

Recommendations on Adapting Crowdsourcing to Problem Types

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Outline

- **Crowdsourcing taxonomy**
- Research question
- Crowdsourcing problem types
- Methodology
- Feature categorisation
- Results
- Conclusions

Crowdsourcing

- Crowdsourcing is outsourcing a task that is usually done in-house, to a potentially large and diverse group of people in form of an open call
- People bring their knowledge, expertise, innovation, resources, or money and usually get rewarded financially, get social recognition for their activity or get entertained
- There are many crowdsourcing platforms such as Amazon Mechanical Turk, Threadless, and Kickstarter.

Taxonomy of Crowdsourcing

- Our taxonomy of crowdsourcing¹, consisting of the following four pillars:
 - The Crowd
 - The Crowdsourcer
 - The Crowdsourced Task
 - The Crowdsourcing Platform
- Each pillar has a set of features (or in the case of the crowdsourcing platform, facilities or services)

¹ M. Hosseini, K. Phalp, J. Taylor, and R. Ali, "The four pillars of crowdsourcing: A reference model," in Proceedings of the 2014 IEEE Eighth International Conference on Research Challenges in Information Science (RCIS), May 2014, pp. 1–12.

List of All Crowdsourcing Features¹

The Crowd	The Crowdsourcer	The Crowdsourced Task	The Crowdsourcing Platform
1. Diversity 1.1. Spatial Diversity 1.2. Gender Diversity 1.3. Age Diversity 1.4. Expertise Diversity	1. Incentives Provision 1.1. Financial Incentives 1.2. Social Incentives 1.3. Entertainment Incentives 2. Open Call	1. Traditional operation 1.1. In-house 1.2. Outsourced 2. Outsourcing Task	1. Crowd-related Interactions 1.1. Provide Enrolment 1.2. Provide Authentication 1.3. Provide Skill Declaration 1.4. Provide Task Assignment 1.5. Provide Assistance 1.6. Provide Result Submission 1.7. Coordinate Crowd 1.8. Supervise Crowd 1.9. Provide Feedback Loops
2. Unknown-ness 2.1. Not Known to Crowdsourcer 2.2. Not Known to Each Other	3. Ethicality Provision 3.1. Opt-out Procedure 3.2. Feedback to Crowd 3.3. No Harm to Crowd	3. Modularity 3.1. Atomic Tasks 3.2. Divisible to Micro Tasks	2. Crowdsourcer-related Interactions 2.1. Provide Enrolment 2.2. Provide Authentication 2.3. Provide Task Broadcast 2.4. Provide Assistance 2.5. Provide Time Negotiation 2.6. Provide Price Negotiation 2.7. Provide Result Verification 2.8. Provide Feedback Loops
3. Largeness 3.1. Number Fulfils the Task 3.2. Number Not Abundant	4. Privacy Provision	4. Complexity 4.1. Simple Tasks 4.2. Complex Tasks	3. Task-related Facilities 3.1. Aggregate Results 3.2. Hide Results from Others 3.3. Store History of Completed Tasks 3.4. Provide Quality Threshold 3.5. Provide Quantity Threshold
4. Undefined-ness		5. Solvability 5.1. Simple for Humans 5.2. Complex for Computers	4. Platform-related Facilities 4.1. Online Environment 4.2. Manage Platform Misuse 4.3. Provide Ease of Use 4.4. Provide Attraction 4.5. Provide Interaction 4.6. Provide Payment Mechanism
5. Suitability 5.1. Competence 5.2. Collaboration 5.3. Volunteering 5.4. Motivation 5.4.1. Mental Satisfaction 5.4.2. Self-Esteem 5.4.3. Personal Skill Development 5.4.4. Knowledge Sharing 5.4.5. Love of Community		6. Automation Characteristics 6.1. Difficult to Automate 6.2. Expensive to Automate	
		7. User-driven 7.1. Problem Solving 7.2. Innovation 7.3. Co-creation	
		8. Contribution Type 8.1. Individual Contribution 8.2. Collaborative Contribution	

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The Problem

- Crowdsourcing has a large set of features
- Crowdsourcing can be utilised in different problem types
- Ad-hoc feature selection from such a large set of features and configuring them for the specific crowdsourcing problem type can pose problems, such as:
 - Reducing motivation in the crowd
 - Affecting available resources of the crowdsourcers
 - Lowering the quality and quantity threshold of the crowdsourced task
 - Creating management and supervision difficulties in the crowdsourcing platform

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Research Question

- For every crowdsourcing problem type, how important different crowdsourcing features are and which of these features should be selected?

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Five Common Problem Types

TABLE I. CROWDSOURCING PROBLEM TYPES AND THEIR CHARACTERISTICS

Problem Type	Correct Answers?	Task Simplicity	Expertise Required?	Incentives
Opinion-Based Problems	No	Varied	Yes/No	(un)limited
Basic Problems	Yes	Simple	No	(un)limited
Complex Problems	Yes	Difficult	Yes	(un)limited
Competition Type Problems	Yes	Varied	Yes/No	limited
Collaborative Fundraising	No	Simple	No	(un)limited

Crowdsourcing Features Under Study

TABLE II. CROWD, CROWDSOURCER, AND CROWDSOURCING PLATFORM FEATURES

Crowd Features	Crowdsourcer Features	Crowdsourcing Platform Features	
Diversity	Financial Incentives	Provide Enrolment	Provide Feedback Loops
Unknown-ness	Social Incentives	Provide Authentication	Provide Quality Threshold
Largeness	Entertainment Incentives	Provide Skill Declaration	Provide Quantity Threshold
Undefined-ness	Open Call	Provide Task Assignment	Manage Platform Misuse
Competence	Privacy Provision	Supervise Crowd	Provide Ease of Use
Motivation	Feedback to Crowd	Provide Task Broadcast	Provide Attraction
		Provide Price Negotiation	Provide Payment Mechanism

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Methodology

- We conducted an online expert study
- Each problem type was first introduced through an example, and then the crowdsourcing features were presented
- Experts were asked to choose the relevant and useful features for every crowdsourcing problem type
- The experts were chosen using GoogleScholar. Experts with at least three related publication in crowdsourcing were invited to join in our study by email
- A total of 139 experts were invited; 50 experts replied by filling in the first page only; Only 37 actually completed the survey

TABLE III. SUMMARY OF EXPERTS' INFORMATION

Type of Expertise in Crowdsourcing		Major Expertise in Crowdsourcing
Academia	32	Social sensing, Crowdfunding, Citizen Science Project, Crowdsourcing for multimedia quality assessment, Trust and privacy in crowd-enhanced systems, Structured volunteer crowdsourcing,
Industry	1	
Both	4	Quality assurance in crowdsourcing, Micro tasking platforms

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Feature Categorisation

- **Trivial Features:** We define trivial features as those features with votes fewer than 20 per cent (votes of seven experts or fewer), and when there was also no argument given by any of the experts or the literature on the essential nature of the feature for the problem type.
- **Insignificant Features:** We define insignificant features as those features with votes between 20 per cent and 50 per cent (votes of eight experts to 18 experts), and when there was also no argument given by any of the experts or the literature on the essential nature of the feature for the problem type.
- **Important Features:** We define important features as those features with votes between 50 per cent and 80 per cent (votes of 19 experts to 29 experts), and when there was an argument why the feature should be considered important for the problem type given by experts or the literature.
- **Critical Features:** We define critical features as those features with votes more than 80 per cent (votes of 30 experts or more), and when there was an argument why the feature should be considered critical for the problem type is given by experts or the literature.

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Problem Type 1: Crowdsourcing for Opinion Collection Tasks

TABLE IV. IMPORTANCE OF CROWDSOURCING FEATURES IN OPINION-BASED CROWDSOURCING PROBLEMS

Opinion-Based Problems	
Critical Features	Ease of Use (32), Largeness (31), Diversity (30), Financial Incentives (30)
Important Features	Payment Mechanism (28), Feedback Provision (25), Attraction (25), Open Call (24), Quality Threshold (24), Platform Misuse Management (24), Social Incentives (23), Feedback Loops (23), Entertainment Incentives (21), Authentication (21), Quantity Threshold (21), Motivation (20), Task Broadcast (19), Privacy Provision (19)
Insignificant Features	Enrolment (18), Skill Declaration (17), Task Assignment (17), Unknown-ness (16), Competence (16), Supervise Crowd (15), Undefined-ness (11), Price Negotiation (9)
Trivial Features	None

Problem Type 2: Crowdsourcing for Basic Tasks

TABLE V. IMPORTANCE OF CROWDSOURCING FEATURES IN BASIC CROWDSOURCING PROBLEMS

Basic Problems	
Critical Features	Financial Incentives (33), Largeness (31)
Important Features	Ease of Use (29), Payment Mechanism (28), Quality Threshold (28), Entertainment Incentives (25), Platform Misuse Management (25), Motivation (24), Feedback Provision (23), Feedback Loops (23), Attraction (23), Open Call (21), Quantity Threshold (20)
Insignificant Features	Social Incentives (18), Diversity (17), Task Broadcast (17), Authentication (15), Unknown-ness (14), Competence (13), Enrolment (13), Supervise Crowd (13), Task Assignment (12), Undefined-ness (10), Privacy Provision (10), Price Negotiation (9), Skill Declaration (8)
Trivial Features	None

Problem Type 3: Crowdsourcing for Tasks That Require Expertise

TABLE VI. IMPORTANCE OF CROWDSOURCING FEATURES IN PROBLEMS THAT REQUIRE EXPERTISE

Problems That Require Expertise	
Critical Features	Competence (33), Feedback Provision (32), Social Incentives (31), Motivation (30)
Important Features	Quality Threshold (28), Skill Declaration (26), Feedback Loops (26), Largeness (25), Ease of Use (25), Entertainment Incentives (24), Attraction (24), Open Call (22), Enrolment (22), Authentication (21), Platform Misuse Management (21), Financial Incentives (20), Task Broadcast (19)
Insignificant Features	Task Assignment (18), Quantity Threshold (18), Payment Mechanism (18), Supervise Crowd (17), Diversity (16), Privacy Provision (10), Price Negotiation (10)
Trivial Features	Unknown-ness (7), Undefined-ness (1)

Problem Type 4: Crowdsourcing for Competitive Tasks

TABLE VII. IMPORTANCE OF CROWDSOURCING FEATURES IN COMPETITIVE PROBLEMS

Competitive Problems	
Critical Features	Financial Incentives (32)
Important Features	Payment Mechanism (28), Ease of Use (28), Competence (26), Quality Threshold (26), Motivation (25), Feedback Provision (25), Enrolment (22), Skill Declaration (22), Quantity Threshold (22), Attraction (21), Social Incentives (21), Open Call (21), Platform Misuse Management (20), Authentication (19), Largeness (19), Feedback Loops (19)
Insignificant Features	Supervise Crowd (17), Task Assignment (16), Entertainment Incentives (14), Diversity (13), Task Broadcast (13), Price Negotiation (12), Unknown-ness (11), Privacy Provision (9), Undefined-ness (8)
Trivial Features	None

Problem Type 5: Crowdsourcing for Collaborative Fundraising Tasks

TABLE VIII. IMPORTANCE OF CROWDSOURCING FEATURES IN COLLABORATIVE FUNDRAISING PROBLEMS

Collaborative Fundraising Problems	
Critical Features	Social Incentives (37), Largeness (33), Open Call (30)
Important Features	Ease of Use (29), Attraction (28), Feedback Provision (28), Motivation (27), Diversity (23), Feedback Loops (21), Platform Misuse Management (20), Unknown-ness (20), Task Broadcast (19)
Insignificant Features	Enrolment (18), Undefined-ness (16), Privacy Provision (16), Entertainment Incentives (15), Authentication (15), Quantity Threshold (14), Financial Incentives (9)
Trivial Features	Price Negotiation (7), Payment Mechanism (7), Quality Threshold (6), Supervise Crowd (5), Competence (3), Skill Declaration (3), Task Assignment (3)

A Guide to Feature Selection Based on Crowdsourcing Problem Types

TABLE IX. FEATURE CLASSIFICATION ACCORDING TO THEIR DEGREE OF IMPORTANCE FOR PROBLEM TYPES

Problem Type	Feature Classification
Opinion Based Problems	Ease of Use (32), Largeness (31), Diversity (30), Financial Incentives (30), Payment Mechanism (28), Feedback Provision (25), Attraction (25), Open Call (24), Quality Threshold (24), Platform Misuse Management (24), Social Incentives (23), Feedback Loops (23), Entertainment Incentives (21), Authentication (21), Quantity Threshold (21), Motivation (20), Task Broadcast (19), Privacy Provision (19)
Basic Problems	Financial Incentives (33), Largeness (31), Ease of Use (29), Payment Mechanism (28), Quality Threshold (28), Entertainment Incentives (25), Platform Misuse Management (25), Motivation (24), Feedback Provision (23), Feedback Loops (23), Attraction (23), Open Call (21), Quantity Threshold (20)
Problems That Require Expertise	Competence (33), Feedback Provision (32), Social Incentives (31), Motivation (30), Quality Threshold (28), Skill Declaration (26), Feedback Loops (26), Largeness (25), Ease of Use (25), Entertainment Incentives (24), Attraction (24), Open Call (22), Enrolment (22), Authentication (21), Platform Misuse Management (21), Financial Incentives (20), Task Broadcast (19)
Competitive Problems	Financial Incentives (32), Payment Mechanism (28), Ease of Use (28), Competence (26), Quality Threshold (26), Motivation (25), Feedback Provision (25), Enrolment (22), Skill Declaration (22), Quantity Threshold (22), Attraction (21), Social Incentives (21), Open Call (21), Platform Misuse Management (20), Authentication (19), Largeness (19), Feedback Loops (19)
Collaborative Fundraising Problems	Social Incentives (37), Largeness (33), Open Call (30), Ease of Use (29), Attraction (28), Feedback Provision (28), Motivation (27), Diversity (23), Feedback Loops (21), Platform Misuse Management (20), Unknown-ness (20), Task Broadcast (19)

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The Overall Importance of Crowd Features

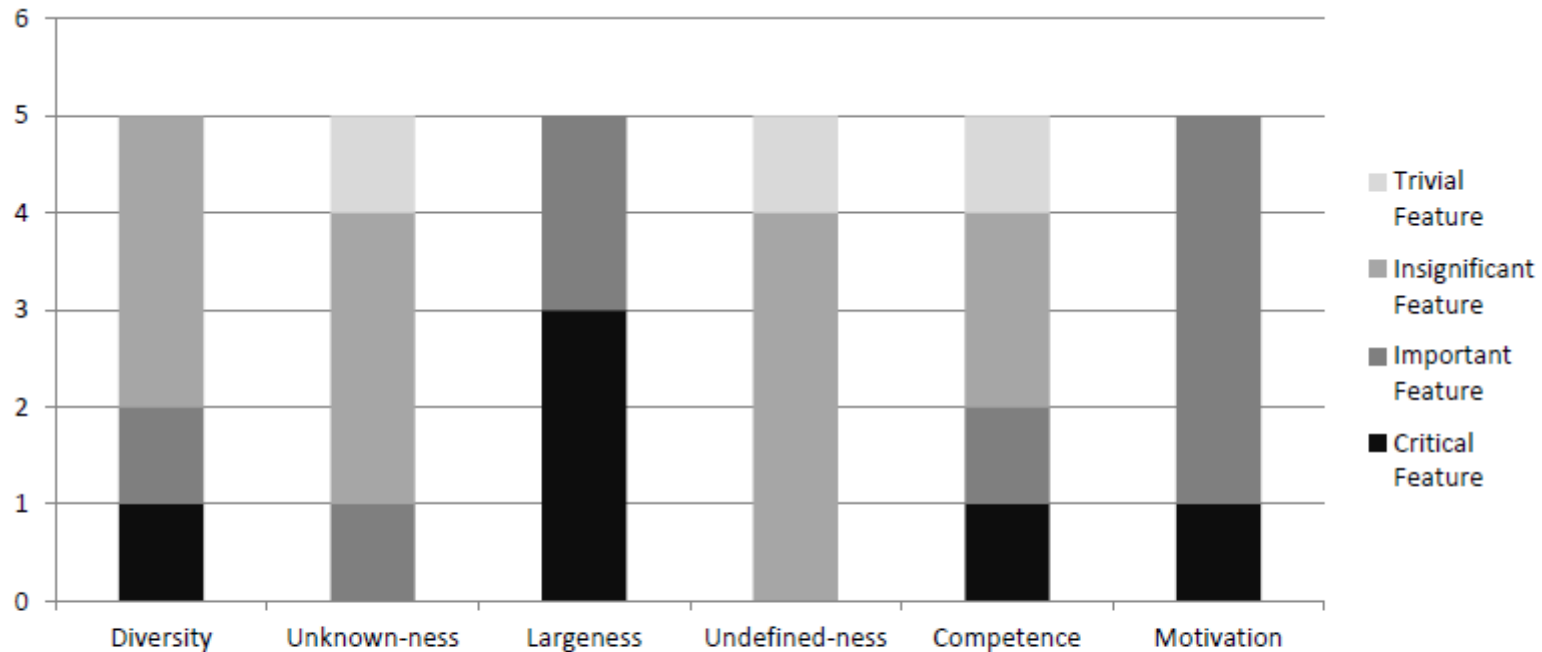


Fig. 1. Crowd features and their degree of importance regardless of crowdsourcing problem types

The Overall Importance of Crowd Features

- Diversity is not always an essential feature, especially when the solutions to the crowdsourced task can be verified as right or wrong answers
- Anonymity or unknown-ness was generally voted as an insignificant feature, probably due to many problems such as information integrity problems and fraudulent activities
- Largeness is usually considered to be a core feature of crowdsourcing. Our study confirmed this
- Randomness or undefined-ness was deemed either trivial or insignificant, in order to decrease the chances of obtaining low-quality information or inefficient solutions
- Competence of the crowd was voted high in activities which really need expertise. Simple online tasks and collaborative donation tasks had therefore a low voting for competence
- Motivation as a crowd feature was always an important or critical feature. It should be an essential feature of the participating crowd

The Overall Importance of Crowdsourcer Features

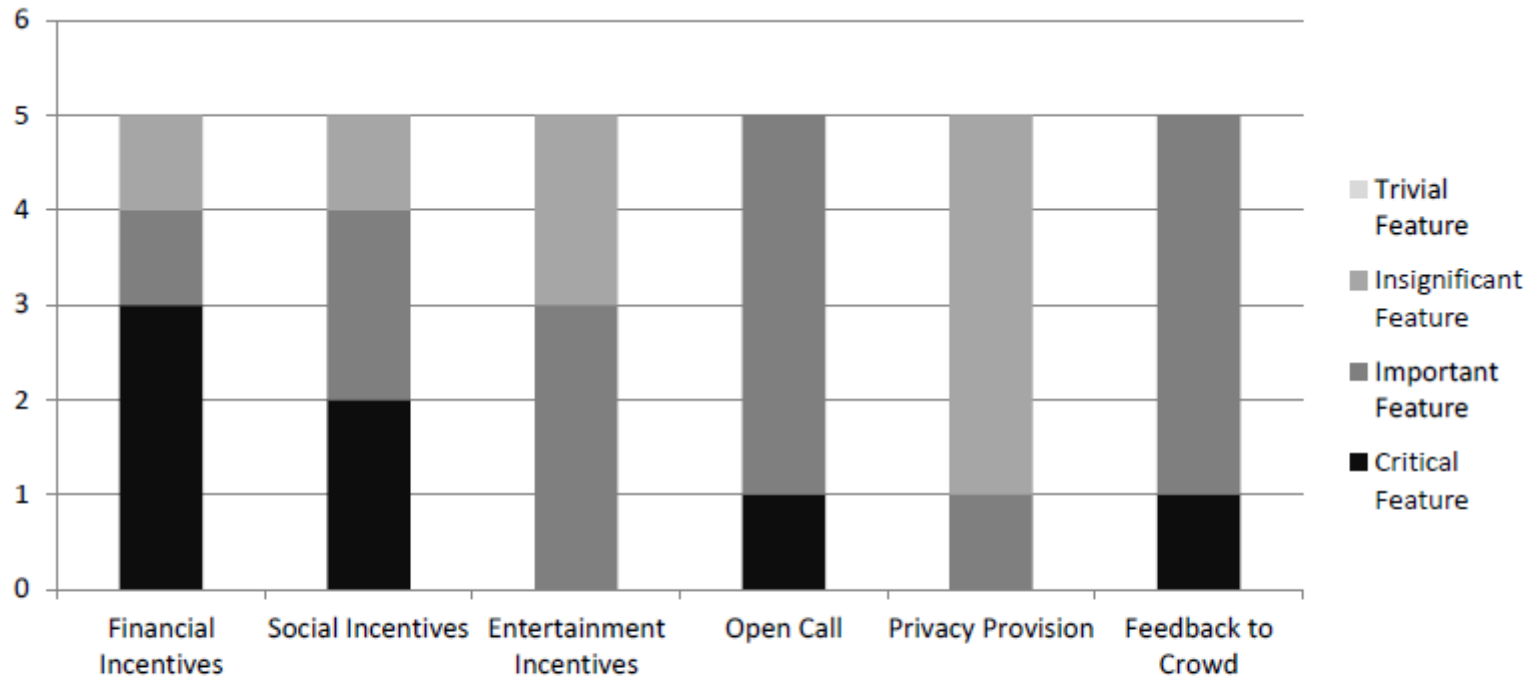


Fig. 2. Crowdsourcer features and their degree of importance regardless of crowdsourcing problem types

The Overall Importance of Crowdsourcer Features

- Providing incentives for the crowd is usually considered to be an integral part of any crowdsourcing activity
 - Financial incentives seem to be the dominant type of incentives
 - For tasks that need expertise and for tasks that need collaboration, social incentives outvoted financial incentives
 - Entertainment incentives were also voted as important in both simple and difficult tasks, but they were voted insignificant in competitive and collaborative donation tasks
- Providing an open call for participants was also important in all crowdsourcing problem types. This means that crowdsourcing activities should be open to the general public
- Providing feedback to the crowd was a crowdsourcer feature that was always voted as important

The Overall Importance of Crowdsourcing Platform Features

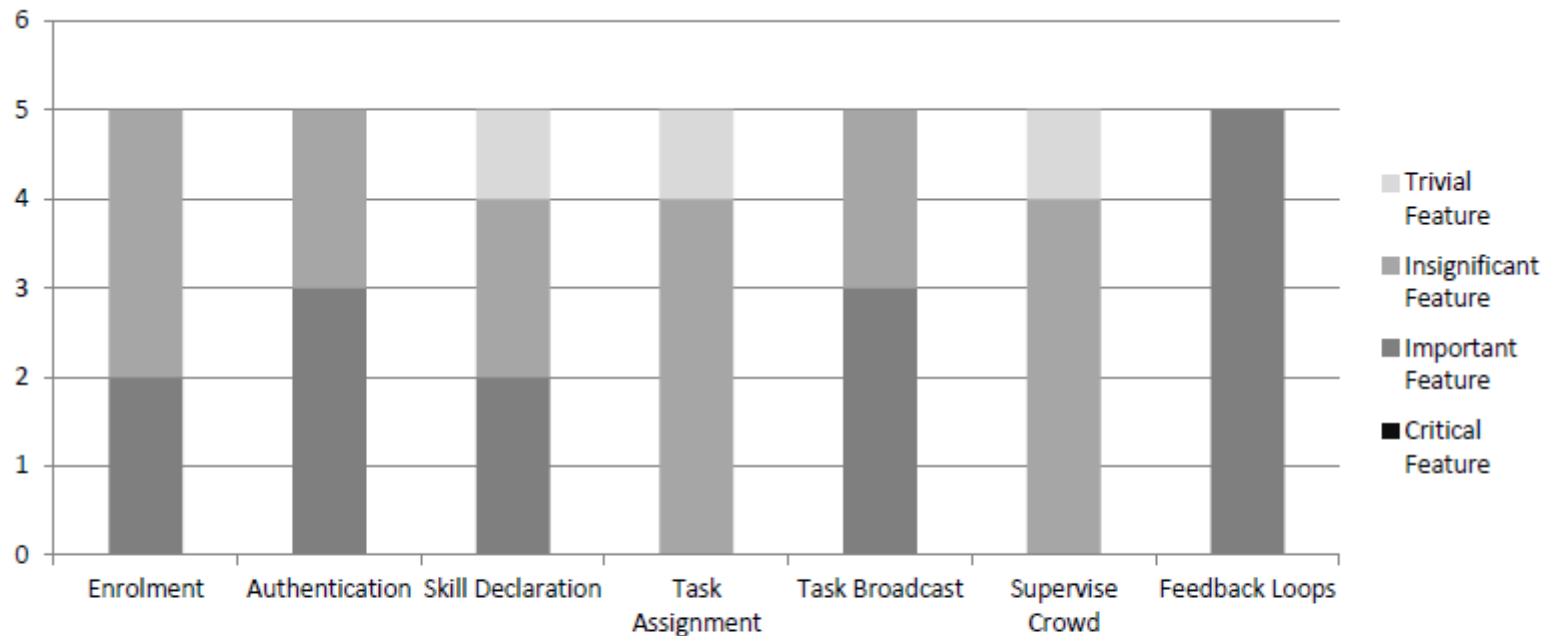


Fig. 3. Crowdsourcing platform features and their degree of importance regardless of crowdsourcing problem types, part 1

The Overall Importance of Crowdsourcing Platform Features

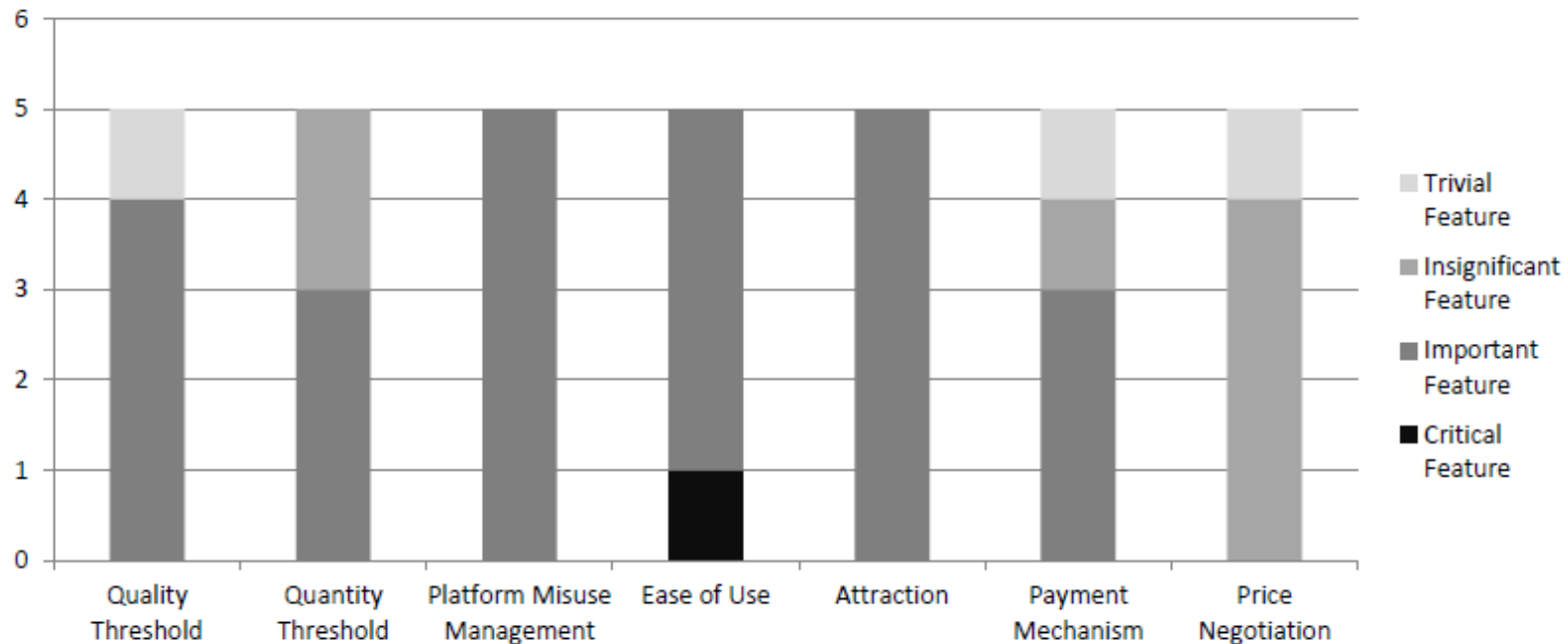


Fig. 4. Crowdsourcing platform features and their degree of importance regardless of crowdsourcing problem types, part 2

The Overall Importance of Crowdsourcing Platform Features

- Providing enrolment and authentication for crowd members showed a correlation in this study, being insignificant features in simple activities and donation activities
- Skill declaration and task assignment illustrated similar correlation, having the lowest votes in simple activities and donation activities
- Supervising the crowd and price negotiation were two platform features that obtained constantly low votes
- Task broadcasting was considered to be an important feature for opinion acquisition, difficult tasks and donation activities. This is justified by the fact that diversity plays an important role in these crowdsourcing problem types

The Overall Importance of Crowdsourcing Platform Features

- Quality and quantity thresholds are two more platform features which were generally considered to be an important feature, except for donation activities where there is no quality to be measured and there is no limit to the quantity
- Platform misuse management was also considered to be an important platform feature
- Platform ease of use and attraction were always important or critical features as well
- Payment mechanism in a platform was only deemed trivial in donation activities, in line with providing financial incentives as a crowdsourcer feature

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- Different crowdsourcing problem types should employ different crowdsourcing features for optimal results
- There is need for a crowdsourcing configurator which can help crowdsourcers and developers in their choice of crowdsourcing features

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