Problem Specification in Crowdsourcing Contests: A Natural Experiment

Kai Ye
Hong Kong University of Science and Technology, kai.ye@connect.ust.hk

Tat Koon Koh
The Hong Kong University of Science and Technology, koh@ust.hk

Problem Specification in Crowdsourcing Contests: A Natural Experiment

Completed Research Paper

Kai Ye
Hong Kong University of Science and Technology
Clear Water Bay, Kowloon, Hong Kong
kai.ye@connect.ust.hk

Tat Koon Koh
Hong Kong University of Science and Technology
Clear Water Bay, Kowloon, Hong Kong
koh@ust.hk

Abstract

Problem specification is a key aspect in crowdsourcing contests through which seekers convey their requirements and taste for the desired submissions. Hence, it is important to understand how problem specification should be framed to achieve better crowdsourcing contest outcomes. In this empirical study, we investigate the effects of a relatively more structured problem specification on contest quantity, solver quantity, and idea quality. We leverage a natural experiment set up on a major crowdsourcing contest platform where the problem specification of logo design contests changed from open-ended to structured. Our results show that the specification change impacts both seekers and solvers. Specifically, the number of contests increases after the change but solver quantity and idea quality in the respective contests tend to be lower. We discuss the theoretical and practical contributions of this research.

Keywords: Crowdsourcing contests; problem specifications; seeker and solver behaviors

Introduction

Crowdsourcing contests are a novel avenue for organizations to seek ideas from the crowd to solve their problems. These contests allow organizations to outsource tasks that were once performed in house to external solvers and leverage on the wisdom of the crowd. A critical aspect of crowdsourcing contests is the problem specification, through which seekers communicate to solvers the focal problems and convey their requirements for the desired ideas or solutions. For example, in logo design contests, seekers can describe the key tasks (e.g., logo for a restaurant) and what they look for in potential solutions (e.g., the look and feel of the logo) in the project briefs. Such information about the focal problems plays important roles in solvers' contest participation decisions and strategy. As solvers value winning (Brabham 2010; Koh 2019; Ye and Kankanhalli 2017) and expect to perform better for problems that match their specializations (Mo et al. 2018), they are likely to decide which contests to join based on the problem specifications in the respective contests. In addition, given the difficulty in clearly identifying the criteria for idea evaluation in contests (Jian et al. 2019), solvers can use the problem specifications to infer the types of solutions that meet the seekers' tastes, which are a critical factor that determines the winning solutions (Terwiesch and Xu 2008). Hence, problem specifications can impact solvers' behaviors and outcomes in contests.

By and large, there are two common ways that the problem specifications are presented in contests. The first is a less structured, open-ended format, where seekers articulate their expectations using open text, with relatively little restrictions in terms of the details they can provide. The second format is a more structured, where seekers answer several pre-determined questions regarding their project requirement; each of these questions can have a specific set or range of answer options that seekers can choose from. In this research, we examine how the different approaches of problem specification affect seekers and solvers

on contest platforms. On the seeker side, we are interested in how problem specification approaches impact the number of contests that seekers launch, which is a material outcome as it affects earning opportunities for solvers and revenues for platforms. On the solver side, we wish to understand the effects of problem specification approaches on the number of solvers who participate in the respective contests as well as the idea quality therein. The quantity of solvers participating in contests is an important consideration because it affects the extent of parallel exploration of the solution space and can affect idea diversity, thus impacting the likelihood of acquiring high quality solution (Boudreau et al. 2011; Terwiesch and Xu 2008). Idea quality, in turn, is important to seekers as they are acquiring solutions for their problems. Using a change implemented by a major design contest platform on seekers' problem specification, we find that a more structured problem specification increases the number of contests launched by seekers but has a negative impact on the solver quantity and the idea quality therein.

This work contributes in the following ways. First, while extant literature examines how problem specification impacts solvers in contests, we holistically study its effect on seekers as well. This is important, as crowdsourcing contests essentially are multi-sided. Second, we show a more structured problem specification format adversely impacts solver quantity and idea quality therein. This has practical implications for contest platforms to better fulfill their intermediary roles.

Related Literature

Our work relates to two main strands of literature. First, this work contributes to research on the effects of crowdsourcing contest attributes on contest outcomes. Attributes such as prize amount (Koh 2019; Terwiesch and Xu 2008), and prize guarantee (Jian et al. 2019) can influence solver behavior. Research has also looked at how seekers' problem specifications convey their expectations and preference for solutions and allow solvers to decide whether to submit a solution or not (Pollok et al. 2019). Studies have investigated the effect of different aspects of problem specifications (e.g., length, linguist styles (e.g., concreteness of language, use of anxiety words, and use of personal pronouns, etc.), and clarity (about the task goal and the workflow)) on crowdsourcing contests outcomes (see Table 1). In this present research, we focus on the effect of information structure (open-ended vs structured) of problem specification. In addition, we analyze its effect on both seekers and solvers while prior works tend to focus mainly on the latter.

Second, this work relates to task autonomy in crowdsourcing contests. The concept of task autonomy comes from work autonomy in management literature, which is defined as "the degree to which the work provides freedom, independence, and discretion in determining what to do and the procedures to be used in carrying it out" (Hackman and Oldham 1975). Management scholars consider work autonomy as an antecedent of intrinsic motivation (Deci 1973) and acknowledge its important role in shaping employees' perception of task completion and task performance (Haas 2010; Xie and Johns 1995). In the context of crowdsourcing contests, Zheng et al. (2011) define "contest autonomy as the extent to which the contest provides a problem solver freedom and control over how the contest task is to be solved". While there are various motivations for solvers taking part in crowdsourcing contests (Ye and Kankanhalli 2017), task autonomy is a key factor (Deng et al. 2016). Building on this, our work theorizes how task autonomy affects solver behaviors in crowdsourcing contests.

Third, our work relates to the literature of information representation in information systems. Existing literature shows that the way that information is provided can influence individuals' information acquisition and decision-making in multiple settings (Hutchinson et al. 2010; Jiang and Benbasat 2007; Lurie and Mason 2007). While prior works draw on the cognitive fit theory (Shaft and Vessey 2006; Vessey 1991; Vessey and Galletta 1991) and emphasize the match between task characteristics and information representation, an in-depth understanding of the mechanism is still lacking. Our study extends the literature by shedding light on the role of task autonomy in the fit between task characteristics and information representation.

Study	Aspect of Problem Specifications	Dependent Variables
Yang et al. (2009)	Length of problem specifications	Solver quantity
Erat and Krishnan (2011)	Completeness of problem specifications	Solver quantity
Wu et al. (2019)	Linguistic style in in problem specifications	Solver quantity
Jiang et al. (2021)	Information ("conceptual objectives" or "execution guidelines") in problem specifications	Solver quantity and solver effort
Yin et al. (2022)	Writing strategy of specifications (requirement-oriented and reward-oriented)	Solver quantity
This study	Open-ended vs structured problem specifications	Contest quantity, solver quantity, idea quality

Table 1. Studies of Problem Specifications in Crowdsourcing Contests

Theory and Hypotheses Development

Problem specification in project briefs is an important aspect of contests which conveys information about project requirements and signals about seeker preferences for desired solutions (Pollok et al. 2019). Problem specification that is poorly framed and/or contains incomplete and vague information can increase the chance of misinterpretation (Afuah and Tucci 2012; Natalicchio et al. 2017) and result in solutions that do not meet the requirements (Blohm et al. 2013). However, because the focal problems that seekers face can be non-reoccurring or infrequent (e.g., logo or website design) and they may lack the relevant expertise (Jeppesen and Lakhani 2010), some seekers may be unsure about the pertinent information to provide and/or idea attributes to specify in contests. For example, in logo design contests, seekers without design knowledge and training may not know what design features they should specify or how to describe the features in the problem specification. Hence, an unstructured problem specification format, such as one that uses open-ended questions, can require greater cognitive efforts from seekers and can deter some from hosting contests. By contrast, a relatively more structured format, such as using multiple choice questions or slider bars to indicate what they look for in predetermined solution attributes, lowers the prerequisite knowledge and time to describe the problem scope, even and especially for first-time seekers who have not hosted contests before. Thus, we expect there to be more contests when the problem specification format is relatively more structured.

H1. Number of contests is higher when the problem specification format is relatively more structured than when it is relatively less structured.

Problem specification formats can also affect solvers' selection and perception of contests, thereby impacting their contest participation. First, as solvers face limited resources, they will compare ongoing contests and select the one(s) to participate in. By referring to the problem specification of the respective contests, solvers can gauge the fit between the focal problems and their expertise and estimate the needed effort for the respective contests; these factors affect their choice of contests to join due to their concerns for winning and effort economization (Koh 2019; Koh and Cheung 2022). In this regard, a more (less) structured problem specification format should it make easier (harder) for solvers to compare and select contests. Second, a more (less) structured format can give solvers the impression of lesser (greater) task autonomy, or the extent they have freedom and control over how the contest tasks are to be solved (Kaufmann et al. 2011; Zheng et al. 2011). For example, when the problem specification in logo design contests is presented in a structured manner, solvers may perceive seekers' requirements to be less open for interpretation and they have little say in the idea generation process. This can impact solvers' behaviors, as task autonomy generally relates positively to solvers' intrinsic motivation and participation in crowdsourcing contests (Ye and Kankanhalli 2017; Zheng et al. 2011). Therefore, we hypothesize that a

structured problem specification format decreases solver quantity in contests because of stronger solver self-selection and reduced task autonomy perception.

H2. Solver quantity in contests is lower when the problem specification format is relatively more structured than when it is relatively less structured.

Structured problem specification format can negatively affect idea quality. First, structured problem specifications can limit solvers' freedom of creation by imposing unnecessary specific constraints or guidelines (Erat and Krishnan 2011; Sobel 1995). As contests are different in terms of scope, specific requirements appear necessary for some contests and could be redundant for others. Applying a structured problems specification format to all contests increases the chance that unnecessary constraints are imposed. This may cause solvers to focus more on adhering to the given requirement, rather than exploring unconventional or innovative ideas. Second, tightly specified problems are more likely to induce convergent thinking and lead to solutions that are similar in nature (Baer 2014). This can result in a lack of diversity in the ideas generated, as solvers might focus on the same aspects of the problem or follow similar trains of thought. By contrast, a more open-ended problem specification format may encourage solvers to approach the problem from different perspectives, increasing the likelihood of discovering novel and previously unexplored solutions (Jeppesen and Lakhani 2010). Based on these arguments, we expect idea quality to be generally lower in contests when the problem specification format is relatively more structured.

H3. Idea quality in contests is lower when the problem specification format is relatively more structured than when it is relatively less structured.

Data and Method

Empirical Context

99designs is a crowdsourcing contest platform for creative graphic designs. Seekers can initiate contests (e.g., logo, webpage, banner ads) on the platform by formulating the problem specification and setting winning prizes. Solvers then join the contests and submit their ideas or solutions. At the end of the contests, the seekers choose the solutions they want and award the prizes to the winning solvers. An exogenous change occurred on 99designs on January 25, 2011, when the problem specifications of logo contests changed from a relatively open-ended format to a relatively more structured one. Figure 1 shows the stylized problem specification formats for logo contests before and after the change. The most salient change in the format was the replacement of Contest Details section with Visual Style section. Before the format change, seekers had to describe their requirements and expectations of solvers' ideas, which might appear wordy and inconsistent across different contests (See Figure A1 (a) for example). Moreover, this format could be relatively difficult for seekers (especially inexperienced ones) to articulate their requirements and for solvers to discern and compare them across contests. By contrast, the Visual Style section in the new format allowed seekers to conveniently specify their preferences about logo type by answering multiple choice questions, quantitatively indicated style attributes using slider bars (using integer values between -5 and 5), and concisely described the use cases of the logo and color preferences (An example of this is shown in Figure A1 (b)). The problem specification format thus became more structured and comparable among different logo contests.

Our analyses indicate that the change in problem specification structure did not affect the content of the problem specifications (See Table A2). Seekers disclosed a similar number of visual style attributes before and after the change ($M_{before} = 5.04, sd_{before} = 3.24, M_{after} = 4.95\ sd_{after} = 2.01, t = 0.97, p = 0.33$). Hence, the informativeness of the problem specifications was generally unaffected by the change in the problem specification structure, minimizing the concern of a potential confound.

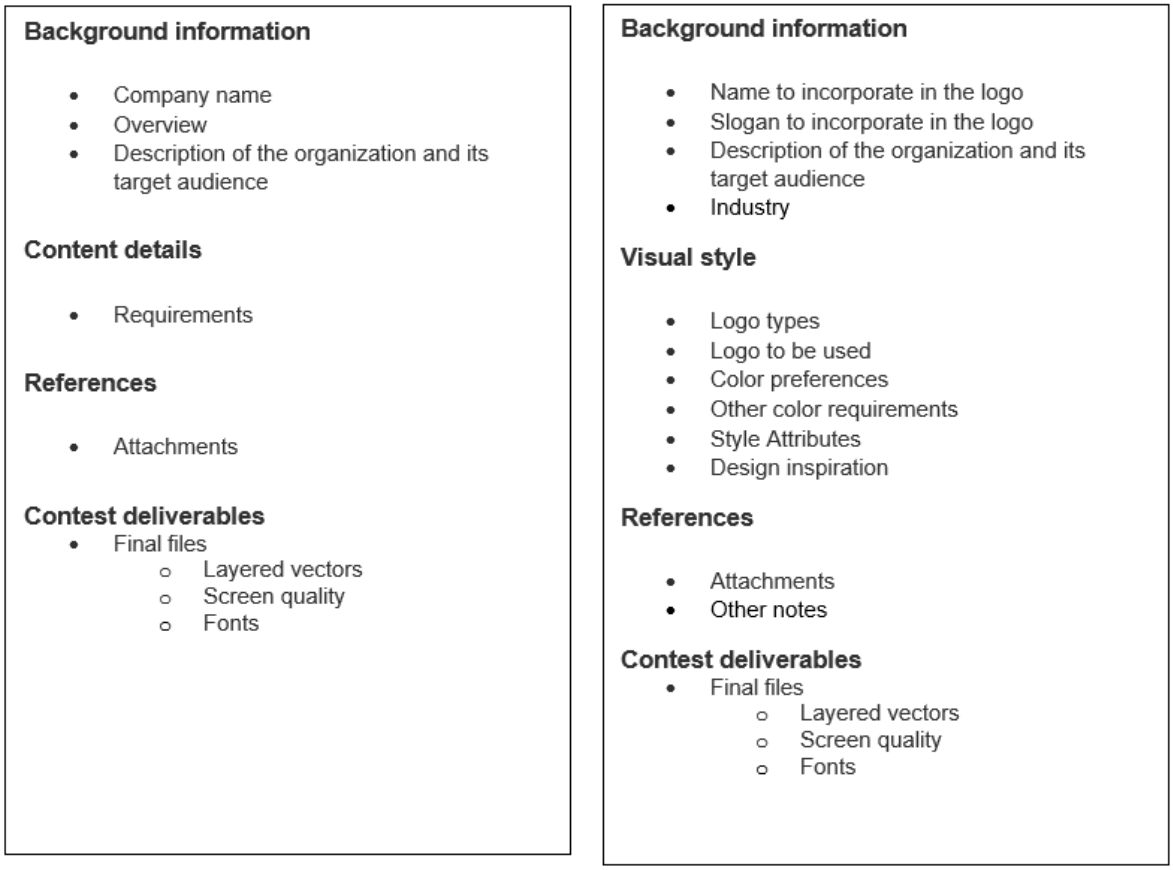


Figure 1. Problem Specification Formats for Logo Contests Before and After Change

Data and Variables

We obtained our dataset from 99designs using a self-developed web crawling program. The data consisted of 3,588 contests (3,219 logo contests and 369 webpage contests) posted six weeks before and six weeks after implementing a more structured problem specification format (from 14 December 2010 to 7 March 2011). For each contest, we collected the contest attributes (prize amount, prize guarantee, number of winners, and solution visibility) and information about solvers and their submissions.

An essential objective for seekers is to receive high-quality ideas in contests. We operationalize *Idea Quality* as the number of high-quality ideas (as rated by seekers) in the respective contests. Seekers could rate a submission between 1- and 5-star or leave it unrated. We measured submission quality by the number of 5-star submissions in individual contests, as having more 5-star submissions should indicate higher submission quality. Table 2 shows the variables in this study.

Variables	Description	Mean	SD
Contest Quantity	Number of contests in each day	21.61	20.19
Solver Quantity	Number of participants in the focal contest	27.56	33.08
Idea Quality	Quantity of 5-star submissions in focal contest	3.13	6.50
Logo	1 for logo contest, 0 for webpage contest	0.90	0.30
Structured	1 for after problem specification format change, 0 for before change	0.60	0.49
Avg Prize	Average prize amount of all contests in each day	428.34	225.40
Prize	Prize amount in focal contest	283.68	164.23
Guaranteed	1 if focal contest guaranteed prize, 0 otherwise	0.42	0.49
Blind	1 if focal contest allowed solvers to see others' submissions; 0 otherwise	0.17	0.38
Multi Winner	1 if focal contest had multiple winners; 0 otherwise	0.02	0.13

Table 2. Description of Variables and Summary Statistics

Econometric Specification

Our identification strategy relied on the exogenous change in the problem specification format. First, to our knowledge, there was no evidence that the platform preannounced the change. Therefore, seekers and solvers were unlikely to anticipate and pre-empt the implementation of a new problem specification format. Second, as formulating the problem specification was necessary for seekers to launch contests and solvers had to refer to the project brief when joining the contests and creating their designs, both parties likely noticed the format change.

As the problem specification format change applied only to logo contests, we used these contests as the treated group. For the control group, we chose webpage contests in 99designs because the problem specification format for these contests remained unchanged throughout the focal period. Furthermore, webpage contests were the second largest category on 99designs in contest quantity, behind logo contests. Using contests on the same platform for the treated and control groups allowed us to minimize unobserved platform-dependent factors.

We estimated the causal effects of the problem specification format on the respective dependent variables using the following difference-in-differences (DID) model:

$$y_{it} = \beta_1 Logo_i + \beta_2 Logo_i \cdot Structured_t + \gamma X_{it} + \mu_t + \varepsilon_{it} \quad \text{[Equation 1]}$$

where $Logo_i$ is coded as 1 for logo contests and 0 for webpage contests, $Structured_t$ is coded as 1 for after the change in the problem specification format and 0 for before the change, X_{it} are control variables, and μ_t is the week fixed effect. The unit of analysis for *Contest Quantity* is at the day level whereas that for *Solver Quantity* and *Idea Quality* is at the contest level.

Results

Preliminary Analyses

Model-free analyses of the impacts of changing the problem specification format for logo contests from less to more structured on 99designs were consistent with our theorizing and hypotheses. The format change increased the average number of logo contests per day by 50.1%. However, the number of solvers in logo contests was 27.6% lower after the change, implying that logo contests with a more structured problem specification tended to have fewer solvers participating. This could adversely affect the quality of ideas for seekers, as evident by a 20.8% reduction in the average number of 5-star submissions in logo contests after the format change.

	Problem Specification Format: Relatively less structured	Problem Specification Format: Relatively more structured	Δ	Percentage Change
Average number of logo contests per day (H1)	30.64 (12.84)	46.00 (13.63)	15.36 *** (2.86)	50.1%
Number of solvers in logo contests (H2)	34.92 (34.97)	25.28 (33.32)	-9.64 *** (1.23)	-27.6%
Average number of 5-star submissions in logo contests (H3)	3.65 (7.06)	2.90 (6.22)	-0.75 *** (0.24)	-20.8%

TABLE 3. Preliminary Analyses

Main Results

Table 4 shows the results of our main analyses. In Model 1, *Logo* x *Structured* is positive ($\beta = 13.74, p < 0.001$), indicating that there were more logo contests per day after the problem specification format became more structured, supporting H1. In Model 2, the negative *Logo* x *Structured* ($\beta = -7.55$, $p < 0.05$) implies the quantity of solvers was generally lower in contests with a relatively structured problem specification format, supporting H2. In Model 3, the negative *Logo* x *Structured* ($\beta = -1.21$, $p < 0.05$) indicates the quantity of 5-star submissions reduced after the problem specification format became relatively structured, supporting H3.

	Model 1	Model 2	Model 3
DV:	Contest Quantity	Solver Quantity	Idea Quality
Logo x Structured	13.74*** (2.93)	-7.55* (3.67)	-1.21* (0.59)
Logo	27.24*** (2.23)	65.45*** (6.36)	2.38** (0.84)
Avg Prize	0.00 (0.00)		
Prize		0.12*** (0.02)	0.00** (0.00)
Guaranteed		12.89*** (1.03)	1.88*** (0.22)
Blind		-10.70*** (1.66)	-0.56 (0.34)
Multi Winner		-2.54 (6.02)	3.69* (1.68)
Contest Quantity		-0.08* (0.04)	-0.01 (0.01)
Solver Quantity			0.03*** (0.01)
Week fixed effect	Yes	Yes	Yes
Observations	168	3,588	3,588
R^2	0.797	0.259	0.083
Within R^2	0.786	0.243	0.080
Robust standard errors in parentheses. * $p < .05$ ** $p < .01$ *** $p < .001$			

Table 4. Main Results

Additional Analyses

Pre-treatment Trends

One may be concerned that the relationship between our dependent variables and structured problem specifications could be driven by unobservable confounding factors prior to the format change. To address

this, we followed Liu and Bharadwaj (2020) and evaluated the effect of format change in an event study framework by setting the time of treatment to zero and measuring the difference between the logo and webpage contests before and after this period. Specifically, we estimated the following equation:

$$y_{it} = \sum_h \beta_h Treated_i Week_h + \gamma X_{it} + \varepsilon_{it} \quad \text{[Equation 2]}$$

where $Week_h = 1$ if contest i was launched h weeks after the treatment (or launched -h weeks before the treatment if $h < 0$). β_h represented the difference between the treatment and control contests in period h compared to the last pretreatment period (h = -1).

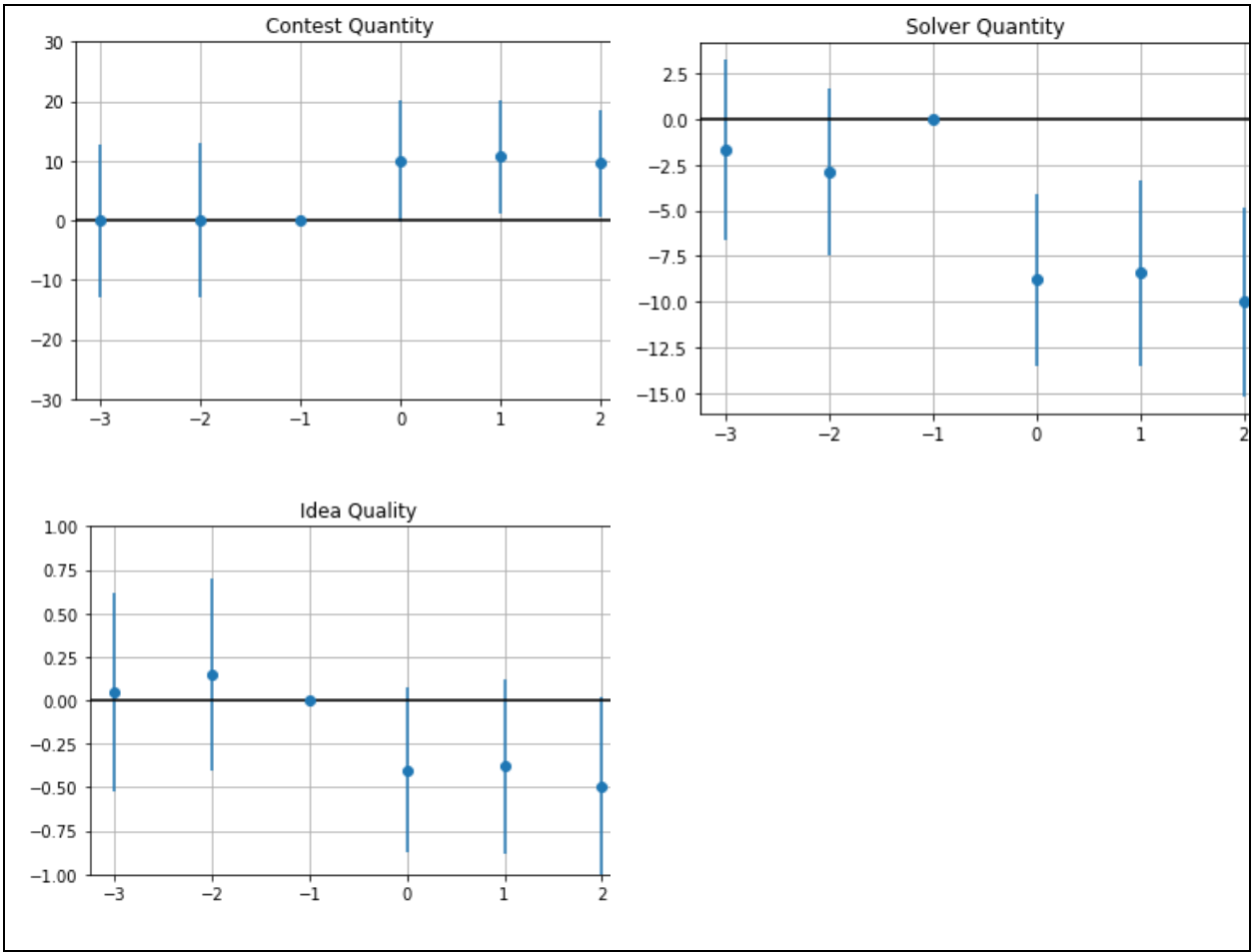


Figure 2. Impacts of Structured Problem Specifications on in Contests

Figure 2 presents the coefficients and corresponding 95% confidence intervals for our dependent variables. There were no significant effects in the three weeks before the change in problem specification format for all dependent variables. These results provide support for the parallel trend assumption in our DID analyses. (Consistent with the main analyses, the effects were significant in the three weeks after the change.)

Seeker Analyses

In Hypothesis 1, we theorize that a structured problem specification format makes it easier for first-time seekers to formulate their problems. To validate this argument, we compared the number of first-time seekers (i.e., those who had not launched any contests before) for logo and webpage contests before and after the format change. The statistics in Table 5 suggest that most seekers launching contests in the focal period indeed did it for the first time, consistent with our argument.

	Logo Contests			Webpage Contests		
	Before	After	Change%	Before	After	Change%
Total Contests	1287	1932	50.1	153	216	41.2
Total Seekers	1241	1873	50.1	145	203	40.0
First-time Seekers	1152	1781	54.6	125	178	42.4

Table 5. First Time Seekers Before and After Change

We ran DID analysis on the count of contests by first-time seekers per day. The model specification is similar to Equation 1, except that we only accounted for those contests launched by first-time seekers. The results are presented in Table 6. The positive *Logo* x *Structured* ($\beta = 13.87,\ p < 0.001$) suggests that the number of first-time seekers increased after the problem specification format became more structured, supporting our theorization.

	Model 1
DV:	Contests Quantity (First-Time Seekers Only)
Logo x Structured	13.87*** (2.76)
Logo	25.45*** (2.14)
Prize	0.00 (0.00)
Week fixed effect	Yes
Observations	168
R^2	0.801
Within R^2	0.788
Robust standard errors in parentheses. * $p < .05$ ** $p < .01$ *** $p < .001$	

Table 6. Regression Result for First-Time Seekers

A concern is that the change in problem specification format might have led to other simultaneous changes in the seeker side, such as prize and contest duration, and impacted solver participation behaviors and decisions. To address this, we ran DID models with the contest prize as the dependent variable. In Table 7, Model 1 is the baseline model without control variables, and we controlled for contest attributes in Model 2. In both models, *Logo* x *Structured* is not significant, suggesting that the format change did not substantially affect the contest prize. (The impact of the format change on contest duration is not a concern because all contests had the same duration in our focal period.)

	Model 1	Model 2
DV:	Prize	Prize
Logo x Structured	-5.35 (30.38)	3.04 (29.79)
Logo	-390.39*** (23.69)	-373.26*** (22.34)
Guaranteed		14.00*** (3.87)
Blind		48.20*** (6.66)
Multi Winner		73.73 (40.40)
Contest Quantity		0.11 (0.12)
Week fixed effect	Yes	Yes
Observations	3,588	3,588
R^2	0.544	0.546
Within R^2	0.529	0.544
Robust standard errors in parentheses. * $p < .05$ ** $p < .01$ *** $p < .001$		

Table 7. Regression Result for Prize

Solver Analyses

In Hypothesis 2, we theorized that a more structured problem specification format can deter solver participation because of the reduction in perceived task autonomy. To provide support for this argument, we ran DDD analyses on solvers' contest participation and average submissions in contests before and after the change.

In theory, the effect of task autonomy can depend on solvers' self-efficacy, or their capabilities to organize and execute the required actions to produce given attainments (Bandura 1997). According to Langfred and Moye (2004), individuals with higher self-efficacy are more likely to prefer discretion in their tasks and believe they can improve their performance by taking advantage of task autonomy than those with lower self-efficacy. Building on this, we should expect solvers with high self-efficacy to participate in fewer contests after the problem specification became more structured than those with low self-efficacy.

We measured *Solvers Efficacy* using the number of prior contests won by the solver. As individuals' accomplishments and experiences are influential sources of efficacy information (Bandura 1997; Langfred and Moye 2004), the number of contests the respective solvers won should be a reasonable proxy of their self-efficacy. Higher self-efficacy solvers were likely to be better at navigating the competition and completing the tasks in contests, and thus have better contest performance.

We log-transformed solver efficacy to reduce skewness. We also controlled for solvers' preferences for contests (*Avg Solver Quantity*, *Avg Top Solver Efficacy*, and *Avg prize*) and included solver fixed effect. In Model 1, *Logo* x *Structured x log(Solver Efficacy+1)* ($\beta = -0.99$, $p < 0.001$) is negative, suggesting that high efficacy solvers participated in fewer contests after the change. In Model 2, *Logo* x *Structured x log(Solver Efficacy+1)* ($\beta = -0.33$) is not significant, implying that high efficacy solvers submitted similar number ideas in respective contests after the change. This alleviates the concern that participating in fewer contests may lead to solvers spending more effort in respective contest they joined. Therefore, the results provide evidence for the mechanism of task autonomy in solvers' reduced participation after the problem specification format became more structured.

	Model 1	Model 2
DV:	Contests Participated	Average Submissions
Logo x Structured x log(Solver Efficacy+1)	-0.99***(0.20)	-0.33 (0.20)
Avg Solver Quantity	-0.01***(0.00)	-0.00*** (0.00)
Avg Top Solver Efficacy	0.10***(0.00)	0.07*** (0.00)
Avg Prize	0.00*** (0.00)	0.00*** (0.00)
Solver fixed effect	Yes	Yes
Observations	29,020	29,020
R^2	0.796	0.919
Within R^2	0.121	0.643
Robust standard errors in parentheses. * $p < .05$ ** $p < .01$ *** $p < .001$		

Table 8. Solver Level Analysis

Improving Idea Quality in Contests with Structured Problem Specification Format

Our results show that a structured problem specification format can lead to fewer high-quality ideas in contests. It is necessary to see how seekers can mitigate this in contests that use such a format. As having more solvers can increase the extent of parallel exploration and idea diversity and thus contribute to greater likelihood of extreme outcomes (i.e., highly rated ideas) (Boudreau et al. 2011; Terwiesch and Xu 2008), we posit that seekers hosting contests with structured problem specification format can consider improving the attractiveness of their contest prizes; this tactic of strengthening extrinsic incentives can be particularly critical in attracting solvers given that the negative impact of a structured format on the intrinsic aspect (i.e., task autonomy) of contests.

Table 9 shows the DDD analyses of the impact of contest prizes in contests. In Model 1, the negative *Logo* x *Structured* ($\beta = -66.82$, $p < 0.001$) indicates that a structured format reduced the number of participating solvers. However, the positive *Logo* x *Structured* x *Prize* ($\beta = 0.24$, $p < 0.001$) suggests this could be mitigated by higher prizes, as we posited above. All else being equal, every ten-dollar increase in prize attracted 2.4 additional participating solvers in our data. In Model 2, *Solver Quantity* ($\beta = 0.03$, $p < 0.01$) positively affected idea quality. Thus, having more solvers join contests did indeed contribute to more high-quality ideas.

	Model 1	Model 2
DV:	Solver Quantity	Idea Quality
Logo x Structured x Prize	0.24*** (0.03)	0.00 (0.00)
Logo x Structured	-66.82*** (7.95)	-2.33* (1.14)
Logo	44.84*** (4.52)	2.18** (0.79)
Prize	0.07*** (0.01)	0.00* (0.00)
Guaranteed	12.07*** (0.90)	1.90*** (0.22)
Blind	-10.40*** (1.54)	-0.58 (0.33)
Multi Winner	1.77 (5.63)	3.76* (1.67)
Contest Quantity	-0.07 (0.04)	-0.01 (0.01)
Solver Quantity		0.03** (0.01)
Week fixed effect	Yes	Yes
Observations	3,588	3,588
R^2	0.373	0.084
Within R^2	0.360	0.081
Robust standard errors in parentheses. * p < .05 ** p < .01 *** p < .001		

Table 9. Improving Solver Efficacy and Idea Quality

Discussions

This study examines the impact of problem specification format in crowdsourcing contests using a natural experiment setup on 99designs. We analyze how the problem specification format, in terms of how structured it is, can affect the number of contests launched, which to our knowledge has not been studied in prior crowdsourcing contest research. We find that requiring seekers to specify their problem using a more structured format can lead to more contests launched per day. We also observe that a more structured format can have adverse effects on the quantity of solvers and idea quality in contests. The findings in this study complement research that investigates the effects of different aspects of problem specification, such as length, linguistic style, and information completeness, on seekers and contest outcomes (Erat and Krishnan 2011; Jiang et al. 2021; Wu et al. 2019; Yang et al. 2011) .

An insight from this study is that the project specification format affects both seekers and solvers in crowdsourcing contests, and its impacts are not always positive. For seekers, a relatively structured problem specification helps them frame their problems and articulate their needs, making it easier to launch contests. However, their contests may attract fewer solvers and receive fewer good ideas. For solvers, we theorize that a more structured format helps them better understand the project scope and requirements but may also reduce perceived task autonomy. Our research highlights the need for future studies to consider the impacts of contest attributes from the perspectives of seekers *and* solvers. For example, prior studies examine the impact of certain contest attributes, such as contest prize (Ales et al. 2017) and feedback (Jian et al. 2019; Wooten and Ulrich 2017), on solvers. However, increasing contest prizes or providing feedback requires seekers to exert more resources and effort in contests. This can affect their motivation to launch contests, which in turn influences solvers' behavior. Apart from the theoretical implication, our findings have practical implications for contest platforms, as how information is presented in contests affect both seekers and solvers and thus the platforms' intermediary role in facilitating seekers find good solutions from the crowd.

Idea quality is a crucial consideration for seekers in crowdsourcing contests, as their main objective is to acquire high-quality solutions from the crowd. Our theory and results show that contests that use a relatively more structured specification format are likely to receive fewer high-quality ideas. Although the format is determined by contest platforms and seekers have little control of it, there are tactics that seekers can use to help improve the number of high-quality ideas in their contests. Our additional analyses show that seekers can offer higher contest prizes to increase the number of solvers in their contests, so as to

increase the number of high-quality ideas. Future research can further explore other non-monetary approaches to attract solvers, in crowdsourcing contests.

We conclude by discussing some limitations in the research and avenues for future studies. We use the quantity of 5-star submissions rated by seekers in contests to measure idea quality in contests. New studies can measure idea quality in different ways, such as using peer evaluations or expert ratings, to improve the generalizability of this study. While we focused on the impact of problem specification format on idea quality, new studies can examine the effect on other aspects of solvers' ideas, such as novelty and feasibility. In addition, our empirical context focuses on graphical design contests, which is a category of innovative crowdsourcing contests. The implicit assumption is that these tasks involve a certain level of creativity and task autonomy is therefore important for solvers' participation and idea generation. Further study can explore whether structured problem specification is more suitable for other tasks. Lastly, we used webpage design contests as the control group, which can be different from the logo design contests, in terms of several attributes, such as the effort needed. Future work may try to address to add to the validity of the findings.

References

Afuah, A., and Tucci, C. L. 2012. "Crowdsourcing as a Solution to Distant Search," Academy of Management Review (37:3), pp. 355-375.

Ales, L., Cho, S.-H., and Körpeoğlu, E. 2017. "Optimal Award Scheme in Innovation Tournaments," Operations Research (65:3), pp. 693-702.

Baer, J. 2014. Creativity and Divergent Thinking: A Task-Specific Approach. Psychology Press.

Bandura, A. 1997. Self-Efficacy: The Exercise of Control. New York, NY, US: W H Freeman/Times Books/ Henry Holt & Co.

Blohm, I., Leimeister, J. M., and Krcmar, H. 2013. "Crowdsourcing: How to Benefit from (Too) Many Great Ideas," MIS Quarterly Executive (12:4), pp. 199-211.

Boudreau, K. J., Lacetera, N., and Lakhani, K. R. 2011. "Incentives and Problem Uncertainty in Innovation Contests: An Empirical Analysis," Management Science (57:5), pp. 843-863.

Brabham, D. C. 2010. "Moving the Crowd at Threadless: Motivations for Participation in a Crowdsourcing Application," Information, Communication & Society (13:8), pp. 1122-1145.

Deci, E. L. 1973. "Intrinsic Motivation,").

Deng, X., Joshi, K. D., and Galliers, R. D. 2016. "The Duality of Empowerment and Marginalization in Microtask Crowdsourcing: Giving Voice to the Less Powerful through Value Sensitive Design," MIS Quarterly (40:2), pp. 279-302.

Erat, S., and Krishnan, V. 2011. "Managing Delegated Search over Design Spaces," Management Science (58:3), pp. 606-623.

Haas, M. R. 2010. "The Double-Edged Swords of Autonomy and External Knowledge: Analyzing Team Effectiveness in a Multinational Organization," Academy of Management Journal (53:5), pp. 989-1008.

Hackman, J. R., and Oldham, G. R. 1975. "Development of the Job Diagnostic Survey," Journal of Applied Psychology (60:2), p. 159.

Hutchinson, J. W., Alba, J. W., and Eisenstein, E. M. 2010. "Heuristics and Biases in Data-Based Decision Making: Effects of Experience, Training, and Graphical Data Displays," Journal of Marketing Research (47:4), pp. 627-642.

Jeppesen, L. B., and Lakhani, K. R. 2010. "Marginality and Problem-Solving Effectiveness in Broadcast Search," Organization Science (21:5), pp. 1016-1033.

Jian, L., Yang, S., Ba, S., Lu, L., and Jiang, L. C. 2019. "Managing the Crowds: The Effect of Prize Guarantees and in-Process Feedback on Participation in Crowdsourcing Contests," MIS Quarterly (43:1), pp. 97-112.

Jiang, Z., and Benbasat, I. 2007. "The Effects of Presentation Formats and Task Complexity on Online Consumers' Product Understanding," MIS quarterly (31:3), pp. 475-500.

Jiang, Z., Huang, Y., and Beil, D. R. 2021. "The Role of Feedback in Dynamic Crowdsourcing Contests: A Structural Empirical Analysis," Management Science (68:7), pp. 4858-4877.

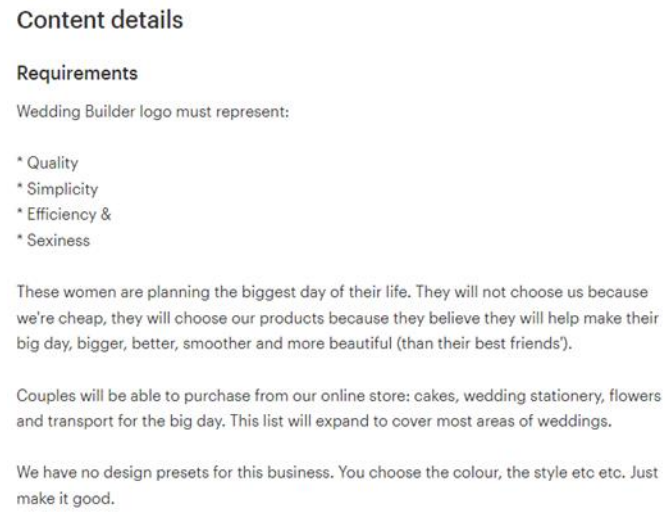
Kaufmann, N., Schulze, T., and Veit, D. 2011. "More Than Fun and Money. Worker Motivation in Crowdsourcing–a Study on Mechanical Turk," AMCIS 2011 Proceedings.

Koh, T. K. 2019. "Adopting Seekers' Solution Exemplars in Crowdsourcing Ideation Contests: Antecedents and Consequences," Information Systems Research (30:2), pp. 486-506.

Koh, T. K., and Cheung, M. Y. M. 2022. "Seeker Exemplars and Quantitative Ideation Outcomes in Crowdsourcing Contests," Information Systems Research (33:1), pp. 265-284.
Langfred, C. W., and Moye, N. A. 2004. "Effects of Task Autonomy on Performance: An Extended Model Considering Motivational, Informational, and Structural Mechanisms," Journal of Applied Psychology (89:6), p. 934.
Liu, J., and Bharadwaj, A. 2020. "Drug Abuse and the Internet: Evidence from Craigslist," Management Science (66:5), pp. 2040-2049.
Lurie, N. H., and Mason, C. H. 2007. "Visual Representation: Implications for Decision Making," Journal of Marketing (71:1), pp. 160-177.
Mo, J., Sarkar, S., and Menon, S. 2018. "Know When to Run: Recommendations in Crowdsourcing Contests," MIS Quarterly (42:3), pp. 919-944.
Natalicchio, A., Messeni Petruzzelli, A., and Garavelli, A. C. 2017. "Innovation Problems and Search for Solutions in Crowdsourcing Platforms – a Simulation Approach," Technovation (64-65), pp. 28-42.
Pollok, P., Lüttgens, D., and Piller, F. T. 2019. "Attracting Solutions in Crowdsourcing Contests: The Role of Knowledge Distance, Identity Disclosure, and Seeker Status," Research Policy (48:1), pp. 98-114.
Shaft, T. M., and Vessey, I. 2006. "The Role of Cognitive Fit in the Relationship between Software Comprehension and Modification," MIS quarterly (30:1), pp. 29-55.
Sobel, D. 1995. "Longitude: The True Story of a Lone Genius Who Solved the Greatest Scientific Problem of His Time," New York: Walker).
Terwiesch, C., and Xu, Y. 2008. "Innovation Contests, Open Innovation, and Multiagent Problem Solving," Management Science (54:9), pp. 1529-1543.
Vessey, I. 1991. "Cognitive Fit: A Theory-Based Analysis of the Graphs Versus Tables Literature*," Decision Sciences (22:2), pp. 219-240.
Vessey, I., and Galletta, D. 1991. "Cognitive Fit: An Empirical Study of Information Acquisition," Information Systems Research (2:1), pp. 63-84.
Wooten, J. O., and Ulrich, K. T. 2017. "Idea Generation and the Role of Feedback: Evidence from Field Experiments with Innovation Tournaments," Production and Operations Management (26:1), pp. 80-99.
Wu, S., Liu, Q., Sun, B., and Zhao, X. 2019. "Understanding the Effect of Task Descriptions on User Participation in Crowdsourcing Contests: A Linguistic Style Perspective," Proceedings of the 52nd Hawaii International Conference on System Sciences.
Xie, J. L., and Johns, G. 1995. "Job Scope and Stress: Can Job Scope Be Too High?," Academy of Management Journal (38:5), pp. 1288-1309.
Yang, Y., Chen, P.-y., and Banker, R. 2011. "Winner Determination of Open Innovation Contests in Online Markets," in: 32nd International Conference on Information Systems. pp. 3737-3752.
Yang, Y., Chen, P.-Y., and Pavlou, P. 2009. "Open Innovation: An Empirical Study of Online Contests," ICIS 2009 proceedings, p. 13.
Ye, H. J., and Kankanhalli, A. 2017. "Solvers' Participation in Crowdsourcing Platforms: Examining the Impacts of Trust, and Benefit and Cost Factors," The Journal of Strategic Information Systems (26:2), pp. 101-117.
Yin, X., Zhu, K., Wang, H., Zhang, J., Wang, W., and Zhang, H. 2022. "Motivating Participation in Crowdsourcing Contests: The Role of Instruction-Writing Strategy," Information & Management (59:3), p. 103616.
Zheng, H., Li, D., and Hou, W. 2011. "Task Design, Motivation, and Participation in Crowdsourcing Contests," International Journal of Electronic Commerce (15:4), pp. 57-88.

Appendices

(a)



(b)

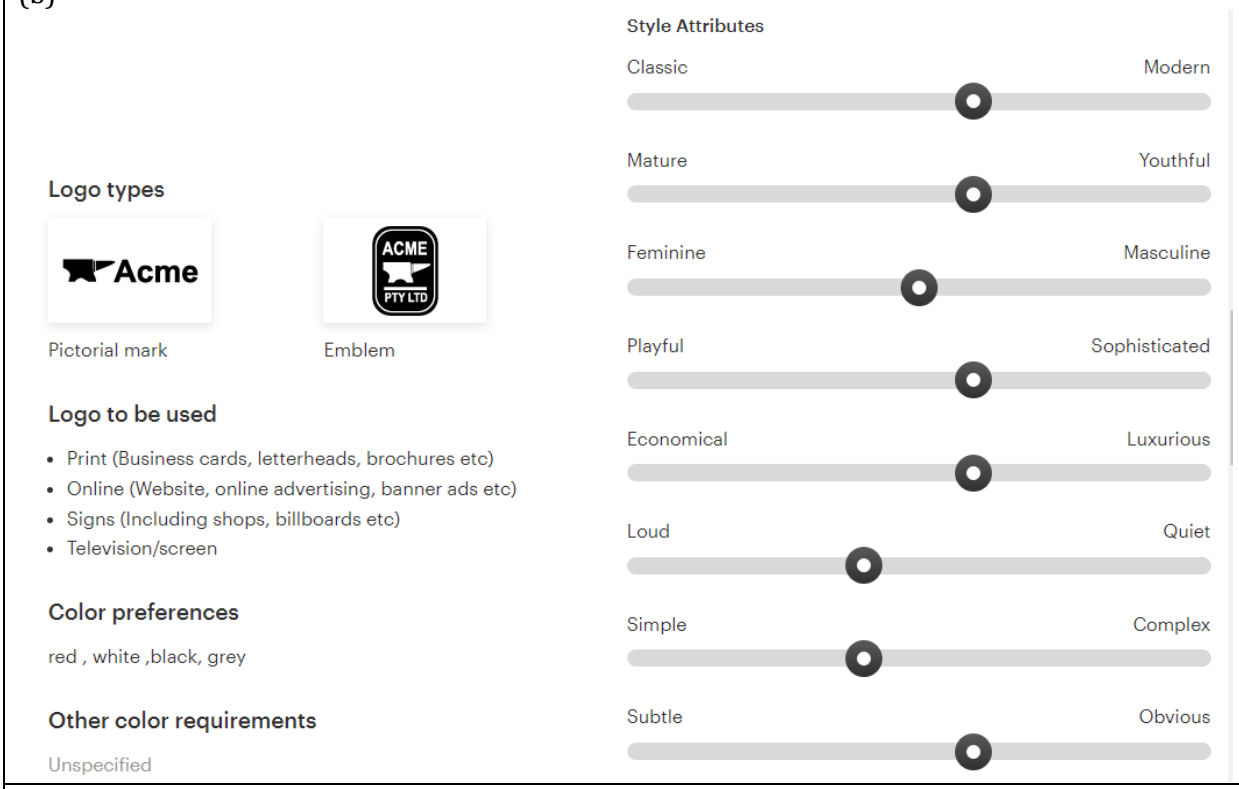


Figure A1. Examples of (a) Open-Ended and (b) Structured Problem Specification for Logo Contests

We compared the informativeness of the problem specifications in contests before and after in terms of the following five attributes: (1) described organization (2) mentioned industry (3) specified logo types (4) specified preferred color (5) average number of visual attributes requirement disclosed. The results suggest that there were no significant differences in all these attributes.

Described organization: we consider seekers described their organization if they provide information in the field "Description of the organization and its target audience" in either open-ended or structured problem specifications.

Mentioned industry: we consider seekers mentioned industry if (1) they explicitly mentioned which industry they belong to in the open-ended problem specifications or (2) The field "Industry" in the structured problem specifications is non-empty.

Specified logo types: we consider seekers specified logo types if (1) they explicitly mentioned how their logo will be used in the open-ended problem specifications, e.g., print, online, screen etc. or (2) The field "Logo to be used" in the structured problem specifications is non-empty.

Specified preferred color: we consider seekers specified preferred color if (1) they explicitly mentioned their preferred color in the open-ended problem specifications or (2) The field "Color preferences" in the structured problem specifications is non-empty.

Average Number of Visual Attributes Requirement: (1) We calculated the number of visual style related adjectives provided by seekers in the Requirement section in open-ended problem specifications. (2) We calculated the number of non-zero style attributes in the structured problem specifications.

	Before(N=1287)	After(N=1932)	*p*
% Contests Described Organization	100%	99.9%	0.41
% Contests Mentioned Industry	29.8%	30.0%	0.87
% Contests Specified Logo Types	93.4%	94.5%	0.21
% Contests Specified Preferred Color	74.7%	72.6%	0.19
Average Number of Visual Attributes Requirement	5.04(3.24)	4.95(2.01)	0.33

Table A1. Problem specification Informativeness Before and After Change