SCT
SALUD, CIENCIA Y TECNOLOGÍA

Check for updates

ORIGINAL ARTICLE

Measuring the social impact on employee engagement using agent-based simulation

Medición del impacto social en el compromiso de los empleados mediante simulación basada en agentes

Arief Rahman[1] ✉ , Sri Gunani Partiwi[2] , Ratna Sari Dewi[2] , Naning Aranti Wessiani[2]

[1]Institut Teknologi Sepuluh Nopember. Interdisciplinary School of Management Technology. Jawa Timur, Indonesia.
[2]Institut Teknologi Sepuluh Nopember. Department of Industrial Systems and Engineering. Jawa Timur, Indonesia.

ABSTRACT

Employee Engagement is a pattern of human interaction in an organization that presents excitement, dedication, and comfort in the work environment: the higher employee engagement, the more efficient way to reach the goals. Measuring the impact of employee interaction on employee engagement became essential for the organization. This study applied the social impact model to describe the interaction patterns of employees within an organization, including the intervention of leaders in groups. The agent-based simulation is constructed to simulate the behavior and interaction patterns. This study assessed the impact of 4 employee engagement aspects: recognition, care, commitment, and best friend. Agent leader and agent employee were the two primary roles of the simulation. The employee engagement survey has conducted by our university with more than 380 respondents, including the leader and staff. New trait adoption role as a pattern of employee engagement interaction has been formulated in this study and becomes a state of change of agent behavior in simulations. The level of employee engagement can be calculated and displayed in the dynamics of change with agent-based simulations. The four aspects of employee engagement show the effect of increasing the level of engagement with a variety of different patterns.

Keywords: Employee Engagement; Multi-Agent Simulation; Social Impact; Human-Organization Interaction.

RESUMEN

El compromiso de los empleados es un patrón de interacción humana en una organización que presenta entusiasmo, dedicación y comodidad en el entorno de trabajo: cuanto mayor sea el compromiso de los empleados, más eficaz será la consecución de los objetivos. Medir el impacto de la interacción de los empleados en su compromiso se ha convertido en algo esencial para la organización. Este estudio aplica el modelo de impacto social para describir los patrones de interacción de los empleados dentro de una organización, incluida la intervención de los líderes en los grupos. Se construye una simulación basada en agentes para simular los patrones de comportamiento e interacción. Este estudio evaluó el impacto de 4 aspectos del compromiso de los empleados: reconocimiento, atención, compromiso y mejor amigo. El agente líder y el agente empleado fueron los dos roles principales de la simulación. La encuesta sobre el compromiso de los empleados ha sido realizada por nuestra universidad con más de 380 encuestados, incluidos el líder y el empleado. En este estudio se ha formulado el nuevo rol de adopción de rasgos como patrón de interacción del compromiso de los empleados y se convierte en un estado de cambio del comportamiento del agente en las simulaciones. El nivel de compromiso de los empleados puede calcularse y visualizarse en la dinámica de cambio con simulaciones basadas en agentes. Los cuatro aspectos del employee engagement muestran el efecto de aumentar el nivel de engagement con una variedad de patrones diferentes.

Palabras clave: Employee Engagement; Simulación Multiagente; Impacto Social; Interacción Persona-Organización.

INTRODUCCIÓN

The organization is a complex system that involves various forms of interaction between individuals with multiple dynamic factors.[1]

The quality of human interaction in organizations is determined by the behavior and values possessed by everyone. The more effective the pattern of individual interaction, the less effort it takes to increase organizational productivity. In an organization, individuals actively interact in numerous activities and influence each other in diverse scopes and forms.[2]

One of the different types of social interaction is knowledge-sharing or information-sharing involved in the learning process in an organization. Moreover, the influence of a leader on an organization is also a type of social interaction. Various forms of individual interaction in organizations become the form of modeling social impact.

Employee engagement is a pattern of human interaction in an organization that presents excitement, dedication, and comfort in the work environment.[3] The higher the employee engagement, the more efficiently they will achieve certain goals. True loyalty, high dedication, strong morale, a culture of mutual respect, and sincere support will result from high employee engagement. Otherwise, employees with low engagement may experience decreased work motivation, poor performance, excessive complaining, stress, or even resign as employees. As a result, assessing the impact of employee interaction on employee engagement has become critical for any organization.[4]

Individual interaction modeling and interaction theories have been developed in a variety of scopes and complexities.[2] Interaction modeling involves factors of the qualitative nature of individual behavior, subjective responses, and an abstract exchange of values, among others. On the other hand, a quantitative model for disseminating cultural values among individuals in an organization has been introduced[5] and one of its developments is the impact peer pressure model.[6]

The STrust model is also one of the interaction models based on measuring trust in social network communities.[7] Social dynamics in the sphere between individuals in an organization can also be presented with The Ising model.[8]

All individual interaction models use a network system, and each node in the network displays both behavior and decision patterns. The exchange or distribution of data or messages in an interaction network determines a change in the next state in the interaction modeling.

This study proposes patterns of individual interaction in order to evaluate employee engagement. The existence of several individual behaviors must be considered in the engagement pattern, this supports the hypothesis that employee engagement is strongly related to the interaction between individuals. The leader's role should also greatly influence the level of employee engagement. A social impact model has been built to display individual interaction and engagement patterns by developing an agent-based simulation.

Employee Engagement

An employee with high engagement will show high work enthusiasm, be energetic, be full of motivation, and be enthusiastic about completing his work. On the other hand, employees with low engagement generally appear apathetic, work like robots, experience depersonalization, feel isolated, and often withdraw from work. Engagement means positive and satisfying perspectives and thoughts on work that are reflected in highly passionate, dedicated, and absorptive employees.[2]

Employee engagement is closely related to how to cultivate employee affective motivation in a positive way.[3] Engagement is not only related to attitude, but also reflects the level of attention and appreciation for the individual's role in achieving the organization's objectives.[2]

In addition to cognitive involvement, engagement also entails the active use of emotions and behaviors. There would be a positive association between employee engagement and customer satisfaction, customer loyalty, productivity, and profitability. On the contrary, there would be a negative association between employee turnover and employee engagement.[4]

One of the most popular instruments used for measuring employee engagement is the Gallup Q12 engagement survey. Gallup's measurement framework is based on data from hundreds of focus groups conducted by several companies and human resource practitioners. The Gallup framework employs a technique focusing on individual and group work effectiveness. Gallup's employee engagement measurement framework is straightforward and focuses on 12 statements that have evolved from several qualitative and quantitative studies.[5]

These 12 aspects, that are stated in the Gallup engagement survey, are: Expected, Material and Equipment, Opportunity, Recognition, Care, Development, Opinion Count, Mission, Commit, Best Friend, Progress, And Learn and Grow.[9]

METHODS

Based on Gallup's framework for employee engagement, only four social impact-related components are

discussed in this research. Consequently, the level of engagement evaluated in this research focuses on factors that are influenced by employee-to-employee interaction and leadership involvement with workers. This research interaction between leaders and workers was confined to occasional team meetings and briefings.

This study focuses on four aspects of employee engagement: recognition, care, commitment, and best friend. Recognition: identifies the worth of employees at work; care: refers to providing care between individuals, such as humans; commitment: refers to instilling pride in one's work; and best friend: focuses on mutual trust.

An employee engagement survey was carried out on 380 employees at the Sepuluh Nopember Institute of Technology, Surabaya. Survey participants included 233 male employees and 147 female employees. The employees who took part in this survey were lecturers and support staff. The average age of the employees who participated in the survey was 40 years, and the length of service was 15 years. Each survey participant filled out an online questionnaire with guidance from the survey team. Based on the results of the employee engagement survey, the initial values for the aspects of recognition, care, commitment, and best friend were 0,72, 0,82, 0,82, and 0,82, respectively. Furthermore, the engagement survey assessment results became the inputs in determining the Probability Density Function for each aspect of the engagement.

This study presents individual interaction patterns by considering the chances of change or displacement for each cognitive stage of the new trait adoption process. An agent-based simulation was built with two main agents: leaders and employees. Each agent was composed of specific attributes, behaviors, and parameters. The pattern of adoption in interactions in the organization becomes a reference in shaping agents' behavior.

Design of Agent-Based Simulation

Modeling employee engagement involved two primary agents: employees and leaders. This study focuses only on the dynamics of employee engagement inside a group or work unit in which a leader coordinates several group members. Figure 1 depicts the interaction between agents inside a group. Each agent can persuade other agents to influence the nature or degree of interaction within their group. A leader of agents might invite or be a role model for other agents so that they can change the nature or degree of their members' participation.
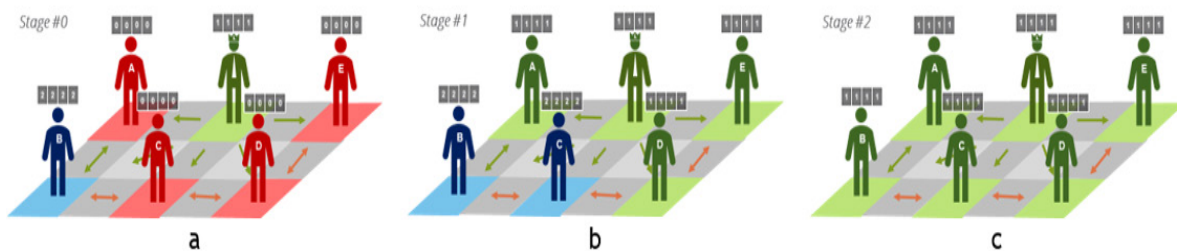

Figure 1. *Illustration of social impact by applying the agent model*

The phenomenon of social impact in the active interaction of a work team includes behaviors that can affect other individuals, cognitive patterns to follow or imitate the behavior of other individuals, and the ability to follow each other or even reject each other's traits of an individual. In the illustration of interaction patterns (Figure 1a), initially, a leader presents a different trait or behavior pattern from other team members. In stage #0, the leader is illustrated with a dominant trait or behavior labeled green, with four members having a red-labeled trait and one with a blue-labeled trait.

Furthermore, after multiple periods of interaction called stage #1, the leader can influence other members to follow the green labeled traits or behaviors. In stage #2 a change in the nature or behavior of 3 members is observed as well as one member also changes following a member who has a blue trait or behavior. Moreover, in this period of change, all team members have changed their traits or behaviors following leaders who have green-labeled traits or behaviors (Figure 1b).

The adoption pattern of new or unowned traits by team members adheres to the cognitive pattern seen in Figure 2. For example, for the recognition aspect, each member will start a state to gain insight if a change condition is reached or is interested in a certain duration of time, it will move on the state start to shift. Furthermore, each member can move to state higher engagement within a certain duration when certain conditions are met according to probability $P(ss_1)$. At the end of this state engagement, each employee can achieve a state of adopting new traits whenever it meets the probability of $P(he_1)$.

The experience of adopting a new trait can be a pattern of behavior to invite or influence other members naturally presented at the P(WOM). WOM or word of mouth is a pattern of spreading experiences from one member to another. Agent employees can spread "recognition" messages to other agents with a certain probability, and other agents who receive messages can directly move the state to higher engagement from the

state to gain insight.

The "giving insight" behavior pattern applied by a leader or employee will spread "good example" behavior hence it can be followed or seen (seeing) by other agents. Instead, a "turn back" behavior represents an opposite pattern when a certain probability is achieved.
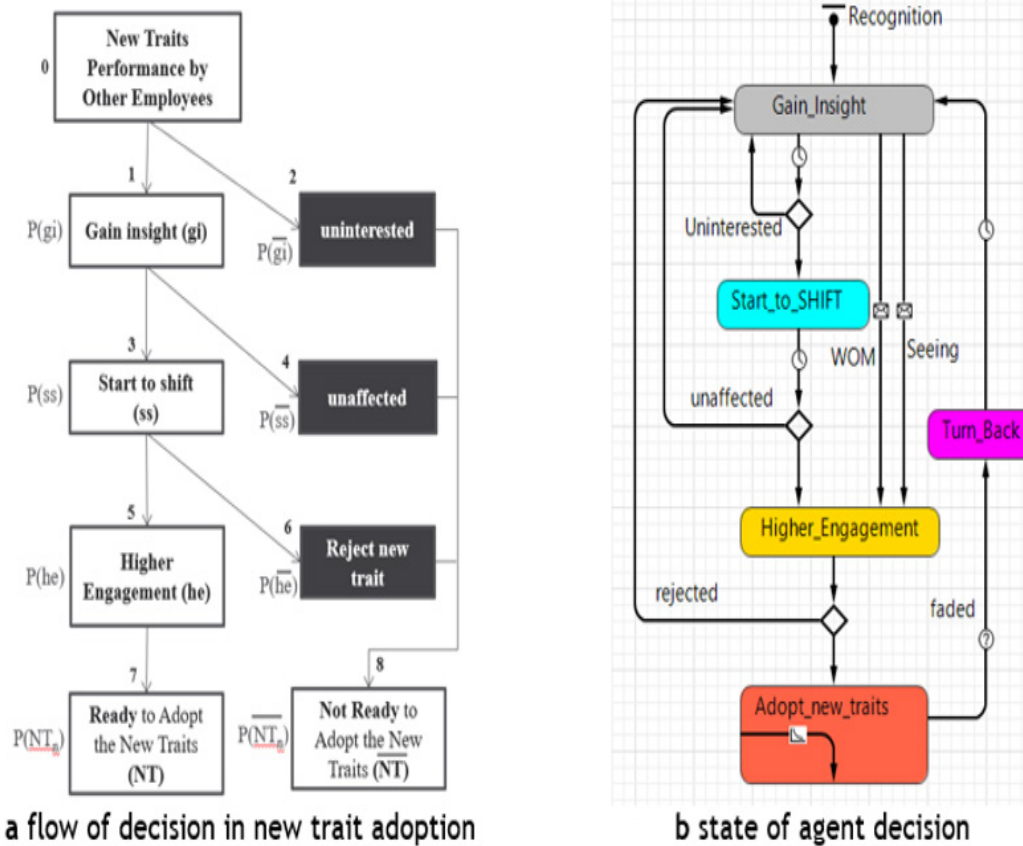

Figure 2. *Cognitive pattern in new trait adoption*

Social impact modeling and simulation of human interaction with agent-based organizations were designed in this study. There are two agents defined in the social impact simulation in the work team, namely agent leaders and agent employees. An agent leader will interact with several team members, and interaction among team members is also allowed.

The behavior and variables considered by the agent are described in Table 1.

Table 1. *Agent attributes and behaviors*		
Agent	**Behavior**	**Probability Variable**
Leader	Internalization of new trait or aspects of engagement (Influencing)	P(INF)
	Practicing new trait or engagement aspects (Giving insights)	P(SGTL)
Employee	Practicing new trait or engagement aspects (Giving insights)	P(SGTE)
	Invite or influence other agents with personal trait or aspects or aspects of engagement that have been owned (Affecting)	P(WOM)
	Follow or adopt a new trait or aspect of engagement (Adopt new trait)	P(NT)

Based on an employee engagement survey conducted at our university, a probability density function (PDF) can be calculated and determined for each new trait adoption state. The amount of data considered in assigning PDFs is 380 for each aspect. Determination of appropriate PDFs was performed by using Easy Fit 5.5 software. Table 2 provides a list of distributions and their parameters for each aspect of the engagement.

Agent-based simulations were built by applying an interaction model between leaders and several team members. The simulation model has implemented several behaviors of leaders and employees that describe impact patterns. This employee engagement pattern simulation uses Anylogic software. Figure 3 shows an illustrative image of an interface display of agent-based social impact simulations.

Table 2. Probability Density Function for several aspects of engagement

RECOGNITION (i=1)	$P(gi_1)$	Weibull	α=4,3708	β=0,81322
	$P(ss_1)$	Triangular	a=0,12714; b=1,0525	m=0,7999
CARE (i=2)	$P(he_1)$	Weibull	α=4,207	β= 0,82379
	$P(gi_2)$	Weibull	α=5,6424	β = 0,93852
	$P(ss_2)$	Weibull	α=5,4418	β = 0,8844
COMMITMENT (i=3)	$P(he_2)$	Normal	o=0,13973	μ= 0,82053
	$P(gi_3)$	Weibull	α=4,3422	β = 0,81983
	$P(ss_3)$	Weibull	α=5,2105	β =0,8765
BEST FRIEND (i=4)	$P(he_3)$	Weibull	α=6,0733	β =0,98554
	$P(gi_4)$	Weibull	α=5,0809	β =0,88657
	$P(ss_4)$	Weibull	α=4,3708	β =0,81322
	$P(he_4)$	Weibull	α=5,2739	β =0,92126

The interaction between agents in the simulation is visually displayed in the animation of the movement of each agent. The color change describes the state of the agent's behavior. A total of 20 agent employees and one agent leader were involved in the simulation of this new trait adoption model.
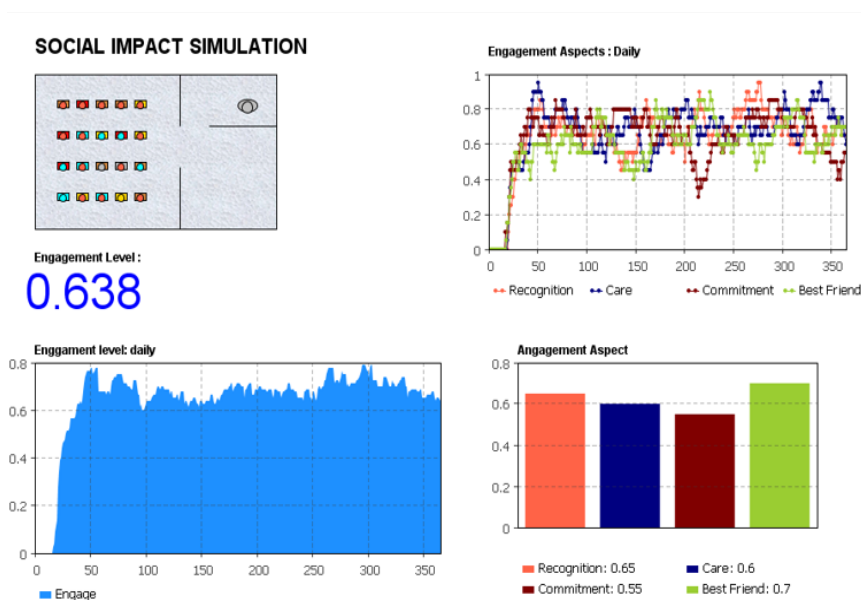

Figure 3. *Dashboard of the agent-based simulation*

RESULT AND DISCUSSION

A decrease in the level of employee engagement can occur when an employee agent experiences disharmony or discrepancies in the interaction between agents. The probability of a change or decrease in the level of engagement is expressed by a parameter called the turnback probability.

Based on the sensitivity analysis in the agent simulation, an increase in the turnback probability can cause a significant decrease in the level of engagement. With several simulation cycles, the average engagement level decreases by 33,7 % when the turnback probability increases by 50 %, from 0,667 to 0,443. Then, if the turnback probability is increased by 100 %, the average engagement level will decrease by 51,5 %, from 0,667 to 0,324. A linear decrease in employee engagement level due to increased turnback probability is depicted in Figure 4a. Interactions that have a negative impact on team members need to be avoided consequently the decline in the level of engagement that has been built does not decrease drastically.

Based on the simulation results, it can be seen the pattern of relationship between the level of engagement and efforts to increase the four aspects of employee engagement. The scenario of increasing the four aspects of engagement has been implemented with an increase of 25 %, 50 %, and 75 % to the initial value of each aspect.

The sensitivity analysis results, about the increase percentage aspect of engagement, are described in Figure 4b. All aspects are relatively increased when the scenario percentage aspect engagement was of 25 %. Furthermore, all aspects experienced a slight decrease in the scenario percentage engagement aspect when this aspect reaches 50 %, except for the Care aspect, which experienced an increase in engagement level.

Moreover, when the aforementioned scenario increases by 75 %, the increase in all aspects also increase the engagement level except for the Care aspect which experienced a fairly sharp decline.
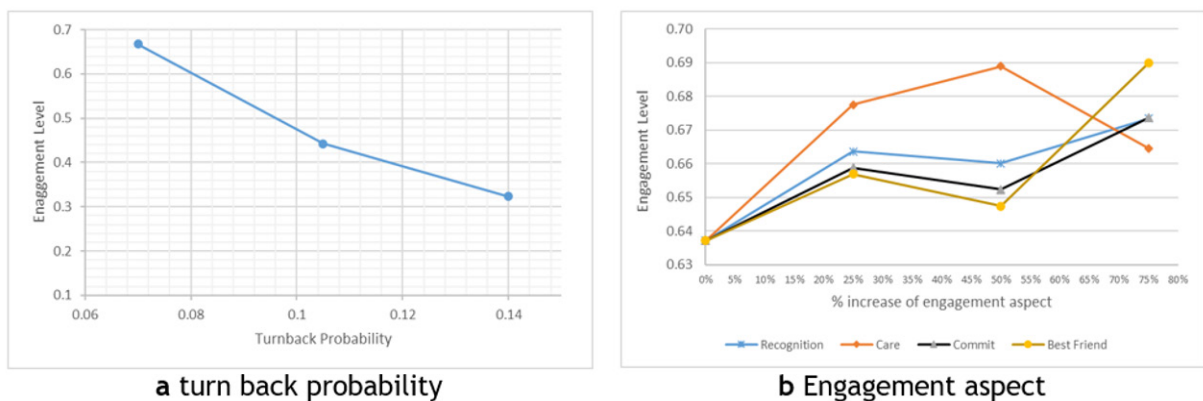
Figure 4. *Sensitivity analysis for some parameters of interaction*

Agent-based simulations that have been developed can implement interaction patterns between agents in a work team. The decision and interaction patterns of each type of agent embodied in the state chart can describe quite complex social impact behaviors.

CONCLUSION

Several important points can be concluded based on the development of social impact models and agent-based models in this study. Changes in behavior parameters or traits in each agent can represent the status of changes in each trait following the results of the interaction process in the agent environment. The four aspects of employee engagement were analyzed to provide a pattern of changes in engagement levels, where the Care aspect shows the most reactive increase in agent interaction patterns. Turning back is a response pattern that directly affects the engagement level, so it will provide a significant and fast change.

BIBLIOGRAPHIC REFERENCES

1. Pires B, Goldstein J, Molfino E, Ziemer KS. Knowledge Sharing in a Dynamic, Multi-level Organization: Exploring Cascade and Threshold Models of Diffusion. Proceedings of the 2017 International Conference of The Computational Social Science Society of the Americas, New York, NY, USA: Association for Computing Machinery; 2017, p. 1-7. https://doi.org/10.1145/3145574.3145601.

2. Menguc B, Auh S, Fisher M, Haddad A. To be engaged or not to be engaged: The antecedents and consequences of service employee engagement. Journal of Business Research 2013;66:2163-70. https://doi.org/10.1016/j.jbusres.2012.01.007.

3. Saks AM. Antecedents and consequences of employee engagement. Journal of Managerial Psychology 2006;21:600-19. https://doi.org/10.1108/02683940610690169.

4. Sun L, Bunchapattanasakda C. Employee Engagement: A Literature Review. International Journal of Human Resource Studies 2019;9:63-80.

5. Keyes CLM, Haidt J. Flourishing: positive psychology and the life well-lived. 1st ed. Washington, DC: American Psychological Association; 2003.

6. Morris R, Turner L, Whitaker R, Giammanco C. The Impact of Peer Pressure: Extending Axelrod's Model on Cultural Polarisation. 2019 IEEE International Conference on Cognitive Computing (ICCC), 2019, p. 114-21. https://doi.org/10.1109/ICCC.2019.00030.

7. Nepal S, Sherchan W, Paris C. STrust: A Trust Model for Social Networks. 2011IEEE 10th International Conference on Trust, Security and Privacy in Computing and Communications, 2011, p. 841-6. https://doi.org/10.1109/TrustCom.2011.112.

8. Moulick R. The Ising Model And Social Dynamics. European Journal of Molecular & Clinical Medicine 2020;7:3834-6.

9. Gallup I. Q12 ® Survey Implementation Guide 2013. https://pdf4pro.com/cdn/q-survey-implementation-guide-gallup-2c6ed.pdf

CONFLICTS OF INTEREST
None

FUNDING
None.

AUTHORSHIP CONTRIBUTION
Conceptualization: Arief Rahman, Sri Gunani Partiwi, Ratna Sari Dewi, Naning Aranti Wessiani.
Methodology: Arief Rahman, Sri Gunani Partiwi, Ratna Sari Dewi, Naning Aranti Wessiani.
Writing - Original Draft: Arief Rahman, Sri Gunani Partiwi, Ratna Sari Dewi, Naning Aranti Wessiani.
Writing - Review & Editing: Arief Rahman, Sri Gunani Partiwi, Ratna Sari Dewi, Naning Aranti Wessiani.