Workplace Topology Model for Assessment of Static and Dynamic Interactions Among Employees

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Abstract. Interactions among employees promote spread of infectious diseases at workplaces. Enterprise architecture provides rich information about organizational structure and its relations to other elements in an enterprise. This paper develops a workplace topology model as a sub-set of enterprise architecture to analyze both static and dynamic interactions among the employees and to monitor and to limit spread of infectious diseases. The model is developed as a multi-layer graph combining organizational, facility and sensing layers. The graph analytical methods are elaborated to analyze the interactions. The analysis provides inputs to spread of infectious diseases risk assessment models. The application of the graph analytics methods is demonstrated using an example from an Information Technology consulting company producing both software and hardware products.

Keywords: Organization graph, graph analytics, spread of infection

1 Introduction

Propagation of Covid-19 and similar infectious diseases depends on human behavior and working environment [1]. The human behavior concerns the way they interact with each other and the working environment concerns facilities and conditions they interact within. There are many different types of interactions among employees at a workplace making it one of the most frequent places for spread of infectious diseases such as flue or Covid-19 [2, 3]. The organizational structure and processes cause emergence of localized bubbles either promoting or limiting the spread of diseases [4].

The organizational structure typically shows a hierarchy of organizational units and roles and employees working for these organizational units. Modeling of organizational structure is a part of many enterprise architecture management frameworks. The organization structure is relatively static and majority of companies also have dynamic project or product development teams involving interactions across many organizational units. Increasingly, companies are adopting team-oriented approaches. In both cases, interactions among units, teams and employees are naturally represented as a graph [5]. The graph analysis methods provide a powerful tool to analyze the interactions in the organization. There methods include centrality measures, shortest path as well as identification of clusters and major components.

While the organization structure shows interactions among employees, it lacks a physical dimension. The physical dimension, i.e., specific work place, is important to understand spread of infectious diseases [6]. The aforementioned features can be captured by adding another layer to the organization's graph. The combined layers are represented as a multi-graph [7]. Multi-layered graphs are well suited to show and to analyzed interactions among various aspects of the modeling problem. The organization and physical layers jointly show employee and their location and interactions among them. In order to limit and prevent, the spread of infectious diseases ambient conditions also should be observed and suitable actions should be carried out. The ambient conditions are determined by sensing and various types of actuators are used to perform the actions. Sensing and enactment capabilities can be represented as another layer in the multi-graph.

Although graphs and physical layout of various are frequently used to analyze spread of infectious diseases up to now there is no comprehensive method to jointly represent various aspects of the interactions and to analyze these interactions to configure scheduling and access systems. It is proposed to use a topological model to represent the organizational, work place layout and sensing concerns. The work environment topology model is a multi-graph jointly representing organizational structure, physical dimension of the work place and sensing capabilities. It is applied to analyze Covid-19 related risks.

The objective of this paper is to formulate the work environment topology model and to define means for analyzing the model using the graph theory and network analysis methods. The topology model can be perceived as a representation of enterprise architecture, which provides rich means for representing organizational structures [8] and recently has been extended to represent aspects specific to sensing enterprises [9]. Both structural and missionary organizational units can be represented [10]. Graph-based analytical methods are shown as a promising technique to gain quantitative insights on the basis of enterprise architecture models [11]. Graph analysis techniques also have been applied to analyze spread of infections in workplaces [12]. The contribution of this paper is elaboration of graph-analytical methods to analyze static and dynamic interactions among employees in the organizational context with an intent to assess the risk of spreading infectious diseases such as Covid-19. Among other factors this risk is affected by intensity of interactions within and outside of organizational bubbles as well as duration of these interaction [13].

The rest of the paper is structured as follows. The background information is discussed in Section 2. The topology model is formulated in Section 3. Analysis of the topology model is demonstrated in Section 5. Section 6 concludes.

2 Background

Enterprise architecture management is an approach for analyzing complex organizations [14]. It is typically represented as a layered structure including business, logical and physical layers. The workplace topology model is a representation of enterprise architecture focusing on interactions among employees and sensing capabilities to analyze these interactions. The three relevant layers are:

1. Organization layers – business layer;

2. Facility layers – physical infrastructure;
3. Sensing layer – digital infrastructure.

2.1 Organizational layer

ArchiMate states that the business layer elements are used to model the operational organization of an enterprise in a technology-independent manner[1]. It includes active structure elements such as business role, business actor and business collaboration to represent the organization as well as behavior and passive elements. The topology model focuses on active structure elements although the behavior elements also could play a major role in dealing with the spread of infectious diseases.

The elements represented in the organizational layer are:

- Person – a human working at or visiting the organization. They are employees of the company as well as customers, partners and other persons visiting organization on-site. The visitors are also usually registered in the access management system.
- Organization unit – a persistent logical grouping of employees with common goals and activities.
- Team – a temporary organizational unit involving the persons dedicated to a common course and having frequent interactions though not necessarily having specific physical location.

2.2 Facility layer

The facility layer representing some of the physical aspects of the organization. It assumes that a work place (e.g. office or manufacturing site) is divided into zones. The zones are identified in an access management system and employees have permission to access specific zones.

The elements represent in the facility layer are:

- Organization unit – the same as defined in the organizational layer.
- Zone – a physically bounded and identifiable location in organization's premises.
- Sub-zone (work station) – a constituent part of the zone.

A sub-zone can have sub-zones on its own. Zones and sub-zones form a hierarchy, where an upper level element encompasses lower level elements.

2.3 Sensing layer

The sensing layer represents digital infrastructure used at the organization to monitor and to limit Covid-19 risks. It focuses on sensors and actuators and their association with specific zones.

Two types of elements are represented in the sensing layer:

[1] https://pubs.opengroup.org/architecture/archimate3-doc/chap08.html

1. Sensor – a physical or logical device measuring conditions at a workplace. That includes IoT sensors measuring ambient conditions as well sensors measuring properties of wastewater and web sensors retrieving contextual data from internal and external information systems;
2. Actuator – a physical or logical active element, which allows to change conditions at a workplace. These include actuators interacting with building management system to change ventilation parameters or access management system to restrict access to specific zones.

The nodes of the sensing layer correspond to devices in the ArchiMate's technology layer, where additional information about the devices, interfaces and communication networks is provided.

If a sensor or an actuator is attached to a zone having multiple sub-zones, then it is serving all sub-zones, e.g., there is typically one waste water analyzer per object. The wastewater analyzer a specific time of sensor considered in this project as a non-intrusive early warning method [15].

2.4 Integration

The topology model is intended to provide input data to assess the risk of spreading infectious diseases in a workplace. Data provided by various sensors, organizational information systems and wastewater analysis are combined to estimate the risk level, which in turn triggers a corrective action performed by actuators (Fig. 1). The topology model extracts and structures data from the organizational information systems. Both master and transactional data are used. The Time management system manages data about the organizational units and the zones, the Project management system manages information about dynamic project teams and the Enterprise calendar contains scheduled events and their participants. This way the model characterizes interactions among the employees. The intensity and type of interactions is combined with IoT sensor measurements and wastewater analysis results to evaluate the risk. While the topology model based analysis of interactions focuses on planned interactions, the IoT sensor data can capture informal interactions, e.g., anonymized video stream data can be used to apprise interactions taking place at a resting place.

The risk is either predicted or its current value is evaluated. There are several risk evaluation models. For example, Buonanno et al. [13] evaluate the risk of infection depending on duration and type of interactions among people as well as characteristics of the meeting room. The proposed topology model would provide the necessary input data to the risk estimation model. These input data include type of interactions among people and duration of these interactions. Outputs of the risk model are used to trigger risk reduction activities by involving appropriate actuators. For example, ventilation can be adjusted with regards to expected number of the employees in a room and current air quality measurement or events can be rescheduled if the wastewater analysis warning has been triggered.

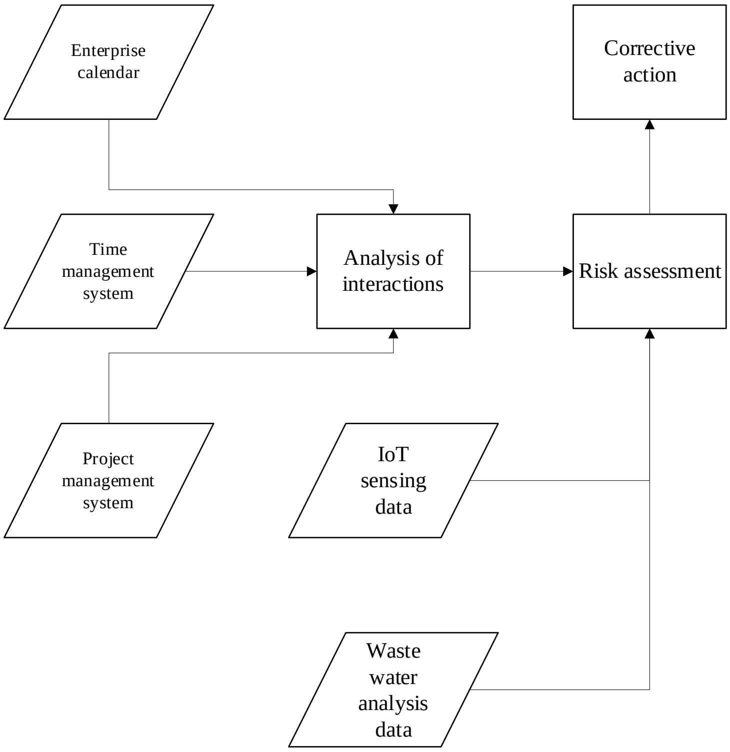


Fig. 1. Integrated risk-based decision-making

3 Model Formulation

The graph theory is chosen as a method to represent the workplace topology. The graph-based representation can be transformed in a visual representation of the target enterprise architecture framework. The work environment topology model is a multi-layer attribute graph:

$$TM = (\mathcal{Y}, \mathcal{N}, \mathcal{E}, \beta, \lambda), \tag{1}$$

where $\mathcal{Y}$ is a set of layers, $\mathcal{N}$ is a set of nodes, $\mathcal{E} : \mathcal{N} \times \mathcal{N}$ is a set of edges connecting the nodes and $\beta : \mathcal{N} \to \mathcal{Y}$ is a function mapping the nodes to layers. Individual nodes and layers are denoted by n and y, respectively. An edge e_{ij} connects nodes n_i and n_j. Thus, the set of nodes is defined as $\mathcal{N} = \{n_i \mid i \in \mathbb{Z}^*\}$ .The nodes have a specific type, and this type is represented by a set of node labels $\mathcal{L}$ is defined as:

$$\mathcal{L} = \{\text{Person, Org. Unit, Team, Zone, Sub-zone, Sensor, Actuator}\}. \tag{2}$$

There is a function $\lambda(n_i)$ that maps the nodes to their labels. The nodes have properties represented as key-value pairs and a set of the property keys is denoted as $\mathcal{K}$.

Every node has the name property as well as other properties as necessary. A set of the property values is denoted as $\mathcal{V}$. For example, sensors have an attribute Type assuming a value "Air quality sensor":

$$\{k_{i1} = \text{type} : v_{i1} = \text{Air quality}\}, \lambda(n_i) = \text{Sensor} . \tag{3}$$

Sensor attributes are defined according to the Fiware[2] data model and other attributes can be introduced as necessary.

The topology model captures both static and dynamic interactions among employees. In order to represent short term interactions, the Person node has the Calendar attribute. It is a complex attribute including elements such as:

1. Event – name of the calendar event;
2. Event date – date of the calendar event;
3. Event start and end time – specific time slot of the working day the event takes place;
4. Duration – duration of the calendar event;
5. Zone – location of the event;
6. List of participants – persons required or invited to the event;
7. Type – regular meeting, ad hoc meeting etc.

The Calendar attribute is populated by integrating data from Time Management System, Project Management System and Enterprise Calendar. The calendar merges regular working schedule, regular meetings and ad-hoc meetings.

The function β mapping the nodes to layers states that (see [16] on representation of multi-layered graphs):

- Org. unit., Team and Person nodes are present in the Organizational layer;
- Person, Zones and Sub-zones nodes are present in to the Facility layer;
- Zone, Sensor and Actuator nodes are present in to the Sensing layer.

Note that the Person nodes are present in the Organizational layer and the Facility layer, thus linking the two layers and a connection between matching nodes is implied (i.e., if the same node is present in two layers a connection between the nodes can be established). Similarly, the Zone nodes are present to the Facility layer and the Sensing layer and connect the two layers.

The edges connect only specific types of nodes:

- Person to Org. unit – defines an organization unit a person works for;
- Person to Team – defines a project team a person is assigned to;
- Person to Zone – identifies a zone a person has a work place. It can be slowly changing as indicated in the Time Management System;
- Person to Sub-zone – similarly to the previous identifies a sub-zone a person is assigned to;
- Sub-zone to zone – represents the composition of zones;

[2] https://github.com/smart-data-models/dataModel.Device/blob/1c41e5128a54d7b67bf51f3a7daba3c72f497aa0/Device/doc/spec.md

- Sensor to Zone – shows sensors available for monitoring environmental conditions in a zone;
- Actuator to Zone – shows actuators available in a zone to change the environmental conditions.

The model formulation defines the layers, types of the nodes and permissible edges. A topology model is instantiated for a particular organization, and it shows specific units, employees and other elements for this organization. Typically, most of the information is extracted from various information systems. However, one cannot expect that all information would be readily available without some data transformation and integration effort.

A sample topology model is shown in Fig. 2. All persons are assigned to and organizational unit. Some of the persons are also working for temporary teams. Team membership crosses boundaries of the organizational units. A person works at a specific zone deemed as his or her default work place. However, persons can mover dynamically from one zone to another. That is captured in the calendar or zone access data.

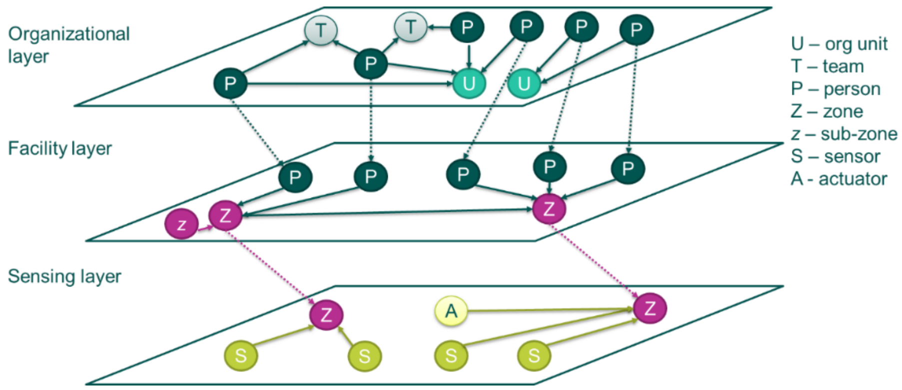


Fig. 2. A visualization of the topology model.

4 Model Analysis

The instantiated (i.e., organization specific) topology model is used to understand interactions in the organization and to evaluate sensing needs. The topology model is used to:

1. Perform static analysis – analyzes interactions using a snapshot of the topology model without using the calendar information;
2. Perform dynamic analysis – analyzes interactions using multiple versions of the topology model or the calendar information;
3. Configure applications used to manage work environment – the access rights to zones, work scheduling and sensing requirements can be derived from the topology model to configure the time management and access management system.

The following sub-sections discuss the static and dynamic analysis while the configuration is beyond scope of this paper.

4.1 Static analysis

The static analysis is performed using the permanent (more precisely slowly changing data) from the topology model. Several types of static analysis have been identified:

1. The variety of employees in the zone – how many different units relative to the number of persons are present in a single zone;
2. The centrality of person in the zone – how many persons are related to a person;
3. The sensor data availability – how many sensors are available in a zone?
4. The overall graph density in each layer – shows connectivity of nodes.

The variety of employees in the zone (*VE*) that is defined as a ratio between the number of units and the number of persons associated with the zone. Given a node n_i of type Zone, a set of connected nodes of type Person is:

$$\mathcal{N}_i^* = \left\{ n_j \mid \lambda(n_j) = \text{Person}, \exists e_{ij} \in \mathcal{E} \right\} \tag{4}$$

and a set of organization units these persons belong to is:

$$\mathcal{M}_i^* = \left\{ n_k \mid \lambda(n_k) = \text{Organization unit}, n_k \in \mathcal{N}_i^* \right\}. \tag{5}$$

VE is calculated as:

$$VE = \frac{\left|\mathcal{M}_i^*\right|}{\left|\mathcal{N}_i^*\right|}. \tag{6}$$

The centrality of person (CP) indicates connectiveness of the person in the organization and it is calculated:

$$CP = \left|\mathcal{P}_i^*\right|, \tag{7}$$

where $\mathcal{P}_i^* = \left\{ n_j \mid \lambda(n_j) = \text{Person}, \exists e_{kj} \in \mathcal{E} \wedge n_k \in \mathcal{N}_i^* \right\}$ is a set of persons connected to the *i*th person via its associated unit and teams and $\mathcal{N}_i^* = \left\{ n_j \mid \lambda(n_j) \in \left\{\text{Unit,Team}\right\}, \exists e_{ij} \in \mathcal{E} \right\}$ is a set of units and teams the *i*th person is associated with.

The sensor data availability is simply calculated as a degree of the zone node calculated withing sensing layer. It can be expressed in both absolute and relative terms. The measure indicated that some of the zones might be lacking sufficient sensing capabilities.

The overall graph density is calculated the ratio between the edges present in one layer of the graph and the maximum number of possible edges in the layer. In the organizational layer, high density suggests a large number of possible interactions. In the sensing layer, high density suggests that the organization is well equipped with sensors and actuators.

4.2 Dynamic analysis

The dynamic analysis is performed using the frequently changing data from a version of the topology model with a specific timestamp. Several types of dynamic analysis have been identified:

1. Intensity of interactions with other units and teams – characterizes how many events involving persons from other units and teams a person has;
2. Expected duration of interactions – characterizes duration of interactions with persons from other zones;
3. Expected variety – the number of different units or teams a person interacts with.

The intensity of interactions *DP* is calculated for a person and characterizes the number of contacts and the time this person spends with employees working at other organizational units or teams. It is calculated using the following algorithm:

1. Select a node n_j of type person
2. Set $DP_i := 0$
3. For each Event *j* in the person calendar
   3.1. Set $DP_i := DP_i + kd_j$, where d_j is duration of the *j*th event and *k* is a number of participants from a different organization unit or team;
4. Set $DP_i := \frac{DP_i}{D}$, where *D* is duration of all events for the person (note that events also include the regular scheduled work hour).

DP can exceed one implying that a person is having interactions with multiple persons from different organization units at a single event.

The expected duration of interactions is calculated in a similar manner to *DP* without adding the number of persons multiplier and selecting the persons from other zones in Step 3.1. This measure is often used to calculate the risk of infection. The measure takes into account interactions with persons from other zones assuming than precautionary measures are implemented within the zone.

The expect variety is calculated by counting how many different units or teams are represented in the person's calendar as participants of various events.

5 Application

The topology model is developed for a small and medium size Information Technology and Communications company. The company develops and deploys integrated hardware and software solutions. It has about 35 employees organized in nine units including administration, sales and marketing, software development, electronics and networking services. Five distinctive zones are identified and access is controlled using an access management system. The electronics and technical services in particular cannot work remotely. The company is functionally-oriented and prefers on-site work for all employees. Project teams are established for specific missions like development of new products or onboarding of new customers.

The topology model represents the actual static structure of the case company. However, the team composition and the calendar data are generated for experimental purposes on the basis of interviews with company representatives concerning their work organization. Experimental studies are conducted to compare intensity of employee interactions in the case of functional organization and project-oriented organization. The project-oriented setting is considered to explore possibility for the case company to switch to more project-oriented way of working.

The topology model is shown in Fig. 3 and Fig. 4. It represents a snapshot at a specific time moment. The person to unit and person to zone assignments as well as assignments in the sensing layer are relatively stable. The person to team assignments are changing frequently. The topology model shows that employees belong to specific organization and some of them also belong to project teams. There are five zones in company's office: Office, Electronics, Programming, Common area and Conference room. These zones are treated as sub-zones to the overall office building zone (z0), which has an access gate actuator controlling access to the whole building. It is envisioned that a water monitoring sensor also will be added to z0. The fifth zone has no persons assigned as a permanent work place. It is booked for specific events and dynamic analysis is mainly relevant for this zone. All zones are equipped with air quality sensors, while other types of sensing devices and actuators are sparingly available. This is one of the observations made during the static analysis that sensing capabilities are not sufficient for comprehensive monitoring and enactment of response actions.

The measures used in the static analysis can be calculated. Table 1 reports the calculated values of the variety of employees in a zone. The higher value indicates that employees from many zones are represented in the zone. The largest variety is in z1, where employees from administration, marketing, project management and accounting are located. Larger variety could potentially indicate a greater risk of spreading infections outside an organizational bubble.

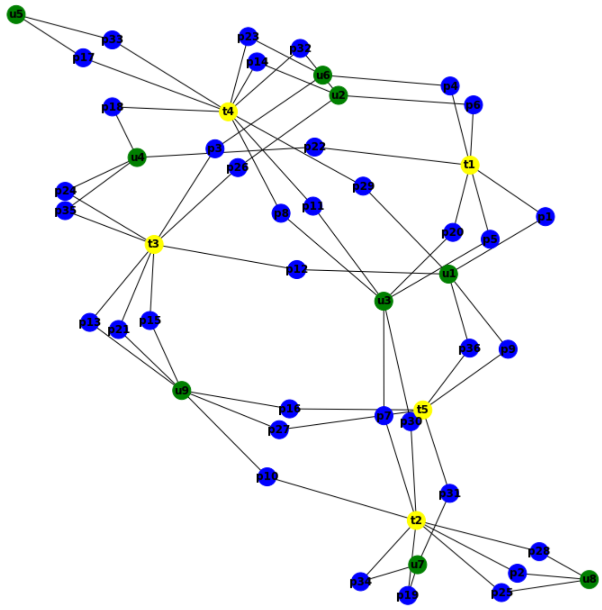


Fig. 3. The organizational layer of topology model for the case company

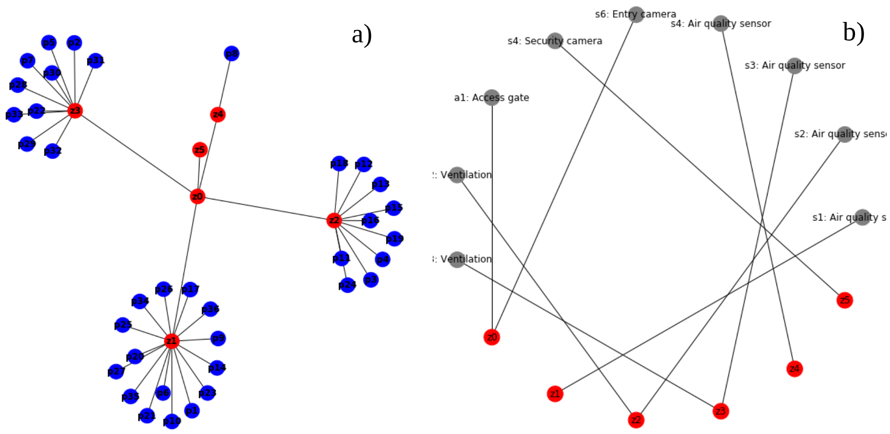


Fig. 4. The topology model of the case company: a) facility layer; and b) sensing layer.

Table 1. Variety of employees in a zone (*VE*) for selected zones

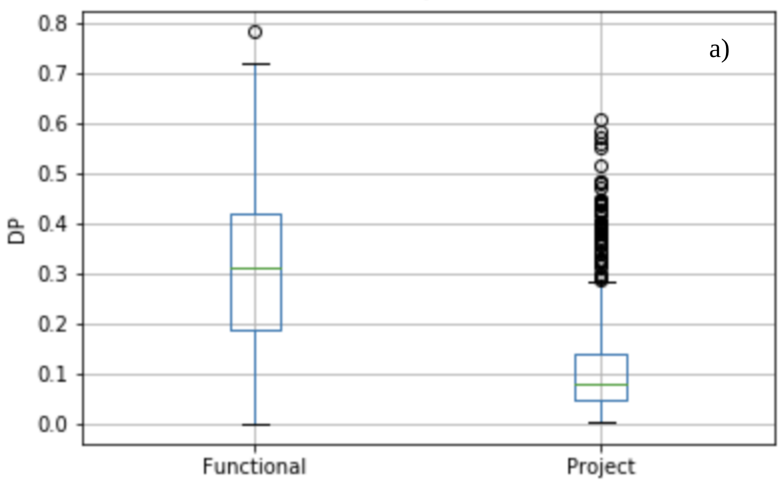
Zone ID	z1	z2	z3
Zone Name	Office	Electronics	Programming
VE	0.27	0.25	0.2

The experimental studies are conducted to show an example of dynamic analysis using simulated data. The following assumptions are made in the experimental studies:

1. Participants of events mainly come from the one organizational unit in the case of the functional organization;
2. Participants of events mainly come from one team in the case of the project-oriented organization;
3. The events are classified as unit meeting and team meetings. The unit meetings are more frequent than the project meetings in the functional organization while the team meetings are more frequent in the project-oriented organization;
4. Participants from other units or teams are also invited to events. The share of external participants is larger for the unit meetings than team meetings (because external information requirements are higher).

The Intensity of interactions (*DP*) is evaluated in the experiments. The measure is evaluated for the functional organization and the envisioned project-oriented organization, and the share of external participants (4th assumption) is also varied. Each experimental treatment is evaluated for 500 randomly generated person to team assignments and calendar events.

In the first experiment, the share of external participants (*FE*) in each meeting is 50% of all participants. The experimental results (Fig. 5 a)) shows that the intensity of interactions is higher for the functional organization. That is slightly contra-intuitive because less interactions are expected in the functional organization. However, the need for many external advisers is the cause of the high level of interactions. That is also illustrated in Fig. 5 b) showing that *DP* has a bi-modal distribution. The first mode represents meetings with a few external participants while the second mode points towards meetings with many external participants. The project-oriented organization has many outlying cases with a significantly larger number of interactions than usual. With regards to spread of infectious diseases, this observation suggests that the risk prediction is more challenging for the project-oriented organization even though the overall level of interactions might be lower.



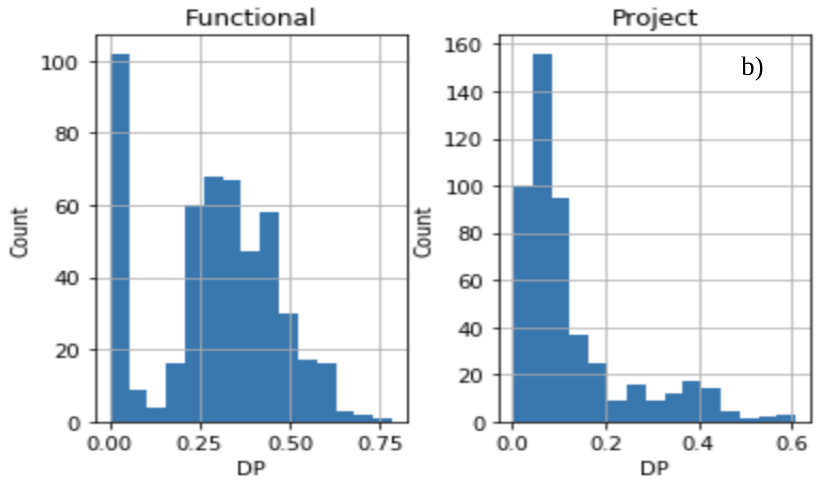


Fig. 5. The intensity of interactions in functional and project-oriented organizations: a) box-plot chart of *DP* and b) distribution of *DP*, *FE*=0.5

To assess the impact of *FE* on the results, the experiments are repeated with *FE* = 0.2 (Table 2). The intensity of interactions was larger for the functional organization if *FE* = 0.5 and the Wilcoxon test confirms that *FE* values differ substantially depending on the type of organization for any level of statistical significance. However, the intensity of interactions is lower for the functional organization if *FE* = 0.2 (at the significance level of 3%). The shape of distributions is similar for both types of the organization (Fig. 6). The results imply that involving fewer external participants significantly reduces the intensity of interactions and this reduction is more profound for the functional organization. In general, involving fewer external participants makes it easier to predict the intensity of interactions.

Table 2. The average value of *DE* for all persons depending on organization type and *FE*

Organization type	*FE* = 0.2	*FE* = 0.5
Functional	0.067	0.288
Project	0.072	0.126
Wilcoxon test p-value	0.03	0.00

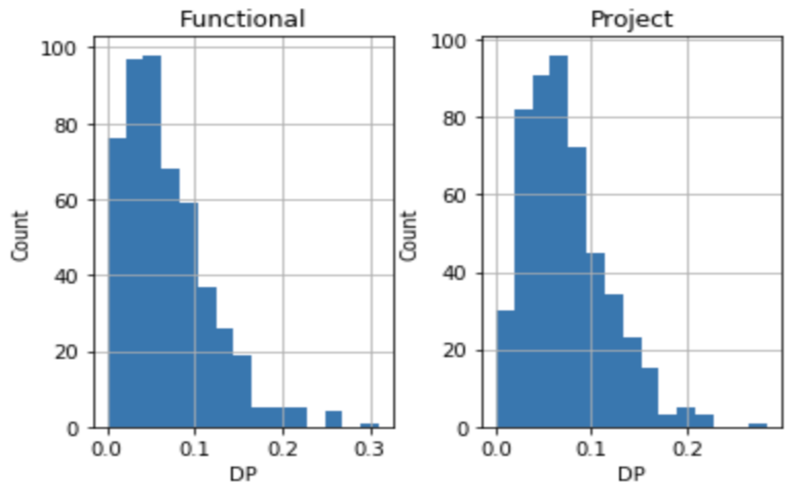


Fig. 6. The intensity of interactions in functional and project-oriented organizations characterized by distribution of *DP*, *FE* = 0.2

6 Conclusion

The paper has elaborated a workplace topology model, which provides inputs to risk assessment of spread of infectious diseases. Using the graph theory as a representation method allows to calculate quantitative measures to analyze and to compare characteristics of the organization. Some of the measures serve as inputs to infection risk assessment models. Several static and dynamics measures are defined in the paper while others can be added as necessary. The topology model contains only a sub-set of elements describing the overall enterprise architecture. These sub-elements are selected to allow for quantitative analysis of interactions among employees and infection sensing capabilities.

This research is conducted as a part of applied research project jointly with the aforementioned IT consulting company. The aim of the project is to enhance the company's access management system with features reducing spread of infections such as Covid-19 at workplaces with restricted opportunities for remote work. The further research will focus on identification of the most suitable topology analysis measures from the practical perspective and to gather data for further analysis of dynamical aspects of the topology model.

The topology model itself is dynamic (e.g., person to zone assignments are variable). Therefore, versions of the model and its evolution are tracked. The topology model will be implemented as a part of the access management system, which will also track the model evolution and correlate the topology measures with enterprise performance measures.

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References

1. Molinaro, M., Romano, P., Sperone, G.: The organizational side of a disruption mitigation process: exploring a case study during the COVID-19 pandemic, Operations Management Research, in press (2022)
2. World Health Organization Homepage, https://www.who.int/publications/i/item/WHO-2019-nCoV-workplace-actions-policy-brief-2021-1, last accessed 07/03/2022
3. Koh, D.: Migrant workers and COVID-19, Occupational and Environmental Medicine 9, 634-636 (2020)
4. Shaw, J., Day, T., Malik, N., Barber, N., Wickenheiser, H., Fisman, D.N., Bogoch, I., Brownstein, J.I. & Williamson, T.: Working in a bubble: How can businesses reopen while limiting the risk of COVID-19 outbreaks?, CMAJ, 192(44), E1362-E1366 (2020)
5. Song, M., van der Aalst, W.M.P.: Towards comprehensive support for organizational mining, Decision Support Systems 46(1), 300-317 (2008)
6. Arnicans, G., Niedrite, L., Solodovnikova, D., Virbulis, J., Zemnickis, J.: Towards a System to Monitor the Virus’s Aerosol-Type Spreading. In: Byrski, A., Czachórski, T., Gelenbe, E., Grochla, K., Murayama, Y. (eds) Computer Science Protecting Human Society Against Epidemics. ANTICOVID 2021. IFIP Advances in Information and Communication Technology, vol 616. Springer, Cham (2021) https://doi.org/10.1007/978-3-030-86582-5_9
7. Chakravarthy, S., Santra, A., Komar, K.S.: Why Multilayer Networks Instead of Simple Graphs? Modeling Effectiveness and Analysis Flexibility and Efficiency!. In: Madria, S., Fournier-Viger, P., Chaudhary, S., Reddy, P. (eds) Big Data Analytics. BDA 2019. Lecture Notes in Computer Science, vol 11932. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-37188-3_14
8. de Kinderen, S., Kaczmarek-Heß, M.: On model-based analysis of organizational structures: an assessment of current modeling approaches and application of multi-level modeling in support of design and analysis of organizational structures. Softw Syst Model 19, 313–343 (2020). https://doi.org/10.1007/s10270-019-00767-4
9. Zimmermann, A., R. Schmidt, K. Sandkuhl, M. Wißotzki, D. Jugel and M. Möhring: Digital Enterprise Architecture - Transformation for the Internet of Things, 2015 IEEE 19th International Enterprise Distributed Object Computing Workshop, pp. 130-138, doi: 10.1109/EDOCW.2015.16 (2015)
10. Pereira, D.C., Almeida, J.P.A.: Representing organizational structures in an enterprise architecture language, Proceedings of the 6th Workshop on Formal Ontologies meet Industry, CEUR Workshop Proceedings, vol. 1333 (2014)
11. Smajevic M., Bork D.:Towards Graph-Based Analysis of Enterprise Architecture Models. In: Ghose, A. et al. (eds) Conceptual Modeling. ER 2021. Lecture Notes in Computer Science, vol 13011. Springer, Cham (2021)

12. Mauras, S., Cohen-Addad, V., Duboc, G., Dupréla Tour, M., Frasca, P., Mathieu, C., Opatowski, L., Viennot, L.: Mitigating COVID-19 outbreaks in workplaces and schools by hybrid telecommuting, PLoS Computational Biology 17 (2021)
13. Buonanno, G., Stabile, L., Morawska, L.: Estimation of airborne viral emission: Quanta emission rate of SARS-CoV-2 for infection risk assessment, Environment international 141 (2020)
14. Lankhorst, M.: Enterprise Architecture at Work: Modelling, Communication and Analysis, Springer Berlin (2013)
15. Zhu, Y., Oishi, W., Maruo, C., Saito, M., Chen, R., Kitajima, M., Sano, D.: Early warning of COVID-19 via wastewater-based epidemiology: potential and bottlenecks, Science of the Total Environment767 (2021)
16. Kivelä, M., Arenas, A., Barthelemy, M., Gleeson, J.P., Moreno, Y., Porter, M.A.: Multilayer networks, Journal of Complex Networks 2(3), 203–271 (2014)