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Team Problem Solving and Motivation under Disorganization – An agent-based modeling approach.

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Introduction

In modern organizations, teams are an essential component in providing higher manpower (Huckman and Staats, 2013), have the capacity to engage problems from multiple angles (Zeilstra, 2003) and at times allowing also for democratized decision making processes (Gradstein et al., 1990; Coopman, 2001). The levels of productivity amongst teams can differ for a multitude of reasons (Sengupta and Jacobs, 2004) to include being more flexible in their decision making (Christensen and Knudsen, 2008). The environment in which a team resides and how it is structured plays a crucial role in the team's performance and ability to engage in problem solving (Heckscher and Donnellon 1994; Tongo and Curseu, 2015; Fraser and Hvolby, 2010). Therefore, developing an understanding of how teams can be structured in order to exploit team dynamics and enhance problem solving across team members is important for managers. Additionally, understanding team structures and team dynamics helps to improve corporate performance. In rigidly structured organizations, teams tend to mirror the organizations' inflexibility (Coopman, 2001). Whereas in less rigidly structured organizations, teams tend to be less formalized (March, 1991; Coopman, 2001). Consequently, managers forming teams need to understand what type of working environment will maximize team performance and problem solving.

Traditionally, management has accepted order (used synonymously with control and rigid organization structure) as a necessary condition for productive teams. Researchers and managers alike assumed that increasing order within organizations and teams would lead to increased

productivity (Taylor, 1911; March, 1991). However, researchers in the 1960's began to question this assumption and found that this was not always the case (Crozier, 1969). Accordingly, a mechanism to reduce highly ordered and (overly) complex organizations was needed (Abrahamson and Freedman, 2006). This process of reducing highly structured organizations has become the precursor to the concept of disorganization management.

Disorganization is the reduction of organizational protocols and structure that enables flexibility and better access to resources across the workforce (Merton, 1968; Crozier, 1969). Given the complexity of contemporary business life (e.g. vast network of suppliers, intermediaries, customers and stakeholders) and the environment (e.g. social, political, economic and technological) in which businesses operate, disorganization is bound to occur to some degree (Bridges, 2009; Sellen and Harper, 2003). This leads to opportunities to proactively leverage the potential benefits of disorganized work environments within teams instead of simply reacting to emerging disorganization.

Organizational teams can be structured in a multitude of ways. Such variations are readily observable in non-profit organizations that often rely heavily on volunteers. Teams of volunteers can be highly ordered (i.e. Boy Scouts with its checks and balances and regulations for volunteer members) while other teams can be highly disorganized (i.e. spontaneous volunteering e.g. helping as the first on the scene responder for a natural or manmade disaster). This varying degree of disorganization in volunteering offers an ideal setting to study disorganization.

Additionally, teams differ in their baseline characteristics (e.g. different motivation levels, mix of gender). Motivation is a key factor that contributes to an individual's performance (Andersen, 2009). When working in a team, the individual motivations of each team member shape how the team performs overall (de Jong, 2014). When a team performs well, the

motivation of the individual team members can increase. Yet, when a team performs poorly the motivation decreases affecting the overall motivation and performance level of the team (Jae Wook and Murninghan, 1997). Hence, this study examines changes of motivation when teams engage in problem solving under various levels of disorganization. We use Agent-based modeling (ABM) as it has proven to be an effective tool for studying organizational behavior related problems (Secchi, 2015).

The paper proceeds as follow: First, we begin with the theoretical background that underpins the framework of the ABM model. Second, we discuss how ABM was used with empirical data to capture varying baseline characteristics of teams. The use of ABM in calibrated with empirical data enabled the simulation of wide varieties of scenarios while bringing the model closer to reality. Third, we present the results. The final section discusses the implications of the findings and the limitations of the study.

Theoretical Framework

The proposed model combines the two elements of disorganization and motivation to explore their impact on teams. We look at disorganization from two viewpoints: process-oriented and state-oriented. Then we categorize disorganization into three types: natural, structural and functional. Finally, we introduce the concept of Public Service Motivation (PSM: Perry and Wise, 1990; Perry, 1996) in order to operationalize motivation within the model.

Disorganization

Cohen *et al.* (1972) first equated disorganization to organized anarchy as it places the onus of responsibility on the individual opposed to a system of control under which many organizations

operate. Supporting the movement away from the status quo of needing order within an organization, Abrahamson (2002) argues "[d]isorganization is the disorderly accumulation of varied entities in hierarchically ordered complex human structures" (p. 4). This implies that different organizational components (either physical or non-physical) can combine randomly. As such, disorganization is positioned as improving employee well-being (Abrahamson, 2002), enhancing innovation (Freeland, 2002), amplifying stakeholder involvement and increasing motivation (Warglien and Masuch, 1996). Given that disorganization creates a more conducive environment for employees to find and obtain resources (Abrahamson , 2002; Abrahamson and Freedman, 2006), this flexibility can lead to improvements in efficiency and creativity. Flexibility, however, does not imply that disorganization is unmanageable.

Research has shown that managers are not devoid of the ability to manage disorganization (Warglien and Masuch, 1996; Abrahamson and Freedman, 2006; Freeland, 2002). Managing in this context does not imply structuring or ordering. Rather, it points to the idea that disorganization can be optimized and utilized on an ad hoc basis within a more organized setting (Abrahamson and Freedman, 2006). The application of disorganized mechanisms and procedures (e.g. in decision making or in innovating) can be construed as disorganization management. From the disorganization literature (Abrahamson, 2002; Abrahamson and Freedman 2006; Warglien and Masuch, 1996), we can categorize the study into two types based on how disorganization comes about: states and process. When looking at disorganization as a state, one focuses on the outcomes of disorganization (e.g. accumulation of documents in disarray on a desk). In other words, a disorganized state will have distinct characteristics from which the most trivial characteristic would be that such a state would lack

order. In contrast, disorganization as a process allows for the de-structuring of a highly structured environment enabling managers to achieve a desired result (i.e. increased productivity).

Disorganization as a process can be seen as any set of routines, procedures and tasks used to reduce the stability of a highly structured system. For example, in a situation where a team is highly structured (i.e. hierarchically ordered, clearly defined lines of command and centralized decision making) this could be exemplified by the process of breaking down the hierarchy. In this regard, increasing the autonomy of team members and decentralizing the decision-making procedures and routines is understood as the process of disorganization – a process observable in teams (Foss, 2003; Aldrich, 1972; Rivkin and Siggelkow, 2002). For instance, Foss (2003) looked at Oticon- an organization which pioneered disorganization as a process by introducing flexible rules, collective decision making, cross functional teams and increased employee autonomy (components of disorganization) to achieve a substantial increase in organizational performance. It should be noted that these two viewpoints, i.e. disorganization as state or process, are two methods of describing the same phenomenon complementing each other. In this study, we are primarily focusing on disorganization as a process as this approach allows us to model the process of inducing disorganization within an organization.

Building on our understanding of disorganization from a process-oriented viewpoint, disorganization consists of three distinct types: (1) natural, (2) structural and (3) functional disorganization. Natural disorganization (1) occurs randomly and organizations have no control on how, when or the extent of the disorganization (Abrahamson, 2002). Structural disorganization (2) refers to the topology of the team and how the team is structured in terms of line of command and hierarchical order.

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Figure 1 here

Figure 2 here

The variation in structural constraints can be seen between Figure 1 and Figure 2. Figure 1 shows a team where the team is hierarchical structured with a leader (on top). The arrows depict how authority flows within the team and how team members relate to one another (leader/subordinate/colleague). Figure 2 depicts a more structurally disorganized team where there is no designated leader and the authority is shared. Ultimately, functional disorganization (3) refers to rules of interaction within the team and between the team and its environment. The manner in which a team obtains resources can either be organized by having rigid rules or can be disorganized by having flexible rules and more opportunities to find resources.

Figure 3 here

Figure 4 here

Figures 3 and 4 visualize the idea of functional disorganization. In Figures 3 and 4, the triangles refer to problems (tasks), squares refer to an opportunity and the circle refers to solutions. These symbols are used to crudely depict resources available at various hierarchical levels of an organization. The four horizontal lines separating these symbols on the right are used to show the separation of organizational levels. Figure 3 shows a work environment where the employee in level 2 (left hand side) is constrained in obtaining resources in level 3 and level one depicted by the blocks running across the arrows. In contrast, Figure 4 shows a less constrained work environment in which we would label as disorganized. The difference between structural and

functional disorganization is that the former deals with how team members relate and interact with one another while the latter refers to how the team interacts with the resources in its environment.

MOTIVATION

In order to understand motivation and the underlying attitudes in the volunteering context, we refer to concept of Public Service Motivation (PSM; Perry and Wise, 1990). PSM has been described as "an individual's orientation to delivering service to people with the purpose of doing good for others and society" (Perry and Hondeghem, 2008, p. 6). It allows researchers to examine rational, norm-based and affective motives through attitudes towards attraction to policy making, self-sacrifice, commitment to public interest , compassion , and also occasionally civic duty and social justice (Perry, 1996). A decisive component of PSM is its strong focus on pro-social behaviour and commitment to the public good (Grant, 2008). As such, it is ideally suited to capture motivation of volunteers. PSM studies, while predominately conducted in an environment that could be deemed as highly organized (i.e. public sector and government institutions), have increasingly explored PSM of volunteers (Houston, 2006; Coursey et al., 2011) which could be seen as less bureaucratic. Volunteering work at a local level could be considered a loosely ordered activity (no strict hierarchy) without well-defined lines of authority because local non-profits and grassroots organizations often lack a formal volunteer coordination manager and rigid rules and regulations governing volunteers (Eliasoph, 2014). As with any work environment, if the individual does not share values and agrees with the mission of organization then this lack of person-organization fit (P-O fit) can negatively influence the

motivation performance link (Wright and Pandey, 2008).

Establishing a disorganization continuum of volunteer organizations

Volunteer organizations could be ranked according to levels of disorganization present in their teams. Such a classification can be understood as an organization-disorganization continuum with highly structured organizations as one extreme and complete disorganization as the other extreme. The literature suggests (Bode, 2006; Salmon and Sokolowski 2001), that small local volunteer organizations (i.e. local student volunteer groups) tend to be less formally structured and less regulated by rules and routines. In contrast, comparatively larger international volunteer organizations (i.e. Boy Scouts or Doctors without borders) require a higher level of structure for their global scale operations. Thus, the continuum positions local, small-scale volunteer organizations with relatively disorganized working conditions on one pole, while the opposite pole depicts international large-scale volunteer organizations with highly organized working conditions[1].

For the purpose of the model discussed in this paper, we have used the literature as a guideline to place the organization on the proposed disorganization continuum. We use the task of fundraising as the main problem each team faces. Using fund raising as a task eliminates the need to focus too much attention on the type of volunteering or the context, as it is a common

[1] The literature does not suggest that this is always the case and emphasizes the importance of context and the type of volunteering as determinants of the volunteer organization is highly structured or not.

problem faced by volunteer organization in all contexts (Lee, 2003). Nevertheless, there are limitations to this approach where a context specific model would provide further insight in the effects of disorganization. However, the model discussed in this paper can be used as a starting point.

Insert Figure 5 here

Following the continuum depicted in Figure 5, we model the teams attributing different baseline characteristics to each team according to their position on the continuum. This approach enables us to consider the level of disorganization in those volunteering teams relative to each other.

METHODOLOGY

In modeling problem solving and motivation under disorganization, we combined agent based modeling and survey data. Survey data subsequently was used to define values of some team member (volunteer) attributes in the agent-based model. The three attributes fed from the data collection into the model are volunteer intensity (the individual's perception of effort exerted), PSM (motivation) and P-O fit.

We surveyed individuals who volunteer in the Southwest region of the UK. In November 2014, an email was sent from a community volunteering centre to 433 people who had expressed an

interest in volunteering and 180 actively volunteering individuals inviting them to take part in a web-based survey. After checking unengaged responses and duplication of surveys, we were left with 226 surveys, with respondents age 15 to 90, 61.9% female, 43.4% baby boomers, 43.8% volunteering weekly with 46.9% without children.

Agent-Based Modeling (ABM)

Using real world data, we simulate the effects of disorganization on team problem solving and motivation using ABM. This method is well suited to simulate phenomena in the field of organizational behavior (Lomi and Harrison, 2012; Secchi, 2015) because it allows for capturing emergent phenomena as well as unexpected team behaviors. Additionally, it is flexible in the parameters that can be specified within the model (Gilbert and Terna, 2000; Gilbert, 2008). ABM has been used to model and simulate effects of disorganization in decision-making and found that "the 'disorganization' condition provides a better structural environment for employees to solve problems rather than under the 'organization' condition" (Herath *et al.*, 2015, p. 77). The modelling rules used for the simulation presented in this paper build on the work of Herath *et al.* (2015), Fioretti and Lomi (2008) and Lomi and Harrison (2012) and extend previous work to the team level.

An ABM of Disorganization and Team Performance

This model contains five teams, each consisting of seven members competing to solve freely moving problems at the correct opportunity using resources available in the vicinity. The teams operate under to two primary conditions which are *organization* and *disorganization* (when organization is switched off).

Space and agents

The model contains four agents which have a set of individual characteristics (attributes) moving within a three dimensional space. First, we model the *volunteer* (V) agent with the attributes ability (a), efficacy (efc), intensity (e), PSM, P-O fit and level. Second, the *problem* (P) agent is characterized by the attributes *complexity (comp)* and *level (l)*. The problem agent represents any problem faced by volunteers on a day-to-day basis. In the simulation, the volunteers (V) will try to solve these problems (P). Third, the *solution* (S) agent is described by *efficiency (ef)*, and level *(l)*. The solution (S) agent is introduced into the model as a representation of resources available for tackling the problems (P). The solution agent is broadly defined to encapsulate any resource available for volunteers (V) in solving problems (P). Fourth, the opportunity (O) agent only has one attribute: the *level (l)*. The opportunity (O) agent is used to represent the window of opportunity (i.e. the available amount of time to come up with a solution to a problem) a given volunteer (V) or team has in order to use to solutions (resources) (S) to solve the problems (P). Every agent in the model is assigned a level. There are five levels in total (0 to 4). The level is used to indicate at which position in the organizational hierarchy that particular agent operates. The position in the organizational hierarchy represented by the level (*l*) is used to depict the point at which a given agent is situated in the organization. For example, a volunteer in the mailroom is in a lower hierarchical position than a volunteer in senior management. For example, with regard to the volunteer agent, the lowest tier of the organization (0) represents i.e. local volunteers while the highest tier (4) represents i.e. the senior management of the charity. Table 1 summarizes the value parameters.

Insert Table 1 here

The ‘Volunteer’ agent is used to represent a member within a volunteer team belonging to a non-profit organization. There are five teams of volunteers with each team representing a different organization. Each volunteer acts as a team member with the other volunteers of the same team (breed). Effort (volunteer intensity), PSM and P-O Fit are characteristics of each volunteer and are attributed through the data gathered. The ‘problem’ agent represents the common fundraising task faced by all volunteer organizations. Each problem has a complexity (random normal distribution) with an adjustable mean and standard deviation ranging between -5.0 and 5.0. This range was chosen in order to model a wide array of complexities mirroring a real world setting. The *complexity* attribute is used to capture the inherent structural and procedural intricacies associated with a problem. Therefore, a problem can be considered more or less difficult based on how a given problem’s complexity matches with the volunteer team’s attributes, opportunities and solutions. The ‘solution’ agent characterizes both physical and non-physical options available (e.g., resources, finances, political capital etc.) which can be utilized to resolve problems. An *Efficiency* value is assigned to every solution (Random normal distribution; Mean 0, Standard deviation 1). In organizations (non-profit or otherwise) there are opportune times for when a problem can be engaged and when resources (solution) are present, in encapsulating these windows of opportunity the ‘opportunity’ agent was created.

Team Composition

Each team has a designated team leader and can have up to seven members at full capacity (including the leader).

Movement

Insert Table 2 here

Under disorganization (i.e. organization is "switched-off") the teams move without restrictions in accordance to movement conditions (Table 2). Instead, under organization (i.e. "switched on") the teams are only allowed to move to a certain set of other agents based on the hierarchical levels (level variable). This encapsulates the structural and functional limitations within real-world work settings. For example, a problem in a door-to-door fundraising setting tends to be handled by a volunteer rather than by a senior manager of the non-profit organization.

In order to understand how volunteers are given access to resourcing, the model under the "organization" condition utilizes three settings: "Same Access", "Higher Access" and "Lower Access". Algorithm 1 (Same Access) is used to allow volunteer teams to only access problems, solutions and opportunities at their own hierarchical level. Algorithm 2 (Higher Access) is used to allow volunteer team to access problems, solutions and opportunities at a higher hierarchical levels other than their own level and Algorithm 3 (Lower Access) allows volunteer teams to access problems, solutions and opportunities on their own level and at levels below them.

These three algorithms can be unpacked using the following example. Imagine a product design company that has four hierarchical levels in the design department: design interns, junior designers, senior designers and expert consultants. Algorithm 1 specifies a situation where a junior designer team will only have access to problems, resources and solutions in the department of product design assigned to them. Algorithm 2 equates to the junior designers team

being given access to resources available to senior designer teams or access to an expert consultant team or their resources in the company (Higher Access). Algorithm 3 equates to a situation the junior designer team being given access to design intern resources (Lower Access). These three algorithms can be utilized to simulate movement in any organization with hierarchical levels in the public or private sector.

The algorithm of the “Same Access” is as follows:

$$V_l \neq P_l \text{ OR } V_l \neq S_l \text{ OR } V_l \neq O_l \quad (1)$$

In equation 1 let “V” be volunteer, “P” be problem, “S” be solution and “O” be opportunity that are available at a given ”level,” “l.” The volunteer’s hierarchical level is checked against the hierarchical level of the solution, problem, and the opportunity. If the condition depicted in equation 1, is not satisfied the agents disperse. The above organization condition is the most restrictive of the three conditions. In order to implement the aforementioned algorithm fitting a real world scenario we allow for cross-level interactions. We distinguish two types of cross-level interactions: (1) higher access and (2) lower access.

$$V_l \leq P_l \text{ OR } V_l \leq S_l \text{ OR } V_l \leq O_l \quad (2)$$

The extent to which the volunteers interact across levels is dependent on the randomly defined position they find themselves in. In a real world scenario, volunteers on a higher level might solve problems appearing in lower levels, eventually. Therefore, in order to implement a more practical hierarchical rule the algorithm was modified as follows.

$$V_l \geq P_l \text{ OR } V_l \geq S_l \text{ OR } V_l \geq O_l \quad (3)$$

The algorithm in equation 3 enables volunteers from higher levels to solve problems below their level, but still maintains the strict rule that no volunteer can interact with agents above their level.

Decision rules

Given that the simulation involves volunteer teams, in order to model how a team engages with problems each team is assigned a combined team capability score (Tc). As shown in equation 4 this is the summation of the attributes PSM (m), P-O fit (p), Effort (e) of all team members. We assume that team capability is the sum aggregate of individual capability. This is done by aggregating the value of PSM (m), P-O fit (p) and Effort (e) of each individual (i) volunteer in the team as displayed in equation 4 below into an overall team capability score.

$$T_c \equiv \sum_{i=1}^{n} (Ve_i + Vm_i + Vp_i) \quad (4)$$

Using the team capability score, problem solving was modeled next. Once opportunities, participants, problems and solutions meet at the same place (patch)- the problem solving algorithm begins. A problem is solved when a team used solutions where the right opportunity arose. This means a problem will be solved when a team, problem, solution and opportunity come together. Equations 5 shows that for a problem to be solved, a team should find a sufficiently efficient solution (each solution has an efficiency attribute *Sme*). If the team capability score is multiplied with the solution efficiency score and is greater than *a* or equal to *a*

given problems complexity (P*comp*) that problem would be solved. This equation depicts how a team can use resources (solutions) to solve a problem at the right opportunity in an organizational setting (See equation 5).

$$T_c * S_{me}(ef) \geq P_{comp} \quad (5)$$

In the event where the problem's complexity value is higher than the combined value of the team's capability and solution efficiency- that problem will not be solved replicating a situation where a team fails to solve a problem (see equation 6).

$$T_c * S_{me}(ef) < P_{comp} \quad (6)$$

Motivation

In line with the motivation theory, when a problem is solved in the decision making phase of the model the team motivation of the volunteers increases. In order to simulate the team's increased motivation when they solve a problem, we utilize a motivation attribute. Each volunteer has this attribute and it is updated when a problem is solved. When a problem is not solved the team faces deflation and demotivation. This is reflected by decreasing the values of the motivation attribute of each team member. Equation (7) and (8) show how these motivation increases and decreases are carried out.

When a problem is abandoned the motivation of the volunteer team reduces. The levels of motivation among volunteers are assigned through the data gathered. We employ Herath et al.'s (2015) logic to distinguish between hard and easy problems as displayed in equations (7) and (8).

$$2*Tc \leq P\ (comp) \quad (7)$$

$$2*Tc > P\ (comp) \quad (8)$$

Please note that very challenging problems can be solved when teams generate highly efficient solutions. We modeled such situations as simultaneously going along with a 20% increase in motivation levels. In contrast, easy problems trigger much smaller increases of motivation (10%) when being solved. Furthermore, in situations where the team cannot solve a problem even after utilizing a solution-problem abandonment (6)- the team motivation decreases (i.e.10%).

Computational Experiments

Given the large number of simulation parameters and the variations of values available, it was imperative to select a specific set of parameters for this particular study. Table 3 depicts the parameter used for the simulation experiments.

Insert Table 3 here

The range parameter enables the agent to screen his environment, i.e. the number of patches the agent can see. This allows the agent to decide whether to move in a certain direction (e.g. towards other agents located within the range). Therefore, range represents the way workers socialize with those close to them more often than to those far away. The vicinity is to be intended as working closeness, as it is within people in the same team/ department.

A time limit of 1000steps for each run of the simulation was imposed on each experiment and

after conducting a power analysis (Secchi and Seri, 2014) it was determined 15 repetitions of the experiments were needed to check the consistency of the results obtained. Each step signifies an opportunity of a volunteer team to interact with problems. On each run teams are given 1000 opportunities to interact with problems. These 1000 opportunities are units of simulated time known as ticks, which gives the opportunity to study the problem solving dynamics of the volunteer teams over time.

FINDINGS

The analysis showed that more problems are solved under disorganization conditions than under two of the three organized (same access and lower access) conditions while under higher access the number of problems getting solved are almost identical to the number solved under disorganization.

Insert Figure 6 here

These results were consistent amongst all variations of the parameters (range, problem complexity). However, the results showed that higher access (access to resources on the same hierarchical level and above) outperformed compared to same access and lower access organization conditions. Same access was the most restrictive condition and showed the lowest number of problems solved as expected. While lower access did perform better than same access, it could not match the problem solving efficiency of the higher access condition.

The reason for these variations can be found in how each of these organizational conditions is designed. Under higher access, the volunteer teams are able to access resources on their own average hierarchical level while also having access to resources above their average hierarchical level. In this case, the resources found on the higher levels of the hierarchy tend to be of better quality that the resources found on the same level. This is reflected in the real world where teams consisting of people who hold higher positions than teams consisting of individuals with lower positions have access to a wider range of resources that also tend to be of higher quality. On the other hand, the lower access condition still provides the teams with the opportunity to access resources from a level other than their average level, but only if the resources are below their hierarchical level. This is the most common case in many organizations. In contrast to resources above a team's average level, the resources found below the team's average level tend to be lower in quality than the resources found in the same level. Therefore, the problem solving efficiency is lower than the higher access condition. However, the lower access condition still has a higher problem solving efficiency than the same access condition. This is because even though the resources found under the lower access condition are generally of lower quality, the teams still have a wider range of resources to work with than having only access to resources on their same level. Consequently, it is very important that when having an organized work environment adequate access to resources it provided to employees.

Furthermore, the results showed that when problems increase in complexity problem solving efficiency of teams go down under organization, while under disorganization the efficiency remains at high levels even if the problem complexity rises.

Insert Figure 7 here

The results depicted in Figure 7 exemplify that disorganization is a better condition for solving highly complex problems. Additionally, the range parameter plays a major role in the number of problems solved under both the organization and disorganization condition. The optimal range seems to be six while anything lower makes the teams perform slower (as the team members do not have enough vision to seek out resources) while anything larger makes the team members confused as to which problems to engage (as there is too much information for the team to handle).

Ultimately, results linking motivation and problem solving efficiency appear to be varied. On the one hand, results displayed in table 4 show that the teams with the higher combination of PSM, Intensity and PO Fit tend to solve the highest number of problems. On the other hand, the religious volunteering team weakens this result as it deviates from this pattern. It should be noted that, the results were consistent over time for all the experiments conducted.

Insert Table 4 here

DISCUSSION

This study simulated team problem solving behavior in organized and disorganized volunteering environments. We employed an agent based modeling approach to identify the dynamics behind problem solving behavior. Furthermore, the model was calibrated using survey data from

individuals that actively volunteer. Overall, the findings of the study directly support the idea that disorganization is beneficial to problem solving, especially in non-profit organizations that have a constantly fluxing workforce due to reliance on volunteers. More specifically, the results have a number of implications for the debate on problem solving efficiency. First, the findings on the number of problems solved under disorganization and organization, clearly displays a stark difference between the two conditions where more problems are solved under disorganization. This finding directly links to the theoretical claim that disorganization is a more efficient condition for problem solving. Thus, these results corroborate the theoretical claims made by Abrahamson (2002) with respect efficiency and effectiveness gains arising from disorder. These findings also mirror the findings of Abrahamson and Freedman (2006); Fioretti & Lomi (2008) and Herath et al. (2015), extend them to the team level and lend further support to some of the benefits of disorganization discussed by researchers (i.e. access to more resources, greater stakeholder participation; see e.g. Freeland, 2002; Warglien and Masuch, 1996; Shenhav, 2002).

Second, under disorganization the teams also have access to more problems. This access could explain the higher number of problems solved as theorized by Fioretti and Lomi (2008). These results indicate that when it comes to problem solving efficiency (number of problems solved within a specified period) reducing restrictions to access to resources plays a major role in increasing the number of problems solved.

Third, the variations of problem solving efficiency observed when comparing higher access conditions have some implications for organizations. In an organization where teams have access to resources from higher levels, the teams should find it easier to solve problems given that they get access to higher quality resources (Freeland, 2002). Support for this theoretical

claim by Freeland, 2002 was apparent in the findings (Figure 6) where teams solved more problems when given access to resources at higher hierarchical levels. How access to resources is authorized is ultimately a strategic decision varying amongst organizations and depends on organizational culture, management style, and governmental policies. However, the level of access a team receives is often decided on a case-by-case basis (Sellen and Harper, 2003). In an ideal scenario, completely unrestricted access (complete disorganization) is desired. However, more realistically, mechanisms for access to resources on higher levels should be provided within reasonable boundaries. Even with unrestricted access to resources below the average level of a team's hierarchical level proper legal and ethical factors should be taken into account.

With respect to our own study, two clear implications for practitioners are clearly emerging: First, disorganization consciously induced by management should go along with a removal of hierarchical access restrictions. As a result team members are likely to perceive higher organizational support and also more autonomy at work, both of which is beneficial for motivation and ultimately problem solving. Second, even though access to resources regardless of hierarchical level is generally better for problem solving there seems to be no utility in having access to resources multiple levels higher or lower than a team's average hierarchical level (Bridges, 2009; Freeland, 2002). This is because a team on a lower level with access to a resource several levels higher than their usual access might find the resource unmanageable or too complicated to handle as observed through the simulation. Similarly if the resource is multiple levels below, that resource might not have enough quality or effectiveness for what it is required for at the team's hierarchical level. This finding establishes a boundary condition for the use of disorganization processes which is of high importance for practitioners.

Apart from the implications disorganization theory and management practitioners discussed earlier, this study adds two main contributions to academic research. First, the model's ability to act as a virtual laboratory allows us to study disorganization. Second, the methodological application of ABM allows for simulating disorganization. As discussed in section Disorganization (page 3 - 6), disorganization needs to be analyzed from multiple theoretical vantage points in order to provide mangers and organizations a better understanding of how to manage disorganization. This model provides a virtual laboratory to test the dynamics and implications of the theory focusing on disorganization as a process.

Ultimately, on the technical level, as discussed in the ABM section (page 10), ABM provides a robust platform which organizational behavior can be studied. This approach is novel in its application and enables further research in studying disorganization in a virtual laboratory. Additionally, it also provides the basis for studying other problems in management research.

LIMITATIONS

The model mimics the basic problem solving process within a volunteering fundraising environment; however, the dynamics it encapsulates are currently limited. For instance, the structural disorganization component of disorganization continuum is not fully operationalized in the current version of the model. Therefore, in future iterations the disorganization continuum should be further operationalized in order to reflect different structural makeups of volunteer teams. Introducing multiple types of problems, solutions and opportunities (i.e. stationary and mobile) are also future enhancements that will increase the simulation's link to reality. Currently

we employ a unified value of a given agent in the decision making process.

In future iterations, a more straightforward operationalization of P-O fit and its relation to motivation can be implemented. Finally, when experimenting on the simulation we are currently employing a subset of all the parameter ranges. Thus, there are parameter variations that have not been tested yet and can be studied in the future.

Building on this study future research should consider further exploring conduciveness of disorganized work environments on problem solving efficiency by introducing more ways of structuring the work environment. Such work has the potential to generate more nuanced insights on what structures lead to efficient problem solving. Researchers can also focus on the benefits of disorganization, for example innovation and study how creative solutions emerge under disorganization. Exploring different types of organizational hierarchies (flat, lean, layered) potentially yields interesting results. Finally, future research could strive to build and model a stronger link to motivational theories which might provide insight into how to motivate a disorganized team.

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Table 1: Parameters and Values (source: adapted from Herath et al., 2015, p.71)

Parameters	Values	Description
Levels	0,1,2,3,4	Each agent is randomly assigned a hierarchical level. This parameter allows the creation of a hierarchy within the model. Each team consists of volunteers belonging to various hierarchical levels, thus where a team resides in the organizational hierarchy is determined by averaging the volunteer hierarchy levels belonging to each team
Efficacy	N ≈ (0, 1)	Unique to an employee. Represents an employee's capability in solving problems
Ability	N ≈ (0, 1)	Unique to an employee. Represents an employee's level of skill and competency in solving problems
Intensity (effort)	N ≈ (0, *n*)	This attribute was modelled based on the empirical data gathered. Standard deviations for teams 1 to 5 are as follows 1) Religious: 0.9086935 2) Youth: 1.194035 3) Cultural: 1.157944 4) Healthcare: 0.9437783 5) Civic: 0.6734919
PSM	N ≈ (0, *n*)	This attribute was modelled based on the empirical data gathered. Standard deviations for teams 1 to 5 are as follows 1) Religious: 0.2950209 2) Youth: 0.5591867 3) Cultural: 0.4756984 4) Healthcare: 0.5540717 5) Civic: 0.6246199
P-O fit	N ≈ (0, *n*)	This attribute was modelled based on the empirical data gathered. Standard deviations for teams 1 to 5 are as follows 1) Religious: 0.6790827 2) Youth: 0.5318161 3) Cultural: 0.5563178 4) Healthcare: 0.6541871 5) Civic: 0.5052478
Problem Complexity	N ≈ (-5 to 5, -5 to 5)	Represents the inherent level of complexity of the problem.
Solution Efficiency	N ≈ (0, 1)	Represents the suitability of available resources to be used for problem solving.
Range	1 – 15	The range determines the amount of patches an agent will scan. i.e., if the range is set at 5 an agent will scan 5 patches around itself at every step.

* N ≈ (x, y) is technical notation used to denote the mean and standard deviation of the variable

Table 2: Movement Conditions

Agent	Movement Rules
Problems	At each step the agent moves forward one patch at a random angle. When a problem is resolved it dies within the model.
Solutions	Upon scanning the surroundings as specified by the 'range' parameter the agent moves towards the nearest problem.
Opportunities	Upon scanning the surroundings as specified by the 'range' parameter the agent moves towards the nearest problem.
Volunteers	Each individual agent is fully mobile. Each volunteer team (breed) moves as one unit within the solution space. Volunteer teams move towards problems in 'range' at any given time.

Table 3: Parameter Variations

Varying Parameters	Values
Initial Number of Volunteers – Team 1	[7]
Initial Number of Volunteers – Team 2	[7]
Initial Number of Volunteers – Team 3	[7]
Initial Number of Volunteers – Team 4	[7]
Initial Number of Volunteers – Team 5	[7]
Organization	[TRUE:FALSE]
Range	[3; 6]
Initial Number of Opportunities	[100]
Initial Number of Solutions	[100]
Initial Number of Problems	[100]
Mean Problem Complexity	[-4; 0; 4]
Standard Deviation of Problem Complexity	[0.6]
Access Condition	[Lower: Same: Higher]

Table 4: Number of problems solved by each team

Teams (1 – 5)	**Standard Deviation of Parameters (Mean = 0)**			**Number of Problems Solved after 1000 steps, Range 6**			
				Organization			**Disorganization**
	PSM	**Intensity**	**PO FIT**	**LA**	**Same**	**HA**	
Religious	0.2950209	0.9086935	0.6790827	14	12	19	20
Youth	0.5591867	1.194035	0.5318161	18	12	20	20
Cultural	0.4756984	1.157944	0.5563178	11	10	18	16
Healthcare	0.5540717	0.9437783	0.6541871	11	10	18	17
Civic	0.6246199	0.6734919	0.5052478	10	8	11	15
Total				**64**	**52**	**86**	**88**
LA: Lower Access, HA: Higher Access							

Figure 1: Structural Organization

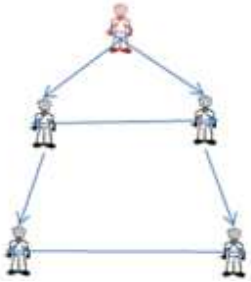

Figure 2: Structural Disorganization

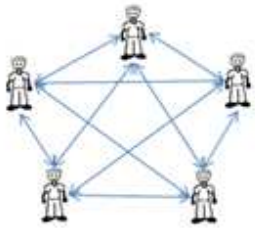

Figure 3: Functional Organization

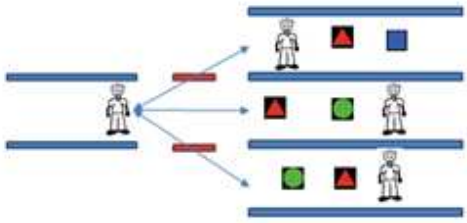

Figure 4: Functional Disorganization

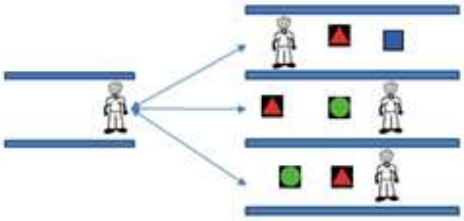

Figure 5: Disorganization Continuum

Figure 6: Number of problems solved under disorganization (false) and organization (true) depending on access type

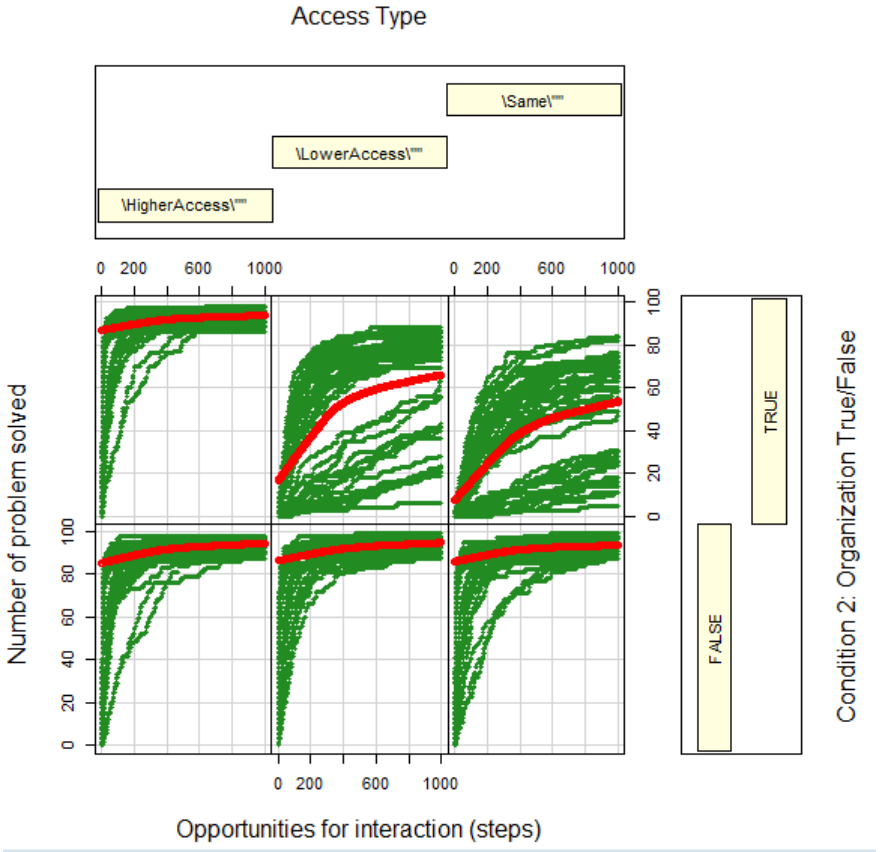

Figure 7: Number of problem solved under disorganization (false) and organization (true) depending on the mean problem complexity