The Role of E-Intermediaries in Local Retail Hyperlink Networks: A Hyperlink Network Analysis

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Abstract. Local Owner Operated Retail Outlets (LOOROs) are threatened by the digitalization pressure from offline and online competitors on the one hand and by changing shopping habits of customers on the other. The involvement of e-intermediaries like e-marketplaces could help LOOROs to regain competitive power – not only in terms of additional online sales channels, but also with regard to professional online behavior and e.g. online visibility in terms of SEO. However, little is known about LOOROs online networking patterns, link-building strategies and the specific role of e-intermediaries in this matter. To investigate the raised questions, this study analyzes hyperlink networks of local retailers in three German cities. We explored 14.780 websites and identified 12 categories of important stakeholders for local retail hyperlink networks. Our results reveal that LOOROs neglect the opportunities of local online cooperation. E-Intermediaries act as link hubs for local retailers, but local retailers follow passive link-building strategies and hesitate to link to e-intermediaries.

Keywords: LOOROs, Retail, Hyperlink Network Analysis, Stakeholder Analysis

1 Introduction

Despite the omnipresence of large retail chains and pure online players, local owner operated retail outlets (LOOROs) constitute the vast majority of retailers in German cities [1]. LOOROs are characterized by small-sized store areas, a limited number of staff and high owner-involvement in the day-to-day business operations [2]. Although LOOROs operate in a growing market environment, they are exceedingly challenged by the transformation of the retail industry and pressured to adapt their traditional business model to the intense competitive situation in the retail sector. The market share of the LOORO business type has already declined from 26% in 2003 to 17.9% in 2015 [1]. Further, several independent studies predict a decline in revenue for

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LOOROs of 30% in the next four years [3] and about 50% in the next ten years [4]. The fundamental cause of this negative development is the growing online trade that challenges LOOROs with strong price and service competition, while, at the same time big-box retail outlets and chain stores have started to digitalize their business models and offer multichannel sales and services to their local customers [1]. At the same time, customers are verifiably changing their shopping habits: as they are already used to online shopping and digital services, accordingly their shopping frequency in city centers is diminishing [5]. To increase the ability of LOOROs to meet customer expectations and to compete with pure online players and large retail chains, the use of e-intermediaries like e-marketplaces is an intensively discussed approach / research topic [6] and part of government subsidy programs in Germany [7]. E-intermediaries provide brokerage functionality by connecting the supply and demand of goods, information, and/or services [8]. For LOOROs, e-intermediaries as e-marketplaces are extra-organizational support for the evolving challenges of e-commerce [9]. E-intermediary roles range from simple externalization of online front-end management (e.g., e-commerce site, e-marketplace) to the outsourced management of complex marketing and sales processes related to e-commerce, including pricing, invoicing, and logistics [10]. However, little is known about the online networking activities of LOOROs and the specific role of e-intermediaries in this matter. As the local retail sector is composed of businesses that are diverse and independent in nature, explorative research on relationships on the company-level is challenging. In this paper, we therefore analyze hyperlink structures to learn about online networking patterns within the local retail sector.

Hyperlinks are the structural elements of the Web. They are designed and modified by the owners and administrators of the retail websites and reflect their communicative agenda (e.g. exchange of information or maintaining collaborative relationships) [11]. Hyperlinks thereby are a type of representational communication because no information flow is involved [12]. The totality of hyperlinks on a company's website constitutes an inter-organizational network [13] and demonstrates the structural embeddedness of online organizational behavior [14]. Therefore, organizational hyperlinking is a purposive and strategic communication choice [15]. Hyperlinks have been described as vehicles for the expression of collective identity, public affiliation, credibility, visibility, reputation, authority, and endorsement [16]. Furthermore, the resulting link structures play an important role for the visibility of websites in search engines. Active link-building strategies are a core measure of search engine optimization (SEO) [17].

Therefore, in this paper, we aim to analyze the online networking patterns of LOOROs and all other relevant local retail stakeholders. A thorough understanding of online connections between the stakeholders can provide valuable insights into LOOROs online networking strategies and the specific role of e-intermediaries in this matter. Furthermore, it can shed light on how to promote local retailers online visibility and on how to improve their network relationships with e-intermediaries. Accordingly, we aim to answer the following research questions:

RQ1: What hyperlink structures exist among the stakeholders of local retail?

RQ2: Is there a visible link-building strategy of LOOROs?

RQ3: What role do e-intermediaries play in local retail hyperlink networks?
This study is structured as follows: In section 2, we discuss the methodological background. In section 3, we describe the research framework and the conducted analysis. In section 4, we discuss our findings and point out the implications and limitations of our research.

2 Theoretical Background

Hyperlink Network Analysis (HNA) is a subset of Social Network Analysis (SNA). SNA is the process of investigating social structures by applying networks and graph theory [13]. A social network is a representation of social structures, containing components (people, organizations or other social entities) and relationships such as friendships, affiliations and information exchange [18]. SNA examines the structures of social networks, based on the analysis of relationships (also referred to as links) among the system components (also referred to as nodes) [18, 16]. The difference between hyperlink and social network analysis is that HNA does not analyze social relationships. HNA relies on the use of hyperlink data that can be obtained only from websites. A hyperlink network emerges if at least two nodes (two websites) are connected through hyperlinks. HNA therefore requires an exploratory analysis of the hypertext markup (HTML) of websites to determine if there is a unilateral or bilateral hyperlink relationship between the examined websites [18]. This procedure is named link mining and is usually carried out by web crawlers [16]. In contrast to SNA, in HNA it is difficult to assign weights to links between nodes (websites) as link mining does not collect any additional information or attributes about links, like e.g. the interaction intensity (traffic) between the linked nodes. HNA assesses the importance of nodes by interpreting the identified link structure, considering also secondary data, e.g., external attributes of the nodes based on grouping, clustering or classification [18]. For the examination and assessment of hyperlink networks, 1) link based and 2) network related measures are applicable.
1) Link-based object ranking: The PageRank [19] and HITS [20] algorithms are the most notable approaches for link-based object ranking. PageRank looks at the number and quality of links to a page to determine a rough estimation of the importance of a website [19, 21]. The underlying assumption is that more important websites are likely to receive more links from other websites (link impact) [21]. The HITS algorithm takes this assumption one step further and differentiates between two types/qualities of web pages, called hub and authority. Hubs are web pages that link to many authoritative pages. Authorities are web pages that are linked to by many hubs. Each page in the web is assigned hub and authority scores. The algorithm computes the scores as part of an iterative process and regularly updates the scores of a page based on the scores of the pages in its immediate neighborhood [20].
2) Network theory: The measures of network and graph theory are derived from the relationships between the nodes of a network. Degree, for example, is the number of relations (links) of a node (websites) in a network. In directed networks, an in-degree (e.g. number of incoming links) and out-degree (e.g. number of outgoing links) can be

measured [22]. Based on the relationships between nodes it is also possible to compute the network density of the network and the positioning of single nodes within the network. Network density represents the portion of all possible connections within a network that are actually present [23]. It thus indicates the overall level of integration of the assessed hyperlink network. Ranging from 0% (every node is isolated) to 100% (all nodes are connected with each other), network density is computed as the number of actual connections between nodes divided by the number of possible connections [22]. Network centrality, in contrast, refers to the extent to which a node (website) holds a central position in a hyperlink network [22]. In a connected graph, closeness centrality is an indicator of the extent to which a given node has short paths to all other nodes in the graph. It is calculated as the sum of the length of the shortest paths between the node and all other nodes in the graph. Thus, the closer a node is to all other nodes, the more central it is. Closeness centrality is a reasonable measure to identify nodes in the "center" of a given network [24]. Further, for every pair of vertices in a connected graph, there is one shortest path between them. Either the number of edges that the path passes through (for unweighted graphs), or the sum of the weights of the edges (for weighted graphs) that the path passes through, is minimized on this shortest path. Betweenness centrality measures the number of such shortest paths going through each vertex [25]. The measure thus indicates, which individual nodes play a "brokering" or "bridging" role within a network.

3 Methodology

We carried out the HNA in 5 steps: 1) Definition of scope and sample: First, we defined a clear research scope and chose a representative sample of retailers accordingly. 2) Seed list development: The seed list is the starting list for the examination. It is based on the chosen sample of retailers, from which we have identified and collected the seed URLs for the link mining process. 3) Link Mining: Using a web crawler, we collected the hyperlink data from the seed URLs as well as from the linked network pages. 4) Network Analysis: From the collected link data, we derived the hyperlink networks, which we then analyzed. 5) Interpretation: Finally, we analyzed and interpreted the revealed network data regarding the presented theoretical background [26].

Figure 1. Research procedure

4 Analysis

In our study, all types of resident stationary retailers are considered part of the examination group for local retail hyperlink networks. According to the German Retail Federation, local retailers can be categorized into three types [1]: 1) Local Owner Operated Retail Outlets and 2) Local Chain Stores, both dealing with fast moving consumer goods (FMCG), and 3) Local Specialized Stores, doing business with capital or durable goods (e.g. car dealer).

To gain a better understanding of local retail hyperlink networks and network patterns in Germany, we selected a set of three heterogeneous examination areas (German cities), including one small (10.000-30.000 inh.), one medium (30.000-100.000 inh.), and one large city (>100.000 inh.) [34], with at least one subsidized e-intermediary in each: 1) Attendorn (24.786 inhabitants), as a sample small size city located in North Rhine-Westphalia with a total 103 local retailers; 2) Wolfenbüttel (53.779 inhabitants), as a sample medium size city, located in Lower Saxony with a total 114 local retailers; 3) Heilbronn (122.579 inhabitants), as a sample large city, located in Baden-Wuerttemberg with a total 259 local retailers.

To get an overview of the current state of local retail in each city, we conducted an explorative web research among online vendor archives and city information websites. Subsequently, we established a local retail database for each city including all resident stationery retailers. From this database, we then selected all local retailers with a web presence, resulting in the three seed lists for the HNA:

1) The seed list for Attendorn contains 75 URLs for 103 local retailers (73%), covering 48 LOOROs, 12 Chain Stores, and 15 Specialized Stores. 2) The seed list for Wolfenbüttel contains 50 URLs for 114 local retailers (44%), covering 31 LOOROs, 17 Chain Stores, and 2 Specialized Stores. And finally, 3) the seed list for Heilbronn contains 199 URLs for 259 local retailers, covering 97 LOOROs, 88 Chain Stores, and 14 Specialized Stores.

4.1 Data Collection / Link Mining

We collected the link data in July 2017, harnessing the VOSON web crawler (www.uberlink.com) to visit each of the given seed URLs. The VOSON crawler was configured to focus on outbound links and to ignore internal links. For each seed page, the following stop criteria for the crawling process were defined: > 1000 OutLinks (max. OutLinks); > 25 pages crawled without finding a new outbound link (max. unproductive pages); > 50 pages crawled (max. depth of crawl / pages), and > 2 levels crawled (depth of crawl / levels) [26].

The crawling results helped us derive three types of hyperlink networks, which we used to develop the final stakeholder network for our analysis:

1) The Seed Network, purely based on the hyperlinks of the local retailers of each city.

2) The Full Network, containing all identified and explored stakeholders of the local retail hyperlink network.

3) The Seed + Important Stakeholder Network as a compressed network, including all local retailers and important stakeholders. We considered a stakeholder important when it contained links to at least two seed sites of the local retail hyperlink network [16]. For the analysis of the discovered networks, we used Gephi (www.gephi.org) as an open source software. Fig. 2 shows the identified Seed+Important Networks for the three cities, which we discuss in the following section.

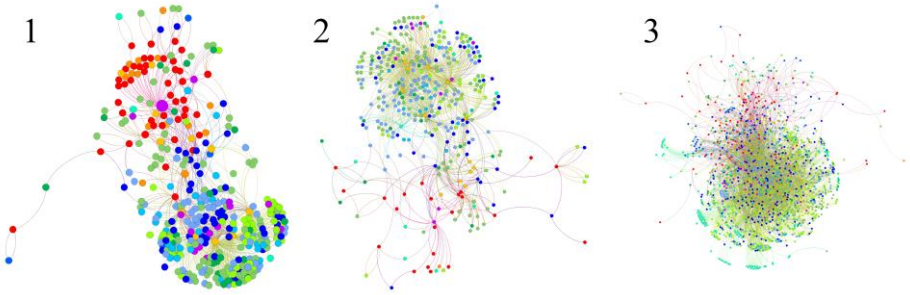

Figure 2. Seed+Important Networks 1) Attendorn, 2) Wolfenbüttel, 3) Heilbronn

4.2 Node Classification and Stakeholder Network

Since the explored Seed+Important and Full Networks are highly complex, we classified all important stakeholders of the local retail hyperlink networks. The categorization is based on the stakeholder classification of Chua et al. (2005), who differentiate between five groups of e-commerce retail stakeholders: customers, retail organizations, suppliers, regulators and indirect stakeholders. We extended this categorization by 12 subtypes in order to allow for a more detailed analysis of local retail hyperlink networks:

Table 1. Stakeholder Categories & Color Code

1.	LOOROs		Websites of local owner operated retail outlets
2.	Chain Stores		Websites of local resident retail chains
3.	Specialized Stores		Websites of local resident specialized stores
4.	Intermediaries		E-Marketplaces (e.g. local shopping platforms, ebay, amazon)
5.	Non-Local Retailer		Websites of non-local resident retailers
6.	Manufacturer		Websites of manufacturers
7.	Service Provider		Websites of service providers
8.	I&C Provider		Websites of information and communication providers
9.	Web Archives		Web-Archives (e.g. address archives of local shops)
10.	Public Sector		Websites of city administration and local clubs
11.	Spam		Content and link pharms and malicious websites
12.	Miscellaneous		Other websites, e.g. foreign language websites

With the help of these stakeholder categories, we derived a final less complex hyperlink network: **4) The Stakeholder Network**. This network shows all explored actors grouped along the 12 stakeholder subcategories (see fig. 4 below).

Table 2. Overview Network Size (Nodes)

	Seed Network	S+I Network	Full Network	Stakeholder Network
Attendorn	75	371	2328	
Wolfenbüttel	50	395	2617	12
Heilbronn	199	1671	9835	

5 Discussion and Conclusion

With the help of the VOSON web crawler and a link mining approach, we investigated local retail hyperlink networks of three German cities. We explored 14780 websites of possible stakeholders and labeled 2437 websites that were considered important according to a developed stakeholder categorization (see table 1).

Regarding the first research question "*What are the link characteristics of local retail stakeholders in local retail hyperlink networks?"* our results show (see fig. 3 below) that there are no direct hyperlink networks between local retailers. If at all, only a very few retailers link to each other.

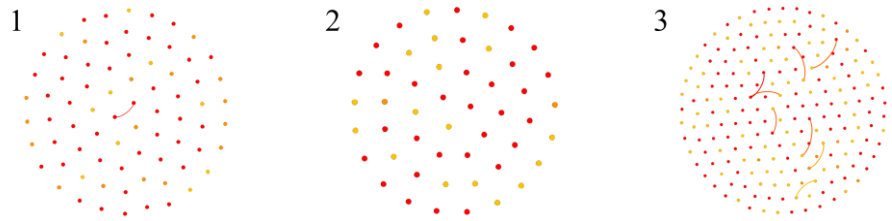

Figure 3. Seed Networks 1) Attendorn, 2) Wolfenbüttel, 3) Heilbronn

However, local hyperlink networks between local retailers and other retail stakeholders are present. Our explorative analysis discovered that all 12 considered stakeholder groups have hyperlink connections to at least two other groups (table 4 / figure 4).

Concerning the relationships between the stakeholders in the identified networks, our results show that the local chain stores have the highest degree and due to the high number of InLinks they act as link authorities (table 4). LOOROs have a high degree of InLinks as well, but significantly fewer relationships compared to Chain Stores (e.g. average degree in Heilbronn, LOOROs 19 and Chain Stores 21). Specialized Stores also tend to be authorities.

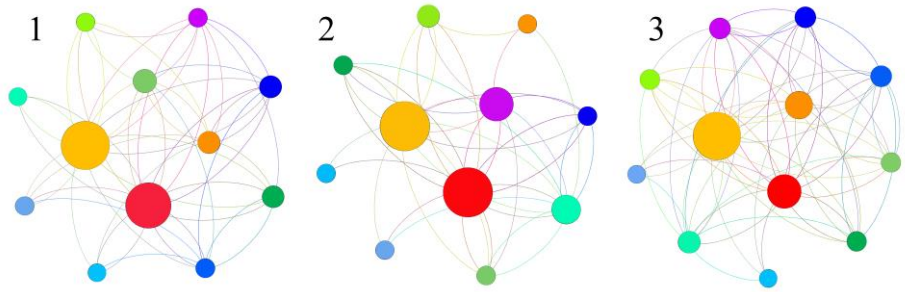

Figure 4. Stakeholder Networks 1) Attendorn, 2) Wolfenbüttel, 3) Heilbronn (Node size according to betweenness centrality)

With regard to the examined link structures, all groups of retailers hesitate to implement OutLinks and rely mainly on InLinks (e.g. indegree/outdegree of retail chains for S+I: Attendorn 513/61, Wolfenbüttel 752/92, Heilbronn 3756/629). Further, local retailers and in particular LOOROs seem to be reluctant to link to e-intermediaries, which could extend their service capabilities (e.g. product visibility, product information, online shopping functionality, etc.) for their customers [17]. On the contrary, e-intermediaries act as link hubs within the hyperlink networks, mainly targeting all three groups of local retailers.

The sparse link building between the local retailers leads to a low overall network density below 1% for all three cities' Seed+Important networks. These low network densities indicate a low bond between the stakeholders of the local retail hyperlink networks. Due to the aggregation of "important" nodes into stakeholder categories, the density of the stakeholder networks is significantly higher (see table 3) - but still only on a medium level.

Table 3. Network density for S+I and Stakeholder Networks

	Nodes S+I	Links S+I	Density S+I	Nodes Stakeholder	Links Stakeholder	Density Stakeholder
Attendorn	371	845	0.62%	12	56	42.42%
Wolfenbüttel	395	1000	0.64%	11	43	39.09%
Heilbronn	1671	5285	0.19%	12	72	54.55%

E-intermediaries act as central nodes within the local retail networks (Attendorn 0.733, Wolfenbüttel 1.000, Heilbronn 0.769), as they are connected to most of the other explored stakeholders. However, the Local Chains and LOOROs also act as brokers in the local hyperlink networks (e.g. Attendorn: LOOROs 29.7, Chain Stores 32.8). Most of the nodes are connected through them. All results for centrality are provided in table 4.

With regards to our second research question "*Is there a visible link-building strategy of LOOROs?"* our analysis shows that LOOROs do not link to other local retailers. This finding is in line with hyperlink research on tourism providers located in one city

[28]. It seems that local businesses do not yet understand the relevance and the opportunities of local networking and local link building, e.g. in terms of search engine visibility [17] and clickstream optimization [29]. Accordingly, there is no local hyperlink network among local retailers. However, there are connections between LOOROs and the other stakeholders, which rely mainly on link-building from the other stakeholders. In conclusion, if at all, LOOROs follow a passive link strategy and only collect InLinks. We found no proof for an active link-building strategy.

Table 4. Network data

Stakeholder Category	Indegree	Outdegree	Degree	Indegree (S+I)	Outdegree (S+I)	Degree (S+I)	Closness centrality	Betweeness centrality	Hits Auth	Hits Hub
Stakeholder Network Attendorn										
LOOROs	3	4	7	104	75	179	0.733	29.7	0.449	0.321
Local Chains	1	11	12	513	61	574	0.688	32.8	0.479	0.264
Specialized Stores	1	0	1	41	14	55	0.478	5.15	0.347	0.163
Intermediaries	0	2	2	9	109	118	0.733	1.59	0.11	0.453
Non-Local Retailer	2	1	2	2	6	8	0.524	0.81	0.11	0.174
Manufacturer	1	1	2	12	6	18	0.611	1.92	0.292	0.294
Service Provider	0	3	3	75	133	208	0.688	6.38	0.226	0.413
I&C Provider	0	2	2	70	88	158	0.579	4.90	0.359	0.24
Web Archives	0	2	2	1	150	151	0.611	1.48	0.05	0.294
Public Sector	0	2	2	12	40	52	0.550	4.59	0.281	0.229
Spam	0	2	2	1	74	75	0.611	0.64	0.06	0.294
Miscellaneous	0	2	2	5	89	94	0.458	1.03	0.273	0.155
Stakeholder Network Wolfenbüttel										
LOOROs	8	6	14	40	77	117	0.800	19.00	0.456	0.345
Local Chains	8	6	14	752	92	844	0.800	19.00	0.456	0.345
Specialized Stores	1	2	3	1	2	3	0.500	0.00	0.103	0.151
Intermediaries	2	8	10	7	43	50	1.000	9.33	0.137	0.520
Non Local Retailer	8	4	12	26	18	44	0.615	6.33	0.492	0.300
Manufacturer	-	-	-	-	-	-	-	-	-	-
Service Provider	4	3	7	84	227	311	0.571	0.33	0.300	0.279
I&C Provider	4	3	7	66	63	129	0.571	0.33	0	0.279
Web Archives	0	3	3	0	308	308	0.563	0.00	0.300	0.279
Public Sector	4	4	8	17	60	77	0.571	0.33	0.240	0.279
Spam	0	2	2	0	43	43	0.529	0.00	0	0.181
Miscellaneous	4	2	6	7	67	74	0.533	2.33	0.270	0.181
Stakeholder Network Heilbronn										
LOOROs	10	9	19	385	236	621	0.833	11.65	0.377	0.343
Local Chains	11	10	21	3756	629	4385	0.909	21.78	0.429	0.352
Specialized Stores	10	5	15	162	39	201	0.588	7.07	0.431	0.206
Intermediaries	6	8	14	22	172	194	0.769	2.23	0.241	0.362
Non Local Retailer	6	9	15	133	179	312	0.833	3.17	0.229	0.394
Manufacturer	6	6	12	41	76	117	0.714	2.42	0.247	0.327
Service Provider	6	4	10	339	1103	1442	0.625	1.35	0.303	0.226
I&C Provider	6	5	11	319	670	989	0.667	2.27	0.303	0.263
Web Archives	1	4	5	1	816	817	0.625	0.13	0.054	0.224
Public Sector	6	4	10	67	252	319	0.625	1.35	0.303	0.226
Spam	0	4	4	0	325	325	0.611	0.00	0	0.224
Miscellaneous	4	4	8	60	788	848	0.625	1.60	0.198	0.225

With regards to our last research question "*What is the role of e-intermediaries in local retail hyperlink networks?"* our results show that e-intermediaries play a central role in the analyzed local retail hyperlink networks. They have relationships with most of the other stakeholders and have a high closeness centrality. Furthermore, e-intermediaries act as link hubs and mainly target local retailers. However, the brokerage power of the e-intermediaries within the networks and between the stakeholders is limited. The low average betweenness centrality of the e-intermediaries is attributable to two facts: 1) LOOROs hesitate to link to e-intermediaries and therefore thwart their brokerage role. 2) Consumers, as the second important target group of e-intermediaries, were not considered in the hyperlink networks. Accordingly, the full brokerage power of e-intermediaries could not be ascertained in the above analysis [30]. The low levels of integration of e-intermediaries in the local retail hyperlink networks in general, and the reluctance of the local retailers regarding OutLinks in specific, are indicators of the inefficient utilization of e-intermediaries in local retail communities.

Practical Implications: Our findings provide valuable insights for the owners of LOOROs and e-intermediaries. LOOROs should revise their link policy and start linking to the e-intermediaries that they collaborate with. They would benefit in at least two ways: 1) Search Engine visibility: Link building is an essential SEO measure and will increase the ranking of LOORO websites as well as the websites of the e-intermediaries [17]. 2) Service infrastructure: With the help of links to e-intermediaries, LOOROs can offer additional online sales and service channels to their customers and website visitors [29]. When LOOROs sell through e-marketplaces and do not link to them from their own web presence, they solely depend on the native visitors of the e-marketplace, and waste the opportunity to offer digital sales and service channels to their own customers. This is becoming more and more problematic, as customers are changing their shopping habits [5] and are adopting practices like showrooming (research offline and purchase online) [31].
E-intermediaries need to recognize this linking failure of local retailers and should provide information and training on the benefits of links to their business partners. LOOROs, in particular, appear unable to integrate e-intermediaries efficiently, in order to facilitate seamless access to digital sales and service channels to their customers and to use click-stream optimization [32, 29].

Limitations and Future Research: Due to the high pace of digital change, the manually derived seed lists for the HNA can only be considered as snapshots. Furthermore, the necessary stop rules for the VOSON crawler limited the link collection. Huge sites (with more than 50 pages) and sites with many links (more than 1000) were not completely analyzed, as this would have overwhelmed our resources. Finally, the conducted crawling process could not reveal any profiling information about the examined websites at this point. Thus, for example, missing information on the SEO-level of a website, the used content management systems, the used shop system(s), etc., limited the explanatory power of the study.

Reflecting on our approach and our findings, future research on the following aspects would be valuable: 1) HNA Process Improvement: How can web and data mining approaches help overcome manual seed list development and manual classification of discovered nodes (automatic node recognition)? 2) Node-Profiles: How can crawler-based node profiling improve the explanatory power of the analysis? 3) Link Building for LOOROs: How can LOOROs be motivated to link to and cooperate with other local retail stakeholders online?

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