Understanding impact of supervisory support on work outcomes using agent based simulation

Suman Kumar, Mayuri Duggirala, Harshal G. Hayatnagarkar, Vivek Balaraman
{suman.kumar4,mayuri.duggirala,h.hayatnagarkar2,vivek.balaraman}@tcs.com
TCS Research
Pune, MH 411013, INDIA

ABSTRACT

Support service environments are stressful with stringent demands on individual and workgroup performance that have to be met day after day. In earlier work we have modeled the impact of stress within such environments on the performance of the individual and correspondingly that of the team. Since teams are social environments, we can intuitively realise that social dimensions such as supervisory support would impact a team member's performance for the better or the worse. But what is the precise impact of supervisory support on a team's macro outcome parameters such as productivity and performance? Using the results of a ground study of a support services organization, we use an agent based simulation approach to understand the dynamics and the implications of supervisory support on individuals and consequently the macro parameters of the team. We show that supervisory support plays a critical role in ensuring that the team as a whole meets its performance parameters particularly in the presence of disruptive factors such as work spikes.

CCS CONCEPTS

•Computing methodologies → Agent / discrete models;

KEYWORDS

Agent-based modeling, Agent-based simulation, human behavior model

1 INTRODUCTION

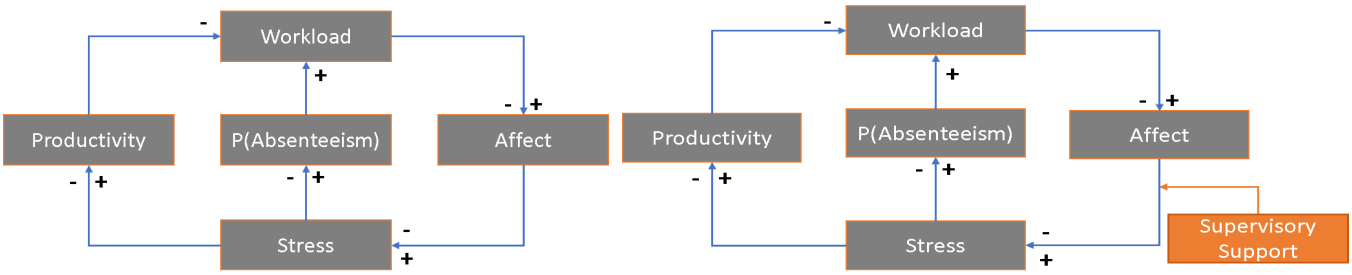
Employees in support services organizations work as a part of large teams. These teams are expected to reach very competitive targets from their business clients in industries such as finance, retail, banking, health-care etc. The targets are specified in service level agreements (SLAs) which indicate aspects such as the Mean Time to Resolution (MTR), Turn Around Time (TAT) for different categories of tasks as well as the escalation hierarchy in case of emergencies. The organizational environment in which these associates work is stressful and requires individuals within the team to rely on each other as well as their supervisors and leadership in order that the tasks are done as specified in the SLA. Studies in such environments [4, 17, 18] including our own [14] indicate that psychological, social, cognitive and environmental factors play a considerable role in impacting organizational metrics of interest such as productivity and job satisfaction. We have already discussed in [1, 3, 6, 13, 14] our fine-grained approach to composing behavior models and our use of these to study how individual behavioral dimensions such as affect, conscientiousness and stress impact work outcomes.

In this work, we extend these models to examine how organizational social dimensions impact workplace outcomes. In particular we study how the organizational social dimension called supervisory support may impact workplace outcomes in case of a support services organization. Past studies including our own show that supervisory support impacts team member characteristics such as engagement, job satisfaction, absenteeism and productivity. In this work we use an agent based system to study the dynamic implications of supervisory support on macro parameters of a prototypical support services team.

2 CONTEXT AND PAST WORK

Past research on the role of supervisory support has highlighted its beneficial impact on a range of individual, team and organizational outcomes. Supervisory support is described as the employees' perception of the extent to which supervisors value their contributions and care about their wellbeing [10]. The role of supervisory support as a buffer for job stress in individuals has been well documented [2]. Supervisory support has also been found to raise levels of employees' trust in the organization with supervisors embodying the organization's goals, values and priorities which in turn was found to positively influence the employee-organization relationship over and above impersonal formal organizational structures [20]. With respect to innovation, studies have indicated how supervisory support behaviors of encouraging innovation, skill building, open communication, rewards and recognition and effective management of responsibilities led employees to willingly participate in promoting initiatives aimed at promoting innovative environmental policies [11]. Other individual level outcomes being influenced by supervisory support include career satisfaction [19], low emotional exhaustion and depersonalization [15] and low turnover intent [9]. Thus past research establishes supervisory support as an important construct in organizational behavior research and justifies its inclusion in the present study.

Before we go on to discuss the context, we introduce a few terms that will be used in rest of the paper. Below we define some of the study variables that have been referred to in the following discussion: **Emotional state** refers to an individualfis experience of positive and negative emotion with respect to their work, at a specific point of time during the work day, namely at the start of their work day and at the end of their work day. **Momentary stress** refers to the perception of stress related to work at the start and end of the individualfis work day. **Workload** refers to the number of tasks arriving on a day, to be completed by an individual before end



(a) Without supervisory support **(b) With supervisory support**

Figure 1: Affective stress dynamics model

Table 1: Behaviour relations

Relation	Model	Description	Source
Affect ← Workload	Affect= 0.106*(workload) + 0.14	Perception of workload has a positive impact on negative affect	[8]
Stress ← Affect	Stress= 0.093*(Affect) + 0.547	Without interaction of moderating supervisory support	Field Study
Stress ← Affect *Supervisory Support	Stress= 0.023*(Affect) + 0.547	With interaction of moderating supervisory support	Field Study
Productivity ← Stress	Productivity = M * BaseProductivity **If**(Stress ≤ 0.1) **then M** = 0.5 **If** (Stress > 0.1 and ≥ 0.25) **then M** = 1.0 **If** (Stress > 0.25 and ≥ 0.75) **then M** = 1.25 **If** (Stress > 0.75 and ≥ 0.9) **then M** = 1.0 **If**(Stress > 0.9) **then M** = 0.5	Stress has an impact on decision making and hence influences productivity. This follows the inverted-U model which suggests that an optimal amount of stress is required for best performance, very low and very high stress degrades performance.	[12, 16]
P(Absenteeism) ← Stress	**If**(stress > 0.9) **then** NORMAL_DIST(0.1, 0.1)	High stress (> 0.9) was correlated with high absenteeism	Field Study

of the day. **Affect** is the extent to which the associate experiences positive or negative mood during the course of the work day. In this study, we are focusing only on the negative affect. **Workload spike** refers to a 1.75 times increase in workload on a particular day (exceptional day). **Backlog** refers to the number of pending tasks for an individual at an instance of time. **Bench strength** refers to individuals in the workforce that are used only during crisis situations like: heavy workload arrival or large number of unplanned absentees on a day, etc. **Supervisory support** refers to perception of employees regarding the degree to which the supervisors value their contributions and care about their well-being [10]. This is expressed as a percentage of the total available workforce. **Turn-around time (TAT)** is the time taken by the simulated team to complete a newly arrived task. **Absenteeism** refers to the number of unplanned leaves taken by an individual participating in the study. **Productivity** was measured via self-reports, i.e. using a survey where the individual rated themselves in terms of whether they had achieved their daily goals and targets, and whether they had achieved all that they had planned to do. Objective productivity metrics were also collected for the participating individuals, from the support services organization in terms of their performance ratings, quality and productivity.

A large support services organization had been facing issues with its employees of unscheduled leave or absenteeism as well as decreases in team productivity. The organizational structure had one supervisor leading a team of several hundred associates. The supervisor was responsible not only for ensuring that SLAs were met on daily basis, but also were required to frequently monitor individual learning and performance particularly for newcomers to the team. It was also the supervisorfis role to maintain team morale on days when there was a heavy spike or accumulated workload due to absentees among the team, seasonality or other factors.

We had carried out an exploratory study in the account teams identified by the support services organization to examine the impact of static (trait) as well as dynamic (state) behavioral factors on the outcomes of interest, i.e. absenteeism and productivity. Elements of our study findings pertaining to individual traits and states such as conscientiousness, affect and stress, have been reported in [1, 3, 6, 13, 14] where we have also discussed the dynamics or implications of those findings.

In the field study, we also observed that, associates who perceived lower supervisory and coworker support reported lower engagement and job satisfaction ($p < 0.05$). Similarly, higher perceived supervisor support was linked to higher objective ratings, productivity and quality as well as perceived engagement and satisfaction ($p < 0.05$). In parallel, higher coworker support was linked to objective ratings and perceived engagement and job satisfaction.

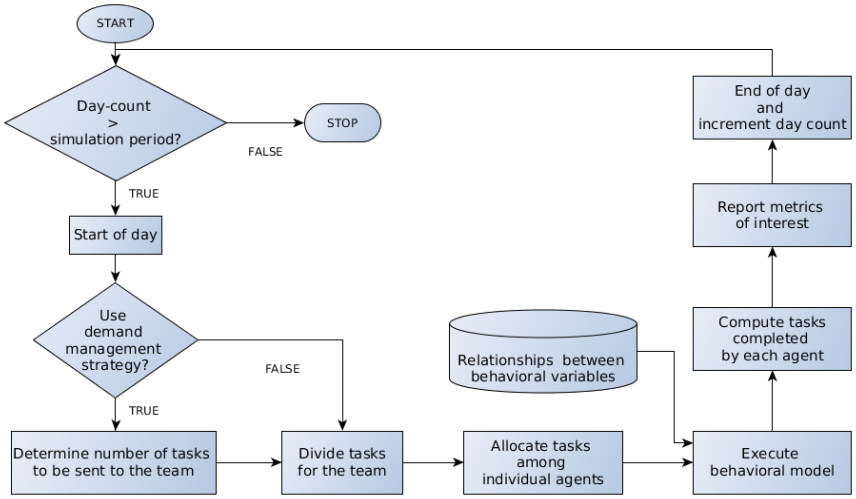


Figure 2: Process Model

In addition to the above analysis, multiple regression also showed the significant impact of supervisory support on job satisfaction ($b = 0.27, p < 0.05$) and stress (b=-0.27, $p < 0.01$). The combined effect of stress and supervisory support on productivity was also significant ($b = -0.21, p < 0.01$) indicating an indirect effect of supervisory support on productivity in the presence of stress. In other words, the buffering effects of supervisory support described in past research were also supported by the empirical findings in our field study. This finding also lends support to our model presented in section 3.1 where we include supervisory support as a moderator in the stress→productivity relationship. In our review of the research on supervisory support we have yet to find a study that models the dynamic effects of supervisory support on productivity. This therefore is a key contribution of the present study.

Thus, support from the larger organization, particularly the supervisor emerged as one of the important insights from this study as we found that supervisory support was linked to both objective performance outcomes measured by the HR team as well as perceived outcomes measured in our survey as discussed above. This result from the study was further supported by in depth interviews with the associates, supervisors and senior leadership in both the teams that participated in the study. These demonstrated the close ties that the supervisor had with the rest of the team despite the large spans of control.

Given the importance of supervisor support in terms of providing consistent role modeling, mentorship, counseling and guidance to their reportees, the present study examines the following research questions: "How does supervisory support at an individual level affect dynamics at the team level, in its presence and absence?" The next section presents the model, experiments, and results obtained.

3 MODEL, EXPERIMENT, RESULTS AND DISCUSSION

These insights on dimensions of behavior and potential for impact on outcomes, led naturally to the need to understand the dynamic implications of these findings. We have been using a grounded fine grained agent based simulation approach to explore these implications and which have been reported in [1, 3, 6, 13, 14]. We compose a simulation as a directed graph of relations that tie together behavior variables with outcome variables of interest and where each relation comes either from past literature or from our own study. We have used this approach to both explore different models for the same situation but different variables of interest or explore the use of the same model in different situations. In the current work, we extend the basic stress model reported in [13, 14] to factor in the impact of supervisory support.

3.1 Simulation Model

Fig. 1a depicts the basic stress dynamics model used for the simulation and which has also been discussed in [13, 14]. This model ignores the role of Supervisory Support. In Fig. 1b we factor in supervisory support which been added in the role of a moderator variable.

Details of the model are described in table 1. Fig. 2 describes the overall simulation process. In this work, we do not use demand management strategy.

As with every agent model we need to make some assumptions: We assume that agents have uniform skills and competency level to complete the given tasks and does not have a fixed deadline to adhere. Tasks also have equal difficulty levels and workload only corresponds to the number of extra tasks getting assigned to an agent. The overall performance of the team is monitored via average TAT and backlog accumulated over the period of time.

3.2 Experiment

For conducting the simulated experiments for our process model, we have chosen the GIS and Agent-based Modelling Architecture (GAMA) [5]. The model uses the specification language GAML to describe the environment, process and behavior of agents. We simulated the experiment using a team of 50 agents.

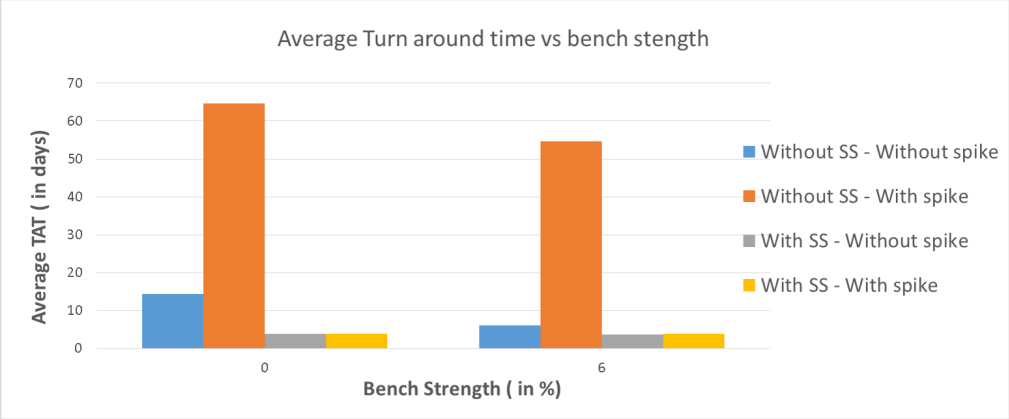


Figure 3: Average Turn-around Time v/s Bench Strength.

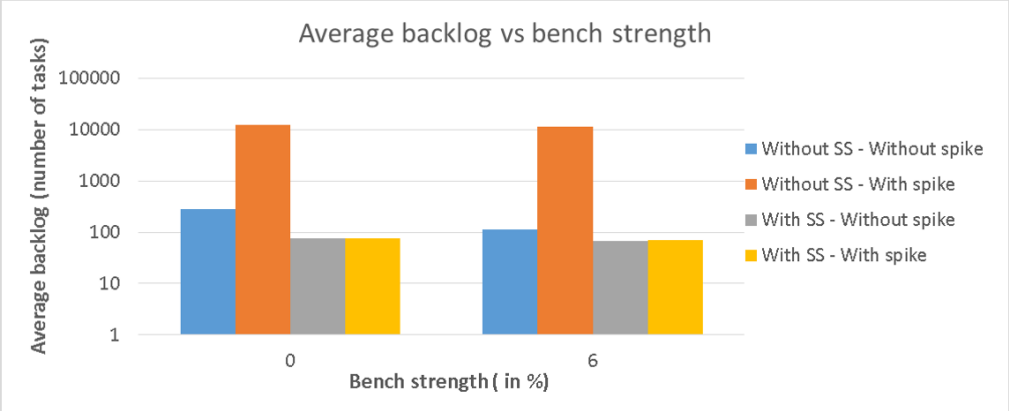


Figure 4: Average Backlog v/s Bench Strength.

The tasks are assigned on daily basis with a mean of 1000 tasks per day and std. deviation of 10%. We monitor the running simulation for 1200 cycles which are equivalent of 120 simulation-days. Average tasks received per day are 1000, with variation of 10%. A spike in workload implies 2000 tasks.

Each simulation of is executed 10 times for every combination and the mean is reported as the final parameter value. During these runs, we collected data for variables such as average turn-around time, average backlog, and average stress. These data are visualized in following charts.

3.3 Results and Discussion

In this section, we discuss impact of supervisory support on average TAT, backlog, and stress in presence and absence of workload spike. In addition, these scenarios are simulated against bench strengths of 0% and 6%.

Fig. 3 informs us of the importance of supervisory support. The chart shows us effect of spike on average TAT for different bench strengths, in presence and absence of supervisory support.

First, we will discuss case without supervisory support. If the team has the 0% bench strength, then without spike average TAT was 16 days, which jumps to 65 days in presence of spike. With bench strength of 6%, the average TAT falls from 16 days to 8 days without spike, and from 65 days to 55 days in handling a spike, which is a small 10% reduction.

With supervisory support, the team with 0% bench strength can turn a task around in 5 days in absence of spike, which is approximately a third of earlier 16 days, and same for bench strength of 6%, which is 33% reduction. However, interestingly, the team also mitigates spike in the workload in the same envelope of 5 days, a reduction from 65 days and from 55 days respectively.

Thus, we see that teams with high supervisory support can deal even with work spikes without significant impact on TAT, while a team that lacks supervisory support shows both higher average TAT without a spike as well as a significant jump when there is a spike. This is macro-level effect, and it can be attributed to a slower rise in the stress at an individual level, when supervisory support is available.

Similarly, we see in Fig. 4 that the average team backlog increases without supervisory support in absence of workload spike, and increases substantially further in presence of such a spike. Please

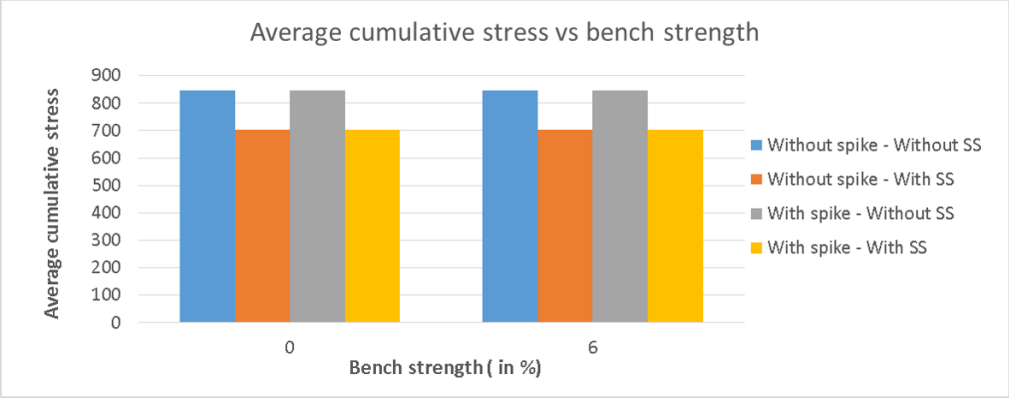


Figure 5: Average Cumulative Stress v/s Bench Strength.

note that this chart uses the log axis for representing average backlog, to accommodate large differences. The primary reason why supervisor support has such a dramatic effect on TAT and backlog is because supervisory support reduces stress levels of team members. Past research also supports this result wherein supervisory support is linked to lower levels of stress among employees by acting as a buffer against work related stress [7].

Fig. 5 shows average cumulative stress levels of individual team members (accumulated per member over simulation duration)with and without supervisory support and with different bench strength. With supervisory support, the stress goes down visibly from approx. 850 to 700. In the presence of moderating interaction of supervisory support, the stress grows much slowly than in absence of supervisory support. This slower growth has a substantive impact on various outcome parameters. We also see that increase in the bench strength from 0% to 6% to counter poor supervisory support does not reduce average stress in the team members.

4 CONCLUSIONS AND FUTURE WORK

In this paper, we have explored the implications of supervisory support on work outcomes using an agent based model. We show that supervisory support has significant impact on TAT and work backlog. We conjecture using our model that this impact is because supervisory support helps mitigate stress caused by negative affect.

This work extended our earlier work on how individual traits and states impact work outcomes by considering the organizational social dimension of supervisory support. We plan to further extend this by studying peer to peer impacts as well as group level effects.

REFERENCES

[1] Vivek Balaraman, Harshal Hayatnagarkar, Meghendra Singh, and Mayuri Duggirala. 2016. Towards better crisis management in support services organizations using fine grained agent based simulation. In *International Conference on Principles and Practice of Multi-Agent Systems*. Springer International Publishing, 366–375.

[2] Robert C Cummins. 1990. Job stress and the buffering effect of supervisory support. *Group & Organization Management* 15, 1 (1990), 92–104.

[3] Mayuri Duggirala, Meghendra Singh, Harshal Hayatnagarkar, Sachin Patel, and Vivek Balaraman. 2016. Understanding impact of stress on workplace outcomes using an agent based simulation. In *Proceedings of the Summer Computer Simulation Conference*. Society for Computer Simulation International, 35.

[4] Robert Eisenberger, Florence Stinglhamber, Christian Vandenberghe, Ivan L Sucharski, and Linda Rhoades. 2002. Perceived supervisor support: contributions to perceived organizational support and employee retention. *Journal of applied psychology* 87, 3 (2002), 565.

[5] Arnaud Grignard, Patrick Taillandier, Benoit Gaudou, Duc An Vo, Nghi Quang Huynh, and Alexis Drogoul. 2013. GAMA 1.6: Advancing the art of complex agent-based modeling and simulation. In *International Conference on Principles and Practice of Multi-Agent Systems*. Springer, 117–131.

[6] Harshal Hayatnagarkar, Meghendra Singh, Suman Kumar, Mayuri Duggirala, and Vivek Balaraman. 2016. Can a buffering strategy reduce workload related stress? (2016).

[7] David P Himle, Srinika Jayaratne, and Paul A Thyness. 1989. The buffering effects of four types of supervisory support on work stress. *Administration in Social Work* 13, 1 (1989), 19–34.

[8] Remus Ilies, Megan Huth, Ann Marie Ryan, and Nikolaos Dimotakis. 2015. Explaining the links between workload, distress, and work–family conflict among school employees: Physical, cognitive, and emotional fatigue. *Journal of Educational Psychology* 107, 4 (2015), 1136.

[9] Ipek Kalemci Tuzun and R Arzu Kalemci. 2012. Organizational and supervisory support in relation to employee turnover intentions. *Journal of Managerial Psychology* 27, 5 (2012), 518–534.

[10] Janet L Kottke and Clare E Sharafinski. 1988. Measuring perceived supervisory and organizational support. *Educational and psychological Measurement* 48, 4 (1988), 1075–1079.

[11] Catherine A Ramus and Ulrich Steger. 2000. The Roles of Supervisory Support Behaviors and Environmental Policy in Employee fiEcoinitiativesfi at Leading-Edge European Companies. *Academy of Management journal* 43, 4 (2000), 605–626.

[12] Barry G Silverman. 2001. More realistic human behavior models for agents in virtual worlds: emotion, stress, and value ontologies. (2001).

[13] Meghendra Singh, Mayuri Duggirala, Harshal Hayatnagarkar, and Vivek Balaraman. 2016. A Multi-Agent Model of Workgroup Behaviour in an Enterprise using a Compositional Approach.

[14] Meghendra Singh, Mayuri Duggirala, Harshal Hayatnagarkar, Sachin Patel, and Vivek Balaraman. 2016. TOWARDS FINE GRAINED HUMAN BEHAVIOUR SIMULATION MODELS. In *Winter Simulation Conference 2016*.

[15] Louise Tourigny, Vishwanath V Baba, and Terri R Lituchy. 2005. Job Burnout among Airline Employees in Japan A Study of the Buffering Effects of Absence and Supervisory Support. *International Journal of Cross Cultural Management* 5, 1 (2005), 67–85.

[16] Michael Van Lent, Ryan McAlinden, Paul Probst, Barry G Silverman, Kevin O'Brien, and Jason Cornwell. 2004. Enhancing the behaviorial fidelity of synthetic entities with human behavior models. *Departmental Papers (ESE)* (2004), 300.

[17] David Watson and Lee Anna Clark. 1999. The PANAS-X: Manual for the positive and negative affect schedule-expanded form. (1999).

[18] Howard M Weiss and Russell Cropanzano. 1996. Affective events theory: A theoretical discussion of the structure, causes and consequences of affective experiences at work. (1996).

[19] Vathsala Wickramasinghe and Mayura Jayaweera. 2010. Impact of career plateau and supervisory support on career satisfaction: A study in offshore outsourced IT firms in Sri Lanka. *Career Development International* 15, 6 (2010), 544–561.

[20] Ann Yan Zhang, Anne S Tsui, Lynda Jiwen Song, Chaoping Li, and Liangding Jia. 2008. How do I trust thee? The employee-organization relationship, supervisory support, and middle manager trust in the organization. *Human Resource Management* 47, 1 (2008), 111–132.