A Workflow-supported Activity-Performer Affiliation Network Model

Hyun Ahn[1] , Alyeksandr Battsetseg[1], Minjae Park[2], Haksung Kim[3], and Kwanghoon Pio Kim[1]

[1] Collaboration Technology Research Laboratory
Department of Computer Science
KYONGGI UNIVERSITY
e-Mail: kwang@kgu.ac.kr
http://ctrl.kyonggi.ac.kr
[2] Software Research Laboratory
BIZTEL, INC.
e-Mail: mjpark@biztel . co .kr
http://www.biztel.co.kr
[3] Department of Computerized Tax and Accounting
DONGNAM HEALTH UNIVERSITY
e-Mail: amang@dongnam.ac.kr
http://www.dongnam.ac.kr

Abstract. This paper[4] formalizes a special type of social networks, which is called 'workflow-supported affiliation network.' A workflow model specifies execution sequences of the associated activities and their affiliated relationships with roles, performers, invoked-applications, and relevant data. Especially, these affiliated relationships exhibit a series of valuable organizational knowledge and utilize to explore business intelligence concealed in the corresponding workflow model. In this paper, we particularly focus on the activity-performer affiliation relationships and describe its implications as organizational knowledge and business intelligence in workflow-driven organizations. Conclusively, we formally and graphically define a workflow-supported activity-performer affiliation network model as an activity-performer affiliation knowledge representation technique of a workflow model. It eventually becomes a theoretical basis for discovering those activity-performer affiliation knowledge from a workflow-supported organization.

Keywords: workflow-supported social network, ICN-based workflow model, affiliation network, organizational knowledge, business intelligence

[4] This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education, Science and Technology (Grant No. 2012006971).

1 Introduction

The workflow literature starts being interested in "People". It begins from the strong belief that social relationships and collaborative behaviors among people who are involved in enacting the specific workflow models affect the overall performance and being crowned with great successes in the real businesses and the working productivity as well. In a workflow model, performers (or actors) are linked through their joint participation in activities; conversely, workflow activities are connected to the extent that they have performers in common; we have dubbed a collection of these links "a *workflow-supported performer-activity affiliation network."* So, it ought to have a great implication as organizational knowledge if we are able to visualize these interrelated relationships and to quantify them, as well.

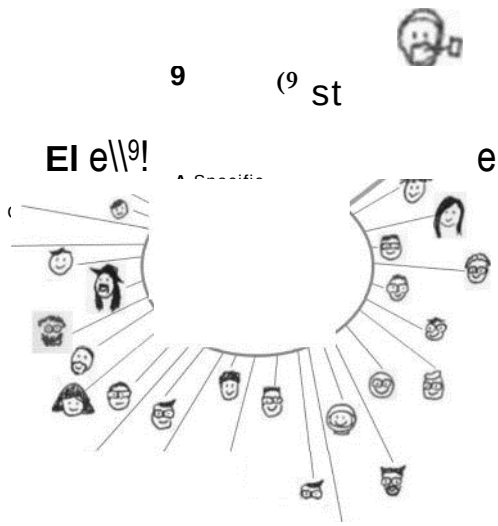

Fig. 1. The Workflow-supported (Activity-Performer) Affiliation Knowledge

The paper, particularly, focuses on the workflow-supported affiliation networking knowledge formed by two key groups of the elements, a set of performers and a collection of activities in a workflow model, as shown in Fig. 1. An affiliation network to be discovered from a workflow model is non-dyadic because the affiliation relation relates each performer to a subset of activities, and relates each activity to a subset of performers. From the figure, it might be quite in the nature of things to raise a question as followings:

> Which performers are linked to each other as members of collectivities (activities), and which collectivities are linked to each other through shared performers in the specific workflow procedure?

Conclusively, the answer for the question ought to be able to convey a wide variety of very valuable and meaningful insights to the organizational knowledge, which is the primary rationale in the concept of discovering workflow-supported affiliation networking knowledge. In other words, from the discovered organizational knowledge of activity-performer affiliations, it is possible to visualize how actors and activities are simultaneously interrelated (involvement and participation) in the specific workflow model. The main purpose of this paper is to theoretically develop a means, which is called 'activity-performer affiliation network model,' for discovering and visualizing performer-activity affiliation knowledge from a workflow-supported organization.

2 Activity-Performer Affiliation Network Model

In order to represent the workflow-supported activity-performer affiliation knowledge, the paper newly defines a graphical (Bipartite Graph) and formal representation model, which is dubbed activity-performer affiliation network model. An activity-performer affiliation network model, which is abbreviated as APANM, consists of two types of nodes _a set of performers and a set of activities ___and a set of relationships between those nodal types. Thus, an activity-performer affiliation network model is a two-mode network model, through which it used to accomplish the following dual objectives:

- to uncover the relational structures of workflow-performers through their joint involvement in activities, and
- to reveal the relational structures of workflow-activities through their joint participation of common performers.

2.1 Formal and Graphical Definitions

Additionally, those relational structures can be weighed to measure the extent of their strengths by assigning a value to each of relations between nodal types. Therefore, there are two types of activity-performer affiliation networks—binary activity-performer affiliation network and valued activity-performer affiliation network. In the binary activity-performer affiliation network, its value (0 or 1) implies a binary relationship of involvement (or participation), while values in the valued activity-performer affiliation network may represent various implications according to their application domains; typical examples of values might be stochastic (or probabilistic) values, strengths, and frequencies. The formal knowledge representation of activity-performer affiliation network model is defined in the following [Definition].

[Definition] Activity-performer Affiliation Network Model. An activity-performer affiliation network model is formally defined as A = *(o-oP,* S), over a set C of performers (actors), a set A of activities, a set V of weight-values, a set E_2 C (C x A) of edges (pairs of performers and activities), and a set

E_a C (A x C) of edges (pairs of activities and performers), where, p(A) represents a power set of the activity set, A:

- S is a finite set of work-sharing actors or groups of some external activity-performer affiliation network models;
- Q = u_p *U a,* /* Involvement Knowledge */
  where, u_p : C p(A) is a single-valued mapping function from a performer to its set of involved activities; *ay :* E_p V is a single-valued mapping function from an edge (E E_p) to its weight-value;
- = Wa U /* Participation Knowledge */
  where, O_a : A —> p(C) is a single-valued mapping function from an activity to a set of participated performers; and Op : E_a V is a single-valued function from an edge (E E_a) to its weight-value;

And the graphical knowledge representation is depicted by an affiliation graph, as shown in Fig. 2. So, an activity-performer affiliation network's graphical model consists of two types of graphical nodes—a set of performers (shaped in hexagon) and a set of workflow activities (shaped in circle)—and a set of non-directed edges between two nodal types, which means that a workflow affiliation network is a non-directed graph. That is, in an activity-performer affiliation graph, non-directed lines connect performers aligned on one side of the diagram to the workflow activities aligned on the other side. Importantly, an activity-performer affiliation graph does not permit lines among the performers nor among the workflow activities. Therefore, an activity-performer affiliation graph with *g* performers and *h* workflow activities can be transformed into a matrix with 2-dimension of *g x h.*

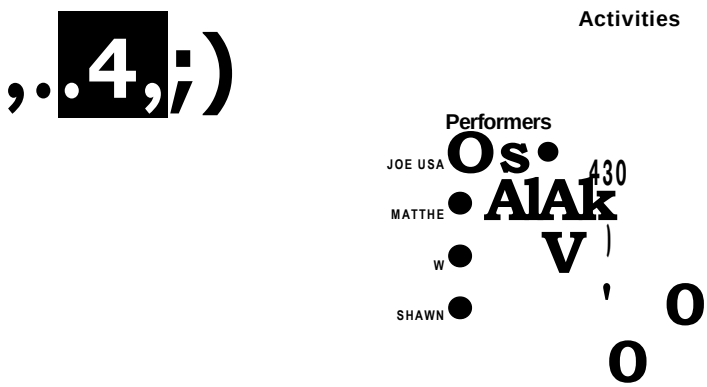

Fig. 2. Graphical Representation (Bipartite Graph)

2.2 Definition of Affiliation Matrix

Eventually, it is necessary for activity-performer affiliation network model to be analyzed in a mathematical representation. An activity-performer affiliation network model is graphically represented by a bipartite graph, and at the same time it is mathematically represented by an affiliation matrix. Based upon the activity-performer affiliation matrices, it is possible to analyze a variety of knowledge analytics issues[13], such as mean rates analysis[7], density measurements[7], centrality measurements[13], and so on, raised from the social networking literature. The affiliation matrix can be realized by either an involvement matrix or a participation matrix. That is, an activity-performer affiliation network model is mathematically transformed into an activity-performer affiliation matrix that records the presence and absence of *g* performers at *h* workflow activities; thus its dimensions are *g* rows and *h* columns, respectively. If a certain performer 0, attends a workflow activity a_p then the entry in the i^{th} and jth cell in the matrix equals to 1; otherwise the entry is 0. Denoting a binary activity-performer affiliation matrix as **Z, its** x_{ij} values meet these conditions:

$$x_i = \begin{cases} 1 \text{ if performer } O_i \text{ is affiliated with workflow activity } a_i \\ 0 \text{ otherwise} \end{cases} \quad (1)$$

The row total, also called row marginals, (D_r), of activity-performer affiliation matrix **Z sum** to the number of workflow activities that each performer will attend, which implies the involvement relations between activities and performers in a corresponding workflow model.

$$D_r - [E\ xi\ j] \quad (2)$$

— The column marginals, (D_r), indicate the number of performers who will attend each workflow activity's enactment, which implies the participation relations between performers and activities in a corresponding workflow model.

$$\left| \sum_{j=1}^{h} E \right|_{g} \quad (3)$$

3 Conclusion

In this paper, we suggested a formal model of representing the workflow-supported affiliation knowledge (involvement and participation behaviors) between workflow-based people and workflow-based activities, which is called the workflow-supported activity-performer affiliation network model. Conclusively, we are able to formally discover activity-performer affiliation networking knowledge from an ICN-based workflow model, and to graphically represent the discovered knowledge by the proposed model. Additionally, we successfully verified the proposed model through applying to the product-order workflow model already introduced in our research group's previous work.

Acknowledgement. This research was supported by Basic Science Research Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education, Science and Technology (Grant No. 2012006971).

References

1. Clarence A. Ellis, Gary J. Nutt, "Office Information Systems and Computer Science," ACM Computing Surveys, Vol. 12, No. 1, 1980
2. Clarence A. Ellis, "Formal and Informal Models of Office Activity," Proceedings of the 1983 Would Computer Congress, Paris, France, 1983
3. Kwanghoon Kim, "Actor-oriented Workflow Model," Proceedings of the 2nd international symposium on Cooperative Database Systems for Advanced Applications, WOLLONGONG, AUSTRALIA, March 27-28, 1999
4. Harri Oinas-Kukkonen, et al., "Social Networks and Information Systems: Ongoing and Future Research Streams," JOURNAL OF THE ASSOCIATION OF INFORMATION SYSTEMS, Vol. 11, Issue 2, pp. 61-68, 2010
5. Mary Griffiths, "Oxygen: Social Intranets, collective intelligence and Government Practices," ELECTRONICS JOURNAL OF E-GOVERNMENT, Vol. 5, Issue 2, pp. 177-190, 2007
6. Wil M. P. van der Aalst, Hajo A. Reijers, Minseok Song, "Discovering Social Networks from Event Logs," COMPUTER SUPPORTED COOPERATIVE WORK, Vol. 14, No. 6, pp. 549-593, 2005
7. David Knoke, Song Yang, SOCIAL NETWORK ANALYSIS - 2n^{d} Edition, *Series: Quantitative Applications in the Social Sciences,* SAGE Publications, 2008
8. Jaekang Won, "A Framework: Organizational Network Discovery on Workflows," *Ph.D. Dissertation,* Department of Computer Science, KYONGGI UNIVERSITY, 2008
9. Aubrey J. Rembert, "Automatic Discovery of Workflow Models," *Ph.D. Thesis Dissertation,* Department of Computer Science, UNIVERSITY OF COLORADO AT BOULDER, 2008
10. Jihye Song, Minjoon Kim, Haksung Kim, Kwanghoon Kim, "A Framework: Workflow-based Social Network Discovery and Analysis," Proceedings of the International Workshop on Hongkong, China, December, 2010
11. E. Ferneley, R. Helms, "Editorial of the Special Issue on Social Networking," Journal of Information Technology, Vol.25, No.2, pp. 107-108, 2010
12. Miha Skerlavaj, Vlado Dimovski, Kevin C Desouza, "Patterns and structures of intra-organizational learning networks within a knowledge-intensive organization," Journal of Information Technology, Vol. 25, No. 2, pp. 189-204, June 2010
13. Katherine Faust, "Centrality in Affiliation Networks," Journal of Social Networks, Vol. 19, pp. 157-191, 1997
14. Haksung Kim, Hyun Ahn, Kwanghoon Pio Kim, "A Workflow Affiliation Network Discovery Algorithm," ICIC Express Letters, Vol. 6, No. 3, pp. 765-770, 2012