

Studies in Organisational Semiotics: A Systematic Literature Review

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Abstract. Organizational Semiotics (OS) is a discipline that supports analyzing and modeling organizations as Information Systems (IS). This paper investigates the use of OS theories in studies published in the last five years, aiming to identify how researchers have been employing the OS theory and the current approaches derived from OS. In this sense, we conducted a systematic review in four scientific databases. Starting with an initial set of 91 papers, we selected 53 for this review. The results suggest almost twenty new modeling approaches using OS artifacts and ideas. Moreover, the number of publications has been increasing and publications have occurred in several different journals and conference proceedings.

Keywords: Organizational semiotics, Semiotics, Systematic literature review

1 Introduction

Organizational Semiotics (OS) is a discipline that emerged around 1973, and it aimed at analyzing and modeling organizations as Information Systems (IS). The pioneers of this discipline, such as Stamper [55] and Liu [34], have developed methods, techniques and approaches grounded in Peircean Semiotics [49] focused on organizations. Therefore, they have inspired other authors to adopt these methods, techniques, and approaches in different IS and to develop new approaches based on OS theories.

This paper investigates the use of OS theories in studies published in the last five years, aiming to identify how researchers have been employing the OS theory and the current approaches derived from OS. To achieve this aim, we searched first the main methods, techniques, frameworks grounded on OS theories and published before 2011, and we named them as OS approaches. Thus, we have followed a systematic literature review process that consists of three key stages: planning, conducting, and reporting the review. In addition, we have defined and applied the inclusion and exclusion criteria. Afterward, we have extracted the data and synthesized them to answer the research questions.

2 Research Method

This research follows a systematic review process adopted by [7, 28, 31]. Therefore, we developed a study protocol, a data extraction strategy to ensure a systematic search and review process.

2.1 Research Question

The performed literature review aimed to summarize the current studies that adopt OS approaches, to identify how researchers employ the methods and techniques derived from various OS approaches and the current approaches grounded on OS theories. We raised four central questions in order to address the research objectives:

- *RQ1*. How do researchers employ OS theory?
- *RQ2*. What are new OS approaches developed by researchers?
- *RQ3*. Where are these studies published?
- *RQ4*. How many papers using OS has been published since 2011 per year?

2.2 Search Strategy

Concerning the adoption of Organizational Semiotics approaches, we searched for papers in four web-based scientific databases: ACM digital library, IEEE Explorer digital library, ScienceDirect, and Springer Link. The search string used for retrieving study materials was as follows: “Organizational Semiotics” OR “Organisational Semiotics” (in title, abstract, or keywords). In relation to the study sources, we made sure that our search covered conferences, journals, and book chapters published over the last 5 years (from January 1st, 2011 to December 31st, 2015). Further, we established inclusion and exclusion criteria. Consequently, we included full papers in English or in Portuguese. Therefore, we excluded duplicated papers and irrelevant papers based on title, abstract or keywords.

2.3 Data Extraction Strategy

This review considered few important considerations to extract the specific kinds of data to reach the review goals. We decomposed these considerations into nine questions to provide effective answers to the research questions stated above. The data extracted (DE) from each study were:

- *DEQ1*. What is the research problem?
- *DEQ2*. What are the research objectives?
- *DEQ3*. What are the OS approaches used by researchers?
- *DEQ4*. How do researchers adopt the OS approaches?
- *DEQ5*. Do the authors present a new approach derived from OS? What are the proposal and OS basis of the new approach?
- *DEQ6*. What is the journal or conference where it has been published?
- *DEQ7*. What is the publication year?

2.4 Conducting the Review

With respect to searching, selecting, as well as reviewing the papers, we conducted the activities during December 2015 to January 2016. The preliminary searching returned 91 papers. Following, we describe the number of hits in each database: ACM retrieved two papers, IEEEExplorer retrieved three papers, ScienceDirect retrieved three papers, and SpringerLink retrieved 83 papers. Applying the inclusion and exclusion criteria, we excluded 36 hits in the first review of titles, abstracts and keywords. Further, we did not find duplicated papers. However, we excluded two non-full papers. Consequently, we considered 53 papers to extract data.

3 Results

We summarized the data by tabulating results against stated questions. Due to space limitation, the complete set of extracting data for each question is not included in this paper.

3.1 How Do Researchers Employ OS Theory?

Concerning the data extraction question numbers 3 and 4, we describe summarily how authors adopted OS theory:

Semiotic Onion (SO): The majority of the authors used the SO to identify the informal, formal and technical norms, and to represent and comprehend the information systems, the rules and stakeholders' needs [15, 16, 18, 19, 21, 26, 29, 30, 45, 46, 49]. For instance, SO helped to identify socio-technical barriers that arise in the domain of integrated digital television (iDTV) [12]. Concerning the design solutions, [47] shows the development of a model to suggest solutions through artifacts which analyze, synthesize and evaluate the informal, formal and technical layers, respectively. In addition, Liu et al. [36] used the SO as a dimension of the Pragmatic Interoperability Measurement Model. Furthermore, this dimension illustrates how an integrated system works. Concerning human values, [48] presents a way to identify values according to SO levels.

Semiotic Framework (SF): It usually supports the elicitation and formalization of the requirements of each SF level [9, 29, 42]. Furthermore, researchers developed frameworks (e.g. Semiotic interoperability framework [32]) and proposed a set of methods (e.g. NormEST [40]) that deal with the six levels of SF in an information system. Additionally, the authors used SF to bring social aspects into smart manufacturing [62], and to support the understanding, design, and analysis of Web systems [21]. Also, they used the six levels of the SF as criteria to compare the existing evaluation frameworks for information systems integration [37]. Concerning the data lifecycle, [27] showed a way to use the six layers in the different stages of the data lifecycle and with different stakeholders, consequently they could map design issues or questions that make the data lifecycle more explicit. Regarding the interoperability, [35] developed the concepts of semiotic interoperability ground on the SF.

Semantic Analysis Method (SAM): It assists the identification of ontological dependence on information systems and the generation of ontology charts [8, 22, 41,

50, 52, 54, 61]. For instance, researchers could represent the possible patterns of behaviors in Clinical Pathway and their relationships in an OC, which delineates the boundary of concern in the analysis and defines the meaning of terminology used in the clinical pathway model [60]. In addition, researchers used the SAM to produce a stable ontology of the context that describes the semantic aspects of the signs shared in a Social Network Services (SNS) [53].

Norm Analysis Method (NAM): The authors usually use NAM to eliciting and formalizing norms [8, 16, 18, 33, 41, 42, 50, 61]. For instance, [60] used NAM to extract and analyze patterns of care activities and informal safety norms that affect patient safety outcomes. Researchers also adopted NAM to identify norms of the production and consumption of Web content [22]. In [42], the authors elicited different interface representations through NAM and participatory practices. Consequently, they defined and implemented several norms that represent the system tailorable behavior. Likewise, NAM helped to identify substantive activities in the university's postgraduate admission process [19].

Problem Articulation Methods (PAM): The authors used PAM to reduce the complexity of the system and to clarify the problem [24, 59]. For instance, PAM artifacts, such as Stakeholder Analysis, Evaluation Framing, and Semiotic Framework, helped to elicit interested parties in the prospective Learning Design software tool, and anticipate possible problems and propose solutions [1].

Evaluation Frame (EF): Researchers usually used the Evaluation Framing to identify the interests, questions, and problems of each stakeholder according to the three problem levels, based on SO, in participatory practices [9, 21]. For instance, Buchdid et al. [9] proposed to participants to fill in the EF artifact in order to think about possible important issues related to the different stakeholders and the way they could affect the project.

Stakeholder Analysis (SA): It supported researchers to elicit stakeholders, their roles, responsibilities and their impact on the different organizations organization [30, 42].

Stakeholder Identification Diagram (SID): The authors used SID because different stakeholders bring different perspectives to the innovation being proposed, and have different interests, views, needs, values, and culture [46, 47]. In [9], participants filled in the SID artifact in participatory workshops. As a result, the SID allowed researchers to observe that only people immersed in the situated context can measure the importance of some stakeholders.

Authors of other papers have mentioned the adoption of OS theories. However, these authors did not explicitly specify the employed artifacts [5, 6, 10, 11, 13, 14, 17, 20, 23, 38, 39, 51, 56–58].

3.2 What Are New Approaches Derived from OS?

Considering *DE5*, we briefly present new methods, artifacts, and frameworks based on OS concepts.

eValue [43]: This artifact aims to evaluate interactive systems or their prototypes through a value-oriented and culturally aware. The authors developed this artifact on the grounds of OS theory [34] and the Building Blocks of Culture [25].

Value-oriented and Culturally Informed Approach (VCIA) [47]: This approach supports the design of interactive systems and involves a set of artifacts (e.g. SID and eValue). The authors developed it on the grounds of the OS theory [34], the Building Blocks of Culture [25], and the Socially Aware Computing view for design [2–4].

Web Ontology Design Aided by Semiotics (WODAS) [52]: This method supports the construction of representative Web ontologies. The authors developed it on the grounds of Semantic Web technologies (Web ontology) combined with OS concepts and methods to identify the users' profile and language.

Decision Making Method for SAAS Adoption (DEMSEA) [59]: This method supports the decision making process for Software as a Service (SaaS) adoption. The method adopts PAM.

InDIE [29]: This method supports the production and validation of the design solutions with end-users in an interactive and iterative process. The authors adopted OS theory such as SA and SF.

Pragmatic Interoperability Analysis Framework and Pragmatic Interoperability Measurement Model [36]: The approaches help to measure pragmatic interoperability from two dimensions including six aspects (informal, formal, technical, substantive, communication, and control). The authors adopted the SO and the organization morphology.

A Semiotic-Based Approach for Search Personalization in SNS [53]: This approach provides means to discover as well to distinguish the meanings used by people at the SNS through the agents represented into Ontology Charts.

PLuRaL [42]: This framework supports the design of tailorable applications. It adopts a sociotechnical approach and a comprehensive view of interaction requirements. The authors included OS approaches in the pillars of PLuRaL such as SA, SF, SAM, and NAM.

SCPS-based manufacturing framework [62]: This framework integrates the social, cyber, and physical systems as a whole, and allows producers/customers/users to collaborate on product design and development. The authors propose a framework from the SF.

Semiotically Inspired Fuzzy Clinical decision support systems (CDSSs) Framework [15]: This framework allows describing medical domain concepts contextually and reasoning with vague knowledge. The authors adopted the SO and SF.

Valuation Framing for Social Software (VF4SS) [44]: This artifact supports designers in the identification and understanding of the cultural dimensions of a product. The authors developed it based on Valuation Frame.

NormEST [40]: This tool provides an intuitive development interface that makes it easy to create Knowledge-Based Systems. It also provides deep considerations of the SF levels that permitted to relate the system user interface to the processes and social practices of the users.

Semiotic interoperability framework [32]: This framework supports the assessment of organization's interoperability level to identify organization's requirement towards comprehensive interoperation. The authors developed this framework based on SF.

Semantics-Oriented Method for Generation of Clinical Pathways (SOG-CP) [60]: This method supports the generation of clinical pathways, and adopts SAM and NAM.

NORMative Modelling of Information Systems (NOMIS) [17]: This approach aims to improve modeling objectivity and precision. The authors adopt a new ontology named Human Relativism, proposing a new vision of IS composed of different views inspired by ideas from OS, and defining a new modeling notation and a set of diagrams to represent NOMIS vision and views.

A Framework for Conceptualizing Dynamic Knowledge [5]: This framework supports an exchange of human “messy” knowledge into shared useful information. The research explored two scenarios: *VilanaRede* (a SNS) and *Yahoo! Answers*. The authors adopted NAM.

Value Pie [49]: This artifact supports designers to identify values in the context of social software. The authors created Value Pie based on OS and Building Blocks of Culture [25].

Semiotic Cockpit Evaluation Method (SCoEM) [41]: This method consists of a checklist where each affordance and norm is evaluated with the artifacts that support the agent’s action. In the development, the authors adopted NAM and SAM.

Value Identification Frame (VIF) [46]: This artifact aims to identify the values related to different stakeholders. The authors use SID to help the system that is being designed.

3.3 Where Have These Studies Been Published?

In response to *DE6*, the systematic review results (Table 1) showed that authors published almost all papers (88%) in conference proceedings. In addition, the authors published more in conferences that focus on information systems such as ICISO (20%) and ICEIS (13%).

Table 1. Number of papers by journals and conferences proceedings.

Conference / Journal	Acronym	No. of papers
IFIP WG 8.1 Int. Conf. on Inform. and Semiotics in Organ.	ICISO	11
Int. Conf. on Enterprise Information Systems	ICEIS	7
Int. Conf. on Human-Comp. Interaction	HCI	5
Int. Symp. on Business Modeling and Software Design	BMSD	3
Int. Conf. on Design, User Experience, and Usability	DUXU	3
Int. Conf. on Information Society	i-Society	3
Int. Conf. on Logistics, Informatics and Service Science	LISS	3
European Conf. on Technology Enhanced Learning	EC-TEL	2
J. Health Policy and Technology	HPT	2
Brazilian Symp. on Hum. Factors in Comp. Systems	IHC	2
Int. Conf. on Universal Access in Human-Comp. Interaction	UAHCI	2
J. Universal Access in the Information Society	UAIS	2
Int. Conf. on Advanced Information Systems Engineering	CAiSE	1
IFIP WG 6.11 Conf. on e-Business, e-Services, and e-Society	I3E	1
Int. Joint Conf. on K. Discov., K. Engin. and K. Manag.	IC3K	1

Int. Conf. Software Engineering and Comp. Systems	ICSECS	1
The Int. Journal of Advanced Manufacturing Technology	IJAMT	1
Int. Journal of Human-Comp. Studies	IJHCS	1
Journal of the Brazilian Comp. Society	JBCS	1
Int. Conf. Online Communities and Social Computing	OCSC	1

3.4 How Many Papers Using OS Have Been Published Since 2011 Per Year?

In response to *DE7*, Table 2 presents the number of papers published each year since 2011. It is possible to notice that the number of publications that use OS concepts has almost increased three times in the last five years.

Table 2. Number of papers published per year

	Year				
	2011	2012	2013	2014	2015
No. of papers	6	7	12	13	17

4 Discussion and Conclusion

The results suggest that slightly more than a quarter of the papers (15 out of 53) employed the SO in order to identify and comprehend the three levels of norms within an information system. Moreover, it was possible to note that 23% of papers (12 out of 53) employed NAM due to eliciting, analyzing and formalizing norms in different types of ISs. Besides, less than one-fifth of the papers employed Semiotic Framework (10 out of 53) and SAM (9 out of 53). In addition, we noticed that few studies employed PAM, Evaluation Frame, Stakeholder Identification Diagram (all, 3 out of 53), Stakeholder Analysis (2 out of 53), Valuation Frame and Semio-Participatory framework (both, 1 out of 53). However, less than one-third of the papers (15 out of 53) do not explicitly describe the OS approach used. Thus, we could not determine which Organizational Semiotic methods and artifacts those researchers have employed.

Somewhat more than one-third of the papers (19 out of 53) describe a new approach derived from OS ideas. In general, these new approaches support the design process and the evaluation of a product, the assessment of the interoperability in an IS, and the identification and understanding of the cultural dimensions of a product. Therefore, researchers have been engaged in creating new approaches based on organizational semiotics to find solutions in different natures of IS.

Regarding to the number of publications in the last five years, we found that the number of publications that use OS concepts has been increasing.

For practice, this review showed the significance of OS to improve the business process, elicit requirements for interface design, understand the nature of different IS, and to create an appropriate approach to design, implement and evaluate IS. In addition, we consider this paper as the basic starting step for future researchers interested in understanding the concepts and applicability of OS, its traditional approaches, and the most current approaches. Furthermore, this review suggests to the research community a small picture of current advances in the OS studies.

References

1. Arpetti, A. et al.: Eliciting Requirements for Learning Design Tools. In: Proceedings of EC-TEL, pp. 1–14 (2014)
2. Baranauskas, M.C.C.: Social awareness in HCI. *Interactions* 21(4), 66–69 (2014)
3. Baranauskas, M.C.C.: Socially Aware Computing. In: Proceedings of The 6th International Conference on Engineering and Computer Education, Buenos Aires, Argentina, pp. 1–5 (2009)
4. Baranauskas, M.C.C., Bonacin, R.: Design - Indicating Through Signs. *Design Issues* 24(3) 30–45 (2008)
5. Bonacin, R., et al.: Pragmatic Aspects of Collaborative Problem Solving: Towards a Framework for Conceptualizing Dynamic Knowledge. In: Proceedings of ICEIS, pp. 410–426 (2013)
6. Bonacin, R. et al.: Understanding Pragmatic Aspects with Social Values in Web-Mediated Collaborative Systems. In: Proceedings of HCII, pp. 471–482 (2014)
7. Borg, J., et al.: Accessibility to electronic communication for people with cognitive disabilities: a systematic search and review of empirical evidence. *Universal Access in the Information Society* 14(4), 547–562 (2014)
8. Buchdid, S.B., et al.: Clarifying the Situational Context of a TV Company towards the Design of iDTV Applications 70–79 (2015)
9. Buchdid, S.B., et al.: Creating an iDTV Application from Inside a TV Company: A Situated and Participatory Approach. In: Proceedings of ICISO, pp. 63–73 (2014)
10. Buchdid, S.B., et al.: Designing an iDTV Application in a Situated Scenario: A Participatory Approach Based on Patterns. In: ICEIS 2014. pp. 341–360 (2015)
11. Buchdid, S.B., et al.: Designing iDTV Applications from Participatory Use of Patterns. In: Proceedings of DUXU, pp. 459–468 (2013)
12. Buchdid, S.B., et al.: Socio-Technical Barriers Induced by the Design of Emerging Technologies. In: Proceedings of UAHCI, pp. 34–45 (2015)
13. Buchdid, S.B., et al.: You Can Interact with Your TV and You May Like It an Investigation on Persuasive Aspects for an iDTV Application. In: Proceedings of DUXU, pp. 208–219 (2014)
14. de Carvalho Correia, A.C. et al.: Syntactic/Semantic Formalizations and Metrics of Residential Applications Based on Gestural Interface. In: Proceedings of DUXU, pp. 521–532 (2014)
15. Chen, X., et al.: Incorporating Semiotics into Fuzzy Logic to Enhance Clinical Decision Support Systems. In: Proceedings of ICISO, pp. 97–106 (2014)
16. Chidzambwa, L.: The social considerations for moving health services into the home: A telecare perspective. *Health Policy and Technology* 2(1), 10–25 (2013)
17. Cordeiro, J.: A New Way of Modelling Information Systems and Business Processes – the NOMIS Approach. In: Proceedings of BMSD, pp. 102–118 (2015)
18. Effah, J.: Virtual Process Control Modelling in Organisational Semiotics: A Case of Higher Education Admission. In: Proceedings of ICISO, pp. 51–59 (2015)
19. Effah, J., Liu, K.: Virtual Process Modelling Informed by Organisational Semiotics: A Case of Higher Education Admission. In: Proceedings of ICISO, pp. 42–51 (2014)
20. Ferreira, A.L.S., et al.: Interfaces cérebro-computador de sistemas interativos: estado da arte e desafios de IHC 5138, 239–248 (2012)
21. Ferreira, M.A.M., Bonacin, R.: Analyzing Barriers for People with Hearing Loss on the Web: A Semiotic Study. In: Proceedings of UAHCI, pp. 694–703 (2013)
22. Ferreira, M.A.M., Bonacin, R.: Eliciting Accessibility Requirements for People with Hearing Loss: A Semantic and Norm Analysis. In: Proceedings of HCII, pp. 277–288 (2014)
23. Gonçalves, V.P., et al.: Providing adaptive smartphone interfaces targeted at elderly people: an approach that takes into account diversity among the elderly. *Universal Access in the*

- Information Society. pp. 1–21 (2015)
24. Gulliver, S., et al.: Changing building user attitude and organisational policy towards sustainable resource use in healthcare. *Health Policy and Technology* 2(2), 75–84 (2013)
 25. Hall, E.T.: *The silent language*. Doubleday (1959)
 26. Hayashi, E.C.S. et al.: Introducing New Technology in Educational Contexts: Schools as Organizations. In: *Proceedings of ICEIS*, pp. 340–357 (2013)
 27. Hornung, H., et al.: Challenges For Human-Data Interaction - A Semiotic Perspective. In: *Proceedings of HCII*, pp. 37–48 (2015)
 28. Islam, M.N.: A systematic literature review of semiotics perception in user interfaces. *Journal of Systems and Information Technology* 15(1), 45–77 (2013)
 29. Jensen, C.J., et al.: An Interaction Design Method to Support the Expression of User Intentions in Collaborative Systems. In: *Proceedings of HCII*, pp. 214–226 (2015)
 30. Ketabchi, S., et al.: A Pattern for Structuring the Information System Architecture - Introducing an EA Framework for Organizing Tasks. *Journal of Chemical Information and Modeling*, pp. 263–273 (2011)
 31. Kitchenham, B.A.: *Procedures for undertaking systematic reviews*. Eveleigh (2004)
 32. Li, W., et al.: Semiotics in Interoperation for Information Systems Working Collaboratively. In: *Proceedings of IC3K*. pp. 370–386 (2015)
 33. Liu, K., et al.: A Design of Business-Technology Alignment Consulting Framework. In: *Proceedings of CAiSE*, pp. 422–435 (2011)
 34. Liu, K.: *Semiotics in Information Systems Engineering*. Cambridge University Press (2000)
 35. Liu, S., et al.: Assessing Pragmatic Interoperability for Process Alignment in Collaborative Working Environment. In: *Proceedings of ICISO*, pp. 60–69 (2015)
 36. Liu, S. et al.: Assessing Pragmatic Interoperability of Information Systems from a Semiotic Perspective. In: *Proceedings of ICISO*, pp. 32–41 (2014)
 37. Liu, S. et al.: Evaluation Frameworks for Information Systems Integration: From a Semiotic Lens. In: *Proceedings of LISS*, Berlin, pp. 1333–1340 (2015)
 38. Maïke, V.R.M.L. et al.: Designing Natural User Interfaces Scenarios for All and for Some: An Analysis Informed by Organizational Semiotics Artifacts. In: *Proceedings of ICISO*, pp. 92–101 (2015)
 39. Mendes, G.: Prototipação de interfaces tangíveis de produtos interativos: estado da arte e desafios da plataforma arduino. In *Proceedings of IHC*, 5138, 249–258 (2012)
 40. Moawad, N. et al.: Knowledge elicitation and representation in a normative approach-a case study in diagnosis of plant diseases in Egypt. In: *Proceedings of IS*, pp. 28–34 (2012)
 41. Moreira, W., Bonacin, R.: A Semiotic Based Method for Evaluating Automated Cockpit Interfaces. In: *Proceedings of HCII*, pp. 530–539 (2013)
 42. Neris, V.P. de A., Baranauskas, M.C.C.: Designing tailorable software systems with the users' participation. *Journal of the Brazilian Computer Society* 18(3), 213–227 (2012)
 43. Pereira, R., et al.: Considering values and cultural aspects in the evaluation of interactive systems prototypes. In: *Proceedings of i-Society*, pp. 380–385 (2012)
 44. Pereira, R., et al.: Interaction design of social software: Clarifying requirements through a culturally aware artifact. In: *Proceedings of i-Society*, pp. 293–298 (2011)
 45. Pereira, R., et al.: On the Relationships between Norms, Values and Culture: Preliminary Thoughts in HCI. In: *Proceedings of ICISO*, pp. 30–40 (2015)
 46. Pereira, R., et al.: Values and Cultural Aspects in Design: Artifacts for Making Them Explicit in Design Activities. In: *Proceedings of ICEIS*, pp. 358–375 (2013)
 47. Pereira, R., Baranauskas, M.C.C.: A value-oriented and culturally informed approach to the design of interactive systems. *International Journal of Human-Computer Studies* 80, 66–82 (2015)
 48. Pereira, R., Baranauskas, M.C.C.: Seeing Social Software Analysis and Evaluation through the Lenses of Culture. In: *Proceedings of ICEIS*, pp. 374–387 (2012)
 49. Pereira, R., Baranauskas, M.C.C.: Value Pie: A Culturally Informed Conceptual Scheme for

- Understanding Values in Design. In: Proceedings of HCII, pp. 122–133 (2014)
50. Piccolo, L.S.G., et al.: Designing to Promote a New Social Affordance for Energy Consumption. In: Proceedings of I3E, pp. 213–225 (2013)
 51. Prado, A.B., Baranauskas, M.C.C.: Capturing Semiotic and Social Factors of Organizational Evolution. In: Proceedings of ICEIS, pp. 264–279 (2014)
 52. Reis, J.C., et al.: Addressing universal access in social networks: an inclusive search mechanism. *Universal Access in the Information Society* 13(2), 125–145 (2013)
 53. Reis, J.C., et al.: Beyond the Social Search: Personalizing the Semantic Search in Social Networks. In: Proceedings of OCSC, pp. 345–354 (2011)
 54. Reis, J.C., et al.: Prospecting an Inclusive Search Mechanism for Social Network Services. In: Proceedings of ICEIS, pp. 555–570 (2011)
 55. Stamper, R.: *Information in Business and Administrative Systems* (1973)
 56. Suurmond, C.: Information Systems and Sign Systems. In: Proceedings of ICISO, pp. 20–29 (2015)
 57. Suurmond, C.: Sign Systems, Information Systems, and Engineering. In: Proceedings of BMSD, pp. 82–101 (2013)
 58. Suurmond, C.: The Business of Business Modeling. In: BMSD 2013. pp. 64–83 (2014)
 59. Tan, C., et al.: An Evaluation Framework for Migrating Application to the Cloud: Software as a Service. In: Proceedings of LISS, pp. 967–972 (2013)
 60. Tehrani, J., et al.: Semiotics-Oriented Method for Generation of Clinical Pathways. In: Proceedings of LISS, pp. 477–482 (2013)
 61. Xu, S., et al.: Applying Organizational Semiotics for Developing Knowledge-Based Cost Estimation of Construction Project. In: Proceedings of ICISO, pp. 80–91 (2015)
 62. Yao, X., Lin, Y.: Emerging manufacturing paradigm shifts for the incoming industrial revolution. *Advanced Manufacturing Technology*, pp.1–12 (2015)