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How to Select Change Agents in Organizations? A Comparison of the Classical and Network Approaches

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The dynamic business environment forces companies to change and adapt constantly. The process can be organized with help of change agents. We develop a simple network approach to spreading information and delivering feedback in organizations. We suggest selecting employees with a role of change agents, focusing on the coverage they can obtain in the network – minimize the number of involved agents and maximize the size of their overall communication area. To explore and pre-verify the proposed approach, we compared and examined several network and classical methods of selection. Data includes networks of collaboration from three medium-sized companies. Agents selected according to network betweenness centrality obtained the best and significantly broader reach than agents selected as employees with high hierarchy levels. Moreover, selected change agents reach impressive coverage; even 5% of company employees engaged as agents may directly reach up to 70% of company staff, compared to 40% for agents selected randomly. A large coverage of a company organizational network can increase the success of change initiatives as vital for spreading reliable, first-hand information and feedback about implemented change. On the other hand, engaging only a limited number of influential employees in a company's network should keep costs of implementing change relatively low.

Keywords: change management, change agents, organizational network analysis, network coverage.

Jak wybrać agentów zmian w organizacji? Porównanie metod klasycznych i sieciowych

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Dynamika rynku zmusza firmy do wprowadzania ciągłych zmian i dostosowywania się do potrzeb i wyzwań otoczenia. Proces ten może być prowadzony przy pomocy agentów zmian rozprzestrzeniających informacje i dostarczających wsparcie innym pracownikom. W artykule przedstawiamy podejście oparte na analizie sieci organizacyjnej. Proponujemy sposób wyboru pracowników do roli agentów zmiany pozwalający na optymalizowanie ich zasięgu w sieci, by przy jak najmniejszej liczbie wybranych osób maksymalizowany był ich łączny zasięg wyrażony liczbą pracowników, do których mogą bezpośrednio dotrzeć. W celach eksploracji i wstępnej weryfikacji zaproponowanego podejścia na trzech sieciach współpracy pracowni-

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ków przedsiębiorstw średniej wielkości porównaliśmy kilka metod wyboru agentów. Wyniki sugerują, że agenci wybrani przy wykorzystaniu miary centralności sieciowej, jaką jest pośrednictwo (*betweenness*), uzyskują najlepszy i istotnie wyższy zasięg w sieci w porównaniu z agentami wybranymi na podstawie wysokiej pozycji w hierarchii. Także sam zasięg agentów wydaje się duży – w najlepszym testowanym przypadku 5% wybranych agentów jest w stanie dotrzeć do 70% wszystkich pracowników, w porównaniu z 40% zasięgiem uzyskanym przez agentów wybranych losowo. Duży zasięg komunikacji i wsparcia w zmianie organizacyjnej może zwiększyć szanse jej powodzenia dzięki kompleksowemu i ciągłemu dostarczaniu pracownikom rzetelnych informacji pochodzących z pierwszej ręki i wsparcia oraz zbieraniu od nich informacji zwrotnej. Jednocześnie zaangażowanie jak najmniejszej liczby osób w proces wsparcia zmiany pozwala na utrzymanie kosztów jej implementacji na relatywnie niskim poziomie.

Słowa kluczowe: zarządzanie zmianą, agenci zmiany, sieć organizacyjna, analiza sieci organizacyjnej, zasięg w sieci.

JEL: C1

1. Introduction

The ability to deal with changing conditions and to react to new opportunities is considered a core capability of almost every business. Organizational change is usually a part of the adaptation process – to learn and adjust to dynamically changing markets, companies put efforts into and make changes of their strategies, structures, processes, and even everyday actions (Beckhard and Harris, 1987; Conner, 1993; Greenwood and Hinings, 1996). As a result, the majority of companies face the problem of how to manage constant organizational change, communication, and learning.

The process can be conducted with the help of employees called *change agents*. Their role in change management is usually significant as they spread information and provide support to employees, as well as collect valuable feedback from them. Thus, it is not surprising that precise selection of employees to play the role of change agents is an important consideration, both in management literature and practice. Once properly chosen and engaged, change agents can make the implementation more effective and successful, acting as catalysts for change (Beckhard and Harris, 1987; Burt, 1999; Gronn, 2002; Noel et al., 1979; Valente and Pumpuang, 2007). The problem lies in how to select the right employees.

The classic process of agent selection is usually based on information about employees' positions in organizational hierarchy and less frequently on the seniority, expertise, or specific roles played in processes or projects (c.f. Beckhard and Harris, 1987; Jacobs and Russ-Eft, 2001). When widespread change is needed, the diffusion of information is managed with cascade training or communication (Jacobs and Russ-Eft, 2001; Wild and Horney, 1996). The process runs as follows: one small group of employees (e.g., high-level managers) train a hierarchically lower situated and larger group of employees (e.g., medium-level managers), who in turn train successive group of employees, and so on.

This approach has some weak points. It reflects top-down communication and learning processes carried out according to a formal structure with the omission of informal social paths, dependencies, and connections within a company. The role of a company's social network is often hidden or misunderstood by managers (Cross and Parker, 2004; Krackhardt, 1993). In the situation of change, the failure of formal versus informal social networks has been observed (Krackhardt, 1993). Hierarchical information-sharing networks are also less successful in the process of widespread change, compared to the cross-functional and less formal networks (Borgatti and Cross, 2003; Mohrman et al., 2003). Formal information is also not always a reliable proxy for roles employees play in a company (Cross and Parker, 2004; Krackhardt, 1993; Stevenson et al., 2003; Zbieg, 2015). This is the reason why, in the process of selecting change agents, managers should not only trust in the formal company framework, but also derive from its informal picture.

Once revealed, organizational networks can play a vital role in the process of widespread communication and action management within organizations (Borgatti and Foster, 2003; Cross et al., 2007; Gulati and Puranam 2009; Krackhardt, 1993; Noel et al., 1979; Stevenson et al., 2003; Zbieg, Żak and Zaręba, 2014). That is because more information flows through informal relations between employees than through formal hierarchical channels or given procedures (Hatala and Lutta, 2009; Krackhardt, 1993; Stevenson et al., 2003). Understanding how it happens and who the key players are within the system can be vital at every stage of the change management process: planning, unfreezing established order, making a change, refreezing new order, and evaluating the whole process (Weick and Quinn, 1999). The lack of acceptance for new information, ideas, or practices can also be explained by basic social mechanisms of influence and imitation: In deciding to adopt new information or behaviours, people depend mainly on the communicated experiences of others that flow through interpersonal networks (Cross et al., 2007).

In this paper, we develop a simple approach to change agent selection in which agents' network coverage is optimized. Network coverage is the share of nodes in the network that can be directly reached by change agents. Accepting that organizational networks can be a better source of information on how to conduct the process than formal organizational paths, we posit that employees reasonably chosen based on a criterion other than the hierarchy level may support the process of widespread information sharing better than directors and managers. Secondly, we assume that direct communication is important as a way to deliver reliable, first-hand information. Finally, to optimize the process of widespread communication, the number of employees engaged as change agents should be as small as possible to directly reach the majority of employees within a company in a first step, direct information sharing, and/or training. A large direct coverage

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of a company network by change agents seems to be vital in short-time spreading of reliable, first-hand information and feedback, while still only a limited number of employees are engaged in the process of change. We develop, explore, and pre-verify this approach using data on networks of collaboration from three medium-sized companies and selection of change agents conducted according to hierarchy and seniority (Jacobs and Russ-Eft, 2001) and network centrality measures (Battilana and Casciaro, 2012; Monge and Contractor, 2003; Noel et al., 1979).

2. SNA Methods for Change Agent Selection

To derive and analyze data from the organizational informal picture, managers may use social network analysis (SNA), also known as organizational network analysis (ONA) while applied in inter- or intra- organizational studies. SNA centrality measures are helpful in finding people that play key roles in a network (Wasserman and Faust, 1994). This knowledge has already been applied in change management processes (Battilana and Casciaro, 2012; Krackhardt, 1993; Noel et al., 1979). Below, we briefly describe these measures.

2.1. Degree centrality – network bonding indicator

Degree centrality is the simplest centrality measure calculated as a number of ties (relationships) that directly connect a node with other network nodes. More connected nodes have a higher degree indicator and may be reached more easily by any information that flows within a network (de Nooy et al., 2005). Employees with many connections tend to be in the center of groups and bond the whole network or its parts (Burt, 1999). They also may have access to information and know the organization well (Lin, 1999).

2.2. Betweenness centrality – network bridging indicator

Betweenness centrality is the measure calculated as a number of shortest paths within the network that pass by the node. A path in the network is any sequence of unique nodes intermediary between two given nodes. The shortest path is a path with the least number of links (edges). A node is more central if it serves as a link in more information chains between other nodes. High betweenness centrality indicates an important intermediary in a network (Monge and Contractor, 2003). The idea of a measure captures the importance of a node in the circulation of information (de Nooy et al., 2005) and is based on the assumption that resources flow along the shortest possible paths. Employees with high betweenness connect diverse groups that, without their help, probably remain unconnected. The employee who brokers many paths not only links others, but also tends to mediate the flow of resources and control them by deciding whether

the resource can pass further or should be stopped (Monge and Contractor, 2003). Such employees are particularly important for the projects and actions that require cooperation between diverse groups or usage of diverse information and knowledge (Czepiel, 1974). Bridges tend to have knowledge from various areas as well as social and negotiation skills that help them in making contacts with people from diverse groups or who have diverse practices or values. Bridges tend to be effective members of projects that require global knowledge about the whole network and play a key role in the situations when change concerns the whole company's network (Freeman, 1979). As change agents, they may both contribute to the development of effective global solutions, and communicate and implement them. Key employees working across organizational boundaries and bridging groups and individuals were found to be more effective in implementing reforms related to considerably new ideas (Monge and Contractor, 2003). On the other hand, key employees working within cohesive groups play an important role in instituting minor changes (Freeman, 1979; Luke, 1973).

2.3. Closeness centrality – network pulse indicator

Closeness centrality is the measure calculated for a given node as an inverse of an average number of steps (edges) to all other nodes in the network. Closeness reflects the distance to others and time that is needed to reach them (de Nooy et al., 2005). Network distance is the road a node needs to travel to reach other nodes. A node can be directly connected with other nodes with one step, but can be also connected indirectly with a larger number of steps and intermediate additional nodes. Employees having a small distance can get to others (others can also get to them) in a few steps. These employees are well-integrated so any information reaches them faster than others, and they receive most of the information flowing within the network in a short time. That gives them the ability to quickly receive and transmit information (Monge and Contractor, 2003). In consequence, their voices tend to be heard by many others, and they tend to have the knowledge about most of the information flowing "through the grapevine" (Monge and Contractor, 2003). Having the latest information and mediating its flows, those employees can be called *network pulse takers*. Also, because their voices are heard by others, it is a good idea to keep in contact with them in moments of change. They can both quickly inform and influence others and collect the feedback.

2.4. Eigenvector centrality – network influence indicator

Eigenvector centrality is the measure taking into account not only how central a given node is, but also how and to whom central nodes are connected (de Nooy et al., 2005). Calculated as the number of connections of a given node, the measure pays particular attention (high edge weight) to

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those with many links (also evaluated according to how many links their neighbors have, etc., as the measure is calculated for every node in the network). Employees with high eigenvector tend to have a global influence to the entire network. They have direct connections with influential employees with many contacts and have a direct impact on them. Influential network members do not need to have many connections; it is enough to have relations with those network members who have a lot of connections. Employees with high eigenvector centrality can be potentially good change agents and opinion makers because they can influence others both directly and indirectly.

3. Network Coverage as a Change Agent Evaluation Criterion

The process of change is inseparably associated with spreading new information or teaching new skills and practices across the company. When a change is adopted, this basically means new information or a new practice is adopted by the majority but implemented by a small fraction of employees. Thus, it is important to identify the ways in which actors can directly or indirectly reach others in the network.

The concept of reachability in the network is used in social studies on the diffusion mechanisms working in the flow of information (Katz and Lazarsfeld, 1955) or adoption of innovation (Goldenberg et al., 2007; Rogers, 2003; Valente, 1995). This concept has already been applied in many areas – for example, in communication studies (Goel et al., 2012; Watts and Dodds 2007), behavioral research (Jankowski et al., 2012; Valente and Pumpuang, 2007; Zbieg et al., 2012), or marketing (Godes and Mayzlin, 2009; Van den Bulte and Joshi, 2007).

Basics of the process have been well-known for more than 50 years as the two-step flow model of communications (Katz and Lazarsfeld, 1955). In the model, a small group of people called *influentials* are considered important for the information diffusion process as they influence many others. However, in the processes of diffusion, the reach measured for influentials is not necessarily direct. In fact, influentials may influence their neighbors that influence their neighbors that influence their neighbors and so on, forming a cascade. We instead propose to focus and optimize agents' *direct reach* in the change implementation process. We have three main reasons. Firstly, the idea of diffusion as a multi-step cascade derives from epidemiology in which viruses usually spread as a cascade, and one carrying a virus infects others that, in turn, infect succeeding neighbors, and so on (Anderson, May, and Anderson, 1991). Some network studies suggest that other than in epidemiology, in social systems, the cascades of influence occur in the first degree from sender and rarely derive from chains of referrals (Goel et al., 2012; Watts and Dodds, 2007). Secondly, the diffusion with many chains of referrals is a good description for changes perceived

by employees as superior to the status quo. On the other hand, people are rather unwilling to adopt and spread information for changes perceived as inferior to the status quo or controversial (McGrath and Krackhardt, 2003). Finally, even when information can flow through chains of referrals, this may not be sufficient for the adoption of more complex ideas, attitudes, and behaviors.

In other words, very often simple information sharing could fall short of being enough for a change to be implemented successfully. Numerous iterations based on continuous first-hand delivery of information and collecting feedback seem to be vital for a change process to be successful. Employees need to accept, learn, and adapt to new situations to finally put applicable ideas and actions into practice. Second-hand information about a change and no access to the direct, stable, and well-known support can bring organizational rumors and chaos.

Therefore, the influence of a change agent that is important for the change adoption takes place in direct contacts. However, it is less important how many change agents can directly reach an individual in the organization. We assume that direct contact with one change agent is enough. This idea is reflected by the network coverage concept (Żak and Zbieg, 2014).

Network coverage is the extent to which change agents *directly reach* others within the network.

It seems highly important to provide the majority of employees with the direct, first-hand information and necessary help that simplifies and facilitates the adaptation to change. Considering the delivery of direct information and support as crucial in the process of change adaptation, this paper highlights the role of a network coverage indicator in planning, executing, and evaluating change process implementation.

4. Study

4.1. Plan of Analysis

The idea of network coverage optimization has not been empirically applied much to change management, even though it has been studied theoretically (Hannan et al., 2003). This study uses three organizational collaboration networks and aims to explore and verify this approach by focusing on the following analysis.

We explore the method by comparing network coverage of agents chosen with six methods. We select agents based on four network centrality measures, hierarchy, and seniority, and randomly select agents. Agents selected with every method are evaluated against network coverage, which is their impact and feedback area.

Firstly, we analyze whether *agents selected with methods based on network centrality measures (degree, betweenness, closeness, eigenvector) and classical*

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measures (hierarchy, seniority) better optimize the coverage of communication area than agents selected randomly. It is assumed that any method of selection is better than no method. Information carried by centrality measures or hierarchy and seniority should be helpful in the selection process. Employees with high-centrality measures tend to have more collaborators than an average network member (Wasserman and Faust, 1994). Similarly, studies show that employees with a long tenure are more central within a network as they have had more time to establish relationships (Cross et al., 2004). In turn, employees situated high in hierarchy coordinate the work of other employees and should have more extensive contacts than specialists dealing with particular tasks.

Secondly, we analyze whether *agents selected with methods based on network centrality better optimize the coverage of impact and feedback area than agents selected according to hierarchy and seniority.* Compared to formal structures, organizational networks demonstrate company collaboration in details and tend to better represent how the work really gets done in companies (Cross and Parker, 2004; Tsai and Ghoshal, 1998). Thus, change agent selection methods that appeal to network measures are expected to be more effective than formal manners. It should be also noted that coverage is calculated on network data, and for this reason, network measures may have some advantage over methods based on formal structures. Nevertheless, such an approach seems reasonable. Studies show that informal structure and dependencies play central roles in the process of change, and changes that rely on formal assumptions are more likely to fail (Cross et al., 2007; Krackhardt, 1993; Stevenson et al., 2003).

Next, we analyze whether, *among agents selected with network centrality measures, the most extensive network coverage is obtained by agents chosen according to betweenness centrality.* Network literature indicates that nodes with a high betweenness centrality measure are able to extensively reach other network members (deNooy et al., 2005; Wasserman and Faust, 1994). Called *network bridges*, they connect those network fragments that otherwise remain unconnected. Also, when SNA is applied to organizational change, change agents are indicated as people with high betweenness centrality (Battilana and Casciaro, 2012). Thus, the same number of change agents selected with betweenness centrality should reach a broader network area than agents selected with other centrality measures. Their efforts to reach and support other network members should be less doubled because it is more likely that bridging agents reach different network members, while agents selected with other network centrality measures may reach similar people and do not cover less central network fragments.

Once the best change agents are selected, it is simply explored who are the preferred employees in terms of all studied characteristics. In this way, it is demonstrated that network coverage is important, but not the only criterion for evaluating the change agent selection process. On the other

hand, we study whether chosen agents are people from the same hierarchy level since, for ensuring good communication, people from different parts of the organization and hierarchy levels are preferred.

4.2. Sociometric Data Gathering and Preparation

Data were collected from October 2013 to June 2014 at two medium-sized companies operating in Poland: an IT industry company (93 employees) and an engineering industry listed holding (215 employees located in several neighboring buildings). The third study was conducted on one department (184 employees) of a bigger Polish digital media sector company. Characteristics of employees are presented in Tab. 1. The organizational network analysis was conducted with sociometric surveys with lome.io – online participatory ONA software that simplifies and standardizes the process of data collection and provides manager and employee network visualization and analysis instantly after the surveys are completed (Żak et al., 2014).

In the three studied organizations, participation was high and acceptable for network analysis as it incorporated a high fraction of full-time employees: 71 (76%), 156 (85%), and 145 (67%) for the IT industry company (A), a department in the telecommunication company (B), and the engineering industry company (C), respectively (see Holland and Leinhard, 1973; Kossinets, 2006). This high response rate usually characterizes organizational studies (Stork and Richards, 1992) and limits the possible negative effects of missing network data (Kossinets, 2006; Stork and Richards, 1992). We, however, additionally followed the procedure suggested by Stork and Richards (1992): We cleaned data and reconstructed non-respondents' ego networks. Firstly, we deleted from the dataset nodes representing employees who were either not on the employee list provided by the company (employees have the possibility to indicate collaborators that were not on the list), or were on the list but did not fill in the survey and were indicated by a maximum of one other employee (average node degree was in the range of 9–14). Secondly, we verified whether our non-respondents differed from respondents in terms of gender and hierarchy (for seniority, we did not have enough information about non-respondents). Using the chi-squared test, we found no significant differences, suggesting no systematic bias because of non-response (Armstrong and Overton, 1977; Stork and Richards 1992). Finally, because the relationship of collaboration is, by definition, mutual, in the next step we reconstructed missing non-respondents' indications (Stork and Richards, 1992). In our study, the mean percentage of mutual relationship was 52% for weak ties (1), 64% for moderate ties (2), and 72% for strong ties (3, see next paragraph). The linkages of non-respondents were reconstructed with the following rule (Stork and Richards, 1992): A linkage has been reconstructed if the relationship was a strong tie (2 or 3) and removed if it was a weak tie (1). Tab. 1 shows the descriptive statistics of employees (node attributes) from the three reconstructed networks.

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4.3. Measures and Calculations

The study contains several steps of data analysis. Firstly, three networks composed of collaboration ties were created to represent the structures of studied companies. Next, basic network centralities were calculated for all network nodes. These network measures assigned to each employee, together with information about employee hierarchy and seniority, served for the calculations of change agent rankings. Finally, change agent rankings were evaluated against network coverage, calculated as the cumulative direct reach of selected employees. Below, measures and calculations are presented in more detail.

Collaboration networks. A collaboration network is considered a source of information about employees' instrumental ties related to everyday job and work functions (Grossier et al., 2010) and may represent informal organizational structure helpful in identifying real backstage processes accompanying organizational change (Stevenson et al., 2003). Three directed graphs were created on the basis of employees' indications made in response to the question *With whom do you directly work to perform your everyday tasks?* (c.f. Cross and Parker, 2004; Stevenson et al., 2003). Frequency of interaction was coded on the following scale – 1: *a few times a day;* 2*: a few times a week;* 3: *a few times a month*. However, it was used only for the reconstruction of non-respondents' indications.

Centralities of network nodes. Degree, betweenness, closeness, and eigenvector network centralities were calculated for each network node to serve as independent variables operationalized on continuous scales. The calculations were done with lome.io software (Żak et al., 2014) according to standard network basic measurements (c.f. Freeman, 1979; Wasserman and Faust, 1994). For example, the node's degree centrality was measured as the number of incoming and outgoing ties, thus indications that an employee both made to others and received from other employees.

Additional nodes characteristics: hierarchy and seniority. In addition to node's centrality, two other independent variables were used. While centrality measures inform about employees' positions in an informal organizational structure, hierarchy and seniority describe employees' formal positions within an organization. These attributes were coded as ordinal variables, rating from 1 for a company junior specialist to 8 for a company board member. The coding was adapted for each company separately because hierarchy levels slightly differed among the studied firms (see Tab. 1). For example, for company A, the hierarchy variable ranged from 1 to 6, while for company B, it was coded in a range from 1 to 7. Employees' seniority was coded in a similar way.

Change agent rankings calculation. The main goal of the study was the selection of change agents according to two groups of approaches: usual managerial methods based on information about employees' hierarchy and

seniority, and social network approach based on employees' positions within a network (centrality measures). Having calculated centrality measures as continuous variables, the rankings of change agents were created as the lists of employees with decreasing centrality. The higher centrality measure employees have, the higher on a list of change agents they are situated. In this way, rankings of change agents were created according to degree, betweenness, closeness, and eigenvector centrality. Because hierarchy and seniority were coded as ordinal variables, and we had groups of employees with the same hierarchy level, the list of change agents was created in the following way. Firstly, each employee was assigned a number with the first figure corresponding to the coding hierarchy (e.g., 6 for a member of the board of directors and 1 for a junior specialist in the case of company A), while successive figures were chosen randomly. Secondly, the list of change agents was created according to the numbers assigned to all company employees. An analogous procedure was conducted for change agent ranking, created on a basis of employees' seniority. Furthermore, in a similar way, we created additional lists of change agents chosen randomly just by assigning a random number for every employee. In this case, an employee was placed on a list according to the random number. Finally, the number of selected change agents was counted as the percentage of all employees within a network (e.g., for company A employing 73 people, the first five selected change agents give 7% of all employees). This procedure gave us the possibility to compare the three networks. It should be noted that, for each company, we had one list of change agents selected with centrality measures. For random selection and selection according to hierarchy and seniority, the procedure was repeated 50 times. The final network coverage was calculated as mean network coverage obtained in each step (first agent, first and second agent, etc.) by agents from 50 created lists.

Network coverage. Afterward, created ranks of employees chosen as change agents were evaluated against network coverage, our dependent variable. We thus calculated network coverage for agents selected with every method. We defined *network coverage* as the extent to which change agents directly reach others within the network. Coverage of a single node (change agent) has been operationalized as the number of nodes reached by a given node through the direct ties (node degree). For more than one node, the cumulative network coverage is calculated as a sum of unique nodes directly reached by all selected nodes (cumulative nodes' degree). Thus, organizational network coverage is a number of unique direct collaborators of change agents selected in the process (if two or more change agents have the same collaborator, they are each counted only once). It should be noted that we already described the coverage measured for the undirected graph. However, for the directed graph, there are two additional solutions. It is possible to simplify the directed graph to an undirected one.

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Otherwise, it should be decided whether network coverage is calculated as running on incoming ties (*in-degree*) or outgoing ties (*out-degree*). Studying undirected graphs, we decided not to simplify the possessed information and work on nodes' in-degree measure. We identified two reasons for choosing in-degree as a network coverage criterion. First, one can potentially increase the chance that among chosen change agents are employees with authority (de Nooy et al., 2005; Monge and Contractor, 2003; Wasserman and Faust, 1994) that allows them to create trends, show courses of actions, and determine the direction of activities. Engaging such people as change agents may contribute to the success of change implementation.

In-degree centrality is calculated as the number of a node's direct neighbors according to incoming ties. Employees with high in-degree centrality have numerous indications from other network members (Wasserman and Faust, 1994); in our case, these employees are popularly viewed as collaborators. Popularity usually stems from the fact of possessing some resources (e.g., information) or skills, and implies prestige and authority within the network (de Nooy et al., 2005; Monge and Contractor, 2003). Employees with high in-degree centrality are usually considered as formal or informal authorities and opinion leaders showing courses of action. Other employees tend to value and follow their advice and trust their clues in situations of crisis (Cross et al., 2007). Their opinions may contribute to the creation of trends in the entire network and determine the directions of activities and development. If those network members are convinced as to change initiatives, they can contribute to the change acceptance. Secondly, employees' in-degree is built on indications or interactions made by others. That makes this measure more objective and less sensitive to a lack of data than other centrality measures. Choosing change agents according to indications or interactions made by many network members, one somehow can avoid the discount of important employees only because they did not complete the survey. Finally, network coverage first calculated as the number of unique direct employees that indicated selected change agents as collaborators was operationalized as the percentage of all network employees. For example, for an organizational network of 73 people, the reach of 10 people gives a network coverage index at the level of 14%.

5. Findings

5.1. Descriptive Statistics of the Networks

Having reconstructed non-respondents' indications, we obtained three networks with the properties presented in Tab. 1. The density of the smallest network is the largest (12.5%), while the largest network are characterized by the smallest density (6.9%). The density measure shows the proportion

of all the potential network connections that are existing network links. Because it is more difficult to obtain high network density in larger networks than in smaller ones, we also calculated the average node degree that can be compared across networks with different numbers of nodes.

	Company A	Company B	Company C
Number of nodes	73	177	197
Number of edges	658	2742	2669
Density (%)	12.5	8.8	6.9
Average node degree	9	15.5	13.5
Number of components	1	1	1

Tab. 1. Properties of the three studied organizational networks. Source: the author's own work.

Tab. 2 contains descriptive statistics of the samples and presents attributes of nodes (employees) within the three studied networks. In each network, more network members are women than men (74% to 52%, respectively). The tenure varies from less than 6 months to more than 5 years for company A and to 10 years for companies B and C. There are five, six, and seven levels of hierarchy for companies C, A, and B, respectively.

5.2. Network Coverage for Selected Change Agents

Before turning to the analysis of networks, the data was visualized. Figure 1 demonstrates the cumulative reach of change agents selected with six studied methods and compared to random selection. The results refer to means from the three studied organizational networks.

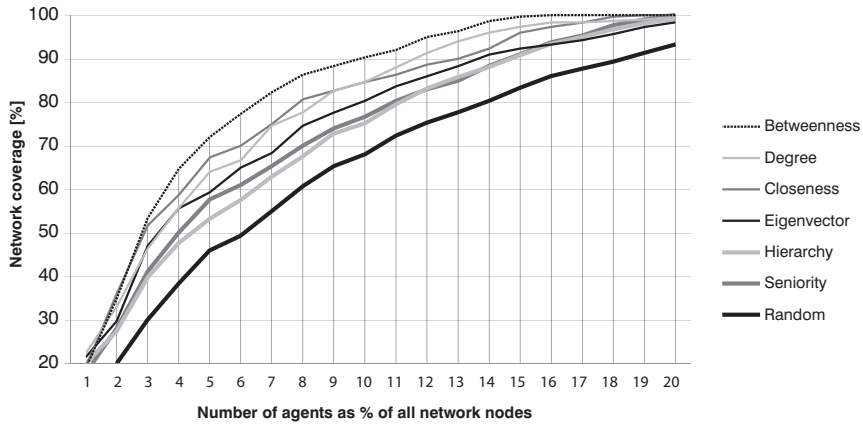

Fig. 1. Network coverage for network nodes selected with different methods (mean values for coverage obtained for the three organizational networks). Source: the author's own work.

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	CompanyA	CompanyB	CompanyC		CompanyA	CompanyB	CompanyC
	Percent (count)	Percent (count)	Percent (count)		Percent (count)	Percent (count)	Percent (count)
Hierarchy Board	3% (2)	–	8% (16)	**Gender** Male	74% (54)	58% (102)	52% (103)
Head of department	6% (4)	1% (1)	21% (42)	Female	26% (18)	42% (75)	48% (94)
Manager	7% (5)	5% (8)	–	**Seniority** > 10 years	–	18% (31)	18% (36)
Team manager	–	8% (14)	–	5–10 years	5% (4)	30% (53)	11% (22)
Supervisor	–	5% (9)	–	2–5 years	19% (14)	14% (24)	14% (28)
Senior specialist	15% (11)	7% (12)	30% (59)	1–2 years	29% (21)	9% (16)	9% (18)
Specialist	42% (31)	23% (41)	32% (64)	6–12 months	27% (20)	7% (12)	7% (13)
Junior specialist	27% (20)	51% (90)	4% (7)	< 6 months	5% (4)	6% (10)	5% (10)
no data	–	1% (2)	5% (9)	no data	14% (10)	17% (30)	36% (70)
Total	**73**	**177**	**197**	**Total**	**73**	**177**	**197**

Tab. 2. Nodes attributes: characteristics of employees in the three studied organizational networks. Source: the author's own work.

Regardless of the method used, selected change agents reach impressive coverage. 20% of company employees engaged as agents may directly contact, support, train, or work with almost 100% of company employees. Engaging 10% of staff members as responsible for change initiatives provides a one-step diffusion of information and training to 70%–90% of company employees, depending on the method of selection. Even employing 5% of company staff as the guides in time of change may provide the direct support for up to 70% of employees for agents selected with the best method and more than 40% for agents selected randomly.

We have asked whether change agents selected according to centrality measures (degree, betweenness, closeness, and eigenvector) and classical managerial methods (hierarchy level, seniority) perform significantly better in terms of coverage than agents selected randomly. In fact, Figure 1 shows the random selection method as the weakest one. Classical managerial methods performed better than a random selection, and the best coverage is obtained by agents selected with network centrality measures. The results of Kruskal-Wallis one-way analysis of variance support indicate significant differences in the median test scores of network coverage among agents selected with the tested methods, $c^2(6, N = 588) = 30.337$, $p < .001$. The highest coverage is obtained by agents selected with betweenness centrality ($M_{rank} = 350.81$), while the smallest network reach characterizes agents selected randomly ($M_{rank} = 221.58$).

In the next step, to verify how exactly the methods differ, the post-hoc comparisons of mean ranks were conducted. All significant differences that resulted from the Mann-Whitney U tests comparisons are presented in Tab. 3 and Tab. 4.

Change agents selected with all tested methods have significantly better network coverage than agents selected randomly. Compared to random selection, the best-performing agents were selected with betweenness, next, agents with high degree and closeness, eigenvector, and with the least coverage, seniority and hierarchy.

While comparing the remaining methods of selection, we observed significantly higher network coverage for betweenness centrality. In terms of network coverage, change agents with high betweenness performed significantly better than agents chosen by eigenvector or by hierarchy and seniority. Although agents with high degree and closeness obtained lower network coverage than agents selected by betweenness (see Figure 1), we have no evidence that they differ at the 0.05 level of significance. However, the overall results suggest that the selection of change agents on the basis of network centrality measures, betweenness centrality in particular, provides better optimization than methods on the basis of the classical managerial categories of hierarchy and seniority.

Moreover, the coverage obtained by a small group of agents (such as 1% of company employees) is similar among methods based on network

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	Selection with betweenness	Selection with degree	Selection with closeness	Selection with eigenvector	Selection with hierarchy	Selection with seniority
Random selection	M_{rB} = 102.87 M_{rR} = 66.13 U = 1985.0 p = 0.000**	M_{rD} = 98.64 M_{rR} = 70.36 U = 2340.5 p = 0.000**	M_{rC} = 98.15 M_{rR} = 70.85 U = 2381.5 p = 0.000**	M_{rE} = 94.47 M_{rR} = 74.53 U = 2690.5 p = 0.007**	M_{rH} = 92.62 M_{rR} = 76.38 U = 2846.0 p = 0.03*	M_{rS} = 93.17 M_{rR} = 75.83 U = 2799.5 p = 0.02*

The two-sided significance levels: * significance level 0.05, ** significance level 0.01.

Tab. 3. Mann-Whitney U test results for differences in network coverage obtained with various change agent selection methods and random selection. Source: the author's own work.

	Selection with degree	Selection with closeness	Selection with eigenvector	Selection with hierarchy	Selection with seniority
Selection with betweenness			MrB = 93.00 MrE = 76.00 U = 2814.0 p = 0.018 *	MrB = 94.69 MrH = 74.31 U = 2672.0 p = 0.005 **	MrB = 93.98 MrS = 75.02 U = 2731.5 p = 0.008 **

N=84 (Company A = 31, Company B = 22, Company C = 31; For each company the selection of agents as % of employees was conducted until 100% network coverage was obtained).

The two-sided significance levels: * significance level 0.05, ** significance level 0.01.

Tab 4. Mann-Whitney U test results for differences in network coverage obtained with the best and other change agent selection methods. Source: the author's own work.

centrality measures and hierarchy and the advantage of agents selected with betweenness rank rapidly increases for a larger group of agents (5%–15%). Tab. 5 presents raw network coverage data from the three studied organizational networks obtained by agents selected with betweenness rank, hierarchy rank, and random rank.

% of employees selected	Coverage for agents selected with betweenness rank (%)			Coverage for agents selected with hierarchy rank (%)			Coverage for agents selected with random rank (%)		
	A N = 73	B N = 177	C N = 197	A N = 73	B N = 177	C N = 197	A N = 73	B N = 177	C N = 197
1	32	9	15	35	14	11	13	10	8
5	75	73	68	67	45	48	39	56	43
10	85	93	93	79	72	75	59	79	66
15	99	100	100	93	88	92	75	93	82
20	100			100	98	100	87	100	93
25					100				99
30									100

Number of selected change agents as 1%, 5%, 10%, 15%, 20%., 25% and 30% of employees is 1, 4, 7, 11, 14, 18, 22 for company A; 1, 8, 17, 26, 35, 44 and 53 for company B; 1, 9, 19, 29, 39, 49 and 59 for company C, respectively.

Tab. 5. Network coverage for change agents selected by different methods. Source: the author's own work.

The small number of selected agents can provide direct support for the majority of company employees and leave only the periphery of the network uncovered. What seems important is the fact that they cover the center of a network, and often more than one agent reaches central employees.

5.3. Change Agent Characteristics

The last step of analysis aims to answer the question of who are selected change agents. Once it is known that agents who obtain the best coverage results are employees acting as organizational network bridges with high betweenness centrality, one would like to verify to what extent they are also sources of network bonding or network pulse takers, influence holders, or employees characterized by a long tenure or high hierarchy level. Tab. 6 presents the results of Spearman's rank-order correlation, used for testing the strength of association between characteristics of network nodes (Johnson et al., 2012; Kossinets and Watts, 2006).

All company employees chosen as change agents are not only characterized by high betweenness centrality, but also, at a similar level, they are people with high degree, closeness, and eigenvector centrality. This was anticipated, as centrality measures tend to be correlated. With one excep-

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Company A (73 employees)	Betweenness centrality	Degree centrality	Closeness centrality	Eigenvector centrality	Hierarchy	Seniority
Betweenness rank	.646**	.520**	.546**	.464**	.399**	.418**

Company B (177 employees)	Betweenness centrality	Degree centrality	Closeness centrality	Eigenvector centrality	Hierarchy	Seniority
Betweenness rank	.573**	.500**	.276**	.411**	.034	.124

Company C (197 employees)	Betweenness centrality	Degree centrality	Closeness centrality	Eigenvector centrality	Hierarchy	Seniority
Betweenness rank	.579**	.485**	.474**	.422**	.220**	.163

Spearman's rank-order correlation (rs), p = 0.01 (two tailed); ** Correlation is significant at the 0.01 level; * at the 0.05 level. Company A: N = 73 (centrality measures); N = 73 (hierarchy); N = 63 (Seniority); Company B: N = 177 (centrality measures); N = 175 (hierarchy); N = 146 (Seniority); Company C: N = 197 (centrality measures); N = 188 (hierarchy); N = 127 (Seniority). For employees not selected as change agents the number of rank was 0.

Tab. 6. Company with 73 employees: the strength of association between node rank selected as betweenness rank and algorithm rank, centrality measures, hierarchy, and seniority. Source: the author's own work.

tion, all observed correlations reached a moderate level, which suggests a dependence between all the roles that arise from the position of a person within a network. In other words, among selected agents are employees playing an important bridging role for a company's collaboration network, together with a bonding role while working in the center of collaboration groups. For example, these employees could take the role of pulse takers that may quickly receive information about tasks, problems, or projects as well as the role of influencer having connections to important network collaborators. In turn, the association between the position of employees in change agent rank and their hierarchy level and tenure is not so unequivocal. In company A, the observed association is moderate. Chosen agents are the employees with a high hierarchy level and seniority; to a similar extent, they play central roles in collaboration networks. In company B, no significant associations were found. Selected agents are not formally higher placed than other employees, nor do they have longer tenure. In company C, the observed associations indicate that people chosen as agents of change are situated higher in the hierarchy than other employees, but they are not characterized by longer tenure.

6. Discussion

6.1. Possible Explanations of the Findings

The results demonstrate that, when focusing on network coverage in the change management process, it is possible to choose the minority of company employees who directly reach the majority with information and support. In the organizational networks of the studied medium-sized companies, this kind of threshold has been observed at a surprisingly low level. Even employing 5% of company staff as the guides in time of change may provide the direct support for more than 50% and up to 70% of employees, for agents selected with studied methods. In turn, engaging 10% of staff members as responsible for change initiatives provides a one-step diffusion of information and training to 70%–90% of company employees, depending on the method of selection. These results suggest that the direct reach with change initiatives can be successfully managed and optimized.

The results also suggest that, by choosing betweenness centrality, one can select change agents who obtain significantly better coverage among company employees than agents usually indicated according to hierarchy level and seniority. Agents selected with other network centrality measures also provide better coverage than agents chosen with the classic managerial approach, but observed differences are not statistically significant. Comparing network centrality measures, we have observed that only agents selected with betweenness significantly better perform than agents selected by eigenvector centrality. This seems reasonable. Change agents selected

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with eigenvector centrality can work much better for two-step (or more) diffusion as they may have few connections, but they link to nodes with many connections (deNooy et al., 2005).

It might seem that, in order to maximize network coverage, one should choose units with the most relationships. However, the results show that effectiveness of degree centrality as a method of selecting change agents is lower than that of betweenness centrality. The importance of degree depends very strongly on the structure of the network, specifically, on the mixing patterns (Newman, 2003). Networks with assortative mixing are the ones in which nodes that have a lot of relationships are linked with others that also have many relationships, while nodes having few relationships often have relationships with each other. In their case, the selection of agents with the highest degree centrality will not be effective as the ego-networks of such nodes heavily overlap. Degree centrality would be a good method of selecting change agents in networks with disassortative mixing – those wherein the nodes with a large number of relations are connected to those that have a low degree and vice versa. However, social networks usually show assortative mixing, while disassortative mixing is found in biological and physical networks.

Analyzing characteristics of change agents selected by betweenness rank, we found that on a moderate level, they are not only bridges in collaboration networks, but they also possess characteristics of the sources of network bonding, network pulse takers, or influence holders. Thus, on a moderate level, they possess various skills, and such diversification can be helpful in supporting the change. The answer to the question on whether chosen bridging agents are employees characterized by high position in the hierarchy and long tenure is not so simple. These associations are probably influenced by the level of alignment between a company's formal and informal structure. While the collaboration network demonstrates how work really gets done within an organization (Cross et al., 2004), the hierarchy provides information about the formally planned organizational structure. In fact, our interviews conducted within all three companies support this kind of explanation. In company A, work heavily depends on employees with high hierarchy levels, while in company B, employees rely less on high executives while doing ordinary work. In this context, ordinary work is organized in a more usual way in company B than in company A as executives and managers usually perform more strategic roles and are involved in coordination of actions rather than collaboration in performing everyday tasks, as measured with our sociometric question. The culture of an organization also seems to influence the results of coverage in a similar way (see Tab. 5). The advantage of coverage obtained by change agents selected according to betweenness, in comparison to hierarchy, has been observed as smaller for company A than for other companies. Nevertheless, the difference has been observed even for company A as, to some extent, the work always

really gets done in a different manner than it has been formally planned (Cross et al., 2004).

6.2. Theoretical and Practical Implications

Social network analysis (Wasserman and Faust, 1994) conducted within an organization can be helpful in making the process of change implementation more precise, measurable, and manageable. SNA provides the picture of organizational structure as a set of connections between employees (e.g., collaboration or information flow) that is less formal and much more actual and detailed than the structure represented by an organizational chart (Borgatti and Foster, 2003; Noel et al., 1979). Literature demonstrates that insights from network analysis and visualizations come into play at each stage of the change process (Weick and Quinn, 1999) and are helpful in finding skillful people for change implementation among employees with high centrality measures (Battilana and Casciaro, 2012; Noel et al., 1979). Our study shows that change agents selected according to high centrality measures are additionally good performers in terms of direct reach to the majority of network members. Commonly used agent selection according to the hierarchy level (Jacobs and Russ-Eft, 2001) seemed to work quite well at a small scale (e.g., when one would like to reach 20% of company employees), but our study shows it as significantly less effective in large-scale implementations.

Concepts describing the process of social influence and diffusion in networks (Anderson et al., 1991; Zbieg et al., 2012) face the similar problem of finding initial seeding members that can have an impact on the majority (Goldenberg et al., 2009; Katz and Lazarsfeld, 1955). An important criterion of evaluation in the diffusion process is the final reach of content initially diffused by a small fraction of network members. The diffusion is considered as successful if the content has been diffused widely and reached the majority of network members. In organizational change initiatives, the goal is similar. The main difference lies in the fact that the paths of organizational change can be precisely planned, while the process of diffusion is characterized by more randomness (Anderson et al., 1991). Nevertheless, in existing approaches to the selection of organizational change agents, there is little attention paid to the reach of initiatives conducted by change agents, which is the extent to which change agents directly reach others within the network. Our findings suggest that managers should also focus on this change implementation criterion.

For managers, the study shows a slightly different new way for the management and optimization of the change process. The change management that assumes as important the long-term direct support provided for the majority of company employees may be precisely optimized with the presented methods. In numbers, the study shows that, by engaging from 5% to 10% of company staff, the majority of company employees have direct contact with people trained and well-informed about the change.

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Thus, for a company that employs 200 people, only 10–20 agents properly selected may directly diffuse the change. Engaging such a number of people in change initiatives seems to be reasonable even in long term, taking into account the costs of change failures.

6.3. Limitations and Future Research Directions

The limitation of the research lies in the fact that the method was verified for a small number of organizational networks. Moreover, all studied networks were the representations of medium-sized companies; we still do not know how high network coverage can be obtained for larger organizational networks. This opens the first field for further research. Secondly, the paper shows the importance of network coverage in change management initiatives based on specific assumptions. The change is studied as a one-step process. This simple model of diffusion can be compounded to the process of two or more steps. Also, network coverage is calculated relying on ties directed to selected agents (in-degree). While we are theoretically and practically convinced to this approach, other types of coverage calculations should be explored in future research. Finally, even if working on real data, the current research tested change agent selection methods and obtained network coverage rather theoretically. In future research, it would be exceedingly valuable to verify the concepts by applying them into the process of real organizational change.

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