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“DOES GOD PLAY DICE?” – RANDOMNESS VS. DETERMINISTIC EXPLANATIONS OF CROWDSOURCING SUCCESS

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INTRODUCTION

Increasingly firms use crowdsourcing tournaments to outsource creative tasks such as idea generation to gather high quality solutions with high levels of originality and innovativeness (Afuah & Tucci, 2012; Bayus, 2012; Bullinger, Neyer, Rass, & Moeslein, 2010; Dahlander & Magnusson, 2008; Hutter, Hautz, Fuller, Mueller, & Matzler, 2011; Terwiesch & Xu, 2008). While a number of such crowdsourcing tournaments were tremendously successful (Boudreau & Lakhani, 2009; Huston & Sakkab, 2006) others failed to produce the desired outcome. This prompted many scholars to investigate the factors determining crowdsourcing success, both conceptually (e.g. Afuah & Tucci, 2012; Pisano & Verganti, 2008; Terwiesch & Xu, 2008) and empirically (e.g. Boudreau, Lacetera, & Lakhani, 2011; Jeppesen & Lakhani, 2010). The underlying (implicit) assumption of the vast majority of studies is that the creative output generated by crowdsourcing tournaments is (1) determined by specific activities set by the crowdsourcing organizers, the characteristics of the participants attracted, and specific situational factors, (2) which are sufficiently general and stable to describe them empirically, and (3) can at least to some degree be influenced by the firm employing the crowdsourcing ideation tournament. Yet findings are quite heterogeneous.

In this article, we suggest that this lack of a consensus may be due to the inherent limitations of the deterministic perspective. We investigate to what degree the output quality of crowdsourcing tournaments is in fact random. As the physicist and Nobel laureate Max Born puts it: “chance is a more fundamental conception than causality” (Born in Mlodinow, 2009: 195). There are many indicators that this also holds in the business context (Ayton & Fischer, 2004; Fisman, Khurana, & Rhodes-Kropf, 2005; Langer, 1975; Mlodinow, 2009; Tyszka, Zielonka, Dacey, & Sawicki, 2008). Managers and other decision makers often misperceive patterns, order, and causality in data structures that are in fact random (Kahneman, 2011). This might also explain why research has not taken up this perspective in the numerous studies on crowdsourcing success even though some few prior studies reveal indications of randomness (Bayus, 2012; Boudreau et al., 2011). Our research question thus is how the explanatory power of randomness and deterministic causal factors compare in explaining the output quality of

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crowdsourcing tournaments. It is important to know which of the two explanations matter more as they have opposing managerial implications. If on the one hand the success of crowdsourcing is determined by specific factors, then it is important to carefully design tournaments in a way that it corresponds to these factors. If on the other hand success is random, all that matters was to get an as large crowd as possible, corresponding to the law of large numbers.

EXPLANATIONS OF CROWDSOURCING TOURNAMENT SUCCESS

The Deterministic Perspective

There is a growing body of literature – both conceptual and empirical – that aims to explain why and under what conditions crowdsourcing may be successful (Afuah & Tucci, 2012, Bayus, 2012; Boudreau, Lacetera, & Lakhani, 2011; Lakhani et al., 2007; Frey, Lüthje & Haag, 2011; Jeppesen & Lakhani, 2010; Leimeister et al., 2009; Malone et al., 2010; Poetz & Schreier, 2012; Terwiesch & Xu, 2008; Zhao & Zhu 2012). A review of this literature reveals that it shares a common perspective: crowdsourcing success is determined by a range of specific factors. Numerous such factors have been within the categories of as e.g. the design of the tournament, characteristics of the attracted crowd and situational factors. We call this view "deterministic" as it assumes that provided that these antecedent factors have the 'right' values according to theory, success of a crowdsourcing event will inevitably happen. This view is therefore a manifestation of the concept of causal determinism that reflects the idea that everything that happens or exists is caused by antecedent conditions (Hoefer, 2008). A broad range of theories is used as a theoretical underpinning of this perspective in crowdsourcing. Such theories include primarily theories on problem solving and creativity. Specifically, concepts such as motivational aspects of creative performance (Afuah & Tucci, 2012; Frey, Lüthje & Haag, 2011; Terwiesch & Xu, 2008), a social network perspective on creativity (Bullinger et al., 2010; Perry-Smith & Shalley, 2003), marginality and a perspective-heuristic view on problem solving (Jeppesen & Lakhani, 2010), local and distant search (Afuah & Tucci, 2012), the recombinant nature of innovation (Fleming, 2001; Terwiesch & Xu, 2008), analogical reasoning in the creative process (Dahl & Moreau, 2002; Franke, Poetz, & Schreier, 2013; Page, 2007), prior knowledge as a source for opportunity recognition (Frey, Lüthje & Haag, 2011; Shane, 2000), and the lead user concept (Poetz & Schreier, 2012; von Hippel, 1986) have been referred to as theoretical bases.

The deterministic perspective on crowdsourcing success is clearly the dominant view in the literature. This observation is hardly surprising as there are systematic reasons for the predominance of the deterministic view. First, humans tend to perceive an "illusion of control" in the sense that they perceive control even in objectively random-driven events (Langer, 1975). Second, humans tend to fall victim of the so-called "clustering illusion" (Gilovich, 1993), a tendency to erroneously perceive streaks or clusters in small samples drawn from random distributions. The deeper reason for both the "illusion of control" and the "clustering illusion" can be found in the psychology of control. Humans prefer to exercise and perceive control over their environment rather than being exposed to randomness (Hamerman & Johar, 2013). White (1959) emphasized in his seminal article on human motivation that the need to control the environment is most central to the human species. After all, this need is crucial for our self-concept, sense of self-esteem, and optimism (e.g. Fast, Gruenfeld, Sivanathan & Galinsky, 2009; Scheier, Carver & Bridges, 1994; Skinner, 1995). And Hawking (1999) states that many scientists have a deep emotional attachment to determinism.

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To summarize, there may be a natural bias towards the deterministic perspective of crowdsourcing success due to various psychological processes. However, there may be an alternative perspective to explain the success of ideation-based crowdsourcing tournaments: randomness.

The Randomness Perspective

Random is commonly referred to as lack of structure, pattern and predictability (Chaitin, 2001). In random events only chance drives the outcome and "luck" emerges as the predominant force. No amount of motivation, skill, knowledge, experience and situational factors can give an actor a comparative advantage in such situations (Bennett, 1998), i.e. each actor has an equal chance of winning.

There is a long tradition in the history of science, especially physics, in debating the actual existence of randomness (e.g. Popper, 1988; Earman, 1986; Butterfield, 1998; Hawking, 1999; Hoefer, 2010). In fact, the view of scientific determinism does strictly deny the existence of randomness. Its underlying idea is that, if one knows the positions and speeds of all particles in the universe, one could calculate their behavior at any other time, in the past or future (Laplace, 1819; Earman, 1986; Hoefer, 2010). The famous quote of Albert Einstein "God does not play dice" reflects his strong attachment to scientific determinism and was meant as a response to emergent scientific work in quantum mechanics that suggested to abandon this view (Hawking, 1999). However, state-of-the art insights and theories from physics reveal that one can only calculate probabilities but not definite predictions about future states (Earman, 1986; Razavy, 2011).

Despite the ongoing debate on its existence and scope, many different fields are concerned with randomness such as the physical sciences, mathematics, statistics, biology, information science, and finance (Bennett, 1998; Chaitin, 2001). In general, applications of randomness in the sciences recognize a lack of predictability, but admit regular patterns in the occurrences of events whose outcomes are uncertain. Randomness also has been used for studying management processes that lack predictability such as strategy formation (Mintzberg & McHugh, 1985; Mintzberg, 1994), marketing (Holt 2004; Brown, 2005), entrepreneurship (Schumpeter, 1934, Sarasvathy 2007; Dew, 2009), new product development (Eisenhardt & Tabrizi, 1995; Thomke, 2003), and creativity (e.g. Austin, Devin & Sullivan, 2012) by including elements of accident and serendipity.

Creativity is a central process to crowdsourcing and the randomness perspective on crowdsourcing success is closely related to the Darwinian view of creativity, which conceptualizes creativity as a process of blind variation and selective retention. There is considerable empirical evidence for the Darwinian view of creativity both experimental and psychometric (for an overview see Simonton, 1999). There are good reasons to believe that ideation-based crowdsourcing tournaments are in line with the Darwinian perspective of creativity, which emphasizes the predominance of random or quasi-random processes for ideation. On an aggregated level, i.e. the entire crowd, ideation-based crowdsourcing may be a governance mechanism that aims to maximize blind variation in order to identify truly novel ideas.

Empirical insights with respect to scientific discovery also emphasize the random and serendipitous dimension of creative work. The "equal-odds rule", confirmed in numerous studies (Davis, 1987; Simonton, 1997; White & White, 1978), suggests that the number of significant

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contributions is dependent on the number of total contributions, which means, in essence, that creative success is luck. Descriptions of the mental processes that led to e.g. scientific discoveries show that they often entail random combinatorial processes (Holton, 1971; Simonton, 2003). With the aim of finding original and useful solutions, scientists are creating relatively unconstrained recombination of a large but finite set of facts, concepts, techniques, heuristics, themes, questions, goals, and criteria that make up their domain (Campbell, 1960). Also lucky accidents may play a role as illustrated by the many examples of "serendipitous" inventions such as classical conditioning, X-rays, or penicillin (Austin, Devin, & Sullivan, 2012; Shapiro, 1986). Also the surprising frequency of "one-hit-wonders" in music, art and entertainment illustrate this component (Kozbelt, 2008).

Summarizing, there are theoretical arguments for both perspectives aiming to explain crowdsourcing success: determinism and randomness. As of today the controversy between those scholars who defend creativity as a guided capability – and are thus in line with the deterministic perspective on crowdsourcing success – and those who portray it as blind variation and selective retention and thus stress the factor of randomness is unresolved (Kronfeldner, 2010; Schooler & Dougal, 1999). The managerial implications are yet very different. If the creative output of crowdsourcing tournaments is determined by specific organizational design features, situational factors and specific characteristics of the individual problem solvers, then the organizers of such tournaments need to focus on providing the proper organizational design features and situational conditions as well as on attracting individuals with the "right" set of characteristics. If, however, the creative outcome provided by an individual problem-solver is inherently non-predictable, the consequence in crowdsourcing tournaments must be to include as many participants as possible (Boudreau et al., 2011; Terwiesch & Xu, 2008).

METHOD

In order to measure the relative explanatory power of randomness and causal factors we conducted an experimental crowdsourcing tournament with a typical ideation task. We manipulated the organization of the tournament and measured the participants' expertise, their skills, their personality traits, and situational factors. Success of crowdsourcing in new product ideation is mostly conceived as originality of ideas, i.e. the degree how much they differ from existing paradigms and involve radically new functions, designs, and elements (Kristensson, Gustafsson, & Archer, 2004; Terwiesch & Xu, 2008). Therefore, our dependent variable is the originality of the ideas generated.

We used our data for a simulation of crowdsourcing tournaments. This corresponds to the perspective of a company that is rather interested in the outcome of the total crowdsourcing tournament than in the performance of each participant. For each crowdsourcing tournament simulated, we randomly drew participants from the overall sample. As we knew their ideas, we could measure what would have happened had we organized the tournament in this specific way and had been able to attract a crowd with these specific characteristics in these specific situational circumstances. The dependent variable was the originality of the best ideas obtained in this specific tournament. The independent variables were the specific crowds' overall expertise, their skills, their personality traits, and situational factors. Randomness was captured by the size of the crowd, which we varied from 10 to 100 in the 36,400 tournaments we simulated. According to the law of large numbers the chance of getting a high number of spots is a function of the number of dices rolled, given that die casts are actually random. Comparing the

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variances explained by the size of the crowd with the variance explained by all deterministic factors allows an answer to our guiding question in how far the success of crowdsourcing is determined by randomness. A detailed description of the method is available from the authors.

FINDINGS AND DISCUSSION

We tested the causal explanators as described in the research framework with OLS regression analyses. Overall, results allow the conclusion that randomness indeed plays a major role in determining the originality of an idea submitted. The total model including deterministic factors and particularly the inclusion of the crowds' size resulted in a high level of variance explained (Model 1, R^2=.725). Obviously, crowd size explained by far most variance, 5.32 times as much as the other 22 independent variables collectively (Model 2 and 3). The second strongest effect comes from the incentive – again as a crowding out effect (see Table 1).

Table 1 about here

Our finding is crystal clear: randomness rules in our crowdsourcing tournament. The originality of the contributions is explained only to a very limited degree by the 22 deterministic factors we derived from the literature on creative problem-solving and the crowdsourcing tournaments more specifically and hence had incorporated in our measurement. Our simulation shows that randomness outperforms all deterministic factors collectively by 532 %. Generalizing this finding, we suggest that in crowdsourcing tournaments, God indeed plays dices.

We contribute to the quickly evolving literature that investigates the factors explaining the success of crowdsourcing tournaments (Boudreau et al., 2011; Jeppesen & Lakhani, 2010; Leimeister et al., 2009; Poetz & Schreier, 2012; Terwiesch & Xu, 2008). The factor we add to this line of research is systematically from extant factors as it involves a different weltanschauung, namely a non-deterministic perspective. In a way this resembles the discussion in quantum mechanics in how far the world is deterministic or governed by pure chance (Bell, 2004). Randomness is also systematically different from extant factors from another perspective: its effect size is much greater. The obvious conclusion for managers who consider starting a crowdsourcing tournament for their new product ideation processes is that they are well advised to recruit as many participants as possible. The degree in how far this is achieved is far more important than the exact organization and the composition of the crowd attracted. Certainly, there will be minimum qualifications for participants and also we must not forget that an unprofessional, unattractive, or unfair design of the tournament will inevitably result in recruitment problems. However, the clear focus must be to increase the number of participants.

Beyond our contribution to the area of crowdsourcing we also contribute to the more general literature on creativity and the factors determining it. Our findings support the position of advocates of the "equal-odds rule" (Simonton, 1997) who portray creativity as a process of blind variation and selective retention. In our huge sample we found relatively weak evidence that creativity is guided by systematic factors as is purported by their opponents (Kronfeldner, 2010; Schooler & Dougal, 1999).

REFERENCES AVAILABLE FROM THE AUTHORS

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Table 1: Tournament level analysis

	DV= mean originality of the top ten ideas		
	Model 1: All variables	**Model 2: All deterministic factors**	**Model 3: Crowd size**
Crowd size	.782		.782
Organization			
Incentives	-.214	-.218	
Interaction	.091	.102	
Task framing	.012	.014	
Crowds' expertise			
Domain-specific expertise	.019	.025	
Analogous domain expertise	.042	.038	
Ideation task experience	-.029	-.018	
Lead userness	.005	.004	
Crowds' skills			
Business skills	-.012	-.017	
Technical skills	.089	.093	
Creative skills	.006	.004	
Competence profile	.081	.088	
Education level	.017	.015	
Crowds' traits and roles			
Creativity	.036	.038	
Information hub	-.015	-.020	
Boundary spanner	.008	.007	
Outsiderness	-.035	-.048	
Age	.037	.024	
Gender	.017	.008	
Situation			
External support	.012	.013	
Motivation	.085	.092	
Time spent	.003	-.012	
Timing of the tournament	-.016	-.022	
Adj. R^2	**.725**	**.115**	**.612**
R^2	.725	.115	.612
F	4180.553	215,168	57448.48
N	36,400	36,400	36,400

Standardized coefficients are shown. Note that we do not indicate significance levels (due to the permutation design with an artificial sample size of 36,400 all coefficients are significant).