Organizational Network Analysis

The integrated meta-model for organizational resource audit is a consistent and comprehensive instrument for auditing intangible resources and their relations and connections from the network perspective. This book undertakes a critically important problem of management sciences, poorly recognized in literature although determining the current and future competitiveness of organizations, sectors, and economies. The author notes the need to introduce a theoretical input, which is manifested by the meta-model. An expression of this treatment is the inclusion of the network as a structure of activities, further knowledge as an activity, and intangible assets as intellectual capital characterized by a structure of connections. The case study presented is an illustration of the use of network analysis tools and other instruments to identify not only the most important resources, tasks, or actors, as well as their effectiveness, but also to connect the identified networks with each other. The author opens the field for applying her methodology, revealing the structural and dynamic features of the intangible resources of the organization. The novelty of the proposed meta-model shows the way to in-depth applications of network analysis techniques in an intra-organizational environment.

Organizational Network Analysis makes a significant contribution to the development of management sciences, in terms of strategic management and more strictly a resource approach to the company through a structural definition of knowledge; application of the concept of improvement-oriented audit, abandoning a narrow understanding of this technique in terms of compliance; reliable presentation of audits available in the literature; rigorous reasoning leading to the development of a meta-model; close linking of knowledge and resources with the strategy at the design stage of the developed audit model, including the analysis of link dynamics and networks together with an extensive metrics proposal; and an interesting illustration of the application with the use of metrics, tables, and figures. It will be of value to researchers, academics, managers, and students in the fields of strategic management, organizational studies, social network analysis in management, knowledge management, and auditing knowledge resources in organizations.

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Organizational Network Analysis
Auditing Intangible Resources

Anna Ujwary-Gil
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The saying it is not who you know, but what who you know speaks to the power of intangible resources. This work goes a step further by also showing the power of what who you know does and what resources they have at their disposal. I have long espoused the value of these high-dimensional or meta-networks and their dynamics for understanding real-world issues. These ideas are operationalized in a sophisticated toolkit for high-dimension network analysis, visualization, and what-if analysis referred to as ORA. I teach ORA and this approach at Carnegie Mellon University during the CASOS Summer Institute (SI). This is how I met Anna. She was a participant in 2015. She instantly grasped the power of this approach and its value for understanding organizations. This book came out of that beginning.

In this book, *Organizational Network Analysis: Auditing Intangible Resources*, Anna goes far beyond the basic methodologies. She situates this approach by building on the theories that underlie team science and resource management. She empirically grounds this approach and builds relevance through numerous real-world examples. In these examples, she shows in detail how to apply dynamic meta-networks to real-world organizations and describes what new insights this application brings to our understanding of the organization at work. She helps the reader understand how network forces impact performance at all levels and across humans and intangible resources. It has long been recognized that informal networks of who talks to whom are key to promotion, to how things get done, and to organizational gaps. This book is unique in that it goes several steps further and builds on the networks connecting people, resources, knowledge, and tasks to each other. This broader perspective is critical for understanding the organization at work. Using this perspective one can measure and reason about policies for effecting organizational needs such as workload distribution, congruence, team stability, and just-in-time teaming. Illustrative examples show how this meta-network approach enables corporate leaders to manage intangible resources as they hire new personnel, reorganize, and build connections among groups. Going still another step the author shows how
the application of dynamic network analysis provides the manager or researcher with a merged picture of the flow of information and knowledge through the organization. Anna has moved organizational network analysis beyond simple assessment of informal networks into the realm of high-dimensional (meta-network) and dynamic network analytics. As such she is able to provide a sophisticated, usable, and practical approach to auditing intangible resources. The universality of the approach means that the metrics and processes are relevant to any organization or group, even one composed of humans and robots.

Scientists and practitioners will find this book of value – as it contains both methodological contributions and detailed practical applications. It provides a promising and systematic data-driven approach for addressing the challenges of identification, measurement, and evaluation of organizational resources. The methods used are sophisticated, but easily understood and employed by doctoral students and MBAs. The approach is scalable and can be used both at the small team level such as a group of five to coordination across the entire space of GitHub. All in all, this is a key contribution to team science.

Earl Nightingale once said, “All you need is the plan, the roadmap, and the courage to press on to your destination.” In this book, Anna has given organizational scholars and practitioners the roadmap. Enjoy.

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August, 2019
Introduction

Value creation in an organization is largely dependent on intangible resources, as shown by research on the modern economy, which is transforming into a knowledge- and innovation-based economy, and increasingly—a network economy. The combination of the entirety of employees’ skills, knowledge, and experiences improves the way the organization uses its intangible resources for value creation (Bukowitz & Petrash, 1997). The evolution of a knowledge-based economy toward a network-based economy demonstrates its gradual passage into the next stage of development, dominated by knowledge—seen as a strategic intangible resource of an organization (Zack, 1999)—and intra- and inter-organizational relations based on the exchange and flow of resources (including knowledge and information). Due to the complexity of interrelations between the intangible resources of an organization, and particularly their indeterminacy and elusiveness, the issue of their assessment and control in the management process remains open. In the 21st century, the success of an organization, especially one operating in a competitive market, depends on investments in the development of intangible resources: information, knowledge, and intellectual capital. In order to understand the complexity of an organization’s functioning, it is worthwhile to investigate the dynamics and relations of these resources by formulating and verifying new hypotheses.

Besides network theory, actor–network theory, and activity theory, the primary theoretical approaches of this book are resource-based approaches, including knowledge- and intellectual capital–based views and resource dynamics. Within these approaches, researchers analyze internal differences in economic outcomes, aiming to explain why some companies perform better than others by identifying resources specific to an organization or the effectiveness of resource use. The dynamics and connections of intangible resources are analyzed less frequently. The resource-based view includes both tangible and intangible resources. However, the fact that these resources are equifinal and may be used interchangeably is not considered here. In this approach, the issue of
direct causal relationships between physical resources and their use remains open.

The present research led to the development of a methodology for organizational intangible resource audit, including in particular an assessment of these resources’ relationships, flows, and intensity (prominence) in the organization. The methodology should allow for developing and interpreting findings, planning the course of action, and identifying all aspects of the defined issues. This methodology has been used to diagnose the organizational requirements for the effective performance of an intangible resource audit. No similar research had been performed, and literature on the subject is scarce to the point of being non-existent. There are noteworthy concepts of information, knowledge, and intellectual capital audit developed by authors, and these concepts have been used by the author as the basis for a meta-model of organizational intangible resource audit. Notably, most of these methodologies are static, and thus do not sufficiently include the dynamic nature of intangible resources in relation to organizational tasks. These include the InfoMap concept by Burk and Horton (1988) and Information Audit by Henczel (2000) and Buchanan and Gibb (1998). In other methodologies, authors only highlight the flow of information, for example, in Orna (1999) or the more recent Buchanan and Gibb approach (2007; 2008). However, all of these lack an approach to information process modeling.

The concepts of organizational knowledge audit are interesting. However, many authors do not differentiate between the relevant definitions, treating information audit as knowledge audit and vice versa (see Wang & Xiao, 2009). This is directly related to viewing information and knowledge as organizational resources. In many cases, hypotheses and assumptions lack precision. Particularly noteworthy are knowledge audit methodologies by Debenham and Clark (1994); Helms, Bosua, and Ignatio (2009); Choy, Lee, and Cheung (2004); Gourova, Antonova, and Todorova (2009); Liebowitz et al. (2000); and Reinhardt (2003). Here, knowledge audit is mainly approached from the process perspective, with authors attempting to identify the major audit stages and map knowledge processes and flows, without key audit components, that is, assessment and control of organizational knowledge resources or dynamics of changes and connections of these resources in the analysis period.

As to intellectual capital audit concepts, they are not common, contrary to the widely known and accepted classification of organization intellectual capital measurement and assessment methods (see: Sveiby classifications at www.sveiby.com). Out of the numerous qualitative and quantitative methods for intellectual capital assessment and valuation, two can be classified as intellectual capital audit methods. These are the Technology Broker by Brooking (1996) and the Intellectual Capital Statement (Mertins, Wang, & Will, 2007). The Technology Broker defines the intellectual capital audit cycle but lacks a precise indication
of the stage where the author suggests valuating each resource (human, market, infrastructure, and intellectual property). The Intellectual Capital Statement comprises two models, a structural and a procedural one, providing a theoretical framework for defining and performing an intellectual capital audit in an organization.

The objective of this book is to develop a methodology for organizational intangible resource audit using organizational network analysis. The audit is seen here as a procedure oriented toward documented systems and processes, which is advisory in nature and used for organizational improvement. A preliminary review of literature on the subject shows that this is a new area of research that has yet to be explored, especially in terms of theoretical precepts regarding intangible resources and their definition, auditing, and analysis of the dynamics of their interrelations in an organization. The downside of inadequate intangible resource management is that efforts are duplicated, resulting in the acquisition and reproduction of the same information, that is, the creation of already existing knowledge due to unawareness of its existence. One issue that had not been investigated before, and is at the core of the present discussion, is the identification of the dynamic interrelations between resources, and their inclusion in the intangible resource audit methodology. An analysis of existing audit models, specifically including organizational information, knowledge, and intellectual capital audits, resulting in the creation of a meta-model, is an important part of this research. The meta-model is formed by way of comparisons and creative integration of the non-conflicting assumptions of the existing models. Abductive reasoning has been used in order to explain events and systems that already exist and are known. This explanation is based on experiment results and theoretical principles. Abduction has been used in order to name the model components and to include specific audit elements (stages) in the meta-model. This approach aims at producing a meta-model created out of the least common denominators of all the activities described in the audit processes (stages and steps). The integrated audit model will comprise those steps that best reflect the overall process of intangible resource audit. Thus, also central to the present discussion is the very concept of intangible resource audit, understood as a control, management, and advisory instrument for the ongoing diagnosis of intangible resources from the perspective of the network of interrelations between an organization’s resources and their dynamics.

The interpretation of static and dynamic concepts of intangible resources and their audit is equally important. The static approach is dominant in the literature on the subject and involves the characterization of the status quo of organizational intangible resources (information, knowledge, and intellectual capital). Notably, resources such as information, knowledge, and skills are integral to the tasks performed by an organization’s employees. The use of these resources in action makes them dynamic,
which entails the identification of a network of relations. There is likely no methodology combining the static and dynamic approaches to audit. A standardized methodology for organizational intangible resource audit is also lacking, which means that audits are performed in a variety of ways in various environments.

Moreover, no audit methodology provides a comprehensive, holistic view of intangible resources rather than a fragmented one. Such a holistic approach would enable intangible resources to be analyzed in a complementary manner, together with their interrelations, flows, and contribution to organizational value creation. Audits described in the literature are mainly performed for a specific purpose, such as a merger or acquisition process, or the implementation of new technology. This is true, for example, in the case of internal audit concepts, which, however, are not the focus of this book.

In many cases, the strictly defined scope and purpose of audit do not allow for universal adaptation in the organization, and thus do not provide comprehensive analyses or indicate the proper tools required for their performance. The development and implementation of instruments for intangible resource auditing are integral to the study procedure. From the process perspective, intangible resource audit is a complex, multitiered fact-finding process, involving an analysis of both quantitative and qualitative data. The purpose of such an audit is to: identify intangible resources, assess their value for the organization, identify individuals that are obstacles to information and knowledge proliferation or intermediaries (brokers) in the process, identify knowledge and information overload in the organization, and diagnose the dynamics of intangible resource flow.

Developing a methodology for organizational intangible resource audit requires a detailed analysis of terminology related to such an audit, the relevant theoretical framework, and the conditions created in the organization in order to understand the dynamics, relations, and flows of intangible resources that are the focus of the investigation. The research should be structured so as to comprise three stages:

1. Concept (defining the precepts, restrictions, and conditions of the research process).
2. Creation (developing research instruments).
3. Verification (testing the instruments).³

The primary research problem can be formulated as a question: How can one identify an organization’s intangible resources and their relations in the information network, knowledge network, task network, and resource network? This gives rise to the following specific research questions:

1. How, in the light of network and management theories, should one develop a methodology for organizational intangible resource audit,
bearing in mind the uniqueness both of the intangible resources and their relations, and of the organization itself?

2. What prerequisites should be met by an organization for intangible resource audit to be feasible and effective?

3. Can organizational intangible resource audit be considered a valuable management technique in the modern knowledge-based economy?

4. How can intangible resources be measured, evaluated, and included in audit planning and performance using the network-based view?

The general objective is to develop a methodology for organizational intangible resource audit using the network-based view and organizational network analysis methods. The specific objectives include:

1. Developing a concept for organizational intangible resource audit, based on an exploration of theoretical precepts, where the author shall creatively combine his or her own and other researchers’ concepts.

2. Creating a methodology for organizational intangible resource audit based on approaches developed by Hong, Van den Goor, and Brinkkemper (1993), and Brinkkemper (1996).

3. Identifying and analyzing the dynamics of connections and relations between intangible resources, on the basis of network and resource theories.

4. Providing an empirical basis for intangible resource audit, and in particular for its key stage, that is, performance, using organizational network analysis techniques.

5. Testing selected instruments indispensable for the diagnosis and operationalization of the relations and connections of intangible resources in an organization.

6. Formulating the findings from the organizational intangible resource audit, highlighting study limitations and areas for further investigation.

7. The developed intangible resource audit may become another important component of the meta-model and meta-process approach to audit for other authors’ future research.

Based on a literature review and an innovative combination of the intangible resource audit meta-model with the network-based view, the author has formulated the following assumptions:

- Organizational network analysis is an instrument in intangible resource auditing, allowing one to view the resources from the perspective of a network of relations and connections.

- Understanding of information, knowledge, and intellectual capital audit concepts, and of organizational network analysis techniques, is a prerequisite for designing an integrated intangible resource audit model.
• The network-based view, in the form of organizational network analysis, is a comprehensive instrument for intangible resource audit, enabling the auditing of relations and dynamics of the resources, and thus going beyond the standard methodology of simply measuring the resources themselves.

• Developing and implementing a measurement system comprising metrics of intangible resource relations and dynamics assists in organizational intangible resource auditing in the aspect of interrelatedness of the resources.

• Simulating changes of each resource in the relationship network allows for shaping conditions optimal for an organization’s performance.

The present study is qualitative in nature due to the complexity of problems associated with the analysis, assessment, and investigation of relations between organizational intangible resources. It is primarily oriented toward a nomothetic explanation based on case study analysis, useful in the development and verification of economic theories. The choice of this research method is motivated by the complexity of the issue and the scarcity of research on the subject. It allows for the explanation of causal relationships that are too complex for survey-based research, and impossible to analyze in experiments, with a detailed description of the context of the focus of research (intangible resources). Selection of cases for the analysis was based primarily on the prominence (intensity) of intangible resources in the functioning of each organization. The pilot study included a higher education organization and a joint-stock company operating in the medical sector. The main study was performed in an IT company. Research instruments were tested during the pilot study in one of the largest Polish university libraries and a medical company. Case study guidelines indicate that a minimum of two to four cases should be included, up to a maximum of 15 (Perry, 1998). As the analyses performed are highly complex and time-consuming, the number has been reduced to a single case, which is the dominant approach in network analyses (see, e.g., de Oliveira Maciel & Chaves, 2016; Tsai & Ghoshal, 1998). Two other cases were additionally selected for pilot study purposes. The current state of knowledge was confronted with the specifically selected case in order to enable the formulation of empirically founded propositions. The credibility of findings from the case study was enhanced using triangulation (Stake, 1995), including secondary data analysis, surveying (which is a part of the organizational intangible resource audit methodology, and must be adjusted to the characteristics and environment of a given organization), interviews, and study result processing. Statistical analyses (survey result analysis, means, standard deviations, and other measures) and qualitative analyses were also used. For network data analysis, the Organizational Risk Analyzer (ORA-NetScenes) software
was used. Statistical analyses were performed using the SPSS and UCI-NET packages, and in particular the QAP and MRQAP tools. Bibliographic databases were also used, including Web of Science and Scopus.

The research plan is illustrated below (Figure 0.1):

**Figure 0.1 Research plan**

This book has five chapters. Contents have been organized around network approaches, intangible resources, and the concept of organizational intangible resource audit. The first two chapters have a theoretical focus. Chapter 1 discusses theoretical approaches to networks in the organizational context, including network theory, actor–network theory, and activity theory, selected for their relevance to the study focus, that is, the intangible resources of an organization and the audit process for these resources. Hence the inclusion of resource-based theoretical approaches. In the book, intangible resources are subjected to organizational network analysis, which is therefore particularly emphasized. Social network analysis and dynamic network analysis are also discussed. Chapter 2 is a conceptual one. The author undertakes to develop a meta-model for organizational intangible resource audit on the basis of existing concepts for information, knowledge, and intellectual capital audit. Importantly, the meta-model includes network-based metrics for intangible resource audit.

The methodology section discusses the research focus, questions, and objectives. The study methodology is comprehensively presented, including in particular the need for further investigations and a larger number of cases that would allow for the empirical verification of the proposed intangible resource audit methodology. Within the present case study, it has only been possible to exemplify the hypotheses based on abductive reasoning, to showcase the primary network research instruments in the
Introduction

context of the scope and purpose of intangible resource audit in a specific organization. The hypotheses do not concern a verification of intangible resource audit methodology, but only the social-based research process focusing on intangible resources and their use. Qualitative, quantitative, and network-based research methods are discussed separately, as each category requires a slightly different approach.

In the empirical section, the findings and conclusions from the organizational intangible resource audit are presented, categorized by network level (entire network, dyads, nodes). Changes in positions of actors in the information and knowledge networks are also discussed, as an example of network simulation and the dynamic approach. Another aspect of the analysis concerns changes in selected metrics following the removal of prominent nodes (knowledge, tasks, and resources). Finally, conclusions regarding the developed concept for intangible resource audit methodology and its exemplification in the selected case study are presented.

The author hopes that the development of a new organizational intangible resource audit methodology, as well as the systematization of theoretical aspects of each audit type and their definitions, differences, and approaches to identifying and analyzing intangible resources will offer a valuable contribution to the literature on the subject.

Notes

1. In this book, the terms “intangible resource audit,” “organizational intangible resource audit,” “integrated intangible resource audit,” and “meta-model” are used interchangeably.
2. Others include, for example, the RICARDIS project (Reporting Intellectual Capital to Augment Research, Development and Innovation in SMEs), MERITUM (MEasuRing Intangibles To Understand and improve innovation Management), DMSTI (Danish Ministry of Science Technology and Innovation), PRISM (Policy-Making Reporting and Measurement Intangibles Skills Development Management), DATI (Danish Agency for Trade and Industry), and Scandia Navigator.
3. Empirical verification of the intangible resource audit methodology is not possible, as a considerably larger number of cases would be required for any generalizations.

References

Introduction


References

1. Since network theory is in the phase of development and empirical verification, the term “network theory” is used somewhat tentatively. References are made to Granovetter’s labor market theory and Burt’s competition theory, most frequently cited in the context of the emerging network theory. The question of how justified associations between these approaches and network theory are, however, merits consideration. This chapter includes attempts at providing a theoretical framework, concepts, techniques, definitions, and research fields, which require further elaboration. An inquisitive reader may find questions that network theory should answer in Salancik (1995).

2. In this book, the words actor and node are used interchangeably, even though they stem from two different disciplines: sociology and graph theory. However, this is a common way of identifying network elements, regardless of whether the actor is human or nonhuman. The term relations between actors (nodes) in the network is used interchangeably with the terms “connections,” “links,” “ties,” or “relationships.” A human actor (in particular in the empirical part of the book) is called a “person,” “individual,” or “employee.”

3. “A” denotes a human actor in the network.

4. Out of organization theories, the resource-based view and knowledge-based view are discussed in the following section.

5. In AT, the terms “element,” “component,” and “category” of the activity system, understood as its constituent part, are used interchangeably.

6. Including a larger number of journals would involve much more extensive analyses, going beyond the scope and aim of this book.

7. Both information and knowledge will be defined and further discussed in Section 2.1, “The Nature of Intangible Resources.”

8. Resources in the resource network are understood as the structural capital of the organization. Further explanation is provided in Chapter 2.

9. Reflections in this section can also be found in another publication by the author, but in a slightly different context, involving connections between business models and intellectual capital in organizational value creation (see Ujwary-Gil, 2017).

1. All 14 audit models (including 3 information audits, 9 knowledge audits, and 2 intellectual capital audits) were selected out of the 38 incomplete literature descriptions published in the years 1990–2014, based on criteria listed in Section 2.3.1.

2. Knowledge management is not the focus of the present book. Knowledge audit is usually a preliminary investigation, potentially aiming at or resulting in an implementation of a knowledge management strategy in an organization.

3. The fundamental differences between the proposed meta-model for intangible resource audit and the models listed here are discussed in detail in Section 5.1.

4. All 14 information, knowledge, and intellectual capital audit models, with their respective numbers, are listed in Tables 2.1, 2.2, and 2.3.

5. This concept of intangible resource audit was presented by the author at the 17th European Conference on Knowledge Management, which took place on September 1–2, 2016, at Ulster University, Belfast, UK (Ujwary-Gil, 2016).

6. In the intangible resource audit model proposed here, especially at the design stage, more emphasis is placed on the external context of the organization.

7. Intangible resource audit metrics are listed and discussed in the following section (2.3.2).
8. These questions concern a portion of the business model template according to Osterwalder and Pigneur (2010). Of course, the business model may be analyzed in more detail within the intangible resource audit, but for the present discussion, it is justified to focus mainly on determining the value proposition offered by the organization to its customers.

9. The performance stage of the intangible resource audit is the primary focus of the present book. It is discussed in Chapter 4, which presents an analysis of network structure and dynamics of associations between network nodes. The implementation stage is only outlined, and will be presented in detail in a separate publication, as the extensive analyses required are beyond the scope of the present book.

10. The ranges are not applicable to organizational network analysis, as such studies have not yet been performed at a large scale in the IT sector, in which the studied case operates. Hence the need for more extensive quantitative studies that would demonstrate the ranges applicable to the specific field, sector, environment, and operating conditions of the organization. It is, however, worth familiarizing the reader with interpretations of social network density found in literature, as such networks are also included in the present book.

11. Knowledge and information maps are similar concepts, with similar functions, as shown in this section. The primary difference between them is the scope of each map, that is, explicit and tacit knowledge for knowledge audit, and information for information audit, respectively, bearing in mind that explicit knowledge in knowledge audit also includes information, as explained in Section 2.1.

12. A “map” is an instrument used for visualizing organizational knowledge and information resources, which are often dispersed. “Mapping” is a process of creating a map by visualizing flows and relations.

1. This refers to the stages and steps of the audit, and not business processes to which the audit can be applied. Business processes provide a framework for analyzing information, knowledge, tasks, or resources that make up the essence of a business process.

2. Resources (R) comprise tools and structural capital in the form of information and communications infrastructure (in the Connecto enterprise, this is mainly specialized production and sales software). A few resources (e.g., telephone, computer, conference room, or company car) are physical, which shows that intangible and tangible resources may be complementary, and their separation may be pointless.

3. Respondents in all studies were assured that the data are confidential and that, after the study, each participant would be coded with a unique identification number, for example, A01. It was impossible to provide anonymity due to the researcher’s need to identify relations between individual employees in the organization. Use of another form of name coding would have been too complex and time consuming.

4. A five-degree Likert scale was used for this and the following questions (5–10).

5. This is part of a linear algebra operation called the inner-dot product of the first row vector and column vector, in which the network (matrix) is multiplied by transposition.

6. The number of graphs (network visualizations) that could be presented here exceeds 60. As it is not possible to show all of them, only several examples have been selected for demonstration.

1. For clarity of illustration, one matrix for each of the following relation types was selected for presentation: AA (joint problem-solving), AK (actor
using knowledge and skills), AT (actor performing a task), AR (actor using a resource), KT (task-related knowledge), and RT (task-related resource).


