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Organizational Capabilities for Virtual Citizen Science projects - A Critical Realist Approach
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Introduction

There has been a renewed interest in the capabilities micro-foundation literature with a number of scholarly works appearing in many special issues of top ranked journals in recent years. In this paper we seek to add our voice to this burgeoning field. Traditional theorising of capabilities seems to have been polarised on the one hand by utility maximisation of the neoclassical school while on the other by the satisficing principle of bounded rationality. Of late the conversation has taken on an ontological turn and battle lines drawn between methodological individualism and methodological collectivism. Both schools of thoughts are variously illuminating in their own right. However, to the extent that transcending the individualism-collectivism divide offers a mutually inclusive solution we suggest looking at the problem from a third perspective. In this paper we draw on the critical realist ontology to propose a morphogenetic approach to the study of capabilities and its origins. We argue that the emergent nature of capabilities is sympathetic to Archer’s notion of analytical dualism. As such, we expose organizational capabilities as emergent social structures existing in a dialectical and reciprocal interplay between the emergent powers of structure, culture and agency. Defined in terms of patterns of action, we build our argument premised on the objective pre-existence of capabilities which serve to condition the situational logic of action.

Organizational actors faced with objective situations exercise their own subjective properties to weigh the opportunity cost of one course of action over another. Actions endorsing the status quo lead to the reproduction of capabilities (morphostasis) while transformative actions lead to change or dynamic capabilities (morphogenesis). Given that organizations exist in a continuous flow of action, the resulting morphostasis or morphogenesis constitutes the anterior conditioning forces for the new cycle of interaction. By maintaining the ontic differentiation between structure and agency, the conditions of action are therefore rendered analytically separable from action itself; thereby enabling their interplay, as opposed to their mutual interpenetration, to be explored.

The assumptions of the theoretical framework developed in this study are put to the test through a qualitative case study of the Zooniverse. The remainder of this paper is organized as follows. The literature review is aimed at exposing the tension between opposing schools of thought as to the nature of organizational capabilities. We show that these tensions might be resolved if the ontological status of capabilities as emergent is given more than just lip service. We then draw on the morphogenetic approach offered by Archer to explain what we mean by the ontology of capabilities and how these could be conceptualised in a nonreductive manner. The methods section presents details of our field work and the protocols of data analysis. We then discuss our findings and contribution to the literature and practice. The conclusion offers suggestions for future research, as well as a discussion of potential limitations of this work.
Ongoing Debate in the Capabilities Micro-foundation Literature

The rise of the micro-foundation project is viewed in reaction to methodological collectivism inherent in the evolutionary agenda. In the evolutionary parlance, a firm at any time operates largely to a set of decision rules (Nelson & Winter, 1974). These rules enshrine action possibilities constraining and enabling actions of current actors, resulting in habitual practice termed in aggregation as ‘organizational routines’. These routines are the building blocks of a firm’s capabilities, offering ontological security against existential anxieties thus ensuring its survivability. Viewed as a collective effect, routinized practices severely impede on intentionality and conscious motivation for the individual’s action. Responding to this primacy of macro level explanation, the basic motivation for the micro-foundations research agenda (Foss & Pedersen, 2014) is to explicate how routines are created and emerge (and change) from individual action, and how they evolve with the subsequent interaction between individual and collective (Felin & Foss, 2005). Notwithstanding, the micro-foundation project has its own sore point in the form of methodological individualism. This conception or rather misconception is partly promoted by ambiguous and at times erroneous statements of its more vocal advocates. For instance, quoting Abell, Felin, and Foss (2008: 492): “We take the position — associated with “methodological individualism” — that the explanation of firm-level (macro) phenomena in strategic management must ultimately be grounded in explanatory mechanisms that involve individual action and interaction.” It is therefore hardly surprising that some have argued that micro-foundations seem to deny the causal role of structure (Barney & Felin, 2013).

As Elder-Vass (2007b: 474) observes, “methodological individualism usually entails advocating the causal efficacy of human individuals while denying the causal efficacy of social structure.” Thus it would seem that neither the evolutionary emphasis on macro effect nor the micro-foundation’s preoccupation with individuals on their own merit possess adequate explanatory power of firm level behaviour. Notwithstanding, it is nevertheless widely recognised that the individual is always the basic strategic factor of the organization (Barnard, 1968; Felin, Foss, Heimeriks, & Madsen, 2012; Ployhart, Nyberg, Reilly, & Maltarich, 2014). The flip side of this social coin portrays collective constructs such as institutions and structures as emergent and irreducible (Barney & Felin, 2013). As it stands, it seems highly suggestive that the holy grail of capabilities lies in unpacking the micro-macro emergence (Easton, Gilchrist, & Lenney, 2012) if the apparent extremes associated with collectivism and individualism respectively are to be attenuated. Indeed, Barney and Felin (2013) note that simple aggregation may fall wide of the mark, calling for more complex, nonlinear, and “emergent” forms of aggregation. Hence, we agree with Mole and Mole (2010) that to fully account for the interplay between the micro and macro we need one of a selection of meta-theories that are used to examine structure and agency. Some have championed Giddens’ structuration theory (e.g., Pozzebon, 2004; Sarason, Dean, & Dillard, 2006). However, as Barney and Felin (2013) point out, the effort to remove the dichotomy between micro and macro, with concepts such as structuration (or habitus), is not completely satisfactory. The problem with structuration, as remarked by Archer (1995: 102), is that it “merely throws a blanket over the two constituents, ‘structure’ and ‘agency’ which only serves to prevent us from examining what is going on beneath it.” We see critical realism, particularly the version developed by Margaret Archer, as offering a more promising if not nuanced ontological lens to unpack the emergent nature of capabilities.
The Morphogenetic Approach – Theoretical Premise

Contrary to determinism and reductionism, Archer’s (1995) view of societal influence is one mediated by an emergent human property. But such an account of being does not entail the unrestricted freedom of agency from structure (Adams, 2006) associated with the notion of voluntarism. Thus, in her attempt to avoid what she sees as conflationary accounts of human action, Archer makes a case for emergence. She draws on Bhaskar’s notion of “synchronic emergent powers materialism” – SEPM for short, to accentuate a non-reductionist view of reality in which higher-order principles cannot be completely explained by lower-order ones (Bhaskar, 1989: 98). Emergence is essentially relational and embedded in interaction, but nonetheless emergent properties, such as organizational capabilities, are not contained in the elements themselves but could not exist apart from them (Archer, 1982). This ontological stratification gives rise to analytical dualism in which social structures are held to be analytically separate from agential activities. Against this understanding, Archer proposes the morphogenetic approach (see figure 1).

Essentially, the morphogenetic approach is a methodological device premised on the interaction of three autonomous cycles of emergent powers; that of structure, culture and agency. It signifies the understanding that people always act out of structural and cultural circumstances, which their very actions then proceed to modify or sustain (Porpora, 2013). Time is important in this framework, T^1 represents the antecedent circumstances either structural or cultural or both (Porpora, 2013). Archer terms this phase as structural (or cultural) conditioning, as it reflects the contextual conditions faced by an agent involuntary placed within an existing social context. People act within their socio-cultural circumstances over time T^2 - T^3; in doing so gradually altering or sustaining those circumstances. The results at time T^4 are the altered or sustained circumstances (elaboration or reproduction) that comprise the antecedent conditions for any further analysis of action. Archer’s central concern is to avoid falling into one of the twin poles of collectivism or individualism (Mutch, 2010). As such, Archer agrees with Giddens’ primacy of practice (T^2 – T^3) as the generating mechanism of the social. Archer’s notion of structure predating practice seems to suggest that the actions of individuals are fully predetermined by structure. But agents are not generally social dopes; they do not simply frame actions against the

Figure 1: The basic morphogenesis sequence (source: Archer 1995: 193)
structural and cultural dispositions of their environment (at $T^1$). Through their emergent properties individuals actively reflect on the circumstances facing them. It follows therefore that there are two causal forces at work in shaping social actions; the objectivity of the social and the subjectivity of the individual. For Archer, this subjectivity is the essence of our reflexivity, and indeed our humanity. Moreover, Archer refutes any modern conception of actors based on rational choice theory since they do not take into account the causal and pre-existing properties of the environment of an action (Dépelteau, 2008). Instead, value rationality (Archer, 2000) is that cornerstone which help shapes the action of Archer’s subjects.

**Morphogenesis and Organizational Capability**

At its most basic, a capability has been characterised as “the capacity to generate action” (Cohen, Burkhart, Dosi, Egidi, Marengo, Warglien, & Winter, 1996: 683). This understanding views capability as *a priori* to action. Yet others view capability in terms of emerging stable patterns of action, behaviour, or practice (e.g., Eisenhardt & Martin, 2000; Teece & Pisano, 1994; Winter, 2000; Zollo & Winter, 2002). Perceiving the issue in such terms suggests that capabilities cannot be conceptually separated from acting or practicing (Felin et al., 2012; Pandza, Polajnar, Buchmeister, & Thorpe, 2003; Schreyögg & Kliesch-Eberl, 2007). Reconciling these two perspectives provides an understanding of capabilities as both antecedents and outcomes of action. There is therefore a continuous cycle of interaction between [capabilities] and individual actions (Elder-Vass, 2007a). The idea of cyclical interdependency between capabilities and action brings the notion of temporality into sharp focus. Winter (2012) accentuates the centrality of time in discussion on origins of capabilities. The idea that “the study of origins of capabilities is primarily a study of transition (and transmission) mechanisms between ancestors and descendants” (Winter, 2012: 1403) sits comfortably with the notion of capability as both an antecedent and outcome of action. An examination of the recent literature provides further guidance on how the architecture of capabilities might be understood. Consensus abounds that capabilities fundamentally operate at the level of structure, processes and individuals (Felin et al., 2012; Teece, 2007; Teece, Pisano, & Shuen, 1997). Elsewhere, scholars have recognised the role of culture as a capability for action (e.g., Grewal & Slotegraaf, 2007; Lado & Wilson, 1994; Pandza & Thorpe, 2009; Schreyögg & Kliesch-Eberl, 2007). Grewal and Slotegraaf (2007) for instance remark that a capability is contextually entrenched within the structural, social and cultural aspects of the firm. Pulling these threads of thoughts together, it is therefore useful to see capabilities as a blend of structural, [cultural], and individual capacities to act (Jackson, 2005). It is against this understanding of capabilities as the interplay between the emergent powers of structure, culture and agency that Archer’s morphogenesis approach provides a useful theoretical as well as analytical lens.

Linking the capabilities approach with the morphogenesis approach also benefits from the notion of path dependency. The idea of path dependency suggests that at any given point in time, firms must follow a certain trajectory of competence development (Teece et al., 1997). This means that a firm’s existing capabilities are based on events located in time (Winter, 2012). As action patterns, current capabilities are therefore the residue of past actions. These results of past actions are deposited in the form of current situations. They account for the nature of the extant role array, the proportions of positions available at any time and the advantages/disadvantages associated with them (Archer, 1995). These roles carry varying job titles (Burstein, Sohal, Zyngier, & Sohal, 2010) such as manager, supervisor, trainee, etc., each
necessarily and internally related to others (e.g. chief executive – employee) (Herepath, 2014) and to associated artefactual, social, and conceptual resources (Fleetwood, 2005). Organizational roles defined by capabilities thus provide organizational actors with the situational logics for action (DiMaggio, 1997).

Elder-Vass (2007a: 32) argues that “when a role incumbent adopts the behaviours defined by a role (e.g. answering the phone in the call centre if your role is “calling agent”), we have a case of downward causation...” However, this is not to suggest wholesale compliance to structural influence in the form of social hydraulics but rather the incumbent’s action is viewed as mediated by the causal power the role incumbent. Thus the action (during $T^2-T^3$) of the role incumbent can be explained as the interplay between his/her subjective personal properties and powers and the objective properties and powers [at $T^2$] of the role occupied (Archer, 2007b). Here, when Archer speaks of subjective properties and powers, she is referring to factors such as consciousness, reflexivity and intentionality. These are exercised in the Internal Conversation (Archer, 2007a). Archer believes that “this inner dialogue about ourselves in relation to society and vice versa is what makes (most of us) “active agents”, people who can exercise some governance in their lives, as opposed to “passive agents to whom things merely happen” (2007b: 42). This means that humans cannot just be held in a particular spatial relationship as a result of which role performance becomes automatic (Elder-Vass, 2005). Notwithstanding, the extent that the causal mechanism of an organization is effective, the behaviour of the role incumbent “in the role” is part of the behaviour of the organization (Elder-Vass, 2007a). The capabilities of an organization, then, are the aggregate of the behaviours of its role incumbents in the role. Although the relationship is additive, the capabilities are nevertheless emergent, because they have a non-linear effect on each of these behaviours as a result of the fact that individuals behave differently as role incumbents than they would have done in isolation if they were not incumbents of these roles (Elder-Vass, 2007b). Thus, on a day-to-day basis, an organizational capability (say operational capability or zero level capability) depends on the organization having incumbents for all essential roles and those incumbents act within the expectation of their roles. However, these “stable” action patterns observable at the empirical level which characterise capabilities are not just simply the product of routinized or habitual practices. Nor are they the linear aggregation of actions of atomistic individuals. We maintain that individuals always act out of structured situations.

The main thrust of these arguments is based around the fact that, although capabilities manifest in observable patterns of action and interaction, it does not necessarily mean unconscious and habitual practices as professed in the evolutionary tradition. Moreover, individuals are not unrestricted entrepreneurs free of structural influences as promoted by some micro-foundation theorists. From a critical realist perspective, we have argued for the interplay between relatively independent emergent powers operating at different time tracts which may or may not be synchronous. Given the organizational context, we have paralleled operational or zero level capability to a morphostasis or reproduction cycle. But this is by no means to suggest operational capability as a fixed quantity or to deny morphogenesis or transformation from the day-to-day organizational processes. In fact, with Tsoukas (1996: 22), we argue that “in organizations, both rule-bound action and novelty are present, as are continuity and change, regularity and creativity.” If operational capabilities can be equated to the morphostasis cycle then morphogenesis is a reflection of dynamic capabilities. DC represents the outcome of corporate agency during $T^2-T^3$ which leads to structural discontinuity or transformation. In combining the ideas of
emergence, stratification, temporality and synchronisation, the morphogenetic approach thus offers not only a new theoretical perspective on capabilities but also an analytical lens (analytical dualism) which permits an examination of the confluence (or otherwise) between the generative powers of structure, culture and agency and their reciprocal influence. By maintaining the ontic differentiation between structure and agency, the conditions for action are therefore rendered analytically separable from action itself, so enabling their interplay, as opposed to their mutual interpenetration, to be explored (Herepath, 2014). This approach promises a deeper understanding of the antecedent structural, cultural and agential characteristics, as well as their interactional dynamics propitious to structural reproduction (morphostasis) or change (morphogenesis). Consequently, for organizational capabilities, the problematic issue of “how actions reproduce or modify institutions over time” (Jarzabkowski, 2008: 623) may be illuminated (Herepath, 2014). The capabilities framework explained above is illustrated in Figure 2 and constitutes the basis for the empirical investigation in the rest of this paper.

![Figure 2: Theoretical Framework](image)
Methodology

Our work was exploratory, we conducted interviews with staff members of the Zooniverse based in Chicago and Oxford respectively. A total of 23 interview transcripts were produced and the interview data were analysed with the help of Nvivo. We adopted a thematic analysis approach guided by the theoretical framework developed a priori and shown in Figure 2. In the section that follows we provide a summary of our findings.

Summary of Findings and Discussions

In summary, our analysis shows that the operational capabilities of the Zooniverse emerge in response to a number of institutional factors. These institutions include, the requirements of the funding bodies, academic prestige, the scientific research communities and the reputation of the scientists involved. These factors help to shape the operational capabilities of the organisation by driving the quality requirements of the data as well as the efficiency of the data collection processes. Much of these requirements are embedded in the technological artefacts, such as the data management system, visualisation technologies, user interface etc. However, institutional legitimacy also rests, to a large extent, on the interaction with the crowd. Not only must these projects be able to generate large quantities of high quality data, but also to sustain contributor involvement. Our findings show that the interaction with the crowd injects a degree of dynamism in the Zooniverse organisational routines. While the majority of volunteers tend to make only a small and infrequent contributions, often stopping quickly after joining, a small number of ‘super users’ make a very large number of contributions (Franzoni & Sauermann, 2014). Irrespective of frequency of contributions, the volunteers, some in more vocal ways than others, make use of the Zooniverse discussion forum as well as the ‘Talk’ platform to, vent their frustrations, post a question, interact with the scientists and report on functionalities deficiencies amongst others.

The Zooniverse team is acutely cognisant of the criticality of user experience as a motivational inducement for sustaining volunteer involvement. While some of the postings are more trivial than others, some do strike a chord with the Zooniverse team. Indeed, some of the scientists interviewed agreed that some of the exchanges do ‘keep them honest.’ Mindful as they are about enriching the user experience, the team tries to accommodate users’ grievances, particularly those related to functionalities, and those often require further innovation in order to address the problem. Furthermore, from time to time, the scientists would give their commitments to completing certain improvements and would feel pressured to keep within the time frame promised. All these various dynamics interact to create a context of discontinuity around the Zooniverse projects. What this means is that crowd interaction has a feedback effect on the internal workings of the Zooniverse, it imposes on the team members the need to take stock and reflect on ways to best improve the user experience.
In fact, our analysis exposes the innovative qualities of the individuals, evidenced in their autonomy, self-reflectiveness (autonomously reflexivity), creative abilities, positive attitude towards change and a high degree of self-efficacy. We believe that these qualities might well be inherently individualised, however, their manifestations are enabled by the supportive organisational climate they are embedded in. Indeed, our findings suggest a work environment in the Zooniverse characterised by a high degree of independence and autonomy, support for new ideas, and a high degree of organisational flexibility. In other words, we believe that reciprocal relationships may be at play between the team members, the organisational context and the interaction with the crowd. Therefore, whilst the operational capabilities are driven by institutional exigencies, responding to the pressures from the crowd creates a contextual environment wherein innovation thrives. Application of these innovations to the operational routines equips Zooniverse with the dynamic capabilities to respond to the ongoing concerns of the users. Our findings are thus consistent with the dynamic capabilities framework advanced by Zollo and Winter (2002), however, illuminated in the context of crowd interaction in the citizen science landscape.

Conclusion

The findings of our work begins to provide support for the morphogenetic approach to organizational capabilities developed in this work. Whilst our findings tend to be contextually specific in that they more substantively reveal the ontic nature of the multilevel interplay that resides within the citizen science black box, we believe that the framework could be applied in different contextual conditions for a more fined-tuned understanding of the forces at work in shaping the emergence and evolution of organizational capabilities. Furthermore, in the context of crowd science, our findings provide an alternative view on the role of the crowd. Previous research has taken a rather reductionist approach to the crowd, treating its relationship with citizen science as almost mono-directional, that is as a resource for data collection. Our findings suggest that the crowd has a more central role in the success of crowd science projects than previously understood. In the grand scheme of things, our findings illuminate the characteristics of the organisational members and of the organisational climate propitious to successful outcomes for initiatives that rely on efficiently harnessing the power of the crowd.
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