Using Agent-Based Simulation to Investigate the Dynamics of Knowledge-Exchange in Organisations

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Abstract: Knowledge-sharing between employees is a complex and dynamic interpersonal process that we investigate using a system thinking approach. Individuals make their knowledge-related decisions (seeking, sharing, hiding knowledge) based on various factors (their traits, experiences, perception of others and the context). Overall, organizational knowledge-sharing is a product of behavioural dependencies and changes in the behavioural patterns of individuals as well as the interactions between individuals and groups. In this paper, our goal is to investigate how employees' reactions to the behaviours of others in the organization, due to disruption or individual behavioural strategy, affect the extent of knowledge-sharing over time. To do this we identify several feedback loops in solicited knowledge-sharing interactions and build an agent-based simulation model of knowledge-sharing in 40-person organization. We perform two 'in silico' experiments. The first investigates the organizational consequences of a local disruption that immediately reduces the inclination to seek and share knowledge of a group of individuals. The second experiment compares the organizational consequences of four strategies for deselecting individuals who have previously declined to share knowledge. The results of the first experiment show that the local event causing higher likelihood of knowledge-rejection affects the overall organizational knowledge exchange due to disruptions in knowledge-seeking attempts. The second experiment indicates that knowledge source selecting strategy reduces not only rejection rates, protecting emotion resources of the seeker, but also reduces knowledge seeking attempts and knowledge-sharing. Empirical studies are needed to obtain more data to enhance the model's realism and to verify or refute the modelling assumptions.

Keywords: Knowledge-Sharing, Knowledge-Hiding, Knowledge-Seeking, Agent-Based Simulation

1. Introduction

Knowledge-sharing among employees enables knowledge possessed by one individual to be spread throughout an organization to other employees who can subsequently apply it, improve upon it or use it as a source in the creativity process (Anand, Muskat, et al., 2020). With that, knowledge-sharing encourages organizational knowledge flow and consequently improves performance (Sung and Choi, 2018). However, knowledge-sharing is based on discretional behaviours that need to be well-understood to be governed in alignment with organizational needs (Foss et al., 2010).

Numerous studies have reported lists of antecedents of asking and providing information and knowledge (cf. Lim et al., 2020; Witherspoon et al., 2013). However, comprehending intraorganizational knowledge-sharing is difficult because organizations are complex social systems comprising diverse interacting individuals who are themselves sub-systems, constantly adapting to changes in their environment, including the behaviours of other individuals (Wang et al., 2009). For example, Borgatti and Cross (2003), who analysed knowledge-seeking and Anand and Walsh (2022), who studied knowledge hiding, emphasised that previous knowledge exchange experiences affect individuals' later behaviours (asking for and providing knowledge), signalling the need to study knowledge-sharing dynamics. Also, disruptive events in one part of the organization affect individuals not only in that part but also in other areas.

The complexity of knowledge-based interactions in organizations makes their study challenging using standard methods, such as regressions, that apply a linear, open-loop approach (Wang et al., 2009). Very few studies investigate the dynamics and spatial contexts in knowledge-exchange interactions while considering individual attributes, their previous behaviours and changes in the organizational environment. One of the few examples is Pires et al. (2024), who used an agent-based simulation that included both spatial and temporal factors and behavioural rules that individuals followed. They found that knowledge-sharing in the simulated hospital depended on individuals' physical movement and changed over time.

In this paper, we adopt a system thinking approach and identify the feedback loops in solicited knowledge-sharing to investigate how employees' reactions to the behaviours of other employees affect the extent of knowledge-sharing in the organization. Specifically, we use an agent-based simulation model (Bonabeau, 2002)

to conduct 'in silico' experiments of knowledge-sharing in a 40-person organization over 20 working days. In the first experiment, we analyse how a disturbance within a group decreases the whole group's positive responses to knowledge requests and, hence, overall organizational knowledge-sharing. In the second experiment, we investigate the effect on overall knowledge-sharing of a range of rejection-response criteria, from never asking the rejector again to no limitations.

Our agent-based simulation model itself has a specific novelty, aiming to represent some of the day-to-day behaviours of office staff, for example, their locations in the office, the locations of people they work with, and their impromptu encounters while walking past or taking a break. This methodological approach enables us to investigate various knowledge-exchange behaviours, including knowledge-seeking, knowledge-sharing and knowledge-hiding between heterogeneous individuals interacting in an organization under different conditions (Macy and Willer, 2002). The results of each interaction influence the individuals involved in a knowledge exchange event and others in the organization. Among the primary simulation outputs are the time spent on knowledge-sharing and the count of individuals' attempts to request knowledge, receive it or be rejected.

2. Theoretical Background

2.1 Solicited Knowledge-Sharing

When knowledge-sharing between individuals occurs as a result of a knowledge request and knowledge response, it is termed *solicited* knowledge-sharing (Teng and Song, 2011). Solicited knowledge-sharing covers the behaviours of knowledge-seeking (Haas and Cummings, 2015), reactive knowledge-giving (Zhang and Jiang, 2015) and knowledge-hiding (Oliveira et al., 2021). The nature of these behaviours depends on the individual's traits, including attitudes, motives and abilities (e.g., Anand et al., 2022; Lim et al., 2020; Witherspoon et al., 2013), the characteristics of the context they are acting in (Cummings and Teng, 2006), and the interpersonal ties and social capital between knowledge-seeker and knowledge-giver/hider (Reinholt et al., 2011).

2.2 Feedback Loops in Solicited Knowledge-Sharing

We use a system theoretic (Senge, 1990) approach to analyse interpersonal knowledge-sharing because this approach offers a holistic perspective to the phenomena usually studied linearly. This approach enables understanding complex, dynamic processes over time and within a specific context (Rubenstein-Montano et al., 2001). In this approach, people are viewed as sub-systems of the organization system. On the individual level, the results (outputs) of individual behaviours (e.g., rejecting a request for knowledge) alter the attributes of all individuals involved in the interaction (e.g., those who asked for knowledge and those who decided to hide it). These changes in individuals' attributes are now inputs to their future behaviours, either reinforcing or reducing the inclination for such behaviours. These are feedback loops that "alter the state of the world, causing changes in nature and triggering others to act, thus giving rise to a new situation which then influences our next decisions" (Sterman, 2001, p. 12).

In the case of solicited knowledge-sharing, our analysis focuses on five key feedback loops (depicted in Figure 1). These loops illustrate how the outcomes of behaviours (such as knowledge-seeking, giving, or hiding) influence (feed back) an individuals' future willingness to engage in these behaviours and their preferences for selecting knowledge-exchange partners (Zhang and Jiang, 2015). For instance, Loop 1 represents the feedback loop for a knowledge seeker (A) when a suitable person to ask for knowledge was not found (nobody met A's selection criteria). This feedback loop could lead to a change in the knowledge seeker's search strategy (Lim et al., 2020), such as shifting from asking others to self-study, perhaps using an organizational repository or an internet source.

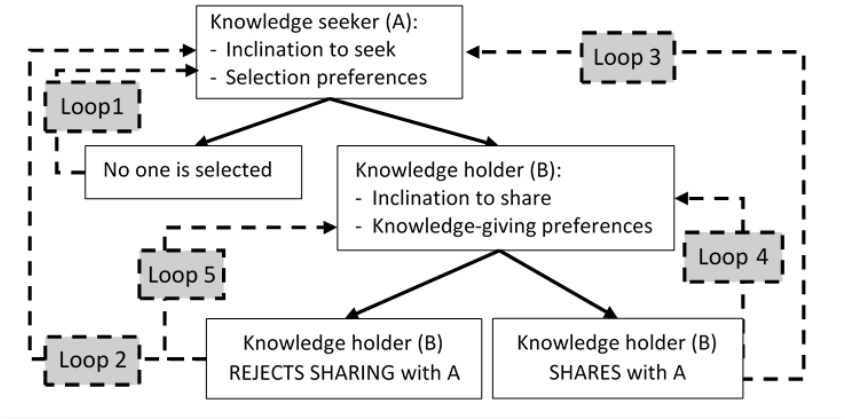


Figure 1: Dynamic model of solicited knowledge sharing

From the perspective of a knowledge seeker (A), the rejection of a knowledge request (Loop 2) initiates negative reciprocity feedback (Černe et al., 2014). The rejection can lead to negative emotions and distrust towards the person who hid knowledge and, to some extent, towards others in the organization. This can increase the likelihood of A hiding knowledge from others in the future (Anand, Centobelli, et al., 2020). Rejection can also increase the social cost of asking for knowledge, leading the rejected knowledge-seeker (A) to reduce their willingness to ask others in the future to conserve their emotional resources (Lim et al., 2020).

From the perspective of the knowledge-holder (B), rejecting sharing (Loop 5) could affect their future inclination to seek and share knowledge as it reduces their perception of psychological safety (Jiang et al., 2019), weakens workplace relationships, and decreases organizational citizenship behaviour (Kaur and Kang, 2023). It will also affect B's future selection preferences when requesting knowledge (decreased inclination to ask a person they previously rejected) - assuming negative reciprocity (Anand, Centobelli, et al., 2020).

When a knowledge request is accepted and knowledge shared, a knowledge-seeker (Loop 3) becomes more likely to ask for knowledge in the future (Leiß and Rausch, 2023). Furthermore, it increases the chances of knowledge providers being approached again, as their effective previous interaction would, among other things, increase the benevolence trust between the two (Mohammed and Kamalanabhan, 2019). Also, A's willingness to share knowledge with B or other organizational members would grow as a result of the need to reciprocate the receipt of knowledge (Lim et al., 2020). Loop 4, which represents feedback for the knowledge provider (B), represents the increase in their willingness to share knowledge due to positive feelings and satisfaction associated with helping. Providing knowledge also increases a person's inclination to ask for knowledge. It affects knowledge-holder selection preferences due to reciprocation expectations from the person to whom they gave knowledge (Lim et al., 2020).

2.3 An Agent-Based Model of Knowledge-Exchange in Organizations

The current agent-based simulation is capable of representing a wide variety of organization layouts and individuals. People are represented as autonomous, heterogeneous agents, each with their own attributes, which change during a simulation. They have a limited number of mutually-exclusive activity states available, with the main activities being solicited knowledge-exchange, simple working together (without a knowledge exchange incentive), and working alone. Agents have designated desks but can choose to walk to their designated break-place (e.g., kitchen/coffee station). They can choose to walk to another person's desk to interact or just communicate with them electronically. Taking breaks and going to others' desks provides individuals with opportunities for impromptu encounters, which increase tie-strengths between individuals. An example office layout is shown in Figure 3a. People are assigned to teams, and team members' desks are grouped together. We assume people work a 7.5-hour workday, but currently we make the simplification that the time of day does not affect people.

An individual agent's behaviour depends on the following main factors: their current attributes (e.g., knowledge level, organizational identification, psychological safety, familiarity with other people, location, current inclinations for each activity state option), their current activity state (e.g., taking a break), what others are doing, and what has happened in the past (e.g., knowledge exchange history, knowledge request rejection history). Agent attributes are initialised at the start of a simulation run and their values change dynamically

during the simulation. Everyone is initialized with one of three state preference profiles: an average person, a highly self-sufficient person who does not seek knowledge so often, or a frequent knowledge seeker. These profiles contain the agent's relative state choice 'probabilities', and they are altered dynamically in response to the agent's experiences. This means that an individual's inclinations, and hence decisions and behaviour, alter according to their experiences – which depend on the others in the organization. Records of past interactions are dynamic cumulative totals and could be considered 'memories' of past situations. The simulation output metrics include state frequency counts and durations for each agent (and hence for the organization) as well as overall interaction totals (such as total knowledge-sharing time), knowledge level, rejection counts, etc.

We took 1 second as our unit of simulation time because this enabled us to incorporate the impromptu encounters mentioned in the introduction. Hence, simulating one office day involved 27,000 simulation time steps (7.5 hours equals 27,000 seconds). At the start of each simulation time step, each person must decide what activity to do. They decide this by using their (dynamic) state preference profile. One of the simplifications we made is that when a person enters a state, the duration in that state is sampled from a plausible distribution of times and the agent stays in that state until that time has elapsed (there are no interruptions, no interactions within interactions).

The logic involved in a solicited knowledge-sharing interaction is shown in Figure 2.

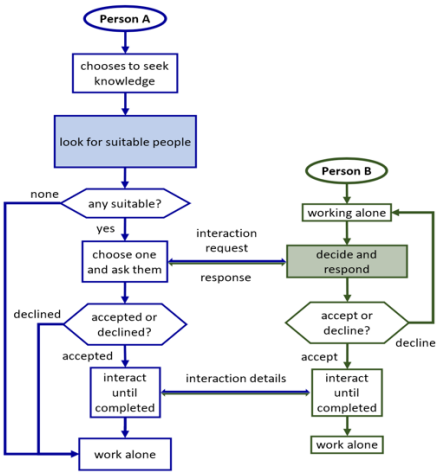


Figure 2: The procedure of arranging solicited knowledge-sharing

When a knowledge seeker (Person A) decides to ask around for some knowledge, they first need to look for suitable people who could be asked. This depends on what others are doing, A's characteristics, the others' characteristics, and what has happened in the past. Person A applies various (configurable) criteria that filter out unsuitable people and produce a set of potential candidates. For example, A would look for someone who:

- is not currently interacting with someone, and has not rejected A before, or has rejected A less than a certain number of times before (accessibility; e.g., Borgatti and Cross, 2003)
- is similar to A in various selectable ways (e.g., similar organizational identification, psychological safety) (similarity; cf. Lim et al., 2020)
- has a greater knowledge level than A (expertise; e.g., Borgatti and Cross, 2003)
- is someone A has some social relationships with (they have met before, preferably many times) (familiarity; e.g., van der Rijt et al., 2013)
- is someone A has exchanged knowledge with before (either direction), preferably many times (trustfulness; e.g., Mohammed and Kamalanabhan, 2019).

The second stage is that Person B has to decide whether to accept the request or reject it (a basic form of knowledge-hiding). This again depends on both agents' characteristics and the past. B also applies various (configurable) criteria, such as:

- B has organizational identification above a certain threshold (motivation; e.g., Phookan and Sharma, 2021)
- B perceives that the context is psychologically safe above a certain threshold (safety; e.g., Škerlavaj et al., 2023)

- B has some social relationships with A – they interacted before above a certain threshold (familiarity; e.g., Zhang and Jiang, 2015)
- B has exchanged knowledge with A before, above a certain threshold (trustfulness; e.g., Le and Lei, 2018).

If all the conditions are met, A's request is accepted otherwise it is rejected (a knowledge-hiding situation).

The simulation records counts of all the results of wanting to interact and all the reaction results. Each of the results of a solicited knowledge-exchange interaction (not finding a suitable person available, rejection of sharing, and sharing knowledge) has consequences for both the knowledge seeker and the knowledge holder. One of the results of interaction is the change in individual knowledge levels. Naturally, when Person A receives knowledge, A experiences an increase in knowledge level. In addition, we assumed that Person B, while explaining knowledge to A, also experiences a slight increase in their understanding. These rates of increase are set by model parameters. When Person A tries and fails in an attempt to seek knowledge from someone, then A's inclination to seek knowledge in the future is reduced (a model parameter sets the rate of reduction). On the other hand, when A's knowledge request is fulfilled, we assume that this would cause a slight increase in A's inclination to seek knowledge in the future (there is a model parameter for the rate of increase).

The model is controlled by twelve main parameters. At present, we do not have much relevant empirical data (e.g., distributions for the frequency of knowledge requesting or duration of knowledge-sharing sessions). For our initial experiments, we fixed some of these parameters at values that produced plausible results. We then conducted a coarse grid search of the resulting parameter space, using 'categorical calibration' (Thiele *et al.*, 2014) to filter out parameter sets that failed acceptability criteria. The most important parameter is the initial state preference profiles, which represent the individuals' activity preferences. Another parameter, *Minimum-Person-Match*, specifies a threshold for how close the match must be (0: 'anyone will do' to 1: 'must be identical') when an agent selects a person to interact with or decides how to respond to a request. When selecting a person based on an attribute value, a parameter *Positive-Response-Threshold* specifies a minimum threshold.

The number of replications was chosen such that the cumulative mean of the total knowledge-sharing time stabilized to within 5% (an arbitrary tolerance of typically less than 2 minutes) (Robinson, 2014). We found that 50 replications provided convergent cumulative outputs.

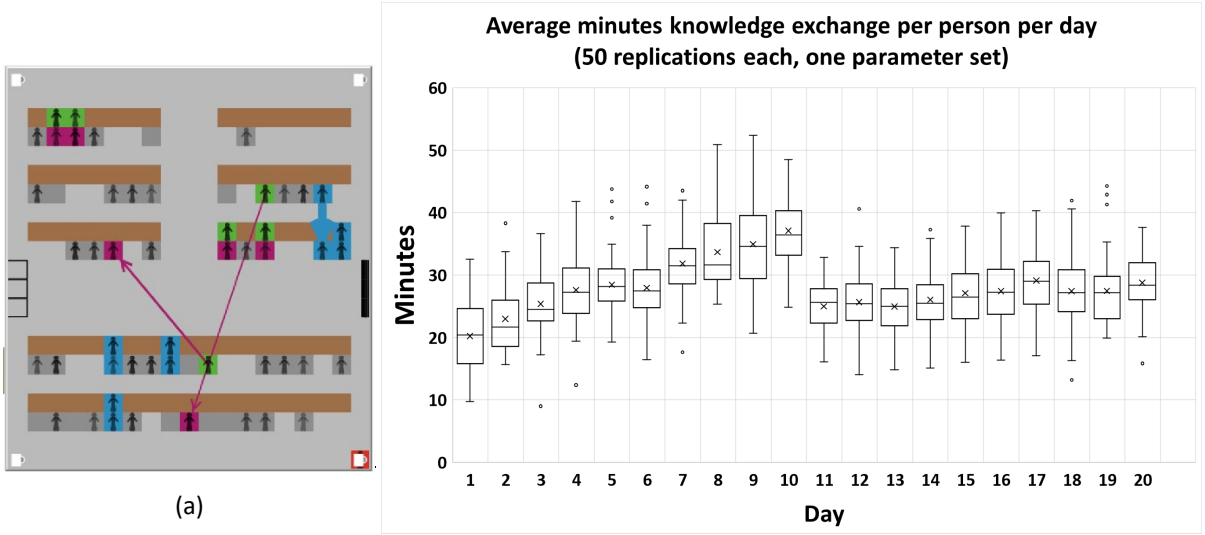
Regarding model verification, the simulation model was developed using conventional software engineering standards (such as error-trapping, meaningful variable names, unit testing). The model is implemented in NetLogo (Wilensky, 1999). Since there were no empirical data to validate the simulation model, all we could do was check that the model produced reasonable results, and sensitivity analyses were conducted to check that the simulation responded sensibly to changes in model parameters and agent characteristics.

3. Experiments and Results

We have conducted two preliminary experiments to investigate knowledge-sharing dynamics over 20 work days (i.e., four weeks). Both experiments were conducted with 40 staff members and used the same set of model parameters. Each scenario was replicated 50 times. The experiments' results cover the average time of knowledge-sharing and average counts of knowledge requests, rejection and acceptance attempts. Every result is reported per person per day.

3.1 Experiment 1 and Discussion

Our aim in Experiment 1 was to analyse the effect of a sudden increase in the likelihood of knowledge rejections in one group on knowledge-sharing in the whole organization. The scenario was that after ten days of normal working, an event occurred that drastically increased the likelihood of knowledge rejections in one of the four groups (Group 4, top-left corner Figure 3(a)). The disruptive event (perhaps some counterproductive, unethical behaviour of the team leader) caused a drastic drop (to 10%) in the group members' organizational identification and psychological safety. The simulation was run for ten more days after disruption.



(a)

(b)

Figure 3: (a) The office layout used in both experiments; (b) Average time spent on knowledge-sharing before and after the disruptive event in Experiment 1.

Figure 3(b) shows boxplots for the resulting distributions of minutes of knowledge sharing per person for each day. They show that the average time spent on knowledge sharing per person per day was increasing during the first ten days of ordinary work. The sudden negative event in Group 4 led to an observable drop in knowledge-sharing, from an average of around 37 minutes after the first ten days to approximately 25 minutes over the next ten days. The upward day-to-day trend from weeks one and two continued but at a lower rate. Analysis of agents' behaviour frequencies revealed that, as expected, average rejection attempts increased significantly in week 3 (11-15th day) and continued in week 4 (16-20th day), see Table 1. Also, in week 4, the variability of rejections between workdays increased. Moreover, while in week 3, the growth rate of knowledge request attempts revealed the same (around 20%), in week 4, the week average growth rate dropped (to 4%) but with higher day-to-day variability. After the disruption, the number of knowledge-seeking attempts when no one was available and suitable (failed search) started to increase (from 3% in week 2 to 11% in week 4).

Table 1: Differences between work weeks in individual behaviour frequencies (day average)

	#knowledge-seeking attempts	#failed searches	Failed searches per knowledge-seeking attempt	#rejected requests	Rejections per request
Week 1 (day 1-5)	1.30	0.13	10%	1.49	68%
Week 2 (day 6-10)	1.62	0.05	3%	1.77	64%
Week 3 (day 11-15)	1.98	0.17	9%	2.45	77%
Week 4 (day 16-20)	2.06	0.22	11%	2.68	76%

Note: All figures are averages per person per day

Experiment 1 examines the consequences of feedback Loops 2 and 5 depicted in Figure 1. The results show that the disruptive event immediately affected the decisions of a few organizational members, but the consequences affected overall knowledge-sharing shortly after, and this stayed at a lower level until the end of the experiment. This decreased overall knowledge-sharing was associated with a higher rejection rate. This increase in rejection attempts exacerbated the growth rate of knowledge-seeking attempts (Lim *et al.*, 2020). It can be explained by the increase in the social costs of requesting (Tidwell and Sias, 2005) and the individuals' intention to reduce them by generally decreasing their request attempts (Flynn and Lake, 2008). Knowledge hiding also deteriorated the relationships between individuals (Škerlavaj *et al.*, 2023), making it harder to find a trusted individual.

3.2 Experiment 2 and Discussion

In Experiment 2, we compared the consequences of four strategies to follow when experiencing a knowledge request rejection. This experiment refers mainly to feedback Loop 2 in Figure 1. Agents remember all rejections

(and acceptances) and can choose to never ask a rejector again. We compared the amount of overall knowledge-sharing during a 20-work-day period when an agent tolerates 1, 2, 3 or unlimited rejections before excluding the rejector completely. However, in all strategies, the inclination to ask others for knowledge declines after every rejection (at a rate set by a model parameter). To make the simulation more plausible, we catered for scenarios where rejection could be a result of factors not explicitly modelled, such as being busy on a deadline. For this, we introduced a random 1 in 5 chance of rejection due to other circumstances.

Table 2: Differences between strategies for responding to knowledge rejections

Maximum Rejections Allowed	Work Alone (mins)	Self-Study (mins)	Knowledge-sharing (mins)	#knowledge-seeking attempts	#accepted knowledge requests	#rejected knowledge requests	Failed searches per knowledge-seeking attempt
1	260	141	6	1.25	0.12	0.08	85%
2	220	116	19	1.44	0.45	0.28	55%
3	203	94	30	1.57	0.75	0.54	31%
unlimited	197	82	35	1.60	0.91	1.65	3%

Note: All figures are averages per person per day

The different strategies caused some differences in the 20-day behaviours and knowledge-sharing outcomes, as depicted in Table 2. It seems that continuing to consider a person suitable - irrespective of the number of times they have rejected you - results in increased knowledge-sharing overall. Although one might experience less rejections by never asking previous rejectors again (0.08 vs 1.65 times per person per day), because people have been excluded one is less likely to find some suitable (85% search failure compared to 3%).

These results suggest that severer strategies for selecting knowledge-holders protect the knowledge seeker from the social and emotional costs of rejections but at the expense of significantly lower knowledge exchange with others. It indicates the trade-offs an individual approaching other for knowledge needs to make based on cost-gain concept and conservation of resources theory (Lim *et al.*, 2020). Also, the experiment suggests a mechanism whereby knowledge hiding can hinder the flow of knowledge in an organization by decreasing knowledge inquiries and limiting the number of knowledge holders who can be approached for knowledge (Borgatti and Cross, 2003).

4. Conclusions

Our study emphasises the importance of investigating the behavioural and relational feedback loops in knowledge requesting, sharing and hiding. Identifying the consequences of knowledge-based behaviours affecting every actor involved in the exchange interaction is informative for theory and practice. We built an agent-based simulation model that performs as a platform for testing consequences of feedback loops in knowledge-exchange behaviours. We believe that our simulation model can usefully model the dynamic, spatial interactions between individuals engaged in knowledge exchange activities, and potentially provide a micro-level explanation of macro-level effects, such as the change in the extent of knowledge-exchange. Specifically, our “in silico” simulation-based experiments show that some consequences of rejecting to share knowledge have individual and organizational level consequences that manifest over time.

However, the simulation model currently has several limitations. For example, the model has not been thoroughly parameterized – only a limited grid search has been conducted. Empirical data are needed to increase confidence in the relative weights of the factors involved. There have been many simplifications that could be addressed, such as taking into account the type of knowledge exchanged, the time of day, the time taken to negotiate an exchange or a rejection (all of which currently take just one simulation time interval). Further models could include individual attributes such as employee tenure, hierarchical position in the organization, and age (Burmeister and Fasbender, 2018). There is a need for longitudinal empirical case studies to identify the feedback involved in knowledge exchange experiences, to find out the delayed effect of some decisions, and to identify the strategies that employees adopt.

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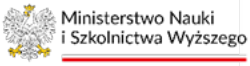

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References

Anand, A., Centobelli, P. and Cerchione, R. (2020) "Why should I share knowledge with others? A review-based framework on events leading to knowledge hiding", *Journal of Organizational Change Management*, Vol. 33, No. 2, pp 379–399.

Anand, A., Muskat, B., Creed, A., Zutshi, A. and Csepregi, A. (2020) "Knowledge sharing, knowledge transfer and SMEs: evolution, antecedents, outcomes and directions", *Personnel Review*, Vol. 50, No. 9, pp 1873–1893.

Anand, A., Offergelt, F. and Anand, P. (2022) "Knowledge hiding – a systematic review and research agenda", *Journal of Knowledge Management*, Vol. 26, No. 6, pp 1438–1457.

Bonabeau, E. (2002) "Agent-based modeling: Methods and techniques for simulating human systems", *Proceedings of the National Academy of Sciences of the United States of America*, Vol. 99, No. SUPPL. 3, pp 7280–7287.

Borgatti, S.P. and Cross, R. (2003) "A relational view of information seeking and learning in social networks", *Management Science*, Vol. 49, No. 4, pp 432–445.

Burmeister, A. and Fasbender, U. (2018) "Being perceived as a knowledge sender or knowledge receiver: A multistudy investigation of the effect of age on knowledge transfer", pp 518–545.

Černe, M., Nerstad, C.G.L., Dysvik, A. and Škerlavaj, M. (2014) "What goes around comes around: knowledge hiding, perceived motivational climate, and creativity", *Academy of Management Journal*, Vol. 57, No. 1, pp 172–192.

Cummings, J.L. and Teng, B.-S. (2006) "The Keys to Successful Knowledge-Sharing", *Journal of General Management*, Vol. 31, No. 4, pp 1–18.

Flynn, F.J. and Lake, V.K.B. (2008) "If you need help, just ask: Underestimating compliance with direct requests for help", *Journal of Personality and Social Psychology*, Vol. 95, No. 1, pp 128–143.

Foss, N.J., Husted, K. and Michailova, S. (2010) "Governing knowledge sharing in organizations: Levels of analysis, governance mechanisms, and research directions", *Journal of Management Studies*, Vol. 47, No. 3, pp 455–482.

Haas, M.R. and Cummings, J.N. (2015) "Barriers to knowledge seeking within MNC teams: which differences matter most", *Journal of International Business Studies*, Nature Publishing Group, Vol. 46, No. 1, pp 36–62.

Jiang, Z., Hu, X., Wang, Z. and Jiang, X. (2019) "Knowledge hiding as a barrier to thriving: The mediating role of psychological safety and moderating role of organizational cynicism", *Journal of Organizational Behavior*, Vol. 40, No. 7, pp 800–818.

Kaur, N. and Kang, L.S. (2023) "Perception of organizational politics, knowledge hiding and organizational citizenship behavior: the moderating effect of political skill", *Personnel Review*, Vol. 52, No. 3, pp 649–670.

Le, P.B. and Lei, H. (2018) "The mediating role of trust in stimulating the relationship between transformational leadership and knowledge sharing processes", *Journal of Knowledge Management*, Vol. 22, No. 3, pp 521–537.

Leiß, T.V. and Rausch, A. (2023) "Informal learning from dealing with software-related problems in the digital workplace", *Journal of Workplace Learning*, Vol. 35, No. 9, pp 291–310.

Lim, J.H., Tai, K., Bamberger, P.A. and Morrison, E.W. (2020) "Soliciting resources from others: an integrative review", *Academy of Management Annals*, Vol. 14, No. 1, pp 122–159.

Macy, M.W. and Willer, R. (2002) "From Factors to Actors: Computational Sociology and Agent-Based Modeling", *Source: Annual Review of Sociology*, Vol. 28, pp 143–166.

Mohammed, N. and Kamalanabhan, T.J. (2019) "Tacit knowledge seeking from teammates: unravelling the role of social capital", *International Journal of Organizational Analysis*, Vol. 28, No. 3, pp 765–790.

Oliveira, M., Curado, C. and de Garcia, P.S. (2021) "Knowledge hiding and knowledge hoarding: A systematic literature review", *Knowledge and Process Management*, Vol. 28, No. 3, pp 277–294.

Phookan, H. and Sharma, R.R. (2021) "Subsidiary power, cultural intelligence and interpersonal knowledge transfer between subsidiaries within the multinational enterprise", *Journal of International Management*, Elsevier Inc., Vol. 27, No. 4, p. 100859.

Pires, B., Goldstein, J., Molfino, E., Ziemer, K., Orr, M. and Jiménez, J. (2024) "Knowledge sharing in a dynamic, multi-level organization: an agent-based modeling approach", *Computational and Mathematical Organization Theory*, Vol. 30, No. 1, pp 75–100.

Reinholt, M., Pedersen, T. and Foss, N.J. (2011) "Why a central network position isn't enough: The role of motivation and ability for knowledge sharing in employee networks", *Academy of Management Journal*, Vol. 54, No. 6, pp 1277–1297.

van der Rijt, J., van den Bossche, P., van de Wiel, M.W.J., de Maeyer, S., Gijselaers, W.H. and Segers, M.S.R. (2013) "Asking for help: a relational perspective on help seeking in the workplace", *Vocations and Learning*, Vol. 6, No. 2, pp 259–279.

Rubenstein-Montano, B., Liebowitz, J., Buchwalter, J., McCaw, D., Newman, B. and Rebeck, K. (2001) "A systems thinking framework for knowledge management", *Decision Support Systems*, Vol. 31, No. 1, pp 5–16.

Senge, P. (1990) *The Fifth Discipline:The Art and Practice of the Learning Organization*, Doubleday, New york.

Škerlavaj, M., Černe, M. and Batistič, S. (2023) "Knowledge Hiding in Organizations: Meta-Analysis 10 Years Later", *Economic and Business Review*, Vol. 25, No. 2, pp 79–102.
Sterman, J.D. (2001) "System dynamics modeling: Tools for learning in a complex world", *California Management Review*, Vol. 43, No. 4, pp 8–25.
Sung, S.Y. and Choi, J.N. (2018) "Building knowledge stock and facilitating knowledge flow through human resource management practices toward firm innovation", *Human Resource Management*, Vol. 57, No. 6, pp 1429–1442.
Teng, J.T.C. and Song, S. (2011) "An exploratory examination of knowledge- sharing behaviors: solicited and voluntary", *Journal of Knowledge Management*, Vol. 15, No. 1, pp 104–117.
Thiele, J.C., Kurth, W. and Grimm, V. (2014) "Facilitating Parameter Estimation and Sensitivity Analysis of Agent-Based Models: A Cookbook Using NetLogo and 'R'", *Journal of Artificial Societies and Social Simulation*, Vol. 17, No. 3, p. 11.
Tidwell, M. and Sias, P. (2005) "Personality and information seeking: Understanding how traits influence information-seeking behaviors", *Journal of Business Communication*, Vol. 42, No. 1, pp 51–77.
Wang, J., Gwebu, K., Shanker, M. and Troutt, M.D. (2009) "An application of agent-based simulation to knowledge sharing", *Decision Support Systems*, Vol. 46, No. 2, pp 532–541.
Wilensky, U. (1999) "NetLogo", Center for Connected Learning and Computer-Based Modeling, Northwestern University, available at: http://ccl.northwestern.edu/netlogo/.
Witherspoon, C.L., Bergner, J., Cockrell, C. and Stone, D.N. (2013) "Antecedents of organizational knowledge sharing: a meta-analysis and critique", *Journal of Knowledge Management*, Vol. 17, No. 2, pp 250–277.
Zhang, X. and Jiang, J.Y. (2015) "With whom shall I share my knowledge? A recipient perspective of knowledge sharing", *Journal of Knowledge Management*, Vol. 19, No. 2, pp 277–295.