METRICS IN ORGANIZATIONAL CENTRALIZATION AND DECENTRALIZATION

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Abstract: Continual improvement of business processes requires, apart from other efforts, to develop effective metrics, by which managers and/or process engineers will be able to manage the organization's growth. Obviously, there are plenty measures that can be taken to optimize processes. Once effective metrics are identified, the assessment team should do what works best for them. In this paper, an organizational "centralization" or "decentralization" is a matter of interest. The dichotomous term "centralization/ decentralization" itself is somewhat inappropriate in the sense that an organizational centralization is not a goal, but rather a means to help us plan and to set goals. Naturally, approaches to the "centralization/ decentralization" measures depend on many factors. The paper's scope is explicitly limited to the vertical decentralization that is concerned with the delegation of decision-making power down the chain of authority. Subsequently, we are also interested to explore network centralization issues.

Key words: structural analysis, discrete probability distribution, graph theory, structure centralization

Introduction

Business Process Improvement (BPI) is currently a concern of most organizations. Kock (2005) defines BPI as "the analysis, redesign, and subsequent change of organizational processes to achieve performance and competitiveness gains". Approaches to the business process improvement can generally be divided into two categories: improvement of the operational properties of business processes (BP) and improvement of the structural attributes of BP. While the first approach deals with dynamic parameters of BP, structural analysis is mainly concerned with finding out the static properties of BP. The scope of this paper is focused on the second category of BP properties with the aim of measuring and benchmarking of business process centralization/decentralization.
The practical problem is that, in spite of the existing BPI tools and standards, most processes in major corporations have never even been measured and/or rigorously analyzed. According to Davenport and Short (1990), there are two basic problems for understanding and measuring processes before redesigning them. First, drawbacks must be understood so that they are not repeated. Second, effective measurement can act as a baseline for future improvements. Subsequent change of organizational processes leads to change of organizational structures. Such steps are fully in line with the management concept of corporate reengineering by

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Hammer and Champy (1993). Ultimately, many writers e.g., Ross (1991), Davenport (1993) and Currie (1996) show that an ideal organization structure allows decentralized organizational settings with centralized reporting and control. In a general meaning, decentralization (or decentralization) presents “the level of power over decisions made in the organization” (Mintzberg, 1983). Siggelkow and Levinthal (2003) add that “a centralized organization is an organization where the decisions are made from the top whereas a decentralized organization is characterized by decision-making lower in the organization”. However, a pertinent question is: which of these properties are predominantly represented in companies? Alonso (2008) in this context pointed out that “decentralization can dominate centralization even when coordination is extremely important relative to adaptation”. Similarly, Hall (1977) argued that “highly centralized organizations often limit the contribution that employees can make in carrying out their work”.

Organizational centralization versus decentralization

Organizational centralization is frequently explained as “the degree to which the right to make decisions and evaluate activities is concentrated; while decentralization of decision-making is a consequence of the distribution of authority among the different structural components” (Fredrickson, 1986). Decentralization fosters the incorporation of a greater number of individuals and organizational levels into the process (Robbins, 1990), (Hall and Saias, 1980), (Modrak et al., 2003). In a new era of management thinking decentralization was predominantly preferred as an advanced practice and management techniques (Toffler, 1981), (Naisbitt, 1982). According to Stoner & Freeman (Stoner and Freeman, 1989) “the clear trend today is toward more decentralization". A Polemic notion related to this topic presented Drucker (1994) by a comparison between the basic characteristics of Japanese and U.S. management. He pointed out that the trend in America towards a system of decentralization is evident, while Japanese management is dominated by attitudes that privilege direction from authority. Another example of an organizational centralization is represented by so called “four party logistics providers” that prefer highly centralized portal network architecture (Modrak, 2007).
Obviously, it is not sufficient to analyze just one meaning of the centralization in a particular context; instead, it is needful to explore other aspects of the term such as vertical decentralization and horizontal decentralization. Nagelker (2005) interprets both terms in these ways: “Vertical decentralization is the distribution of formal power down the chain of command, and horizontal decentralization is the distribution of formal power outside the chain of command where support staff participates in the decision-making process.”
In a case, if the vertical decentralization is limited then much formal power is delegated in parallel to the managers of market biased line units (Mintzberg, 1980). Treisman (2002) defines the vertical decentralization of a system by the rule that the more tiers there are, the more decentralized is the system. Bas on such

assumption one may ask, how many management tiers in medium and large companies can be usually considered to be in equilibrium between centralization and decentralization. Naturally, it is not easy to find a satisfactory answer to this question, because the concept of optimality can depend on the specific criteria and these criteria are time-dependent. In the past, centralized organizational structures were preferred and manufacturing methods were focused on economy of scale. At present, decentralized companies tend to be fewer tiers of management (Blair and Meadows, 1996). If we take, e.g., the productivity as a crucial business parameter, then usability is the prime concern and it could serve as base for the concept of the optimality of equilibrium. Taking these preconditions into account, the following conceptual model can be created, in order to identify the equilibrium between centralization and decentralization (see Figure 1).

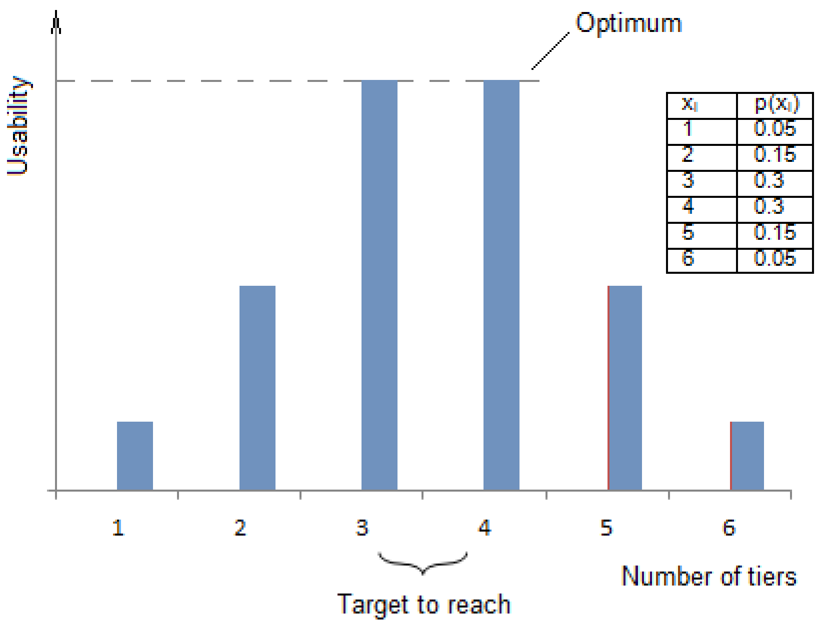

Figure 1. Concept of the equilibrium between centralization and decentralization from the aspect of number of management tiers

The concept of vertical centralization/decentralization versus usability, shown above, is compatible with a probability density function that is easily expressible in the general function form. By transforming this empirical conceptual model through the discrete probability distribution theory it is possible to determine a rate of the vertical decentralization from 0 to 1 based on number of tiers. Then Vertical decentralization index I_D for this purpose can be established, for which in case if I_D=0, a system is fully decentralized. When I_D=1, it means that rate of system decentralization is minimal. The theoretical background of this conception with the quantitative scale (0, 0.05, 0.2, 0.5, 0.8, and 0.95) is shown in Figure 2.

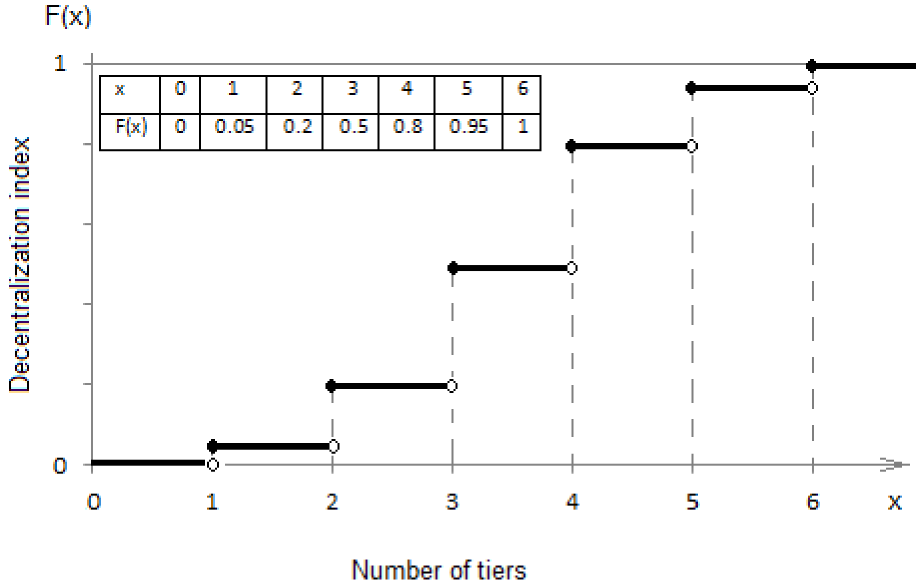

Figure 2. Discrete probability distribution function of usability rate transformed to the decentralization index

Overview of the selected approaches to the measurement of network centralization

Approaches to assessment of the network centralization/decentralization were emphasized using several perspectives by researchers during the past decades. The network centralization can be, in simplified manner, defined as the overall cohesion or integration of the graph. Networks may be more or less centralized around particular points or sets of points. A number of different procedures have been suggested for the measurement of centralization. According to Hanneman & Riddle (2005) "Network analysts often describe the way that an actor is embedded in a relational network as imposing constraints on the actor, and offering the actor opportunities". He also adds that "Actors that face fewer constraints, and have more opportunities than others are in favorable structural positions". This view is consistent with our conception to analyze centralization/decentralization aspects for benchmarking business processes. Freeman (1979) has shown how measures of point centrality can be converted into measures of the overall level of centralization. In generally, measures of centralization refer whether a network is organized around its most central point. The structural centre of a graph is a single point or a cluster of points which can be identified as managerial position handling the team members of given process structure. Christofides (1975) suggested using the distance matrix to determine the absolute centre of a graph. His ideas are related to the two basic classes of network structural properties ‘Centrality’ and ‘Prestige’. Both of them are not individual attributes since they are mutually dependent. The term centrality is broadly used in many disciplines, but it is not explicitly defined within graph theory (Freeman, 1977). However, most writers (e.g. Scott, 2002; Borgatti, 2005; Sabidussi, 1966) think that the graph-theoretic conception of compactness should be renamed “graph centrality”. Prestige can be simply defined as the extent to which one actor has substantially greater prestige than others (Lin, 1976).

Hanneman and Riddle (2005) in context of the network centrality research state that it is useful to first think about very simple networks (see graphs No. 1-4 in Table 1). They argue that such an approach helps to better understand network structure and patterns.

As it was mentioned above, the structural centre of the Star-Graph network (Graph No 1 in Tab. 1) is actor A. The substance of the degree centrality is, that the more links a node has, the more opportunities he has.

Let n = |V| be the number of actors in the graph G = (V;E), then the value of the Actor-level degree centrality of a node v is defined by Wasserman & Faust (1994) as

$$CD(v) = deg(v)/(n-1), \quad (1)$$

where the vertex degree (deg(v)) may be in-degree, out-degree, in-degree + out-degree.

For multi-graphs or graphs with self loops values of degree centrality greater than 1 are possible.

Centralization of a network can be expressed through the so called Group Degree Centralization function (Borgatti et al., 2002):

$$CDgroup =[\sum i(deg(v)max - deg(vi))]/(n-1).(n-2). \quad (2)$$

This index reaches its maximum value of 1 when one actor chooses all other n -1 actors, and the other actors interact only with this one, central actor. The index attains its minimum value of 0 when all degrees are equal. Its disadvantage is that it cannot be used for multi-graphs in case that all vertex degrees are not identical.

Another possibility to measure the structure centralization is to apply the so-called Index of centralization “α” or Degree of structure centralization (Nikolaev and Bruk, 1985). The index values can be obtained through the relation:

$$\alpha =[\sum i(deg(v)max - deg(vi))]/(n-1). [\sum i(deg(v)max - 1)] \quad (3)$$

This index can obtain two limiting values:

α = 1 in the case that the network is centralized to the maximum degree,

α = 0 in the case that the network is decentralized to the maximum degree.

Generic Models of Business Processes

In order to adopt the proposed metrics into a real organization, it is useful to determine a practical framework of business process modeling that will be apprehensible and suitable for all involved actors in an organization (Modrak and Marton, 2013). Firstly, we have to take in consideration a fact that company's processes are generally independent of traditional organizational structure. Accordingly, it is expected to formalize all relevant processes. Furthermore, formalized process models are useful in defining process patterns, as it can provide for identifying processes by their goals (Soffer and Wand, 2007).
The formalized models of business processes focus on roles rather than the people in the positions. Then a theoretical foundation for the modeling of activity-based process models consists of diagrams and process maps, through which it possible to identify resource levels and responsibility scope. For this purpose, the IDEF0 (Icam DEFinition for Function Modelling) method was the most suitable design tool of demonstrating process diagrams, derived from Structured Analysis and Design Technique by Ross (1977). This process modelling technique is based on process decomposition that is resulting in a set of company structure models, which are represented by diagrams. With the aim to have a testing model of realistic business environment the following two diagrams was used to create formalized models of library processes: system diagram and sequence flow diagram. An example of testing model of realistic processes described by these two simplified diagrams is illustrated on Figure 4.

Benchmarking approaches to BP centralization measurement

For the purpose to assess the independent measures, described above by equations (1), (2) and (3), a set of selected graphs will be used. The first four are so called reference graphs. The next graphs (No. 5 – No. 8) were derived from Figure 5. The graph No. 5 represents a decisive part of the System diagram. The graph No. 6 is simplified version of the Context diagram. The graph No. 7 represents the Commodity flow diagram at the first stage, in which only internal relations are considered. Finally, the graph No. 8 presents the Commodity flow diagram at the first stage after integration of selected processes. Table 1 shows the results of the implementation of the centrality/centralization indicators.

Result discussions and conclusions

Based on the analysis of obtained results in Table 1 at least the following pertinent findings can be formulated:

- Only the indicators Actor-level degree centrality and Degree of structure centralization are suitable to measure relevant structural aspects for both type of single-edge graphs and multi-edge-graphs.
- The indicators Group degree centralization and Degree of structure centralization bring for some graphs (No. 1, No. 3, No. 4, No. 5 and No. 8) the

same results. Four of them (No. 1, No. 3, No. 4, No. 5) belong to the category of Regular graphs.

– Measure values of Group degree centralization and Degree of structure centralization for graph No. 2 are relatively very different. An answer on what value is more or less realistic is until now open.

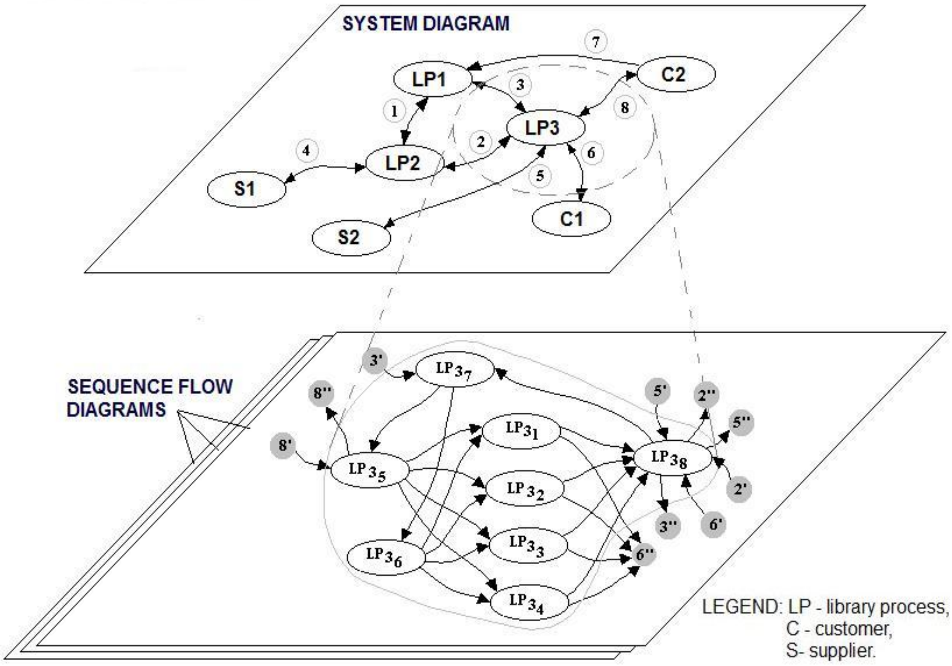

Figure 4. Fragment of a process map modelled by two types of diagrams communicating with external entities Customers (C) and suppliers (S)

Moreover, a new model to measure vertical decentralization in organizations by so called Decentralization index D_I has been developed and proposed. Its practical potential can be seen as independent of current probability density function shown in Figure 1. It is clear that whenever it is possible to modify the scale of measures for vertical decentralization that is constantly determined from 0 to 1.

In a further research in this domain will be needed to specify other relevant structural models of BP and identify further indicators to be able to analyze and recognize decisive attributes and aspects of network centralization/decentralization not only from theoretical viewpoint, but also as important practical implications for improvement of business processes. This article provides the initial step in this process.

Acknowledgements

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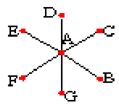
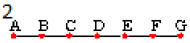
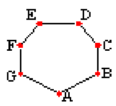
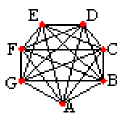
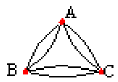
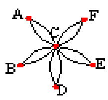
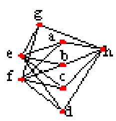
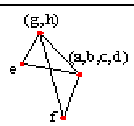
Table 1. Centrality/centralization measure results for selective networks

Graph number	Indicators		
	Actor level degree centrality $C_D(v)$	Group degree centralization C_D^{group}	Degree of structure centralization α
1 	$C_{D(A)}=1$; $C_{D(B)}=C_{D(C)}=C_{D(D)}=C_{D(E)}=C_{D(F)}=C_{D(G)}=0{,}167$	1	1
2 	$C_{D(A)}=C_{D(G)}=0{,}167$; $C_{D(B)}=C_{D(C)}=C_{D(D)}=C_{D(E)}=C_{D(F)}=0{,}333$	0,067	0,333
3 	$C_{D(A)}=C_{D(B)}=C_{D(C)}=C_{D(D)}=C_{D(E)}=C_{D(F)}=C_{D(G)}=0{,}333$	0	0
4 	$C_{D(A)}=C_{D(B)}=C_{D(C)}=C_{D(D)}=C_{D(E)}=C_{D(F)}=C_{D(G)}=1$	0	0
5 	$C_{D(A)}=C_{D(B)}=C_{D(C)}=2$	0	0
6 	$C_{D(C)}=2$; $C_{D(A)}=C_{D(B)}=C_{D(D)}=C_{D(E)}=C_{D(F)}=0{,}4$	not applicable	0,889
7 	$C_{D(a)}=C_{D(b)}=C_{D(c)}=C_{D(d)}=C_{D(g)}=0{,}429$; $C_{D(e)}=C_{D(f)}=C_{D(h)}=0{,}714$	0,238	0,357
8 	$C_{D(a,b,c,d)}=C_{D(g,h)}=1$; $C_{D(e)}=C_{D(f)}=0{,}667$	0,333	0,333

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WSKAŹNIKI W CENTRALIZACJI I DECENTRALIZACJI ORGANIZACJI

Streszczenie: Ciągłe doskonalenie procesów biznesowych wymaga, oprócz innych działań, opracowania skutecznych wskaźników, dzięki którym menedżerowie i / lub technolodzy będą mogli zarządzać rozwojem organizacji. Oczywiście, istnieje wiele działań, które mogą zostać podjęte w celu optymalizacji procesów. Kiedy oznaczone są skuteczne wskaźniki, zespół oceniający powinien robić to, co jest dla nich najlepsze. W niniejszym artykule przedmiotem zainteresowania jest organizacyjna "centralizacja" lub "decentralizacja". Dychotomiczne pojęcie "centralizacja / decentralizacja" samo w sobie jest nieco niestosowne w tym sensie, że centralizacja organizacyjna nie jest celem, lecz środkiem, aby pomóc nam planować i wyznaczać cele. Oczywiście podejścia do środków „centralizacji / decentralizacji" zależą od wielu czynników. Zakres artykułu jest wyraźnie ograniczony do decentralizacji pionowej, która dotyczy delegowania uprawnień decyzyjnych w dół łańcucha władzy. W późniejszym czasie, jesteśmy również zainteresowani zbadaniem kwestii centralizacji sieci.

Słowa kluczowe: analiza strukturalna, dyskretny rozkład prawdopodobieństwa, teoria grafów, centralizacja struktury

集中組織和分散化的指標

摘要：業務流程的持續改進要求，除其他活動外，有效的指標的制定由經理和/或技術人員將能夠管理組織的發展。當然，也有可採取優化過程的許多動作。當表示是有效的指標，評估小組應該
做的是對他們最好的。在這種利益的文章是組織"集權"與"分權"。
"集權/分權"本身的二分概念是在這個意義上有點不恰當，組織的集權化不是目的，而是手段，幫助我們計劃和設定目標。當然，這種方法為"集權/分權"的方式取決於很多因素。本文的範圍顯然是有限的垂直分權，是指決策下的權力鏈的代表團。在稍後的時間，我們也有興趣在研究網絡的集中化的問題。

關鍵詞：結構分析，離散概率分佈圖論，集中式結構