Effects of Disorganization on Team problem solving and motivation – An agent-based modeling approach

Abstract

This paper aims at simulating how "disorganization" affects team problem solving and motivation. The prime objective is to determine how team problem solving varies between an organized and disorganized environment. Using agent-based modeling, we use a real world data set from 226 volunteers at five different types of non-profit organizations in Southwest England in order to define some attributes of the agents. We introduce the concepts of natural, structural and functional disorganization while operationalizing natural and functional disorganization. The simulations show that "disorganization" is more conducive for problem solving efficiency than "organization" given enough flexibility (range) to search and acquire resources. Our findings further demonstrate that teams with resources above their hierarchical level (access to better quality resources) tend to perform better than teams that have only limited access to resources. Our nuanced categories of "(dis-)organization" allow us to compare between various structural limitations, thus generating insights for improving the way managers' structure teams for better problem solving.

Keywords: agent-based modeling, disorganization, team performance, public service motivation

Introduction

In modern organizations, teams are an essential component providing higher manpower (Huckman and Staats, 2013), the capacity to engage in 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 among teams differ for a multitude of reasons (Sengupta and Jacobs, 2004) this is due to the fact that some teams are more flexible in their decision making than others (Christense and Knudsen, 2008). The environment in which a team resides and how it is structured plays a crucial role in team performance (Tongo and Curseu, 2015; Fraser and Hvolby, 2010). Therefore, developing an understanding of how teams can be structured in order to maximize positive dynamics among team members is important. In rigidly structured organizations, teams also tend to mirror the organizations' inflexible structure (Coopman, 2001). Whereas in less rigidly structured organizations teams also tend to be less structured. Therefore, mangers forming teams need to understand what type of working environment will maximize team performance.

Traditionally, management accepted "order" (used synonymously with control and rigid organization structure) to be a necessary condition for a productive team. 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). Consequently, a mechanism to reduce highly ordered organizations was needed (Abrahamson and Freedman, 2006). This process of reducing highly structured organizations became the precursor to the concept of "disorganization".

"Disorganization" is the reduction of organizational protocols and structure thus enabling flexibility and better access to resources among 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 situation provides opportunities to proactively leverage potential benefits of disorganized work environments on teams instead of simply reacting to emerging disorganization.

Organizational teams can be structured in a multitude of ways. These variations are observed in non-profit organizations that often rely heavily on volunteers. Teams of volunteers can be highly ordered (i.e. neighborhood watch) while other teams can be highly disorganized (i.e. informal volunteering for e.g. environmental protection). 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 individual performance. When working in a team, individual motivations of each team member play a role in how the team performs. When a team performs well the motivation of the individual team members should go up and when a team performs badly the motivation is supposed to decrease, usually affecting the overall motivation and performance level of the team (Locker and Latham, 2013). This study examines changes of motivation when teams engage in problem solving under disorganization using agent-based modeling (ABM). This computational simulation technique has proven to be an effective tool for studying such problems (Fioretti, 2013; Secchi, 2015).

We begin with the theoretical background that makes up the framework of the model. We then discuss how ABM was used with empirical data to capture varying baseline characteristics of teams which enabled the simulation of wide varieties of scenarios while bringing the model closer to reality. The next section presents the results. The final section discusses the implications of the findings and the limitations of the model.

Theoretical Framework

The model developed combines two elements - disorganization and motivation - to explore their impact on teams. We first look at disorganization from two viewpoints. These approaches are the process-oriented view and the state-oriented view. Then we categorize disorganization into three types (natural, structural and functional). We introduce the concept of public service motivation (Perry and Wise, 1990; Perry, 1996) in order to operationalize motivation within the model.

Disorganization

Cohen *et al.* (1972) first likened disorganization to organized anarchy as it places the onus of responsibility on the individual opposed to a controlling system. 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) implying that different organizational components (either physical or non-physical) to combine randomly. As such, disorganization has been shown to improve employee well-being (Abrahamson, 2002), enhance innovation (Freeland, 2002), amplify stakeholder involvement and increase 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 while also providing political advantages (indispensability). 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, in innovating) can be construed as *disorganization management*. From the literature on the subject (Abrahamson, 2002; Abrahamson and Freedman 2006; Warglien and Masuch, 1996) we can categorize the study of disorganization 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 (i.e. accumulation of documents on a desk). In other words, a disorganized state will have distinct characteristics from which the most trivial would be that such a state would lack order. Instead, 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). It should be noted that these viewpoints are not mutually exclusive — rather they constitute two methods of describing the same phenomenon complementing each other. In this study, we are primarily focusing on disorganization as a process where we will model the capability of inducing disorganization within the organization into the model.

Building on our understanding of disorganization from a process-oriented viewpoint, we categorize disorganization into 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). The main difference between natural and other type's disorganization is that natural disorganization occurs without any planned intervention and cannot be fully controlled or stopped by the organization while the other types can be planned, controlled and curtailed when needed. 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.

Figure 1 about here

The variation in structural constraints can be seen on the top two quadrants of Figure 1. They show 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). The top right quadrant 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.

The bottom quadrants of Figure 1 visualize the idea of functional disorganization. The bottom left quadrant 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, the bottom right quadrant shows a work environment with less constraints which we would label as disorganized. The primary 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 the 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) and allows researchers to examine rational, norm-based and affective motives through attitudes towards attraction to policy making (APM), self-sacrifice (SS), commitment to public interest (CPI), compassion (COMP), civic duty (CD) and social justice (SJ) (Perry, 1996). A decisive component of PSM is its strong focus on pro-social behavior 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 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 often lack a formal volunteer coordination manager. 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 & Pandey, 2008).

Establishing a disorganization continuum of volunteer organizations

We suggest conceptualizing volunteer organizations on an organization-disorganization continuum based on the level at which the organization operates (i.e. a local church that exists only in town at one end and an international organization such as Doctors Without Borders at the other). Such thinking allows us to capture the structural diversity of volunteer organizations represented in the underlying dataset and provides a basis to conceptualize different baseline characteristics of the various volunteer teams. The continuum positions local, small-scale volunteer organizations with relatively disorganized working conditions on one pole, while the other pole depicts international large scale volunteer organizations with highly organized working conditions.

Insert Figure 2 here

Following the continuum depicted in figure 2 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.

Methods

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 team member (volunteer) attributes feeding into the agent based model. They 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 organizational behavior (Lomi and Harrison, 2012; Secchi, 2015) because it allows for capturing emergent phenomena as well as unexpected team behaviors. Also, it is extremely flexible in parameters specifications (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 this particular piece of work are grounded 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.

Modeling 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*). Third, the *solution* (S) agent is described by *efficiency* (*ef*), and *level* (*l*). Fourth, the *opportunity* (O) agent only has one attribute: the *level* (*l*). 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. 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 (solutions) 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) while the minimum team composition is three (we only experimented on teams with seven members in this paper).

Movement

Insert Table 2 here

Once organization is “switched-off” (i.e. disorganization) the teams move without restrictions in accordance to movement conditions (Table 2). When the organization is “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 reflect how volunteers are given access to resourcing, the model under the “organization” condition utilizes three settings: “*Same Access*”, “*Higher Access*” and “*Lower Access*”. The algorithm of the “Same Access” Is as follows;

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

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.

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

The extent to which volunteers interact across levels is dependent on the randomly defined position they find themselves in. In a real world scenario, volunteers on a higher hierarchical 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.

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

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

In order to solve a problem a team aggregate team capability value (Tc) has to be obtained. This is done by aggregating the value of PSM (m), P-O fit (p), Effort (e) of each individual (i) volunteer in the team as displayed in equation 4 below.

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

Next, equation 5 provides the logic for problem solving. Teams will be able to solve problems when they are capable (following equation 4) and the solution generated is efficient (Sme) enough to solve the problem given the problem's complexity (Pcomp). Such solutions occur when at least one volunteer team member, one opportunity, one solution, one problem are on the same simulated place (the so-called "patch").

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

Once opportunities, participants, problems and solutions meet on the same patch the problem solving algorithm starts. Then since all volunteers of the same breed are connected the team capability is calculated and multiplied by the efficiency of the solution. If the resulting value is greater or equal to the difficulty of the problem the problem will be counted as "solved". Otherwise (see equation 6), the team is unable to solve the problem .

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

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. 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).

$$2*Tc \leq P\,(comp) \tag{7}$$

$$2*Tc > P\,(comp) \tag{8}$$

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 1000 steps 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 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.

Findings

The analysis showed that more problems are solved under the disorganization condition than under two of the three organization (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 3 here

These results were consistent among 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 ‘same access’ and ‘lower access’ organization condition. Same access was the most restrictive condition and showed the lowest number of problem 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 were 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 problem solving efficiency of teams goes down under organization when problems increase in complexity. Instead the efficiency remains at high levels even if the problem complexity rises under disorganization.

Insert Figure 4 here

Results depicted in Figure 4 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 more slowly (as the team members do not have enough vision to seek out resources). Higher values of the parameter make team members confused as to which problems to engage (as there is too much information for the team to handle). Upon analyzing the data in order to determine the effect on motivation on problem solving no convincing link between higher motivation and higher problem solving efficiency could be unveiled.

Insert Table 4 here

From the data shown in table it was discovered that the teams with the higher combination of PSM, Intensity and PO Fit tend to solve the most problems. However there was one notable exception, which was the team based on religious volunteer teams. Given this exception we cannot conclusively claim that higher PSM, Intensity, P-O fit, or aggregate of the three leads to better problem solving efficiency.

One interesting outcome of the results as depicted in Figure 4 is that problem complexity seems to have very little influence on the number of problems solved under disorganization (i.e. organization condition switched to ‘false’). The data showed that, under the ‘higher access’ condition with a low problem complexity (-4), the number of problems solved is approximately the same for both the organization and disorganization conditions. However, upon a closer look the data did reveal that disorganization marginally edges ahead of organization. Under the 'same access' condition with low problem complexity (-4), disorganization clearly outperforms organization. This is true also under the 'lower access' condition with a low problem complexity as well. In fact under the 'lower access' condition the performance gap between disorganization and organization is largest.

When problem complexity increases to moderate complexity (0) under the higher access condition, once again the problem solving efficiency of disorganization and organization are similar. Nevertheless, disorganization slightly outperforms organization once more. In the "same" and "lower" access conditions disorganization has a greater problem solving efficiency than organization.

When the problem complexity is further increased (4); in the higher access condition more problems are solved under disorganization compared to organization. However in line with previous findings here too the gap between the problem efficiency is minimal. It should be noted though that with each increase of problem complexity the problem solving efficiency gap between disorganization and organizational also widens. However this gap is not as apparent when compared to the problem solving efficiency gap between disorganization and organization where problems are highly complex (4) and when the access type is either "same" or "lower".

The model is developed in such a way that a clear relationship between problem solving and motivation is maintained. Teams who solve highly complex problems routinely have higher increases for motivation. This in turn increases the team's capability which then enables the team to address more problems with higher complexity, thus creating a positive feedback cycle. This behavior is also shown when teams engage in problems with medium or low complexity as well albeit at a much smaller degree.

Discussion

This study simulated team problem solving behavior in organized and disorganized environments. We employed an agent based modeling approach to identify the dynamics behind problem solving behavior. Additionally, the model was calibrated using survey data. Overall, the results support the idea that disorganization is beneficial to problem solving. 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. These results corroborate the findings of Abrahamson and Freedman (2006); Fioretti & Lomi (2008) and Herath et al. (2015). The results further lend support to some of the benefits of disorganization discussed by researchers such as access to more resources, and greater stakeholder participation (Freeland, 2002; Warglien and Masuch, 1996; Shenhav, 2002).

Second, under disorganization the teams also have access to more problems which explains the higher number of problems solved as theorized (Fioretti & Lomi, 2008). These results then imply 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 shows same access and lower access 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).

How access to resources is authorized is ultimately a subjective decision and can vary from organization to organization depending organizational culture, management style, governmental policies, etc. However, the level of access a team receives is a case-by-case decision and moral and ethical factors should be assessed before access is provided (Sellen and Harper, 2003). In an ideal scenario completely unrestricted access (complete disorganization) is desired; but, more realistically, mechanisms for access to resources on higher levels should be provided within proper legal and moral 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.

Fourth, from the results one may gauge that the close relationship between problem complexity and problem solving efficiency. This is an intuitive result although our analysis further showed the importance of the access type to problem solving efficiency. Teams with access to resources on higher hierarchical levels apart from their own level tend to solve more problems than teams who only have access to resources on the same level or lower. The more remarkable finding was that when the two factors are paired they increase the effect on problem solving efficiency substantially. For managers setting up teams therefore it is imperative to enable them to access enough resources both in terms of quantity and quality in order to achieve desired results.

Fifth, it should also be noted that, 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. 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. Therefore even though from a theoretical point of view unrestricted access to resources is the ideal condition for higher problem solving efficiency, in a more practical sense access to resources multiple levels above or below does not provide a tangible utility.

Limitations

The model does mimic the basic problem solving process within a work 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 the real world. Currently we employ a unified value of a given agent in the decision making process. Given that, upon analyzing the data it was discovered that no conclusive correlation between higher motivation and problem solving efficiency further analysis is needed to confirm this finding and this opens up several future research avenues. Furthermore, 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. In future iterations the remaining variants can be studied.

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 in order get a more nuanced look at what structures lead to efficient problem solving. Furthermore, more attention can be given the benefits of disorganization, namely innovation where how creative solutions emerge under disorganization can be studied. Exploring various organizational hierarchies (flat etc.) should also yield interesting research results. Finally, more exploration on implementing various motivational theories to a model can be a very interesting research avenue as it 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.

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 and Functional Organization and Disorganization

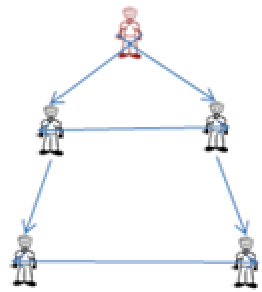
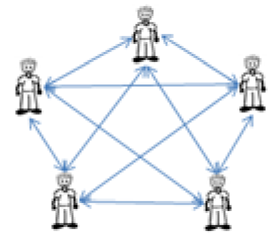
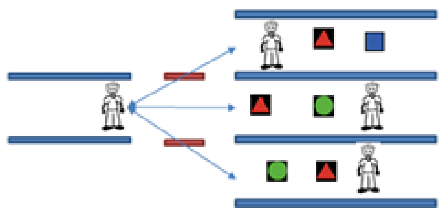
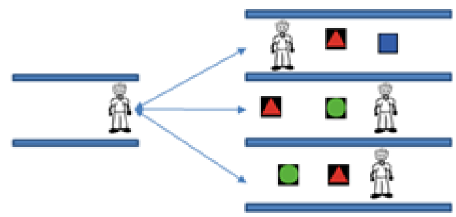
	Organization	**Disorganization**
Structural		
Functional		

Figure 2: Disorganization Continuum

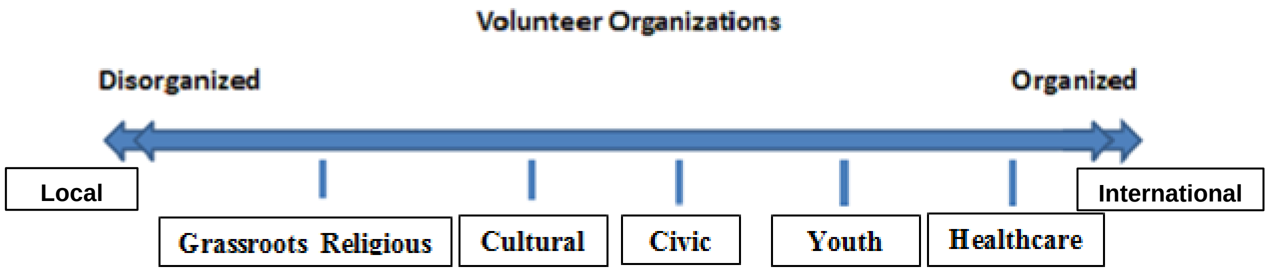


Figure 3: Number of problems solved under disorganization (false) and organization (true) depending on access type

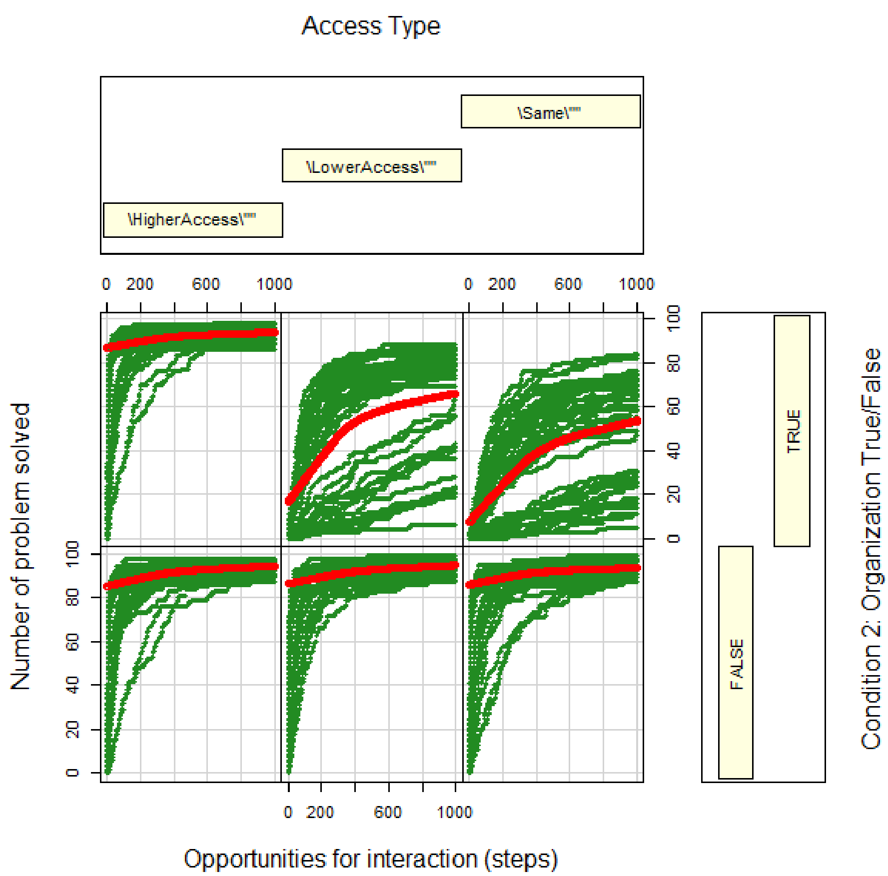


Figure 4: Number of problem solved under disorganization (false) and organization (true) depending on the mean problem complexity