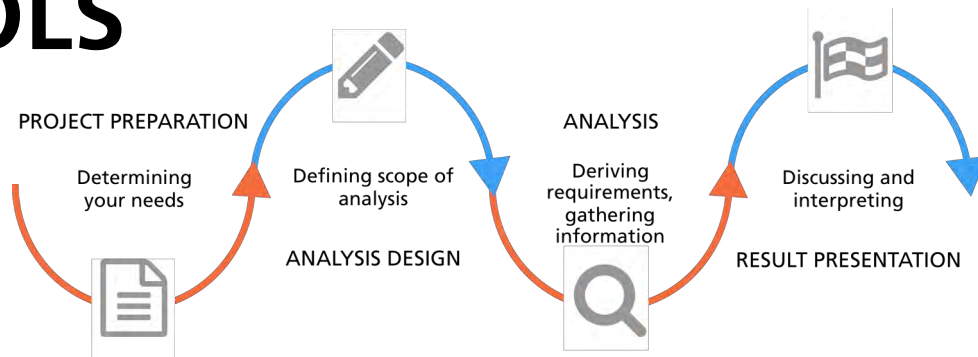
requires achieving an optimal tradeoff between sources and crowd coverage. We **continuously expand** our set of sources so we can tailor our services to your specific wishes and needs. There is enough room for **customization** and for further **extensions** of our already powerful tools!

The data are then analyzed using “mining” techniques. These techniques apply patterns that discover explicated and implicit problems, needs, and ideas. In **text mining**, crowd experience texts are preprocessed and scanned using our fine-tuned language patterns, which tap into general and domain-specific word lists so that even jargon and professional expressions can be identified. They identify meaningful information, such as positive, negative, and requesting statements made about both features and quality aspects of your product. We furthermore optimize the identification and classification of statements for your specific context. In **usage mining**, crowd evaluation patterns reveal correlations between variables and the workflows of your users.

In our approach, we consider both **text and usage mining** where appropriate to derive your requirements, and are at the forefront of research in this field so that we can present results with greater statistical significance and validity.



BEYOND TOOLS



Performing analyses helps you to **measure the success** of implemented changes by grouping and comparing product ratings and statements between releases, and to track the evolution of feedback in terms of trends regarding its amount, quality, and content. The results will help guide future developments, compose management reports, define requirements, and so forth.

The chart above visualizes how a typical project is set up. In the project preparation, we cater to each project's individual needs by attending to its characteristic features to optimize the results of the analysis. The analysis itself is designed in a workshop in which the scope of the analysis is defined in terms of the sources to analyze with respect to which goals. As a result, the tools to be used for the analysis are customized. After that, the actual analysis can be started, where information is gathered automatically and requirements are derived in a semi-automated way. Finally, the results are presented and discussed with you to ensure their correct interpretation. For your specific situation and needs, we can provide you with tailored services based on our tools!

Motivation mechanisms: We design mechanisms to motivate users to actively participate in the form of writing product evaluations and reviews, and to boost their willingness to share their logging data. Deriving requirements calls for a motivated crowd that produces and shares their information.

Selection of sources: We assist you in selecting the right sources for your context. These sources will influence from how many and from which users you can obtain relevant data, and to what extent these are representative of your user base as a whole. It is also possible to perform stakeholder analysis to specify which parts of the crowds to focus on.

Crawling services: As most of the sources will be from third-party systems and websites, we develop interfaces and crawlers that allow us to gather only relevant information from the selected sources and store the data in a well-structured database.

CRASP

by Fraunhofer IESE



PROJECT

Video Apps

Analyze

Products & Sources

Import Data

Settings

Help

SHARED WITH



Eduard Groen



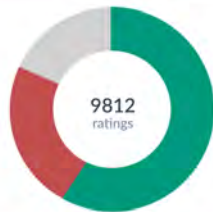
Matthias Koch



Christian Tamanini

All YouTube VLC Vimeo Dailymotion

OVERALL RATINGS



Positive Negative Neutral

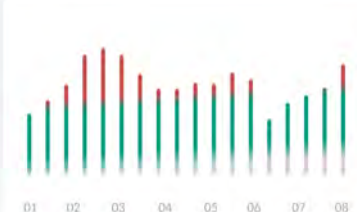
POSITIVE RATINGS

Last quarter
112 +18%

NEGATIVE RATINGS

Last quarter
32 +10%

TREND



Positive Negative Neutral

Results

REQUIREMENT TYPE

All

REVIEW TYPE

Negative

LANGUAGE

English

All iOS App Store Google Play Store Amazon

REQ. TYPE	DATE	REVIEW ID	REVIEW TYPE	STATEMENT
<input type="checkbox"/> Reliability	15 Feb 2018	1	Negative	Then there is the comment section which instead of crashing the app, it now freezes the screen to where you can't pause the video or exit the...
<input checked="" type="checkbox"/> Usability	15 Feb 2018	1	Negative	The quality select is terrible because when I want to select the best quality, I have to click on it a couple of times before I get the quality that...
<input type="checkbox"/> Performance efficiency	13 Mar 2018	2	Negative	when I speed up a video (no matter what times 1.25, 1.5, or 2.0) it buffers like there's no tomorrow.
<input type="checkbox"/> Functional	13 Mar 2018	2	Negative	some videos don't play at all
<input type="checkbox"/> Usability	13 Mar 2018	2	Negative	now I can't comment or it messes everything up and the keyboard stays during the video
<input type="checkbox"/> Reliability	08 Feb 2018	3	Negative	When I lock my phone, all of a sudden the video will be at the correct time, but yet it will be playing either a part earlier or later in the video.
<input type="checkbox"/> Functional	08 Feb 2018	3	Negative	I swear literally every time there's an update for this app, they fix something, but then they add another problem
<input type="checkbox"/> Functional	29 Jan 2018	4	Negative	It can't open videos in their own tab (I like to go through all my subscriptions and open up videos I want to see in separate tabs in just...

Rows per page

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Top 10 Recommendations

BEYOND TOOLS

Crowd experience analysis services: By applying a text mining approach that we have developed specifically to foster the identification of requirements, we apply our fine-tuned language patterns to discover the users' problems, needs, and ideas. Retrospective analyses help you determine whether the latest release excites users and has solved earlier problems, while comparative analyses help you to outperform your competitors.

Definition of crowd evaluation data: We assist you in defining what usage data and system events will be logged while respecting your users' privacy. The choice of data and events determines what parts of your product can be analyzed and, in turn, which problems or needs can be identified through the usage analysis.

Integration services: We collect usage data from users according to data privacy regulations regarding the tracking and observing of user behavior, and design a database structure that meets your needs for storage and analysis purposes. Upon request, this can be combined with experimental usage observation in real time.

Identification of behavioral patterns: Through usage mining, log data are analyzed for behavioral patterns to uncover issues the users experience with the product and to identify ways to improve or expand the product beyond its current service palette.

Derivation of requirements: Our derivation of requirements is based on an unprecedented level of integration of text mining and usage mining results to achieve the highest possible degree of statistical validity. What people say (text) and what we see people do (usage) may be perfectly in line, but may also be in contradiction, which requires us to analyze the cause of this discrepancy and understand the underlying requirements.

Testing and validation: We validate and polish the requirements derived from text and usage mining. This can be done, for example, through online focus groups with selected users to deepen our understanding of the users' problems and wishes, or through A/B testing to identify the best possible implementation. We can furthermore perform predictive analysis to check whether the planned changes will excite users.

Dashboard services: Through our interactive dashboard, you can see at a glance which requirements users have for your product and similar competitive products, what they like and dislike, and what problems they run into, but you can also dig deeper into each of the aspects and obtain a comprehensive overview of the data underlying our statistics.



Fraunhofer

ABOUT US

The Fraunhofer Institute for Experimental Software Engineering IESE in Kaiserslautern has been one of the world's leading research institutes in the area of software and systems engineering for more than 20 years. Its researchers have contributed their expertise in the areas of Processes, Architecture, Security, Safety, Requirements Engineering, and User Experience in more than 1,200 projects.

Under the leadership of Prof. Peter Liggesmeyer, Fraunhofer IESE is working on innovative topics related to digital ecosystems, such as Industrie 4.0, Big Data, and Cyber-Security. As a technology and innovation partner for the digital transformation in the areas of Autonomous & Cyber-Physical Systems and Digital Services, the institute's research focuses on the interaction between embedded systems and information systems in digital ecosystems.

Fraunhofer IESE is one of 72 institutes and research units of the Fraunhofer-Gesellschaft. Together they have a major impact on shaping applied research in Europe and contribute to Germany's competitiveness in international markets.



Prof. Dr.-Ing. Peter Liggesmeyer

Director

Fraunhofer Institute for Experimental Software Engineering IESE

Fraunhofer-Platz 1
67663 Kaiserslautern
Germany

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p. 2, 18, 20, 21, portraits on back: Fraunhofer IESE



Dr. Marcus Trapp

+49 631 6800-2186

Marcus.Trapp@iese.fraunhofer.de

Fraunhofer IESE
Fraunhofer-Platz 1
67663 Kaiserslautern
Germany



Eduard C. Groen

+49 631 6800-2262

Eduard.Groen@iese.fraunhofer.de

Fraunhofer IESE
Fraunhofer-Platz 1
67663 Kaiserslautern
Germany

