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The intellectual structure of behavioral strategy: a bibliometric study

Santiago Urío
Department of Business Management, Universidad Pontificia Comillas, ICADE, Madrid, Spain
https://orcid.org/0000-0001-6458-2220
Raquel Redondo
Department of Quantitative Methods, Universidad Pontificia Comillas, ICADE, Madrid, Spain
https://orcid.org/0000-0002-6534-0271
Diana Gavilan
Department of Marketing, Complutense University of Madrid, Madrid, Spain
https://orcid.org/0000-0002-5293-779X

Abstract
Behavioral strategy is a relatively new subfield of strategic management and yet its roots go back to the origins of the discipline. Its rapid growth over the last few years, the interest created in the research community, and the intrinsically diversified approaches call for organization of the intellectual structure developed by scholars. This paper aims to provide the intellectual structure of the subject based on the published research for the entire period covered by the Social Science Citation Index (SSCI) Database. By using bibliometric and data analytic techniques, we determine the key works in the development of the subfield, the groups that determine the conceptual contributions and the bridging works that provide the common bond between them. To achieve this, we have used co-citation analysis to capture relationships. It is followed by multidimensional scaling (MDS) and a principal component factor analysis (PCFA) for displaying the groups of works that constitute the different lines of research. The study offers useful insights in the discipline and conclusions for future developments in the subject for researchers and practitioners alike.

Keywords
behavioral strategy, strategic management, literature review, co-citation analysis, bibliometrics.

Introduction

Strategic management deals with the major initiatives taken by general managers on behalf of owners, involving utilization of resources to enhance the performance of firms in their external environments (Nag, R., Hambrick, D. C., & Cheng, M., 2007). Despite its development over more than a century, this field of knowledge is relatively young, yet immature and very fragmented, with several open lines of research (Nag et al., 2007; Nerur, S. P., Rasheed, A. A., & Natarajan, V., 2008; Pettigrew, A., Thomas, H., & Whittington, R., 2002; Volberda, 2004). Attempts have been made by a few authors to structure and summarize the main streams on the subject (Guerras-Martín, L. Á, Madhok, A., & Montoro-Sánchez, Á., 2014; Nerur et al., 2008; Ramos-Rodríguez & Ruíz-Navarro, 2004).

One of the most recent and promising lines of research in strategic management works on the influence of cognitive processes in decision making. It encompasses several approaches to strategy and business management that consider the behavioral, non-rational character of individuals and organizations when making business decisions (Bromiley, 2005). This consideration becomes more important when looking at the two main stages of the strategic management process, formulation, and

implementation, both entailing a high degree of human decision making.

Since the last decade of last century, both academics and practitioners have realized the need to fully explore the opportunities that highlighting the behavioral component of decision making could offer to the development and implementation of business strategies. However, behavioral research in strategic management has been lagging behind other disciplines (Lovallo & Sibony, 2010; Powell, T. C., Lovallo, D., & Fox, C. R., 2011) such as economy (Tversky & Kahneman, 1974), finance (Thaler, 2005), and marketing (Dobni, B., Dobni, D., & Luffman, G., 2001).

In the initial stages, when looking at the behavioral influence in the strategic management process, the researchers focused on specific areas often unconnected to each other (Camerer & Lovallo, 1999; Felin & Foss, 2005; Levinthal & March, 1993; Ocasio, 1997). It was clearly necessary to stand back and gain perspective. A key step in structuring the knowledge and research and providing the basis for a conceptual unity to the approach was taken by Powell et al., (2011), who coined and defined the term "behavioral strategy". Since then, it has been consolidated as a promising field within the strategic management discipline and several researchers have published studies contributing to its rapid development.

Despite the fact that literature reviews for the purpose of structuring a discipline of knowledge intellectually are mostly carried out once that discipline has reached a certain level of maturity, at other times they also address new or emerging topics that would benefit from a holistic conceptualization and synthesis of the literature (Ramdhani, A., Ramdhani, M. A., & Amin, A. S., 2014). The latter initiative is particularly required when the complexity caused by the confluence of different fields of knowledge in a new discipline requires an overall view so as not to lose perspective. This is the case of the behavioral approach in the development of business strategies, as it needs contribution from such disparate areas as psychology, sociology, and organizational management, as well as some of the main research streams of strategic management itself.

To the best of our knowledge, this need has not been addressed using a systematic bibliometric methodology to draw upon the avenues of different disciplines that are converging and developing the discipline. The attempts, previously mentioned, to delineate the intellectual structure of strategic management had not yet identified behavioral strategy as an emergent line of research within the field. Other researchers have carried out extensive narrative literature reviews as part of their work, but their aim was to support their arguments rather than study the topic systematically (Bromiley, 2005; Powell et al., 2011).

To cover this gap, we have conducted a systematic quantitative review. It is systematic because we have used a citation and co-citation analysis methodology, which selects the literature in a way that is explicit, transparent, and reproducible, avoiding biases and subjectivity (Snyder, 2019). The objective of this article is to show the most influential works of the different research streams that are contributing to the development of the behavioral vision of strategic management. It achieves this by identifying the most influential research works and their contributions, grouping them so as to display their structure and development.

This paper is not a substitute for exhaustive study of the content, but rather contributes to assessing the degree of influence and relationships between each of the works and the different fields of knowledge they come from, on objective parameters. The results will help scholars develop this line of research further by clarifying the confluence of the disciplines, through indicating the building blocks used by researchers. This approach will also help practitioners by clearly identifying and delineating the foundations of the intellectual structure of the discipline.

The article is organized into three sections. The first is a review of the methodology in general and its application in this case. The second presents and analyzes the results of the study (describing the different analyses according to the final scheme). The third summarizes the main conclusions obtained, possible limitations, and future research.

1. Methodology

We have chosen citation analysis for the review because it is the technique most accepted in academia to measure the quality and influence of scholarly publications (Cole & Cole, 1971). The assumption is that the works, and authors cited by researchers who explicitly devote their effort to the development of the field, are those that have influenced them to build their contributions (Smith, 1981). This methodology therefore allows the definition of the key influencers in the discipline and it is an objective and powerful tool to systematically analyze a large number of works.

However, the establishment of relationships between works and therefore of the intellectual structure of the discipline requires going beyond mere citation. To achieve this, we have used co-citation analysis to capture relationships. It is followed by multidimensional scaling (MDS) and a principal component factor analysis (PCFA) for displaying the groups of works that constitute the different lines of research.

1.1. Methodology used in this paper

In the case of behavioral strategy, finding the key authors systematically is particularly difficult because of its essential interdisciplinarity. The approaches of seminal articles and the keywords used to position them are not homogeneous. To overcome this difficulty, and to obtain a representative collection of behavioral strategy research, we have carried out a three-step process which allowed us to perform a wide visual sweep of the discipline: first, we focused on the works which explicitly use the term "behavioral strategy", second, we used a wide-angle lens to examine the works cited by studies selected in the first step, and finally, we used co-citation technique to reduce the focus distance and raise the intellectual structure (see Figure 1).

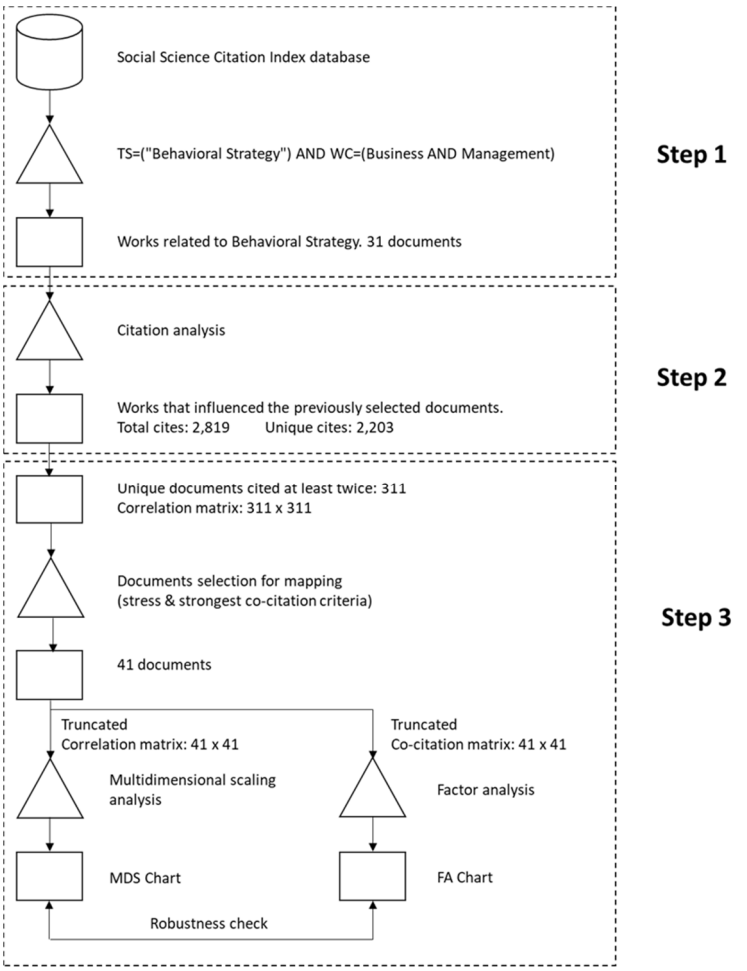

Figure 1: Research steps
Source: the author's

In the first step, we retrieved an initial group of papers from the Social Science Citation Index database from all sources and the time period available, using "behavioral strategy" as the search string. To make sure we were working with the right discipline, the results were filtered by the categories "business" and "management". This search provided 31 documents. The limited number of publications located is due to the fact that the term "behavioral strategy" has gained currency in the field only recently.

In the second step, we retrieved the 2,203 unique cited documents from the previous extraction to perform a citation analysis and gain a view of the literature that influenced them. Not all these cited documents were related to behavioral strategy, as researchers cite in their works documents that support all the aspects covered.

In the third step, we examined the co-citations and their frequency as a proxy for the commonality of the citations around the behavioral strategy topic. The assumption was that frequently co-cited papers represent the key concepts, methods or experiments in the field (Small, 1973). From the 2,203 cited documents of the previous step, we got a co-citation matrix well above four million cells. In order to refine the selection and make the co-citation matrix manageable, we reduced this matrix by selecting the 311 most frequently (at least twice) cited papers (Bergh, D. D., Perry, J., & Hanke, R., 2006; García-Lillo, F., Úbeda-García, M., & Marco-Lajara, B., 2016; Ramos-Rodríguez & Ruíz-Navarro, 2004). This is well over the number selected by other researchers, precluding omission of papers that could be significant and reaching the computational limit of the software used (SPSS, v26). Following Ramos-Rodriguez and Ruiz-Navarro (2004), we then used r-Pearson correlation as a measure of similarity between documents and considered main diagonal as missing data. Once the correlation matrix was determined, we applied multidimensional scaling technique (MDS) using stress as a goodness of fit index. As stress value depends on the number of documents and their original configuration, we had to select the number of papers to map. If the number of papers is between 20 and 50, the stress measure is optimal and allows a readable map in a reduced space, providing a clear graphical representation and containing an adequate number of works to enable the intellectual structure of the field to emerge (Ramos-Rodríguez & Ruíz-Navarro, 2004).

To make that selection, we determined the strongest co-citation as the maximum frequency a paper was co-cited with any other. For example, Gavetti, Greve, Levinthal and Ocasio's (2012) strongest co-citation was 8, the number of co-cites with Powell, Lovallo and Fox (2011), whereas it was co-cited fewer times with other papers.

Strongest co-citation (paper(i)) = max(k) so that co-citation (paper(i), paper(j)) = k for certain j = 1, 2, …2044

We explored both the number of papers and the number of total co-citations involved, considering those papers with strongest co-citations, where s = 1, 2, …, 8, as 8 was the maximum number of co-citations linking two particular papers in the co-citation matrix. Table 1 shows the results of this exploration.

Table 1 Number of papers per co-citation level.

strongest co-citation considered	number of papers	number of co-citations
1	2.044	152.346
2	303	19.556
3	99	5.159
4	**41**	**1.505**
5	11	180
6	5	48
7	3	21
8	3	21

Source: the author's

Accordingly, we chose the 41 documents that presented a frequency of 4 with at least one other document in the co-citation matrix.

Finally, we conducted a factor analysis on the truncated co-citation matrix corresponding to the 41 selected works as a robustness check and grouping them to map the intellectual structure of the field.

2. Results and discussion

2.1. Initial extraction analysis

We first conducted an analysis of the 31 extracted from the SSCI database using "behavioral strategy" as the keyword (see Figure 1). Table 2 shows the initial list of top works ranked by their year of publication and number of citations. In spite of the large number of top ranked citations, the number of entries is small, as the extraction was based on a keyword/term coined in 2011. Thus, all documents retrieved are dated within the period 2011–2021.

Table 2 List of works ranked by year and number of cites

No.	Authors	Cites	Local cites
	2011		
1	Powell, T.C., Lovallo. D., Fox, C.R.	260	19
2	Hodgkinson, G.P., Healey, M.P.	202	7
	2013		
3	Barney, J., Felin, T.	176	1
4	Reitzig, M, Sorenson, O.	37	2
	2014		
5	Powell, T.C.	16	2
6	Hodgkinson, G.P., Healey, M.P.	18	1
	2015		
7	Woodside, A.G.	12	0
8	Maitland, E., Sammartino, A.	42	0
9	Reitzig, M., Maciejovsky, B.	17	1
	2016		
10	Artinger, S., Powell, T.C.	21	2
11	Reilly, G., Souder, D., Ranucci, R.	16	0
12	Schillebeeckx, S.J.D., Chaturvedi, S., George, G., King, Z.	9	0
	2017		
13	Elfenbein, D.W., Knott, A.M., Croson, R.	3	0
14	Luoma, J., Ruutu, S., King, A.W., Tikkanen, H.	5	0
15	Sibony, O., Lovallo, D., Powell, T.C.	10	0
16	Healey M,P., Hodgkinson, G.P.	7	0
17	Powell, T.C.	9	0
18	Meissner, P., Wulf, T.	4	0
19	Bardolet, D., Brown, A., Lovallo, D.	1	0
20	Souder, D., Bromiley, P.	2	0
21	Bettis, R.A.	7	0
22	Levine, S.S., Bernard, M., Nagel, R.	11	1
	2018		
23	Ocasio, W., Laamanen, T., Vaara, E.	17	0
24	Tarakci, M., Ates, N.Y., Floyd, S.W., Ahn, Y., Wooldridge, B.	7	0
25	Rhee, L., Leonardi, P.M.	7	0
26	Luoma, J., Falk, T., Totzek, D., Tikkanen, H., Mrozek, A.	3	0
27	Osiyevskyy, O., Dewald, J.	1	0
	2019		
28	Mohliver, A.	2	0
29	Di Stefano, G., Gutierrez, C.,	1	0
30	Du, X.J., Li, M., Wu, B.	0	0
	2020		
31	Porck, J.P., van Knippenberg, D., Tarakci, M., Ates, N.Y., Groenen, P.J.F. et al.	1	0

Source: the author's

The list of institutions shows a significant involvement of European universities using and supporting the behavioral strategy research term in the field. Of the top eleven institutions with two or more works, nine are European, with an Australian and an American university completing the list (see Table 3). In addition to the strength in cognitive psychology development, particularly in British institutions, this fact points to a higher acceptance of the term "behavioral strategy" by European academia when compared with researchers from other geographies.

Table 3 List of Institutions ranked by number of works (with Total Local and Total Global Cited Score.

Institution	Recs	TLCS	TGCS
Univ Oxford	5	23	316
Aalto Univ	3	0	25
Univ Manchester	3	8	227
Univ Sydney	3	19	271
Bilkent Univ	2	0	8
Erasmus Univ	2	0	8
HEC Paris	2	0	11
Tilburg Univ	2	0	8
Univ Connecticut	2	0	18
Univ Vienna	2	3	54
Univ Warwick	2	8	220

Source: the author's

2.2. The most influential works in behavioral strategy

In the second step of the process, we conducted a citation analysis of the works cited in the records initially extracted. Table 4 shows the top cited works (up to 5 times). The top ten positions look at different aspects of firms' behavior which should be considered from a strategic management point of view.

There is a first group of authors which belong to the early roots of the behavioral theory of the firm, found at the second position, in Cyert and March (1963) together with sixth placed March and Simon (1958). The three authors led the so-called Carnegie School which, working in the field of organizational behavior, questioned rationality in human decision making and developed the concept of bounded rationality. This approach, which applied the cognitive research of psychology in organizations for the first time, was the basis for behavioral research extended to other economic and business fields.

Grounded in the developments of the first group, Kahneman and Tversky (1979) article is seminal for behavioral economics which had a significant influence in strategic management developments. In a later article, Kahneman and Lovallo (1993), analyze the biases in risk taking documented in psychological research and the implications for decision making in organizations. The influence of heuristics has been one of the main subjects of research in organizational behavior (Loock & Hinnen, 2015).

Working on the path of behavioral decision-making and psychological biases, there were a group of works dealing with different aspects of their influence in strategic management. Camerer and Lovallo (1999) explore the overconfidence bias in individuals and organizations, Levinthal and March's (1993) the myopia of learning as an early warning in strategic management research based on rational grounds and Ocasio's (1997) focuses on the attention-based view of the firm.

Finally, in this time travel along the most cited articles, there is a group of works stressing behavioral aspects as key for strategy definition and implementation as the source of competitive advantage. At the top of the list is the article that defines the term "behavioral strategy" (Powell et al., 2011). This was the lead article and introduction to the Strategic Management Journal special issue on the "Psychological foundations of strategic management". Two more articles from the same issue are in top positions, Levinthal (2011) and Hodgkinson and Healey (2011) marking the actual birth of the subfield. Gavetti (2012) joins this group one year later signaling that superior opportunities are cognitively distant.

Table 4 List of top cites.

Rank	#	Work
1	23	Powell, T. (2011)
2	11	Cyert, R. (1963)
3	9	Levinthal, D. (2011)
4	8	Camerer, C. (1999)
5	8	Gavetti, G. (2012)
6	7	Levinthal, D. (1993)
7	7	Kahneman, D. (1979)
8	7	Kahneman, D. (1993)
9	7	March, J. (1958)
10	7	Ocasio, W. (1997)
11	7	Teece, D. (2007)
12	6	Hambrick, D. (1984)
13	6	Hodgkinson, G. (2008)
14	6	Hodgkinson, G. (2011)
15	6	Simon, H. (1947)
16	6	Zajac, E. (1991)
17	6	Zollo, M. (2002)
18	5	Gary, M. (2012)
19	5	Gavetti, G. (2005)
20	5	Gavetti, G. (2007)
21	5	Huy, Q. (1999)
22	5	Kahneman, D. (1982)
23	5	Lovallo, D. (2012)
24	5	Porter, M. (1980)
25	5	Teece, D. (1997)
26	5	Thaler, R. (2008)
27	5	Tversky, A. (1974)
28	5	Schwenk, C. (1984)

Source: the author's

2.3. Strategic management vs. behavioral strategy influencers

As an extension of the previous analysis, we have compared our ranking of the most influential works in the behavioral strategy field with the parent discipline of strategic management. For the purpose we first used Ramos-Rodríguez and Ruiz-Navarro's (2004) ranking of the most cited strategic management works for the period 1980–2000 (see Table 5). As this research ends with the century, we added the comparison with the study of Furrer, Thomas and Goussevskaia (2008) which extends the research period to 2005, but focuses only on the articles published in four of the leading journals of strategy (AMJ, AMR, ASQ, and SMJ) (see Table 6). The comparison shows the intersection of the two sets of influential works for the field and the discipline. Although their study periods ended more than fourteen years ago, it is a valuable

analysis, as most of the cited works in behavioral strategy fall within the research periods. The results show a very limited intersection between the lists, pointing to the fact that even if we consider behavioral strategy to be a field within the discipline of strategic management, it is at the intersection of a varied mix of disciplines and rather than a branch it should be considered a complement that nurtures the current and future development of the discipline.

Table 5 Ranking comparison strategic management vs behavioral strategy

Rank SM	Work	Rank BS
1	Porter (1980)	18
2	Rumelt (1974)	-
3	Porter (1985)	338
4	Chandler (1962)	338
5	Williamson (1975)	-
6	Nelson and Winter (1982)	29
7	Pfeffer and Salancik (1978)	-
8	Miles and Snow (1978)	338
9	Cyert and March (1963)	2
10	Thompson (1967)	-
11	Hofer and Schendel (1978)	338
12	Wernerfelt (1984)	29
13	Barney (1991)	70
14	Lawrence and Lorsch (1967)	70
15	Andrews (1971)	338
16	Penrose (1959)	338
17	Ansoff (1965)	338
18	Williamson (1985)	-
19	Scherer (1980)	338
20	Quinn (1980)	-
21	Prahalad and Hamel (1990)	338
22	Dierickx and Cool (1989)	-
23	Jensen and Meckling (1976)	134
24	Weick (1969)	-
25	March and Simon (1958)	6
26	Mintzberg (1978)	-
27	Bower (1970)	29
28	Child (1972)	-
29	Aldrich (1979)	-
30	Barney (1986)	70
31	Hannan and Freeman (1984)	-
32	Lippman and Rumelt (1982)	70
33	Mintzberg et al. (1976)	338
34	Burns and Stalker (1961)	-
35	Cohen and Levinthal (1990)	70
36	Hambrick and Mason (1984)	12
37	Rumelt (1984)	338
38	Buzzell et al. (1975)	-
39	Tushman and Anderson (1986)	-
40	Hannan and Freeman (1977)	-

Source: the authors based on Ramos-Rodríguez and Ruíz-Navarro, 2004

Some works have been very influential for both behavioral strategy and strategic management: March and Simon (1958), Cyert and March (1963) and Porter (1980). The first two, the cornerstones of the behavioral theory of the firm, are ranked among the top ten in behavioral strategy and the top twenty-five in strategic management. The last is the most influential in strategic management and ranks eighteenth in behavioral strategy.

Table 6 Ranking comparison strategic management vs behavioral strategy

Rank SM	Work	Rank BS
1	Barney (1991b)	56
2	Cohen and Levinthal (1990)	56
3	Teece et al. (1997)	17
4	Wernerfelt (1984)	29
5	Nahapiet and Ghoshal (1998)	312
6	Powell et al. (1996)	-
7	Dyer and Singh (1998)	119
8	Grant (1996)	119
9	Uzzi (1997)	-
10	Peteraf (1993)	312
11	Eisenhardt and Martin (2000)	29
12	Dierickx and Cool (1989b)	-
13	Williamson (1991)	-
14	Tushman and Anderson (1986)	-
15	Gulati (1995)	-
16	Szulanski (1996)	119
17	Amit and Schoemaker (1993)	56
18	Leonard-Barton (1992)	312
19	Hambrick and Mason (1984)	11
20	Eisenhardt (1989a)	312
21	Ring and Van de Ven (1994)	-
22	Hamel (1991)	-
23	Gulati (1998)	-
24	Levinthal and March (1993)	5
25	Eisenhardt and Tabrizi (1995)	-
26	Oliver (1991)	-
27	Ouchi (1980)	-
28	Kogut (1988)	-
29	Lane and Lubatkin (1998)	-
30	Eisenhardt (1989b)	56
31	Ring and Van de Ven (1992)	-
32	Suchman (1995)	-
33	Spender (1996)	312
33	Doz (1996)	-
35	Conner (1991b)	-
36	Mitchell et al. (1997)	-
37	Parkhe (1993)	-
38	Powell (1995)	-
39	Gulati et al. (2000)	-
40	Henderson and Cockburn (1994)	312

Source: the authors based on Furrer et al., 2008

Some other works that have been very influential in strategic management do not even appear in the list of works most cited in behavioral strategy: Rumelt (1974), Williamson (1975), Pfeffer and Salancik (1978), Uzzi (1997), and

Thompson (1967). Their arguments on firm organization and relation to external markets have not had any significant citation impact among the field authors.

Finally, some works which have been key in the development of behavioral strategy are not ranked among the top studies for strategic management. A significant group of contributions to behavioral strategy have come in the new century. The number of citations they have received is small in relation to works that have been exposed for longer periods of time, as regards influence in the discipline. Also, as we discuss later, behavioral strategy is at the intersection of business strategy, economy, and cognitive sciences. Some works from the last three named disciplines have had a very influential role in the field but almost no impact on the strategy main discipline. Some missing works are less obvious. Levinthal and March (1993) about the pitfalls of learning organizations, is not in the top fifty list of strategic management in the first list and is only twenty-fourth in the second, but it sits in a prominent fifth position on the behavioral group list. Learning organizations has been a hot topic in the discipline for a long period of time, and March has been considered a key contributor.

2.4. The intellectual structure of behavioral strategy.

In the third step of the process we grouped the cited documents to build the map of the intellectual structure of behavioral strategy. For this purpose, we paired the cited works of the previous step according to their co-citation in the initial document's extraction. As explained in the methodology, we selected 41 papers (strongest co-citation 4) and used their co-citations for the analysis. As a result, 65 pairs of works were obtained.

Figure 2 shows the application of MDS to the selected documents, yielding excellent goodness of fit (stress = 0.032). In the Figure, we have already labeled the factors of the subsequent analysis (see Table 8).

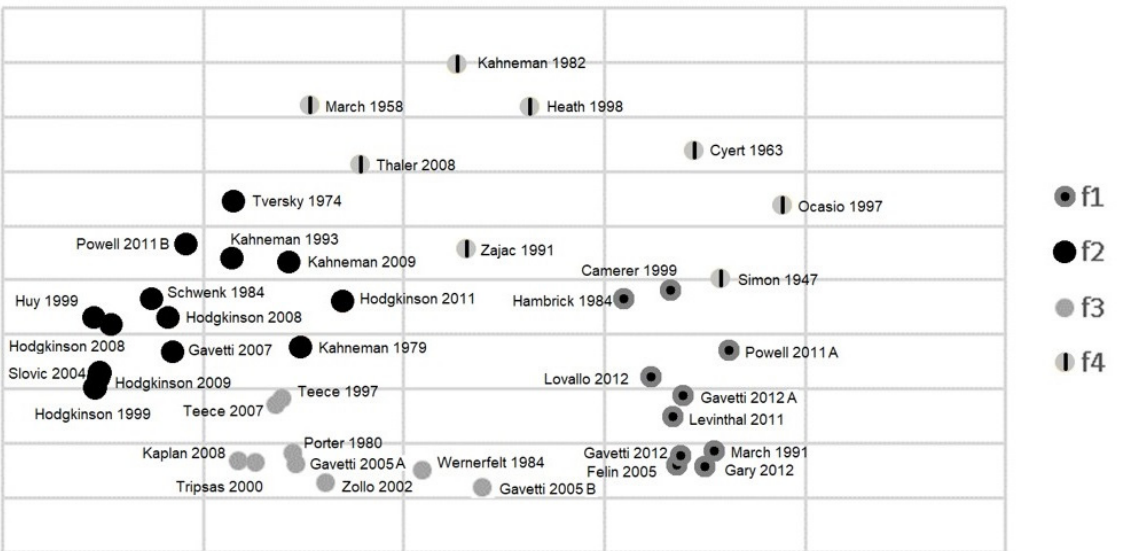

Figure 2 MDS two-component space.
Source: the author's

In order to check the robustness of our results and to have a more objective method than simple visual inspection to group the documents, we conducted a factor analysis (principal component extraction method) on the co-citation matrix confined to the 41 selected papers, extracting 4 factors and applying varimax rotation. The selection of 4 factors to be extracted was also supported on the scree plot/elbow curve (showing a dramatic drop off in the 5th eigenvalue compared to the 4th) and the total amount of explained variance reached (61%) with the four factors retained (see Appendix). Table 7 presents the rotated factor matrix.

Table 7 Rotated component matrix

	Factor			
	F4	F3	F2	F1
Gary, M., 2012, V33, P1229, Strategic Manage J	0,849			
Gavetti, G., 2012, V6, P1, Acad Manag Ann	0,839			
Felin, T., 2005, V3, P441, Strategic Organization	0,826			
Lovallo, D., 2012, V33, P496, Strategic Manage J	0,824			
Levinthal, D., 2011, V32, P1517, Strategic Manage J	0,813			
Gavetti, G., 2012, V23, P267, Organ Sci	0,783			
Camerer, C., 1999, V89, P306, Am Econ Rev	0,755			
March, J., 1991, V2, P71, Organ Sci	0,689			
Hambrick, D., 1984, V9, P193, Acad Manage Rev	0,679			
Powell, T., 2011, V32, P1369, Strategic Manage J	0,506			
Slovic, P., 2004, V24, P311, Risk Anal		0,785		
Hodgkinson, G., 1999, V20, P977, Strategic Manage J		0,785		
Hodgkinson, G., 2009, V42, P277, Long Range Plann		0,785		
Tversky, A., 1974, V185, P1124, Science		0,780		
Kahneman, D., 1993, V39, P17, Manage Sci		0,770		
Kahneman, D., 2009, V64, P515, Am Psychol		0,757		
Powell, T., 2011, V32, P1484, Strategic Manage J		0,722		
Hodgkinson, G., 2008, V59, P387, Annu Rev Psychol		0,719		
Hodgkinson, G., 2011, V32, P1500, Strategic Manage J		0,702		
Schwenk, C., 1984, V5, P111, Strategic Manage J		0,696		
Hodgkinson, G., 2008, V99, P1, Brit J Psychol		0,682		
Huy, Q., 1999, V24, P325, Acad Manage Rev		0,635		
Kahneman, D., 1979, V47, P263, Econometrica		0,572		
Gavetti, G., 2007, V18, P523, Organ Sci		0,461		
Tripsas, M., 2000, V21, P1147, Strategic Manage J			0,800	
Kaplan, S., 2008, V51, P672, Acad Manage J			0,782	
Gavetti, G., 2005, V16, P599, Organ Sci			0,766	
Zollo, M., 2002, V13, P339, Organ Sci			0,690	
Porter, M., 1980, Competitive Strategy			0,664	
Wernerfelt, B., 1984, V5, P171, Strategic Manage J			0,632	
Teece, D., 1997, V18, P509, Strategic Manage J			0,609	
Gavetti, G., 2005, V26, P691, Strategic Manage J			0,512	
Teece, D., 2007, V28, P1319, Strateg Manage J			0,353	
Heath, C., 1998, V20, P1, Res Organ Behav				0,685
Kahneman, D., 1982, Judgment Uncertainty				0,663
March, J., 1958, Organizations				0,662
Thaler, R., 2008, Nudge Improving Deci				0,610
Ocasio, W., 1997, V18, P187, Strategic Manage J				0,609
Zajac, E., 1991, V16, P37, Acad Manage Rev				0,602
Simon, H., 1947, Adm Behav Study Deci				0,595
Cyert, R., 1963, Behav Theory Firm				0,533

Source: the author's

Finally, we plotted the network map with the 65 pairs of 41 documents grouped by the factor analysis and proceeded to analyze the commonalities of each group. The graph can be seen in Figure 3.

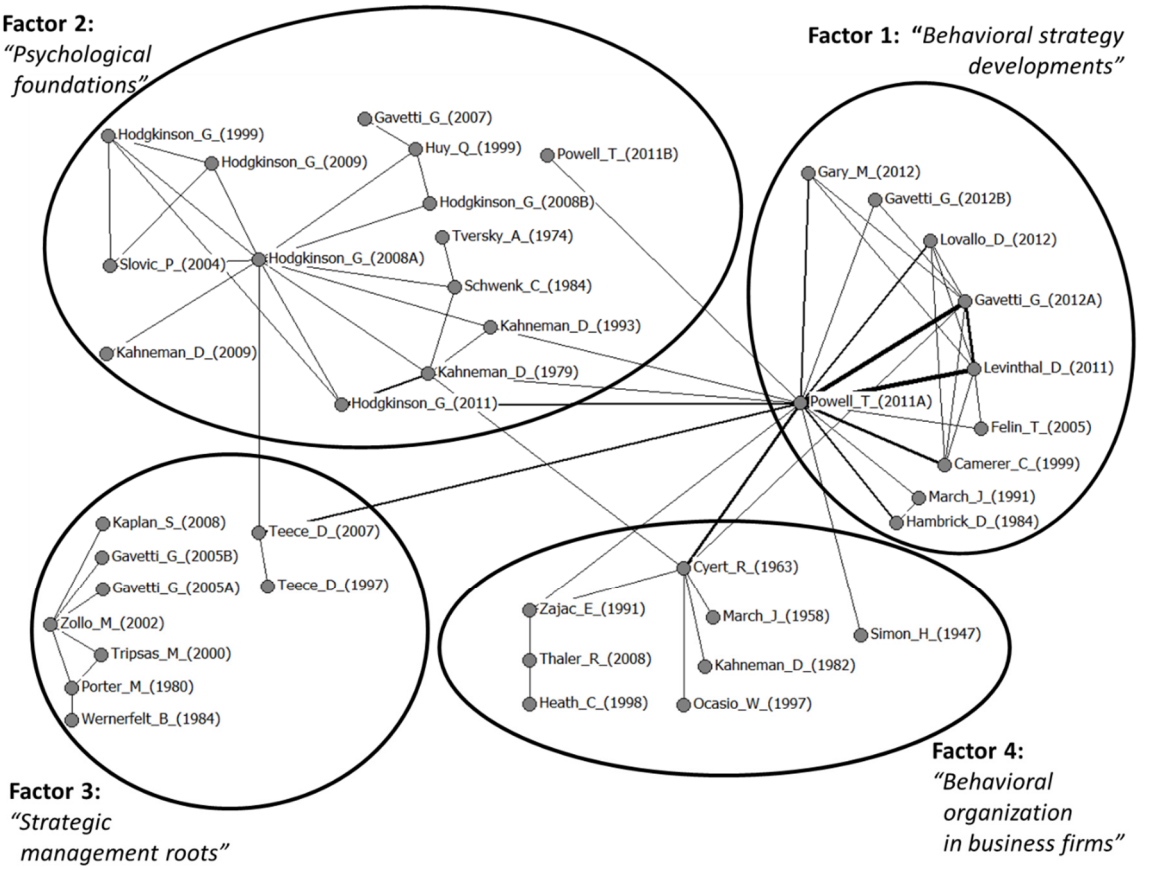

Figure 3 Group analysis
Source: the author's

In the Figure we can identify the central node of the network and the four groups of woks determined by factor analysis. All four factors revolve around the central node, Powell et al., (2011), where behavioral strategy and the structure of the main areas of the field are defined (Powell et al., 2011). Having once defined the groups' structure, we labeled and analyzed the commonalties of the factors and their contribution to the intellectual structure (see Figure 4).

Group		Rank	CoCit	SM	BS	BDR	BTF	TMT	Learn	Org	HB	Journal/Boo	Main
Behavioral strategy devts.													
Simon_H_(1947)		28	4			X	X			X		Book	Decision-making processes in admin. organization
Hambrick_I Mason		20	9	X				X		X		Acad.Manag.R	Upper echelons: the organization and its top managers
March_J_(1991)		21	8	X					X	X		Org.Sci.	Exploration and exploitation in organizational learning
Camerer_C_Lovallo		8	18	X	X						X	m.Econ.Rev	Overconfidence and excess entry
Felin_T_(20Foss		21	8	X	X				X	X		Strateg.Orgar	Individuals and microfoundations in strategic org.
Powell_T_(Lovallo	Fox	1	88	X	X							Strategic Manag	BS definition
Levinthal_D_(2011)		3	29	X	X							Strategic Manag	A behavioral approach to strategy
Gavetti_G_(2012A)		3	29	X	X							Org.Sci.	Behavioral theory of strategy
Gavetti_G_(Greeve	Levinthal	21	8		X		X			X		Acad.Manag.A	Behavioral theory of the firm
Lovallo_D_Clarke	Camerer	9	17	X	X	X						Strategic Manag	Analogies to improve strategic decisions
Gary_M_(20Wood	Pillinger	10	13	X	X	X			X			Strategic Manag	Analogical transfer in strategic decision-making
Psycological foundations													
Kahneman_D_(1979)		5	25			X						Book	Prospect theory
Tversky_A_Kahneman		28	4			X					X	Science	Judment under uncertainty: Heuristics and Biases
Schwenk_C_(1984)		13	12	X	X	X						Strategic Manag	Cognitive simplification in strategic decision-making
Kahneman_ILovallo		13	12			X						Manag. Sci.	Cognitive perspective on Risk Taking
Hodgkinson_Healey		10	13	X	X	X	X			X		Strategic Manag	Psychological foundations of Dynamic Capabilities
Hodgkinson_Healey		2	44			X				X		Annu.Rev.Psycl	Cognition in Organizations
Hodgkinson_Brown	Maule	13	12			X						Strategic Manag	Decision making under uncertainty
Huy_Q_(1999)		13	12			X				X		Acad.Manag.R	Emotional Capabilities of Organizations
Slovic_P_(2Finucane	Peters	13	12			X						Risk Anal.	Risk and rationality
Hodgkinson_Langan-Fox	Sadler-S.	21	8			X						Br.J.Psychol	Intuition
Gavetti_G_(Levinthal	Ocasio	28	4			X	X			X		Org.Sci.	Decision centered organizations
Kahneman_IKlein		28	4			X					X	Am. Psychol	Intuitive expertise
Hodgkinson_Sadler-S.	Burke	13	12			X						Long Range Pla	Intuition in organizations
Strategic management roots													
Porter_M_(1980)		13	12	X								Book	Competitive Strategy Analysis
Wernerfelt_B_(1984)		28	4	X								Strategic Manag	Resource Based View of the firm
Teece_D_(1Pisano	Shuen	28	4	X						X		Strategic Manag	Dynamic Capabilities and strategic management
Zollo_M_(2Winter		7	20	X								Organ. Sci.	Evolution of Dynamic Capabilities
Teece_D_(2007)		10	13	X						X		Strategic Manag	Explicating dynamic capabilities
Tripsas_M_(Gavetti		21	8	X		X						Strategic Manag	Capabilities, Cognition and Inertia
Kaplan_S_(2008)		28	4	X		X					x	ead. Manag.	Cognition, Capabilities and Incentives
Gavetti_G_(Levinthal	Rivkin	28	4	X		X			X			Strategic Manag	Strategy and Analogy
Gavetti_G_(Rivkin		28	4	X		X					x	arv. Bus. Re	Strategy and Analogy
Behavioral org. in business firms													
Cyert_R_(1March		6	22				X			X		Book	Behavioral theory of the firm
Kahneman_ISlovic	Tversky	28	4			X					X	Book	Judment under uncertainty: Heuristics and Biases
March_J_(1Simon		28	4				X			X		Book	Organizations
Ocasio_W_(1997)		28	4				X	X		X		Strategic Manag	Attention-based view of the firm
Thaler_R_(2Sunstein		21	8			X			X			Book	Nudge theory
Zajac_E_(1Bazerman		21	8	X	X	X						Acad.Manag.R	Blind spots in industry and competitor analysis
Heath_C_(1Larrick	Klayman	28	4	X	X				X	X		Res.Organ.Beh	Cognitive repairs

SM Strategic Management
BS Behavioral Strategy
BDR Behavioral Decision Research
BTF Behavioral Theory of the Firm
TMT Top Management Teams
Learn Learning Organization
Org Organizations
HB Heuristics and Biases

Figure 4 Works by topic research topic
Source: the author's

2.4.1. Factor 1: Behavioral roots in business and economics

The group gathers the works which set the pillars of behavioral aspects in economics and business. On average, it is a group with an older date of publication. Half (four out of eight) are books rather than articles. It is a group with higher number of co-citations with the central node, indicating which is not specifically about behavioral strategy but can be considered as its precursor.

It is made out of three branches or subgroups. In the first, standing alone, there is the seminal work of Simon (1947) about decision-making processes in administrative organizations. It introduces the concept of satisficing opposed to the traditional economic optimization, as the criteria for decision-making. The book was of paramount influence for the Nobel Prize in Economic Sciences to Simon in 1978. The second links three top pillars of behavioral economics: Zajac and Bazerman (1991), blind spots in industry and competitor analysis, Thaler and Sunstein (2008), nudge theory and Heath, Larrick and Klayman, (1998), cognitive repairs. Finally, four key works on firm behavior are grouped around the principles of the Carnegie School: Cyert and March (1963), behavioral theory of the firm, March and Simon (1958), *Organizations*, Kahneman, Slovic and Tversky, (1982) judgement under uncertainty and Ocasio (1997) Attention-based view of the firm.

2.4.2. Factor 2: Main stream strategic management influences

The group gathers the strategic management works that have influenced the developments of behavioral strategy most. The main branch is isolated and has no link with any of the other works. The other branch gathers the two main works of Teece which leads the "Dynamic Capabilities" approach in strategic management. Teece (2007) is the only work linking with the rest of the pack, but it pairs with the two most influential works of the study, the central nodes of factors 3 and 4.

The influence and some degree of inter-relationship between strategic management and behavioral strategy are clear. However, the lack of pairing between this group and the central node and the remaining factor 4 works indicate that the latter should be considered more an independent topic which complements the former than a subfield of the main strategic management stream.

2.4.3. Factor 3: "Psychological foundations"

This group is the most populated. We have labeled it "psychological foundations", as it is a group that contains the main works in the psychology discipline influencing strategic management. It is located on the left side of the chart and takes fourteen works of twenty different authors. This group has a central node (Hodgkinson & Healey, 2008) which reviews all major developments from 2000 to early 2007 in the psychological analysis of cognition in organizations. This node is co-cited with ten works of the cluster, which indicates its central role but has no direct co-citation link with the main central node of the network.

In the "Psychological Foundations" group, there are five works of G.P. Hodgkinson, and three of D. Kahneman, making these authors the key influencers of the discipline from the group perspective.

Three subgroups can be identified:

The "decision-making" subgroup covers key aspects of this cognitive process, from intuition (Hodgkinson, G. P., Sadler-Smith, E., Burke, L. A., Claxton, G., & Sparrow, P. R., 2009) to risk and uncertainty influence (Hodgkinson, G. P., Bown, N. J., Maule, A. J., Glaister, K. W., & Pearman, A. D., 1999; Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G., 2004). The three works together with the central node of the cluster are co-cited in pairs, making this a very connected and cohesive subgroup. Also, on the role of intuition in heuristics and biases (HB) and naturalistic decision making (NDM) is the article from Kahneman and Klein (2009) which is not co-cited with the members of this cluster but is with the central node.

The second subgroup applies the psychology developments to the behavior of organizations. Gavetti, Levinthal and Ocasio (2007) point out that the defining commitment to decision-centered view of organizations of the Carnegie School had given way to learning, routines and an increasing focus on change and adaptation and argue to regain the initial focus and incorporate major developments post-Carnegie both within organization theory and in the behavioral and social sciences broadly. Quy Huy takes emotional intelligence individual behaviors and links them with organization behavior specifically in change situations to develop the concept of emotional capability (Huy, 1999). Finally, Hodgkinson, Langan-Fox and Sadler-Smith (2008) introduce intuition as a concept which was underdeveloped but had high potential in exploring behaviors.

We have named the third subgroup "cognitive process". It includes three works that touch on some key biases of the business decision-making psychological process: simplification and judgement under uncertainty (Kahneman & Lovallo, 1993; Schwenk, 1984; Tversky & Kahneman, 1974). The first analyzes executive biases when they consider problems as unique, taking cautious or optimistic attitudes based on plans instead of considering previous experiences. Schwenk applies the simplification biases studied by psychologists to executive decision making and its implications. The last of the three is one of the most cited articles in cognitive bias used by researchers to explore behavioral sciences.

As we have mentioned, the central node of the group is not connected to the central node of the structure. This is done by three key works which act as the intellectual bridge to the rest of the discipline. Kahneman and Tversky (1979) prospect theory, already described as one of the key influencers, is co-cited with the central node of the network, linked with Cyert and March (1963) the central node of factor 4 and with four other works of factor 2 making this work a clear link between three groups of documents. Hodgkinson and Healey (2011), as previously mentioned, look at the psychological foundations of dynamic capabilities. The third link is Kahneman and Lovallo's (1993) work on a cognitive perspective on risk taking.

2.4.4. Factor 4: "Behavioral strategy developments"

This factor groups the set of works that have developed behavioral strategy. The central node is part of the group and as stated before marks the definition of the term and sets the basic principles of the discipline. All works in the factor group are co-cited with it. Four of the works were published before the central node. Another five came out subsequently and are already under its umbrella. Six frequently cited works belong to the group, despite having been published recently.

Within the group, two stands as a separate branch: Hambrick and Mason (1984) look at strategic behavior of top management and March (1991) at a learning organization. Both continue the research line of the behavioral theory of the firm, early pointing to the implications on the business strategy and somehow bridge with the works of factor 1 despite not being co-cited with any of them.

Building bridges with factor 3, Camerer and Lovallo (1999) work on the influence of one of the most common bias in decision-making, overconfidence, in the classic strategic decisions in new market entries. It is one of the most cited articles and it is co-cited with a few other works of the factor pointing to the strong influence exerted in the discipline.

There is another key element of this factor also published before 2011. It is an editorial essay by Felin and Foss (2005) drawing attention to the emphasis put on the organization in strategic organizational research, neglecting the role of individuals who take decisions on individual mechanisms. The focus of the essay is on the organizational capabilities-based literature in strategic management, which serves as a specific example of a more general problem: the lack of attention to individuals in the strategic organizational approach.

The other five works are all inter co-cited particularly having a particularly strong co-citation with the central node, Levinthal (2011) and Gavetti (2012), all three acting as the cornerstones of the definition of the discipline. One year later, Gavetti, with Greeve, Levinthal and Ocasio (2012), reinforced the concepts focusing on the firm ecosystem. Another two articles forming part of this group were published in 2012 (Gary, M. S., Wood, R. E., & Pillinger, T., 2012; Lovallo, D., Clarke, C., & Camerer, C., 2012). Both look at the use of analogies, a very common tool used in taking strategic decisions under uncertainties and novel situations and explore its advantages and pitfalls. As we saw in the previous factor, the cognitive process of analogies in decision-making is featured in other groups of the structure.

Latest contributions

As we will mention in the conclusions a potential limitation of this study is the influence of time in the methodology. Recent published articles may lack a number of cites according to their potential future influence.

During the last few years, a few works on behavioral strategy have been published. However, they have not received enough citations to be part of this study. We have considered some of them have potential to be among the most influencers in the near future.

In an editorial commentary, Foss (2020) deals with the findings that COVID-19 crisis has provided to the field.

> Behavioral strategy is uniquely situated in terms of providing a psychologically based interpretive lens that could lend great insight into decision making in extreme conditions. However, the disruption also points to weakness in current behavioral strategy thinking, notably with respect to the role of models vis-à-vis judgment in strategic decision making, the deeply social (political, institutional) nature of strategy making, and the treatment of fundamental uncertainty. (p. 1322)

Some of the contributions work on the linkage of psychological developments and the impact on decision making in general and strategic decisions in particular. Some examples are Menon (2018) work on strategic mental models, Healey and Hodgkinson (2017) on executive skills of emotion regulation and the real impact of strategic dissent on organizational outcomes (Samba, C., Van Knippenberg, D., & Miller, C. C., 2018).

Another significant recent development in this area is the affect-cognitive theory by Cristofaro (2019; 2020) overcoming the thinking-feeling dichotomy that has predominated in the study of management decisions. The theory is beneficial for behavioral strategy, offering the needed assumptions to intertwine human cognition, emotions, and social behavior.

Finally, there is a group of works recently published that start to be cited by behavioral strategy articles influencing the development of the discipline from the organizational behavior perspective. They do it both in strategy formulation and strategy implementation phases. These are the cases of the analysis of upward social comparison (Obloj & Zenger, 2017), the research on subsidiary performance feedback and internal governance in multiunit firms (Sengul & Obloj, 2017), mix of feelings and emotions influencing leadership (Rothman & Melwani, 2017) and the exploration on how different aspects of diversity influence constructive politics and the extent to which the latter contribute to decision performance, namely, decision success and decision pace (Elbanna, 2018).

We conclude that the first work is a potential future candidate to Factor 1, the second group would be for Factor 2 and last group clearly will in future research with this approach be candidates to Factor 4.

Conclusions

The objective of this article was to organize and display the intellectual structure of behavioral strategy discipline born from the integration of knowledge developed in very different scientific areas. The formulation of business strategies is about decision making, and the developments on cognitive decision making made by psychology and neuroscience researchers has been integrated in strategic management processes research as it has been done with other economic and business disciplines. Due to the youth of this research field and the complexity and variety of its sources, the effort to articulate its structure had not been carried out until now in a systematic way. This paper covers the gap using a proven objective and replicable methodology that had not been used in this area yet.

Several findings have been presented and discussed in the previous section. There are some conclusions which stem from these findings.

There are four clear solid research pillars of the field: behavioral organization, strategic management, cognitive psychology and behavioral strategy seminal papers. Out of the four groups, strategic management is the one with a lesser degree of influence, interaction and integration. Key works in strategic management are not among the most cited in behavioral strategy reference papers and the main stream of strategic management research has a marginal influence of behavioral strategy. This field is not being even identified as part of the intellectual structure of strategic management by the key papers addressing the topic (Furrer et al., 2008; Guerras-Martín et al., 2014; Nerur et al., 2008; Ramos-Rodríguez & Ruíz-Navarro, 2004). At this point in time we can conclude that behavioral strategy should not be considered a field of strategic management but rather a complementary discipline.

Another finding of the analysis relates to the development structure of behavioral strategy. Rather than building a solid theoretical corpus research focus has been put on particular areas and specific situations of the business strategy process of formation and implementation. The aim of researchers has pointed towards avoiding the pitfalls and mistakes caused by cognitive processes and biases. Although some works are starting to fill the gap the most influential works are very much concentrated in these lines of research. There is a wide area still open for research and development of the cognitive decision-making processes characteristics implications in business strategies. These areas include but are not limited to strategy elements such as:

- Behavioral approach to market analysis
- Strategic behavior of competition
- Behavioral competitive advantages
- Stakeholders relationships and interactions

This study has its limitations, particularly in regard to the citation methodology. However, the characteristics of the approach limited impact. Citation methodology is criticized because the value of each citation is considered the same. In our case, we worked with more than two thousand unique citations and more than one hundred and fifty thousand co-citation pairs. The sheer volume helped to soften the impact of the limitation. Moreover, we selected a reasonable number of documents with a co-citation strength 4 or above removing most of the noise created by non-significant citations.

Citation technique is influenced by time. The more recent the work the lesser the opportunities to be cited. However, as the object of this study is to determine the degree of influence, this effect correlates with the fact that influence is determined by the work being recognized and cited, and recent works have had less time to influence researchers over a period of time.

Finally, we think this work should help future research by providing the picture of the current situation of the discipline and the main pillars to build on. We also intend to extend the contribution to the practitioner's community concerned and engaged in a topic which has such a huge economic impact for firms and industries. The findings should help researchers and practitioners alike in their quest to continue the progress of one of the most impacting developments around the strategic management process.SM

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Appendix

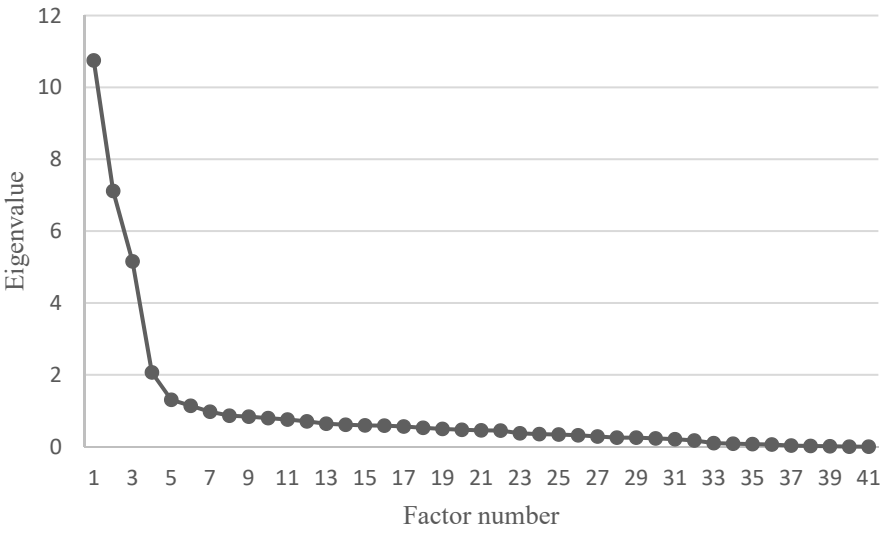

Figure Scree plot / Elbow curve
Source: the author's

Table Total Variance explained.

Factor	Initial eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	% Cumulative	Total	% of Variance	% Cumulative	Total	% of Variance	% Cumulative
1	10,752	26,223	26,223	10,752	26,223	26,223	8,078	19,703	19,703
2	7,188	17,361	43,585	7,118	17,361	43,585	7,975	19,451	39,154
3	5,157	12,579	56,164	5,157	12,579	56,164	5,230	12,757	51,911
4	2,066	5,040	61,204	2,066	5,040	61,204	3,810	9,293	61,204

Source: the author's

✉ **Correspondence**

Santiago Urío

Department of Business Management, Universidad Pontificia Comillas, ICADE
calle Alberto Aguilera 23, 28015 Madrid, Spain
E-mail: surio@comillas.edu

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Learning orientation impact, innovativeness and business performance in Croatian companies

Helena Šlogar
Libertas International University, Zagreb, Croatia
https://orcid.org/0000-0002-7240-1140

Abstract
This study explores whether certain changes in the model of the impact that learning orientation (LO) had on innovativeness and business performance in Croatian companies occurred in the period 2016-2019. Regression and covariance analysis was used to analyse the collected data. According to the results obtained, the impact of learning orientation and its components (commitment to learning, shared vision, open-mindedness and intra-organizational knowledge sharing) on innovativeness (product innovativeness, process innovativeness and business system innovativeness) did not change statistically significantly in the period 2016-2019. The same trend was observed with respect to business performance. In this period, a statistically significant change was identified in the effect of commitment to learning and open-mindedness on product innovativeness, and in the effect of open-mindedness on business system innovativeness. Likewise, the effect of commitment to learning, open mindedness and intra-organizational knowledge sharing within the company on the qualitative effects of business performance also changed. Empirical results provide significant theoretical and managerial implications in implementing a learning orientation with the aim of increasing companies' competitiveness in the market.

Keywords
innovativeness, learning orientation, business performance, Croatian companies

Introduction

Over the past few decades, many researchers have studied the impact of learning orientation as a purposeful use of knowledge in production, management, and value creation that affects a company's competitive advantage (Senge, 1990; Calantone, Cavusgil & Zhao, 2002; Nybakk, 2012). Reasons justifying such an approach can be found in collecting, processing and disseminating information about customers, competitors and new products, technologies, markets and other sources, thus creating knowledge that allows managers to make business decisions faster. Today, we understand innovation in a broader context and talk about an innovative culture that stimulates new work and organizational processes in the enterprise. In this sense, when employees in a company develop an innovative business activity, they reveal their approach, values and principles on which they are based including the commitment to learning, shared vision, open-mindedness and intra-organizational knowledge sharing (Calantone et al., 2002). The interrelationships between learning orientation and enterprise innovativeness are an essential research area for scientists in the literature on strategy and management. The aim of this research was to conduct a longitudinal study of the impact among learning orientation, innovativeness and business performance in Croatian companies, and to determine the occurrence of changes in impact over a span of three years (2016 and 2019). In this regard, research questions are asked: (1) Is there a direct impact of learning orientation on innovativeness

and business performance in Croatian companies? and (2) How much does it change over a span of three years? This research embraced the approach advocated by Oslo Manual (2005), which used a three-year time frame to understand the changes in innovation developments.

Learning-oriented firms can adapt more quickly to the market, anticipate changes in the environment, and be more innovative than their competitors (Slater & Narver, 1995). The focus on learning is based on a long-term strategic orientation carried out by creating and using knowledge, which increases the motivation of employees, their creativity and innovativeness in the development of new products (Calantone et al., 2002). In a number of studies, learning orientation is cited as a key precursor to innovation development (Hult, Hurley & Knight, 2004; Rhee, Park & Lee, 2010), and key attributes are the goal and nature of innovation; types of innovation; stages in innovation development, social context; funds for innovation and others (Baregheh, Rowley & Sambrook, 2009). The literature discusses various aspects of learning orientation such as organizational values that influence managers' decisions about whether a company will promote the concept of organizational learning (Sinkula, Baker & Noordewier, 1997); or how to achieve dynamic learning (Calantone et al., 2002) and to encourage the use of new techniques and procedures by creating and using knowledge (Sinkula et al., 1997; Lee & Tsai, 2005). In a study, Lee and Tsai (2005) confirm that learning orientation is associated with business innovation and collaborative business level, thereby promoting innovation and improving business performance.

An approach to learning and knowledge sharing with managerial support towards organizational creativity is an important process factor that provides the quality needed to develop innovation in an organization (Wang, 2008; Tajeddini & Mueller, 2009). A study by Calantone et al. (2002) identifies that business success is achieved by a shared vision that leads to a culture of trust and knowledge sharing that allows for an increased level of business performance. Open-mindedness emphasizes that employee personality can be a determinant of a particular project's success (Calantone et al. 2002), such as examining the role of the Internet in knowledge creation (Nguyen & Barrett 2006). Moreover, the main attention needs to be focused on the intra-organizational knowledge sharing in all departments through the systematic review and structuring of information (Calantone et al., 2002). More specifically, when considering a learning orientation, it is necessary to emphasize the role and quality of knowledge that determine a company's success or failure (Senge, 1990). In this regard, various studies indicate that the learning orientation is also influenced by the entrepreneur's behaviour, specific characteristics of the company, such as its size or industrial sector (Salim & Sulaiman, 2011; D'Angelo & Presutti, 2019). The study was organized as follows. A literature review was conducted to identify fundamental questions about learning orientation, innovativeness, and business performance. Then the hypothesis was formed, followed by a description of the research methods and the research results. Theoretical and practical implications and conclusion are also stated.

1. Literature review

According to Senge (1990) learning orientation is an organizational characteristic where the acquired knowledge is applied systematically and effectively, thus setting the framework for relationships with customers and competitors. Hurley and Hult (1998) state that a higher level of innovation is associated with companies' cultures that emphasize learning, participatory decision-making, and development. The importance of individual and organizational learning as aspects influencing company growth was extensively discussed (Koryak, Mole, Lockett, Hayton, Ucbasaran & Hodgkinson 2015). The Cosenz and Noto (2018) study states that entrepreneurial learning is a crucial process for acquiring the strategic management competencies needed to start new businesses and achieve success. Learning orientation includes a commitment to vision sharing, openness and information sharing, commitment to learning and knowledge enhancement based on market orientation leading to new market research, technology advancement, product and service development (Slater & Narver, 1994). A number of studies state that the focus on learning is the concept of knowledge creation and use activities in an organization that lead to product innovation and increased market competitiveness (Damanpour, 1991; Day, 1994; Baker & Sinkula, 1999).

Vij and Farooq (2014) point out that a learning orientation has a positive effect on company's business results. New ideas emerge in the mutual interactions of new associates who select those

most likely to achieve the maximum innovation effect. According to the results of older research communicating a shared vision to facilitate the implementation of creative ideas and overcoming problems to be solved is an important basis for proactive learning in the organization (Sinkula et al. 1997; Hurley & Hult 1998; Calantone et al. 2002).

In a study by Jiménez-Jiménez and Cegarra-Navarro (2007), organizational learning has a positive effect on business performance. It also encourages processes of collaboration, assignment, and integration among team members and expands the new knowledge creation (Lumpkin & Lichtenstein, 2005). Organizational learning includes teams in learning processes, and group knowledge in start-up teams is significantly associated with business success (Chandler & Lyon, 2009). Furthermore, Sanzo, Santos, García and Trespalacios (2012) investigated the relationship between organizational learning, operational marketing ability and performance and confirmed the positive impact on performance in Spanish industrial companies. Real, Roldan and Leal (2014) state that the impact of orientation on learning is greater in small and medium-sized enterprises than in large ones. Stelmaszczyk (2020) finds that absorptive capacity is most affected by two dimensions of learning orientation: commitment to learning and open-mindedness.

Furthermore, Wang (2008) reveals on a sample of British companies that learning orientation mediates in relation to entrepreneurial orientation and that it must exist in order to maximize performance. However, Michna (2009) suggests that Polish SMEs that reach a higher level of organizational learning are likely to achieve greater effectiveness. Interestingly, Kharabsheh, Jarrar and Simeonova (2015) show that learning orientation is the most important factor for better organizational performance. Besides, there are significant links between learning orientation and organizational performance of the company.

Previous research has revealed a positive relationship between learning orientation and innovativeness (Calantone et al., 2002; Hult et al., 2004; Keskin, 2006). In a study by Lin et al. (2008), innovativeness, along with learning orientation, functions as a key success factor in technology-intensive firms in Taiwan. On the other hand, Rhee et al. (2010) confirmed the significant impact of learning orientation on small business innovativeness in South Korea. In addition, learning-oriented companies are able to develop intangible assets that are more innovative (Rhee et al., 2010). Similarly, Nasution, Mavondo, Matanda and Ndubisi (2011) suggest that the interaction of learning orientation and human resource practices have a significant impact on the development of innovation.

Furthermore, Salim and Sulaiman (2011) pointed to a positive impact of organizational learning on innovation. Likewise, a positive relationship exists between innovation and the performance of SMEs operating in the ICT industry in Malaysia. Suliyanto and Rahab (2012) confirm that learning orientation plays a mediating role in the relationship between market orientation and innovativeness. Likewise, the results show that innovativeness affects business performance. The findings suggest that companies should strengthen their learning and innovativeness orientation to improve business performance. Moreover, Goh, Elliott and Quon, (2012) support a positive relationship between learning ability and organizational performance. This has significant implications for justifying investment in capacity building in organizations. In a study by Acs, Audretsch and Lehmann (2013) human capital serves not only as a guide for the dissemination of knowledge, but also for innovative activities and improved economic performance through resource allocation.

Aziz and Omar (2013) show that shared knowledge and vision have directly influenced the innovation capabilities of SMEs and are crucial factors for improving business results. Rahab (2012) finds that companies should strengthen their innovativeness and learning orientation to improve business performance. The results show that company innovativeness has a positive effect on company performance, while the focus on learning has a positive effect on company innovativeness. On the other hand, it explains that a learning organization cannot directly improve its performance and that there are other factors that create relationships between organizational learning and business performance. Hakala (2013) confirms the relationship between learning orientation and entrepreneurial orientation and that the effects mediate the profitability of Finnish software companies. In a study conducted by Alegre and Chiva (2013) a positive relationship between innovation efficiency based on strategic human resource management, knowledge and information technology was identified in a sample

of French biotechnology SMEs. Dülger, Alpay, Yılmaz and Bodur (2014) indicate that differentiation strategy, internally oriented learning, and market-oriented learning have significant effects on different dimensions of innovativeness in business operations.

Hussain, Shah and Khan (2016) examine the relationship between learning orientation and business performance in SMEs. They found that the focus on learning was positively and significantly related to the organizational performance of the company. Furthermore, Mahmoud, Blankson, Owusu-Frimpong, Nwankwo, Tran and Trang (2016) show in the context of a developing country that learning orientation has a significant impact on innovation that mediates in relation to business performance. Learning-oriented companies tend to reduce administrative costs by using high technology and new communication channels. Unlike other studies, this study showed that learning orientation has no effect on the relationship between market orientation and organizational performance of SMEs (Beneke, Blampied, Dewar & Soriano, 2016).

Nurhasanah and Murwatiningsih (2018) found that companies that apply learning orientation, innovativeness, and competitive advantage can improve marketing performance. Furthermore, Ismail, Hamid, Senik, Othman and Juhdi (2018) explore the role of innovativeness and a focus on learning in the effects of internationalization of SMEs. Vega Martinez, Martinez Serna and Montoya (2020) find that there is a significant relationship between commitment to learning and a shared vision, and competitiveness and organization performance. The Phorncharoen's study (2020) confirms that learning orientation had a positive impact on innovativeness ($p < 0.05$) in the enterprise. Likewise, Huan, Phong and Giang (2020) have shown that there is a relationship between learning orientation and business model innovation in the tourism sector. Ullah, Mushtaq, Puhakka and Iqbal (2020) explore the mediating role of employee absorptive abilities between learning orientation and market orientation.

Based on a literature review, the following hypothesis was proposed:

H: Learning orientation has a positive and direct impact on the innovativeness and business performance of the company and this impact did not change significantly in 2019 compared to 2016.

2. Research methodology

A longitudinal study was conducted based on the same model, the same hypotheses, the same survey, and subsets of the 2016 and 2019 samples to be compatible for comparison. Results of the previous study were published in papers (Šlogar & Bezić, 2020). Learning orientation and commitment to learning, shared vision, open mindedness, and intra-organizational knowledge sharing exchange within the organization as its dimensions are included in the model as independent variables (Calantone et al., 2002). A five-point Likert scale was used for measurement. Innovativeness and its dimensions (product innovation, process innovativeness and business system innovativeness (Nybakk, 2012) and business performance, comprising dimensions quantitative and qualitative effects served as dependent variables. Answers to the survey questions were scored on a five-point Likert scale.

Only companies from the Croatian Chamber of Commerce database that participated in the 2016 and 2019 surveys were selected for the longitudinal survey to make the comparison as reliable as possible. Finally, 101 companies participating in the 2016 survey and 101 companies participating in the 2019 survey were selected to constitute the sample. An online survey questionnaire was used to collect data in two different periods: October to December 2016 and October 2019 to January 2020. Power analysis found that on a sample of 101 companies for a 95% confidence level and a test power of 90%, a correlation coefficient greater than 0.30 would be statistically significant which is the expected correlation between independent and dependent variables based on a 2016 survey.

Descriptive statistics shows that there are no significant deviations of the mean value (Mean) from the median value (Median), so the parametric methods regression analysis and covariance analysis are applied. Regression analysis examined a statistically significant correlation between independent and dependent variables in 2016 and 2019. Covariance analysis (ANCOVA) examined whether the impact of learning orientation and its four dimensions on innovativeness and business performance in the period 2016 - 2019 had changed. A parallel representation of regression directions from 2016 and 2019 was used for graphical representation.

3. Research results

In this chapter, the analysis of the survey results will be presented. Complex data will be analysed with a table or graph.

Table 1 Descriptive statistics of variables included in model 2016 and 2019 (N = 101)

2016	Mean	Median	Min	Max	Std.Dev
Learning orientation	83.7	84.0	54	109	13.29
Commitment to learning	19.6	20.0	8	25	3.91
Shared vision	19.2	19.0	9	25	3.69
Open mindedness	18.7	18.0	9	25	3.53
Intra-organizational knowledge sharing	22.2	22.0	12	30	4.18
Innovativeness	56.9	57.0	25	79	11.93
Product innovation	20.9	22.0	6	30	5.36
Process innovativeness	14.4	15.0	4	20	3.95
Business system innovativeness	17.4	17.0	11	24	3.61
Business performance	59.3	58.0	39	77	9.03
Business performance - Quantitative effects	23.6	23.0	12	33	4.27
Business performance - Qualitative effects	31.8	32.0	20	45	5.41
2019	Mean	Median	Min	Max	Std.Dev
Learning orientation	85.8	87.0	54	103	10.85
Commitment to learning	20.0	20.0	11	25	2.85
Shared vision	19.9	20.0	10	25	3.24
Open mindedness	19.1	19.0	11	25	3.08
Intra-organizational knowledge sharing	22.8	23.0	11	30	3.54
Innovativeness	59.7	60.0	27	80	13.36
Product innovation	22.6	23.0	6	30	5.92
Process innovativeness	14.8	16.0	6	20	4.11
Business system innovativeness	18.5	19.0	9	25	4.23
Business performance	61.5	61.0	44	80	9.67
Business performance - Quantitative effects	24.0	24.0	16	31	3.85
Business performance - Qualitative effects	33.7	33.0	22	45	6.18

Source: the author

Table 1 shows the basic statistical indicators for the variables included in the survey and for the values obtained in 2016 and 2019. The values of these variables are the answers to the questions from the survey scored on a five-point Likert scale. The results show that there is no significant difference between the arithmetic mean (Mean) and the median value (Median) which means that the values of the variables do not deviate significantly from the normal distribution in the two observed periods. Thus, it is justified to apply regression analysis and covariance analysis in further statistical processing.

Table 2 Regression Analysis – The impact of independent variables on innovativeness in 2016 and 2019.

Dependent Variable: Innovativeness								
Independent variable	2016				2019			
	R	SE	F(1.99)	p	R	SE	F(1.99)	p
Learning orientation	0.692	0.073	91.083	<0.001	0.770	0.064	144.286	<0.001
Commitment to learning	0.583	0.082	51.021	<0.001	0.540	0.085	40.801	<0.001
Shared vision	0.640	0.077	68.678	<0.001	0.751	0.066	128.203	<0.001
Open mindedness	0.642	0.077	69.329	<0.001	0.687	0.073	88.554	<0.001
Intra-organizational knowledge sharing	0.488	0.088	30.889	<0.001	0.613	0.079	59.608	<0.001
Dependent Variable: Product innovation								
Independent variable	2016				2019			
	R	SE	F(1.99)	p	R	SE	F(1.99)	p
Learning orientation	0.611	0.080	58.914	<0.001	0.717	0.070	104.969	<0.001
Commitment to learning	0.493	0.087	31.816	<0.001	0.479	0.088	29.415	<0.001
Shared vision	0.562	0.083	45.797	<0.001	0.721	0.070	107.375	<0.001

Open mindedness	0.616	0.079	60.385	<0.001	0.670	0.075	80.606	<0.001
Intra-organizational knowledge sharing	0.428	0.091	22.192	<0.001	0.555	0.084	44.045	<0.001
Dependent Variable: Process innovativeness								
Independent variable	2016				2019			
	R	SE	F(1.99)	p	R	SE	F(1.99)	p
Learning orientation	0.664	0.075	78.259	<0.001	0.662	0.075	77.112	<0.001
Commitment to learning	0.603	0.080	56.442	<0.001	0.469	0.089	27.897	<0.001
Shared vision	0.596	0.081	54.568	<0.001	0.639	0.077	68.169	<0.001
Open mindedness	0.556	0.084	44.291	<0.001	0.588	0.081	52.378	<0.001
Intra-organizational knowledge sharing	0.490	0.088	31.332	<0.001	0.567	0.083	46.836	<0.001
Dependent Variable: Business system innovativeness								
Independent variable	2016				2019			
	R	SE	F(1.99)	p	R	SE	F(1.99)	p
Learning orientation	0.476	0.088	29.040	<0.001	0.756	0.066	132.348	<0.001
Commitment to learning	0.365	0.094	15.250	<0.001	0.575	0.082	48.786	<0.001
Shared vision	0.449	0.090	24.959	<0.001	0.729	0.069	112.470	<0.001
Open mindedness	0.448	0.090	24.834	<0.001	0.648	0.077	71.641	<0.001
Intra-organizational knowledge sharing	0.348	0.094	13.669	<0.001	0.595	0.081	54.159	<0.001

Source: the author

In Table 2 the regression analysis results showed that in 2016 and 2019, the company's innovativeness was statistically significantly positively influenced by learning orientation, learning commitment, shared vision, open mind and intra-organizational knowledge sharing knowledge within the company ($p < 0.001$). Second, in 2016 and 2019, product innovation was statistically significantly positively influenced by learning orientation, commitment to learning, shared vision, open mindedness and intra-organizational knowledge sharing within the company ($p < 0.001$). Third, it was shown that in 2016 and 2019, the innovativeness of the process was statistically significantly and positively influenced by learning orientation and all four of its dimensions ($p < 0.001$). Fourth, it was shown that in 2016 and 2019, the business system innovativeness was statistically significantly and positively influenced by learning orientation, commitment to learning, shared vision, open mindedness and knowledge sharing within the company ($p < 0.001$).

Table 3 Regression Analysis – The impact of independent variables on business performance in 2016 and 2019

Dependent Variable: Business performance								
Independent variable	2016				2019			
	R	SE	F(1,99)	p-level	R	SE	F(1,99)	p-level
Learning orientation	0.666	0.075	79.089	<0.001	0.655	0.076	74.282	<0.001
Commitment to learning	0.564	0.083	46.257	<0.001	0.495	0.087	32.198	<0.001
Shared vision	0.678	0.074	84.112	<0.001	0.715	0.070	103.770	<0.001
Open mindedness	0.628	0.078	64.396	<0.001	0.541	0.085	40.933	<0.001
Intra-organizational knowledge sharing	0.406	0.092	19.534	<0.001	0.458	0.089	26.245	<0.001

Dependent Variable: Business performance - Quantitative effects								
Independent variable	2016				2019			
	R	SE	F(1,99)	p-level	R	SE	F(1,99)	p-level
Learning orientation	0.489	0.088	31.119	<0.001	0.446	0.090	24.631	<0.001
Commitment to learning	0.364	0.094	15.132	<0.001	0.306	0.096	10.224	0.002
Shared vision	0.492	0.087	31.651	<0.001	0.513	0.086	35.387	<0.001
Open mindedness	0.514	0.086	35.560	<0.001	0.405	0.092	19.443	<0.001
Intra-organizational knowledge sharing	0.301	0.096	9.829	0.002	0.293	0.096	9.329	0.003
Dependent Variable: Business performance - Qualitative effects								
Independent variable	2016				2019			
	R	SE	F(1.99)	p-level	R	SE	F(1.99)	p-level
Learning orientation	0.666	0.075	78.793	<0.001	0.703	0.072	96.545	<0.001
Commitment to learning	0.606	0.080	57.425	<0.001	0.563	0.083	45.830	<0.001
Shared vision	0.681	0.074	85.670	<0.001	0.739	0.068	119.091	<0.001
Open mindedness	0.578	0.082	49.717	<0.001	0.570	0.083	47.769	<0.001
Intra-organizational knowledge sharing	0.408	0.092	19.770	<0.001	0.496	0.087	32.222	<0.001

Source: the author

In Table 3 the regression analysis results showed that in 2016 and 2019, business orientation was statistically significantly positively influenced by learning orientation, learning commitment, shared vision, open mindedness and intra-organizational knowledge sharing within the company ($p < 0.001$). It was shown that in 2016 and 2019, the quantitative effects of business performance were statistically significantly positively influenced by learning orientation, commitment to learning, shared vision, open mindedness and knowledge sharing within the company ($p < 0.01$). Third, it was shown that in 2016 and 2019, the qualitative effects of business performance were statistically significantly positively influenced by learning orientation and all its dimensions within the company ($p < 0.001$).

Table 4 Analysis of Covariance (ANCOVA) Comparison of the impact of independent variables on innovativeness in 2016 and 2019

Effect 2016 vs. 2019	Innovativeness		Product innovation		Process innovativeness		Business system innovativeness	
	F	p	F	p	F	p	F	p
Learning orientation	1.892	0.170	3.075	0.081	0.030	0.862	2.745	0.099
Commitment to learning	2.686	0.102	3.843	0.051	0.066	0.797	3.533	0.061
Shared vision	1.246	0.265	2.334	0.128	0.091	0.763	2.144	0.144
Open mindedness	3.177	0.076	4.582	0.033	0.088	0.765	3.876	0.050
Intra-organizational knowledge sharing	2.254	0.134	3.406	0.066	0.019	0.888	3.136	0.078

Source: the author

Table 4 shows the results of covariance analysis which tested the statistical difference between regression paths where there is no statistically significant difference between the impact of learning orientation, commitment to learning, shared vision, open mindedness and intra-organizational knowledge sharing within the company on innovativeness in 2016 and 2019 ($p > 0.05$). Second, it shows no statistically significant difference between the impact of learning orientation, shared vision and intra-organizational knowledge sharing within the company on

product innovation in 2016 and 2019 (p> 0.05). A marginally statistically significant difference was found between commitment to learning and product innovation in 2016 and 2019 (p is approximately equal to 0.05), and a statistically significant difference between open mindedness and product innovation in 2016 and 2019 (p< 0.05). Third, the results show no statistically significant difference between the impact of learning orientation, commitment to learning, shared vision, open mindedness and intra-organizational knowledge sharing within the company and process innovativeness in 2016 and 2019 (p> 0.05). Fourth, there is no statistically significant difference between the impact of learning orientation, commitment to learning, shared vision and knowledge sharing within the company and business system innovativeness in 2016 and 2019 (p> 0.05). At the same time, there is a marginally statistically significant difference between the impact of open mindedness and product innovation in 2016 and 2019 (p = 0.05).

Table 5 Comparison of the impact of independent variables on business performance in 2016 and 2019

Effect 2016 vs. 2019	Business performance		Business performance - Quantitative effects		Business performance - Qualitative effects	
	F	p	F	p	F	p
Learning orientation	1.150	0.284	0.001	0.991	3.852	0.051
Commitment to learning	1.876	0.172	0.086	0.768	4.758	0.030
Shared vision	0.647	0.421	0.042	0.836	2.976	0.086
Open mindedness	2.088	0.150	0.058	0.808	5.057	0.025
Intra-organizational knowledge sharing	1.645	0.201	0.069	0.792	4.060	0.045

Source: the author

Table 5 shows the covariance analysis results indicating no statistically significant difference between the impact of learning orientation, commitment to learning, shared vision, open mindedness and intra-organizational knowledge sharing within the company on business performance in 2016 and 2019 (p> 0.05). Second, no statistically significant difference was found between the impact of learning orientation, learning commitment, shared vision, open mindedness and intra-organizational knowledge sharing within the company on the quantitative effects of business performance in 2016 and 2019 (p> 0.05). Third, it is shown that there is no statistically significant difference between the impact of a shared vision on the qualitative effects of business performance in 2016 and 2019 (p> 0.05). A marginally statistically significant difference was found between the impact of learning orientation and the qualitative effects of business performance in 2016 and 2019 (p is approximately equal to 0.05). Also, there is a statistically significant difference among the impact of learning commitment, open mindedness and intra-organizational knowledge sharing within the company and the qualitative effects of business performance in 2016 and 2019 (p <0.05).

Figure 1 shows that the score of responses related to the impact of learning orientation on company innovativeness was higher in 2016 than in 2019. The lines intersect near the score of 80, which means that the values around the score of 80 are as frequent in in 2016 as in 2019.

Also, scores higher than 80 are more represented in 2019 than in 2016. As regards the answers related to the impact of learning orientation on business performance more answers with a higher score were recorded in 2016 than in 2019. Similarly, the lines intersect near the score of 80, which means that the values around the score of 80 are as frequent in 2016 as in 2019. The results show more scores higher than 80 in 2019 in comparison to 2016.

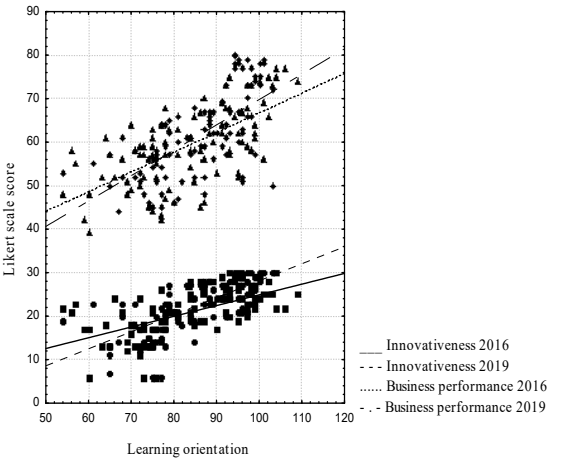

Figure 1 The impact of learning orientation on innovativeness and business performance
Source: the author

Discussion and conclusion

The aim of this study was to investigate whether there are differences in the impact of learning orientation, innovativeness and business performance in the two observed periods depending on their context. In other words, this research examined the role of a particular environment in respect of how companies practice learning orientation and develop innovativeness in order to improve business performance. The findings confirm the hypothesis, thus providing further evidence that the learning orientation has a positive and direct impact on the innovativeness and company's business performance, and this impact did not change significantly in 2019 compared to 2016. A review of the literature allows for the conclusion that learning orientation and innovativeness are important for building company success in markets. Regardless of the existing investigation into the impact of learning orientation, innovativeness on performance, the results are insufficient, which emphasizes the need for further investigation in companies in the international market.

According to the results obtained, there are no significant changes in 2016 and 2019, which may indicate other factors that influence the relationships and are not included in this study depending on the specific management form. Therefore, companies need to encourage employees to share their knowledge within the company and thus improve their openness in order to increase business performance (Calantone et al., 2002). It can be concluded that learning orientation, as a result, also supports strong innovativeness, and therefore, a culture of learning and knowledge sharing should be developed within a company. This conclusion is interesting because, despite the efforts made by various companies in spreading the learning orientation, these efforts are insufficient for significant progress in innovativeness and business performance. The awareness of the learning orientation values and innovativeness should lead to serious changes in business operation, a task not easy to achieve in this turbulent time. Therefore, to effect the change of relationship among learning orientation, innovativeness and business performance more attention should be paid to how companies improve business performance.

The paper discusses the implications that include addressing the need for new mediating factors and influences to understand this complex relationship better. Research is also needed to increase our understanding of effectively developing the ability to learn and transform into innovation processes that are changing current ways of doing business. Likewise, this research advances the understanding of the learning orientation impact on innovativeness and business performance. Moreover, this study has implications for companies with the aim of increasing their innovativeness and performance. The conducted longitudinal study provides empirical evidence that supports the value of building learning orientation and the ability to innovate in enterprises. Practical implications state that innovativeness can be strengthened through organizational learning. Companies should link vision with employee learning abilities to increase business performance. The results suggest that company managers should develop a culture that includes learning orientation to support innovativeness that affects profitability. Companies' efforts to develop learning orientation and improve innovation processes should benefit all stakeholders.

As the business environment has become more dynamic, learning orientation and innovativeness are those important issues that executives need to develop. The interrelationships between learning orientation and enterprise innovativeness are an important research area for scholars exploring management, marketing, and strategy. The research results will help companies to increase efforts that should be synchronized with the development of learning orientation and innovativeness in order to increase profitability. The research results fill a gap in current learning-oriented knowledge and can be useful for managers, independent experts and other stakeholders.

The findings suggest that companies should strengthen their learning and innovation orientation to improve business performance. This is the first study that in the two observed periods investigated the interrelationships between learning orientation, innovativeness and business performance in Croatian companies. Among the identified implications the evidence has been singled out that those found in Croatian companies may result in different relationships in other economies and should be explored in future studies.SM

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✉ Correspondence

Helena Šlogar
Libertas International University
Trg John F. Kennedy 6b, 10000, Zagreb, Croatia
E-mail: hslogar@libertas.hr

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HR practices in the context of the Internet of Things

Kristian Kremer
University of Pécs, Pécs, Hungary
https://orcid.org/0000-0002-9051-9038

Abstract
In an increasingly competitive business environment, it has become important for business organizations to equip themselves with the latest technologies. The Internet of Things (IoT) is considered to be one of the major emerging technologies. By connecting physical objects with the internet, the IoT allows things or smart objects to operate autonomously in a context-adequate way. There is a broad range of business application domains for the IoT. However, most of the research initiatives focus on technological issues in the context of logistics, manufacturing, retailing, and healthcare. That is why it seems to be important to elaborate on application possibilities of the IoT in human resource management (HRM). The present paper aims at providing a perspective on how the application of the IoT can be used to improve core HR practices.

Keywords
human resource management, Internet of Things, technology, human resource practices

Introduction

Along with the internet and technological growth, the Internet of Things (IoT) induces a technological paradigm shift, which connects anyone and anything at any place and any time (Baldini, Botterman & Tallacchini, 2018). The vision of the IoT is that of a smart world full of smart components and sensing technologies. The IoT involves users much more deeply as they are more strongly connected with technology going beyond creating and sharing content (Kreps & Kimppa, 2015). Hence, it is no surprise that such a bold vision, along with its potential to underpin innovative applications and services, has captured the attention of both practitioners and academics. Indeed, executives believe the IoT to be the most relevant emerging technology, ranking it above artificial intelligence or robotics (Insights Team, 2017). As societal norms and business models will be challenged, the IoT is expected making a major impact on businesses and individuals (Stankovic, 2014).

There is a broad range of business application domains for the IoT, such as logistics, manufacturing, retailing, and healthcare. Since large changes with many opportunities and threats are expected in these domains, plenty of research initiatives come along with the growing application of the IoT. The probably most prominent example is manufacturing research. Smart manufacturing is nowadays widely accepted as the new paradigm of manufacturing (Thoben, Wiesner & Wuest, 2017).

In contrast to these developments, it must be noted that the IoT does not appear being a topic of major interest in the domain of human resource management (HRM) with only very few publications existing on this topic (Bondarouk, Parry & Furtmueller, 2017). While most of the IoT studies are focusing on technological issues, this paper pays attention to possibilities and consequences that the IoT offers for HRM.

To ensure a clearer understanding of the topic under review, the first two parts of this paper serve as a theoretical foundation by providing an overview of the concept IoT, along with an elaboration of the main challenges arising from it. Next, the evolution of the IoT in the context of HRM is being outlined. This is followed by a

discussion on the role of HR technology for the IoT. After that, the methodology is described. This is followed by the results of the analyses on HR practices on which the application of the IoT might has a relevant impact on. This is followed by a discussion of the results and conclusions.

1. Literature review

1.1. Internet of Things

While the term IoT is nowadays used widely, there is no common understanding or definition existing on what the concept of IoT encompasses. However, regardless of variations in the definition, the objective of the IoT is similar in a broad sense. Atzori, Iera and Morabito (2010) approach the concept of IoT with three visions, including internet-oriented, things-oriented, and semantic-oriented visions. The authors further conclude that the IoT addresses uniquely objects that can react to their physical environment as well as interact with other objects to reach common objectives.

Another definition by ITU (2012) suggests that the IoT includes all objects of the virtual or physical world that can be identified as well as integrated into networks of communication. One of the probably most comprehensive definitions is proposed by the European Commission. It conceptualizes the IoT by the two words – internet and thing. While internet constitutes a network of interconnected computer systems, thing is an object not exactly identifiable. Hence, the IoT represents a world-wide network of interconnected objects. In other words, the IoT allows connecting people and things at any place and any time, with anyone and anything, using any service and any network (Guillemin & Friess, 2009).

The definitions have a certain amount of overlapping and share a few similar characteristics. Basically, the IoT aims at ensuring an efficient sharing of information among autonomous actors within a network in real time (Yang, Yang, & Plotnick, 2013). According to Stankovic (2014), the IoT refers to the connection of countless intelligent and communicating objects in an internet structure as part of a future smart world. Objects of the future smart world can uniquely be identified and accessed via the internet. They will be virtually represented in a cyberspace, enabling an interaction between humans and objects, or between objects (Andersson & Mattsson, 2015).

Interconnected objects build a network not only harvesting digital information, but also interacting with the physical world. Thus, as well as extending internet advantages to the physical world, including constant connectivity, data sharing, and remote control the IoT merges the digital and physical world (Shin, 2014). The IoT architecture will facilitate the exchange of services and goods and bring new opportunities for service innovation (Winter, 2014). By creating a society of interconnected devices, social systems are moving forward towards full connectivity. Hence, it is no surprise that the IoT is expected to lead to a new technological paradigm and introduce a social shift (Elmaghraby & Losavio, 2014).

1.2. Internet of Things challenges

Although the IoT will certainly create many new possibilities, there are various challenges arising from continuous automation and digitization at the same time. Due to a massive increase of data collected by IoT devices, data centers will face challenges in server technologies, data center networking, storage management, data itself, security, and consumer privacy (Gartner, 2014). The main challenges related to data management, data mining, privacy, and security are being outlined in the following.

IoT devices and sensors create large amounts of data, which need to be stored and processed. However, current data center architectures are usually not prepared to deal with sheer volume of business and personal data, which are very heterogeneous in nature (Gartner, 2014). Lee and Lee (2015) argue that only few organizations are capable to sufficiently invest in respective capacities to store all the IoT data gathered. In consequence, organizations must prioritize operational data or prioritize data based on value and needs. Since IoT devices become more widely used and are consuming more bandwidth, data centers must become increasingly distributed to improve response time and processing efficiency.

Due to the growing amount of data available for analysis, the utilization of data mining tools becomes necessary. Besides traditional data, streaming data are increasingly collected, generated by digital sensors in electrical meters, industrial equipment, automobiles, or shipping crates. Data mining tools can initiate corrective measures that immediately address operational issues or inform managers of findings that will

impact short- and long-term business activities (Lee & Lee, 2015). According to Manyika et al. (2011), data need to be approached by using advanced technologies and statistical techniques. Since traditional techniques related to data mining are not directly usable for unstructured data, such as images and videos, there is a need for advanced data mining tools that are able to mine these kinds of data. This, in turn, calls for data analysts with the respective skills and managers who can make business decisions based on evidence.

IoT devices can provide large amounts of user data related to movements, purchasing preferences, and health conditions – all of them raising data privacy concerns. In this scenario, protecting privacy is often counter-productive, as data generated by the IoT decreases the costs of the service provider by streamlining processes and is likely to enhance people's life quality. However, according to a TRUSTe survey (2014), only 22 percent of internet users agree that advantages of smart objects outweigh concerns in regards to privacy. While the concept of the IoT gains momentum through wearable devices and smart systems, it is obvious that the acceptance and confidence in the IoT will greatly depend on the privacy protection of users (Lee & Lee, 2015).

The potential security threats are about to escalate due to an increasing variety and number of connected IoT devices. While the IoT improves the productivity of organizations and is likely to enhance people's quality of life, it will also increase a potential attack by cyber criminals. According to a study by Hewlett Packard (2014), 70 percent of the most used IoT devices show significant weaknesses due to insecure web interfaces, inadequate software protection, lack of encryption, and insufficient authorization. Lee and Lee (2015) argue that challenges related to security may be resolved, if developers incorporate security solutions into products and users utilize security features. However, failing to do so will build resistance to the adoption of the IoT.

1.3. Evolution of Internet of Things in HRM

Smart things enable the automation of tasks that were not automatable before, due to their complex physical-motoric and perceptive-cognitive requirements (Borgia, 2014). Increasing automation potentials with the possibility to manage security, efficiency, and objectivity with higher transparency and without bias are to be expected when applying the IoT in HRM. Although researchers have been carried out studies measuring the relevance of technology for HRM, only a limited studies are dealing with the application of the IoT in the HRM context (Bondarouk et al., 2017).

In the advent of the IoT, more recent research has shifted towards smart things. According to a study by Gluhak et al. (2011), fundamental changes are needed in work place management to pave the way for the IoT. Weinberger, Bilgeri and Fleisch (2016) introduced the high-resolution management concept, which measures all kind of business operation aspects in an industrial context. According to the authors, organizations that are applying high resolution management (e.g., measuring operational activities in real time) achieved more flexibility, efficiency, and quality. Bauk, Dlabač and Škurić (2018) studied high resolution management to establish business models for the IoT, including digital add-on, object self-service, digital lock-in, and physical freemium. The authors conclude that the IoT enables the development of innovative business models, besides enhancing the overall quality of products and business processes.

Research exploring the linkage between IoT and HRM is mainly concerned with increased automation potentials that can be expected by applying the IoT in HRM. Potential scenarios refer to the employment of smart things for HRM information, such as sensing HR information including staffing requirements, qualification deficits, working times, or break needs (e.g., Bersin, Mariani & Monahan, 2016). Smart tools can also be used in training and development, by introducing new users in a fully automated manner to tool handling and application (Charmonman, Mongkhonvanit, Dieu, & Linden, 2015; Dlodlo, 2012). Besides, smart things can also be used for workforce planning in manufacturing companies. Information on the interaction between work pieces and smart tools can be used to identify the time, quantity, and quality of employees in manufacturing. This, in turn, offers input to create algorithms fully automating manufacturing employees' schedule (Spath, Gerlach, Hämmerle, Schlund, & Strölin, 2013). Moreover, measuring data related to employee stress, exercise level, physical fatigue, etc. and transforming them into algorithms that provide health suggestions for employees can improve organizational health management (Solanas et al., 2014; Nihan, 2013).

The clearly apparent and increasing

information potentials are also expected by applying the IoT in HRM. A broad spectrum of HR-relevant data can be generated by sensors that employees wear during work. This kind of information might refer to employees' requirements, qualifications, performance, physical activity, psychological state, or social situation (Waber, 2013).

1.4. The role of HR technology for Internet of Things

It seems to be obvious that applying the IoT in HRM will first have an impact on present HR technologies, which have already been subject to ongoing change in the last decades (Stone, Deadrick, Lukaszewski, & Johnson, 2015). However, the IoT has not been widely utilized in HRM yet. It is first important to understand that data, software, and hardware are the main components of HR technology. Any application of the IoT in HRM is likely to make changes in all the three components, which need to interact with each other to deliver the expected functionalities (Strohmeier, 2020).

Applying the IoT in HRM implies the utilization of various smart things with the purpose to automate certain HR practices or collecting certain HR information. Although IoT technologies have yet rarely been utilized within HRM, it can be assumed that smart things will complement the current HRM hardware infrastructure. In addition, current HR software, which refers to coded instructions run by HR hardware, will need to be modified to realize information and automation potentials of the IoT. Furthermore, the application of the IoT will change and create new data, which refers to information stored, transmitted, and processed by the interaction of software and hardware. In this respect, a strong increase in data speed and volume can be expected because of applying the IoT, expanding the organizational information potentials (Swan, 2012, Fleisch, 2010).

2. Research methodology

The methodology applied is a literature review based on the inclusion of research journal papers, conference papers, and books dealing with the concept of the IoT applied in HRM context and specifically with the impact of the IoT on specific HR practices. The review was conducted using academic databases accessed through Google Scholar, Scopus, Web of Science, and EBSCOhost using the terms 'IoT' or 'Internet of Things' in combination with the terms 'Human Resource Management' or 'HR practices'.

A total of 49 references were added to the literature review. With three exceptions, all the references were published between 2009 and 2020, underlining the relevance of the theme. It is notable, that all the twelve papers, which are specifically addressing HR practices in the context of the IoT, were published from 2016 on and are either review or survey papers. This emphasizes the relevance of this topic, but also the need for studies that involve testing of theoretically derived hypotheses.

The analysis of the literature revealed six main HR practices on which the IoT might have an impact on. For better transparency, they have been given the following names: workforce planning, recruitment, performance management, training and development, HR Analytics, and health management.

3. Results and discussion

HR practices can be referred to a set of activities related to employees, which are performed to ensure the employee quality and quantity an organization needs to achieve its objectives (Ostroff & Bowen, 2000). While some categorizations of HR practices are existing in the academic literature, like the AMO-framework by Boxall and Purcell (2003), an enormous variability regarding single HR practices and their categorization can be constituted. However, at least six HR practices can be considered that are both frequently employed in practice and relevant for the success of HR, including workforce planning, recruitment, performance management, training and development, health management, as well as information and decision-related activities, which are nowadays also referred to HR Analytics (Lepak, Liao, Chung, & Harden, 2006). Although this set of HR practices is necessarily incomplete, it is a starting point for a first exploration of possibilities when applying the IoT in HRM.

3.1. Workforce planning

Technology is considered being the main driver for workplace change. The nature of workplace changes along with the collective utilization of cloud-based applications and smart phones, which changes the working environment towards more collaborative workplaces, such as working virtually and from home (Barman & Das, 2018). Smart phones are one of the most relevant hubs of the IoT, helping organizations to seek suggestions

and ideas of their employees irrespective of their location. With the help of smart phones, it is possible to implement true flexible working, wherein employees can work anytime and anywhere (Venkatesh, 2017; Hassan, Ali, & Badawy, 2015). Collaborative workplaces and more flexible ways of working enable organizations to manage their human resources more effectively by reducing operational costs and time to a very large extent. The IoT can act as a catalyst for enhancements in HRM by boosting employee productivity and increasing employee engagement (Barman & Das, 2018).

The IoT can increase the productivity and effectiveness of employees in many ways. It provides various means of collecting data in an automated way, reducing the possibility of human error (Rose, Eldridge, & Chapin, 2015). This, in turn, serves as a better foundation for the HR decision-making process, for instance by optimizing employee scheduling to maximize productivity. Employees can be scheduled according to data that pinpoints their most productive periods (Vivekananth, 2016). Indeed, information on the interaction between work pieces and smart tools can be used to identify the time, quantity, and quality of employees in manufacturing. These kinds of data can be used to create algorithms fully automating the scheduling of manufacturing employees (Spath et al., 2013). IoT sensing devices can be attached to workers and to the equipment they are using to record every aspect of employee experience in the organization (Gaur, Shukla, & Verma, 2019).

3.2. Recruitment

The application of the IoT potentially increases the efficiency in regard to the recruitment process. The IoT can optimize all stages of the recruitment process and improve hiring decisions (Gaur et al., 2019). Since in more business domains various smart things are utilized and interact with each other autonomously to support in providing the intended services and products, it can be expected that organizational hiring needs will continuously start to come up in an ad hoc way (Guillemin & Friess, 2009).

In smart factories, for instance, various smart work pieces are interacting with various smart objects to determine and carry out pending duties in the production. In case a specific work step needs support by an employee with certain skills that are currently not available, smart tools and work pieces report an ad hoc hiring need that has to be met as soon as possible to avoid interruptions in the production process. Hence, the assignment and scheduling of employees are increasingly to be undertaken in real time (Strohmeier, 2020).

Nowadays, job seekers rely heavily on mobile technology to access information on jobs and companies. HR can make use of this technology to increase their visibility on social networks (e.g., LinkedIn), which are increasingly accessed via smart devices (Mohanty & Mishra, 2020). Moreover, the behavior of applicants in a virtual situation can be assessed, which reduces biases in the decision. Virtual reality situations enable assessing a candidate in dealing with reality during the selection procedure. At the same time, candidates can attend their interviews from home and will receive a more realistic picture of their potential future job (Venkatesh, 2017). However, Strohmeier (2020) argues that using smart things to automate the recruitment process fully might not be technically feasible, since social competencies of the candidates also must be considered.

3.3. Performance management

The data accumulated by the IoT can be used to create a closer and more constructive connection between managers and their employees, which potentially enhances the performance management process (Venkatesh, 2017). The additional data gathered by IoT devices can be used to set up more concrete objectives for the employees, which is likely to increase their overall productivity level (Gaur et al., 2019). Organizations can use performance management apps with objective criteria to assess the performance of employees, allowing to provide a digital feedback and keep track of organizational growth in a more convenient and efficient way (Mohanty & Mishra, 2020).

However, Strohmeier (2020) argues that it might be managerial undesirable using sensors to evaluate the performance of employees in high resolution and real time, since this would imply over surveillance. According to Mohanty and Mishra (2020), one must be careful with data that provide socio-metric measurements on employees' social behavior. These kinds of data should only supplement and not substitute employees' personal identity.

3.4. Training and development

The application of the IoT can help to personalize training programs, which can also be planned, organized, and coordinated based on the additional data gathered by IoT devices (Gaur et al., 2019). The just-in-time training concept has been discussed for quite a while (Iannarelli, 2009). It seems to be obvious that just-in-time training is fostered by the application of the IoT. With respective software, it is possible to continuously track training outcomes, coaching, and feedback of employees, allowing to identify qualification gaps or training deficits in real time (Mohanty & Mishra, 2020).

Learning management systems will be able to interact with IoT devices to organize and provide training in real time, in case sensors identify qualification deficits of an employee. Necessary training measures are expected to be delivered in real time by sensors attached to smart things, which employees are using. This training acceleration is considered as essential to avoid delays and interruptions in providing services and products (Strohmeier, 2020).

An already elaborated application scenario refers to using smart tools in training and development to introduce new users in a fully automated way to tool handling and application. Another application scenario refers to the increasing utilization of self-services. In this regard, training and development is just one HR area, where smart things can extent HR tasks that employees perform via self-service (Strohmeier, 2020). Dash Farooq, Panda, and Sandhyavani (2019) propose the implementation of an IoT framework for HRM processes that would lead to competency development by deploying IoT sensors and devices. With the help of IoT and other innovative technology, it is feasible to create personalized experiential learning (Pathak & Solanki, 2021)

3.5. HR Analytics

In a business environment that is moving forward towards a quantified workplace and where decisions are made based on data analytics, the IoT potentially enhances the process of quantifying employees' work by gathering and providing useful data on the performance and wellness of employees (Barman & Das, 2018). The application of the IoT will increase the provision and utilization of information in HRM, which is in line with the present discussion on HR Analytics (e.g., Kremer, 2018). Basically, HR Analytics refers to the notion that HR decisions and practices should be based on evidence rather than on intuition and conjecture. Since HR Analytics is about systematically gathering and supplying information that is necessary for the decision-making process in HR, it seems to be obvious that increasing sensing functions initiate extensive changes in HR Analytics' related processes and results (Waber, 2013).

According to Vivekananth (2016), the IoT will be applied in HR Analytics to support in assessing HR practices and processes. The IoT will change the way of gathering and analyzing HR data. Professionals in the field of HR Analytics will have to learn about the new kind of data created by IoT devices. HR Analytics professionals will have to comprehend market trends and the costumers to successfully integrate these data into their analyses.

Larger sets of sensors among an increasing number of smart things enable the measurement of various new issues related to HR (Swan, 2012). The quality of HR data is about to increase, since sensors are expected to enhance the quality of measurement in comparison to conventional ways of HR data ascertainment. Moreover, sensors will decrease time span between the happening of an event important for HR and its information provision, allowing for faster HR decision and service delivery. Due to the increased quantity, quality, and speed of HR data, the overall relevance of HR Analytics is expected to increase (Strohmeier, 2020).

3.6. Health management

The health of the employees becomes increasingly important for organizations, since research indicates that healthy employees are more engaged and perform better. Thus, all measures taken by organizations to protect and improve the health of employees is likely to improve the overall productivity of the business. The IoT has the potential to help organizations in gathering data related to employees' health, enabling them to design and implement respective programs to improve the health of employees, which will in turn enhance organizational productivity and profit (Venkatesh, 2017).

The organizational health management can be improved by measuring data related to employee stress, exercise level, physical fatigue, etc. and transforming them into algorithms that provide health suggestions for employees (Strohmeier, 2020). Organizations can provide fitness tracker

to employees to gather and monitor their health (Venkatesh, 2017). However, these kind of data raises privacy concerns and would need to be used with employee consent (Gaur et al., 2019). According to a study by Kaupins and Coco (2017), especially monitoring heart rates might be critical from an ethical point of view and raises many questions and technology challenges.

Conclusions

The IoT is about to witness rapid change and will gradually become an integrated component of the workplace. We can presume that this technology will have serious implications on organizational activities, especially in the way human resources are being managed. The gradual development and application of the IoT in HRM is discernable, since the IoT generates an unparalleled amount of data related to people.

The present paper provides a novel perspective on how the application of the IoT can be used to improve core HR practices. The concept of IoT is discussed, which is considered being a new technological revolution, allowing people and things to be connected at any place and any time, ideally using any service and any network. Although the IoT certainly creates many new possibilities, there are various challenges arising from continuous automation and digitization. These challenges are outlined by elaborating on issues related to data management, data mining, privacy, and security.

This paper reveals that only limited research on the application of the IoT in the context of HRM is existing, although a major significant of technology for HRM can be constituted. HR technology can be understood as an intersection of HR data, software, and hardware. Changes in all the three components can be expected when applying the IoT in HRM. Based on the assumption that the IoT provides new possibilities for HRM, this paper elaborates on six HR practices, including workforce planning, recruitment, performance management, training and development, HR Analytics, and health management.

Besides many opportunities and possibilities, the challenge is to design workplace IoT applications that are offering value for the employees, even though the main may be improving employee performance.

This paper enriches the current discussion on the application of the IoT in HRM by providing an overview of the most relevant studies dealing with this theme. Previous studies addressed the impact of the IoT on only some of the core HR practices. In comparison, this review offers a more holistic overview and discusses the potential of the IoT for six core HR practices in more detail. While most of the research discussing IoT in the context of HRM is more conceptual, the present paper creates knowledge of how the IoT can be applied in various HR processes. It offers business managers and leading HR managers a prospect on the development of HRM in a digital future, as well as a starting point on how to use the advantages of IoT within HRM in their own organizations. This paper also raises ethical concerns, which should be addressed by politics to set regulations, as well as business managers before applying IoT.

For future research, this paper offers directions on HR practices in the context of the IoT. Quantitative and empirical research should be aimed at generating knowledge on actual applications and consequences of the IoT in HRM.SM

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✉ **Correspondence**

Kristian Kremer

Faculty of Business and Economics, University of Pécs
Rákóczi út 80, 7622, Pécs, Hungary

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Implementation of a SWOT-AHP methodology for strategic development of a district heating plant in fuzzy environment

Ivana Veličkovska
Mathematical Institute of the Serbian Academy of Sciences and Arts, Belgrade, Serbia
https://orcid.org/0000-0001-7692-8436

Abstract
In this paper, SWOT analysis and fuzzy Analytic Hierarchy Process (FAHP) have been employed to structure and determine the importance of all identified alternatives for developing strategic management in a local district heating plant in Serbia. Weaknesses are identified as drivers of technological slowdown in the plant. The outcome of the prioritization highlights the importance of solving challenges regarding weaknesses by relying on a variety of opportunities that emerge in the environment. The potential of restoring the equipment of the district heating plant is found to be the most important alternative for strategic development.

Keywords
district heating, strategic management, SWOT, AHP, FAHP

Introduction

Reaching the sustainable energy development goals can be performed in two directions, by promoting renewable energy sources and by using energy efficient technology (Kveselis, Dzenajavičienė, & Masaitis, 2017; Maljkovic & Basic, 2020). Secure heat supply, mitigation of climate change effects and economic competitiveness can be improved by coping with the problem of low energy efficiency of conventional district heating systems (Ziemele, Gravelsins, Blumberga, & Blumberga, 2017). For that purpose, district heating should be considered not only as a technology that achieves better economic and technological performances, but also to lower the pollution (Wang, Duanmu, Lahdelma, & Li, 2018). District heating is recognized as an efficient technology for achieving climate goals and reducing pollution (Hansen, Gudmundsson, & Detlefsen, 2019). It represents the answer to the ever-raising issue of the use of clean energy sources for heat supply. Pakere & Blumberga (2020) report several advantages and disadvantages of using centralized district heating. Advantages are seen in the possibility to choose the heat source, higher efficiency, decrease in primary energy consumption, reduction of greenhouse gas emissions etc., while identified disadvantages are higher heat transmission losses, high investment costs, and employing personnel with high technical skills.

District heating has evolved over four generations (Mazhar, Liu, & Shukla, 2018). District heating systems using renewable energy sources are the 4th generation systems (Ziemele, Pakere, & Blumberga, 2016). They represent the future development of sustainable heat supply with zero pollution (Pakere & Blumberga, 2020). This latest generation of district heating systems is characterized by low temperatures, low distribution losses, the use of sustainable energy sources and high efficiency (Volkova, Mašatin, & Siirde, 2018). Transformation from the convenient

to the latest, 4th district heating system has been investigated by several authors (Volkova et al., 2018; Lund, Duic, Østergaard, & Mathiesen, 2018). Furthermore, to move towards the next generation of the district heating systems, new business models have to be applied that support introduction of new technology, high energy efficiency buildings and increased share of renewable energy sources (Paiho & Reda, 2016). Many authors study the government's role in the transition towards the 4th generation of district heating systems. In a similar review study, Mazhar et al. (2018) performed comparative analysis of existing district heating systems in several countries and their active policies. The results of the analysis indicate Denmark as a country with modern and best operating district heating network in the world, which indicates high government involvement in legislation and operation. Germany is characterized as the owner of sustainable and advanced district heating network and assertive government involvement. China as a huge economy is seen as the fastest growing network in the world with government involvement in reducing carbon footprint. District heating systems in Poland, China and USA are highly dependent on government regulation of sustainable development of the existing systems by introducing renewable energy sources to reduce carbon dioxide footprint. Transition process is complex and depends on many factors that include innovative technology and government regulation (Khabdullin, Khabdullina, Khabdullina, Lauka, & Blumberga, 2017). The overall goal of the transition is to introduce district heating systems that are flexible and integral part of the future smart energy system (Li & Nord, 2018).

The overall goal of this research is to investigate the possible directions for strategic development of a local district heating plant in the city of Bor, located in Eastern Serbia. Development strategies are constructed using elements from the SWOT analysis and prioritized using multi-criteria decision-making methods. The paper consists of five sections. Section 1 contains brief literature review of the applied methodology in the recent publications regarding strategic development of district heating systems. Section 2 presents detailed theoretical background and computational procedure for applied methods, including SWOT analysis, analytic hierarchy process and fuzzy analytic hierarchy process. Strategies that are used for prioritization are developed in Section 3. Research results are reported in the Section 4. The district heating plant will not be discussed in this paper since it was a subject of a previous research, only the outcome of the SWOT analysis would be presented in order to better understand the research problem. Finally, research conclusion is presented in Section 5. To sum up, main contributions of this research are analysing the challenges of the district heat supply in plants and highlighting the important problems. In addition, decision model that is constructed for providing support in developing strategic management can be used in other district heating plants in Serbia. The model is adaptive and allows modification to the actual situation in individual plants.

1. Methodology

Proposed methodological framework for this research considered the use of the SWOT analysis that is proven as an effective tool for gathering valuable internal and external data. Then, TOWS analysis is used for forming strategies on the basis of strengths, weaknesses, opportunities and threats. The outcome of SWOT and TOWS tolls served for forming a hybrid model with the Analytic Hierarchy Process (AHP) that is a multi-criteria decision-making method. Furthermore, this hybrid model was introduced in its fuzzy environment for providing precise research results.

Multi-criteria decision-making methods have been applied in energy field for solving numerous challenges, and examples of those researches are given in the following part. Fuzzy AHP methodology has been used for solving energy problems regarding the selection of the most appropriate renewable energy source (Kaya & Kahraman, 2010). The advantage of employing fuzzy environment is preference to lower the uncertainty of information and manage with incomplete data (Wang et al., 2018). Wang et al. (2018) employed fuzzy MCDM methodology to provide the support to decision-making process in planning and designing district heating system. Their study takes in consideration several energetic, economic, technological and environmental criteria. The outcome of their study highlights the economic and energy issues as more influential than technology and environment. In 2018 authors (Ligus & Peternek, 2018) used fuzzy AHP and fuzzy TOPSIS to prioritize low-emission energy technologies using social, economic and environmental criteria. The

results of the study indicate on decision-making model that prioritize renewable energy as the most suitable low-emission technology choice.

1.1. SWOT analysis

SWOT analysis represents an often-used strategic tool for collecting data about internal and external factors and it usually refers to a company (Solangi, Tan, Mirjat, & Ali, 2019). Its abbreviation serves to denote strengths (S), weaknesses (W), opportunities (O) and threats (T) where S and W elements are recognized as internal factors, while O and T elements are recognized as external factors (Wang, Xu, & Solangi, 2020). The strategies are generated by combining elements SO, WO, ST and WT. The major limitation of the SWOT lies in its outcome that is only qualitative nature and for further use of the SWOT results; they have to be quantified into numerical values (Tavana, Zareinejad, Di Caprio, & Kaviani, 2016). Therefore, the proposed methodology includes AHP method that quantifies the importance of the qualitative SWOT elements, with the help of the pairwise comparison matrixes, into numerical priority weights to avoid this problem.

1.2. AHP method

Analytic hierarchy process method is among the most used multi-criteria decision-making methodology because it is convenient to use, performs simple calculation procedure and provides the possibility of application to group decision-making problems (Mastrocinque, Ramírez, Honrubia-Escribano, & Pham, 2020). It is frequently employed for solving unstructured problems that emerge in different areas such as health (Büyüközkan, Mukul, & Kongar, 2020), transportation (Bouraima, Qiu, Yusupov, & Ndjegwes, 2020), energy (Gottfried, De Clercq, Blair, Weng, & Wang, 2018), and other. It is introducing human intellect in evaluating priority of alternatives that are set as solutions for a considered decision-making problem (Beşikçi, Kececi, Arslan, & Turan, 2016). The advantage of the AHP method can be found in breaking the complexity of decision-making process by structuring the problem in its hierarchy on various levels, thus making it easier for decision makers to judge their preferences (Salvia, Brandli, Leal Filho, & Kalil, 2019). With the help of the pairwise comparison, the priority weights of all structural elements are being evaluated. The computational procedure for calculating criteria priority weights in the AHP method was introduced by Saaty (1980) and it can be described by using the following three steps.

Step 1. Construct a pairwise comparison matrix. For a decision-making problem that contains n criteria, the process of determining the criteria weights starts by forming a reciprocal square matrix size $n \times n$ (Si et al., 2020).

Saaty's scale is used to implement the AHP method, which is expressed in numerical values from 1 to 9 (Saaty, 2008). To implement the fuzzy AHP method, it is necessary to use triangular fuzzy numbers (TFNs) whose numerical values range from $\tilde{1}$ to $\tilde{9}$.

Step 2. Calculate the criteria priority weights. The arithmetic mean over the normalized columns method is used to determine the criteria weight.

Step 3: Check the consistency of the pairwise comparison. The most important step in performing pairwise comparison is to check the pairwise comparison consistency. The data about pairwise comparison consistency shows that decision makers are able to express its preferences of one criterion over the other and to understand the applied methodology. The decision about acceptability of the performed pairwise comparisons is made on the results of the Consistency ratio (CR). Pairwise comparisons have to be accepted if the CR is less than or equal to the threshold 10% (Si et al., 2020). If that is not the case, comparisons are rejected and it should be re-evaluated by experts.

To compute the Consistency ratio, the following procedure can be used (Si et al., 2020):

***Step* 3.1:** Compute the maximum eigenvalue of the pairwise comparison matrix A.

***Step* 3.2:** Compute the Consistency index CI.

***Step* 3.3:** Finally, compute the Consistency ratio CR.

For a group decision-making that includes two or more experts (K), the criteria weight of each criterion w_j is calculated using the formula for arithmetic mean, or using the geometric mean formula (Khashei-Siuki & Sharifan, 2020).

1.3. Fuzzy AHP

Introducing the fuzzy environment for decision-making problems is done to overcome the problem of the decision maker's consistency. Fuzzy set theory is used when there is incomplete knowledge about the decision-making problem

(Wang et al., 2020). For most of the decision makers, it is hard to perceive the real situation and assess the impact of different criteria. Thus, it makes it difficult to decide which numerical value to appoint to each criteria and alternative. Therefore, uncertainty arises because of those circumstances. The question of the present uncertainty is especially important when the traditional AHP is used to solve ambiguous problems. Fuzzy framework provides solution for this preference problem by using an interval of numerical values so called, triangular fuzzy numbers instead of crisp values that are used in AHP (Khashei-Siuki & Sharifan, 2020). For each crisp numerical value used in AHP, there is an assigned interval of values in TFNs that are used in FAHP. Fuzzy numbers value range from 0 to 1 (Wang et al., 2020). FAHP recognizes three different values that describe a fuzzy event (Beşikçi et al., 2016) and they are entitled as low (l), model (m) and upper (u) value, respectively. Their internal relationship is presented as $l_j \leq m_j \leq u_j$, where l is the lowest value, m is the model value and u is the upper value of the expressed preference. Described methodology is illustrated in the following Fig. 1.

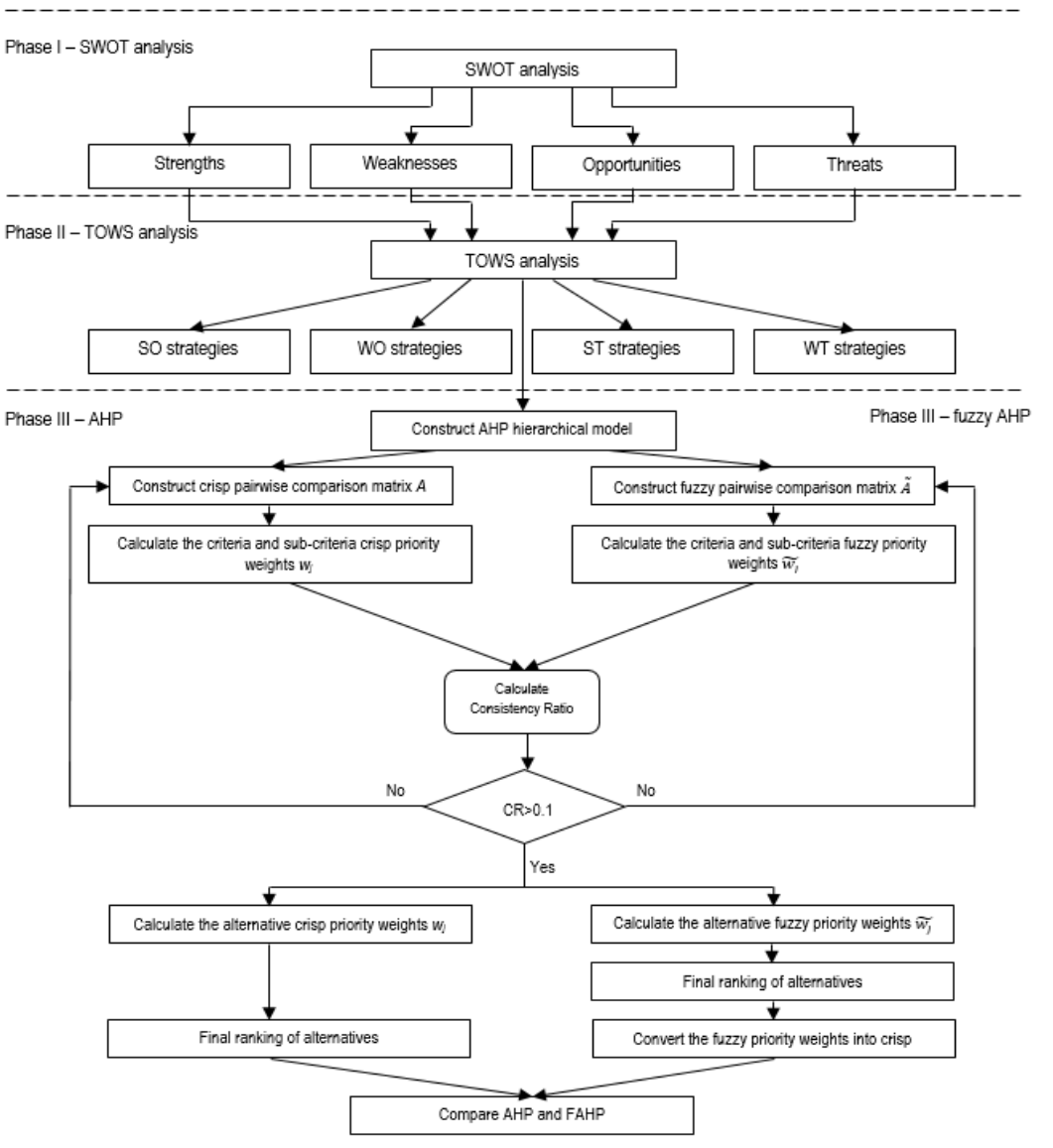

Figure 1 Methodology presentation through research phases
Source: the author

2. Development of alternatives for strategic management

In the process of developing strategies aimed at improving the operation of the district heating plant, SWOT analysis has been employed which was adopted from a previous research (Veličkovska, 2019). In that paper, the strengths, weaknesses, opportunities and threats of the district heating plant were identified and described in details. The presented SWOT analysis consists of 24 elements. Internal factors include 4 elements that were identified as strengths (S_1-S_4) and 7 elements that were identified as weaknesses (W_1-W_7). External factors include opportunities that incorporate 6 elements (O_1-O_7), while threats consist of 7 elements (T_1-T_7). TOWS analysis was adopted in order to obtain alternatives for strategic development of the plant. TOWS analysis is used to construct strategies based on the results of the SWOT analysis. The formulated strategies serve to maximize strengths and opportunities of the plant while at the same time minimize possible weaknesses and threats (Gottfried et al., 2018). TOWS matrix showed in the Table 1 consists of seven strategies. The strategies were generated during the high quality discussion with the interviewed experts.

SO strategies. By relying on the strengths of the company and using the opportunities that emerge in the environment, SO strategies were obtained from the positive elements of the SWOT matrix. They consist of the SO_1 strategy - transition to the renewable energy sources and the SO_2 strategy - finding a strategic partner.

Strategy SO_1 was derived from the two elements identified as strengths that are large number of users (S_3) and expert staff (S_4). On the other side of the SO_1 strategy is the opportunity, which was identified as renewable energy sources (O_3) that was planned to be utilized. The SO_1 strategy is formed to overcome the strict energy policies that are constantly harmonized with the global climate change targets. Since the plant is publicly owned and is the only heating supplier in the city it counts on a large number of heating consumers. The demand for heating supply is high and its position in the heating market is secure. Renewable energy sources are better exploited if district heating systems are larger (Ghafghazi, Sowlati, Sokhansanj, & Melin, 2010). Besides that, the personnel that is hired in the plant is professional, made up of skilled engineers that are competent for planning and introducing the renewable energy sources as the major energy sources for the heating supply. This strategy is related towards reducing coal use and towards consumers that will become aware regarding their ecological footprint and would like to move to renewable energy sources (Paiho & Reda, 2016).

Strategy SO_2 incorporates the following strengths: satisfactory level of production capacity (S_1), built district heating system (S_2) with a large number of users (S_3) and opportunity found in creating public-private partnership (O_5). This strategy is seen as a way to use the existing infrastructure and high heating demand to create partnership with private sector and privatize a part of the heating supply in the city. The partnership will provide private investments for recovering the infrastructure that will benefit the quality of the provided heating services and increase the share of satisfied consumers. The general problem regarding this strategy is difficulty in finding adequate strategic partner since investments in district heating systems are high and the payback period is long, which is not convenient for most of the investors that are looking for fast capital turnover (Mazhar et al., 2018).

WO strategies. The next step in creating TOWS matrix is to cross the company's weaknesses and opportunities in order to define WO strategies where strategies WO_1 – modernization of technology from EU funds and WO_2 – restoration of the obsolete equipment by crediting belong.

Strategy WO_1 includes a variety of weaknesses such as obsolete equipment (W_1), low level of automation (W_2), many failures (W_3), lack of financial resources (W_4), high preparation costs (W_6), while using the opportunity seen in achieving cooperation with the EU (O_6). The plant is reporting many problems with the existing infrastructure and lack of financial resources to cover the modernization of the technology. The high-energy consumption of a district heating plant is often caused by low energy-efficiency operations (Liu et al., 2020). Therefore, strategy WO_1 considers establishing the cooperation between the district heating plant as a public plant and the EU by the means of the government. EU is approving assistance as a form of aid for improving energy efficiency through various programs for acceding countries that could be of use in Serbia which energy efficiency score is below the energy goals of the EU countries. Installation of new technology highly depends on the type of energy source that will be used (Ghafghazi et al., 2010).

Strategy WO2 incorporates the same weaknesses as the strategy WO_1 but the opportunity that was planned to be used to solve those weaknesses is specialized funds (O_2). WO_2 considers other possibilities of financial flow that is provided by crediting institutions specialized in green energy financing. Those financial services already exist and

they are an acceptable solution for modernization of the current technology.

ST strategies. Then, by looking at the strengths of the company and threats that appear from the environment, ST strategies was obtained, which include the ST_1 strategy – improving institutional measures.

ST_1 strategy was constructed using the strengths large number of users (S_3) and expert staff (S_4) to solve threats that is defined as reducing the number of users (T_3). Those measures address the problem of large consumer loss. Each year a significant number of consumers disconnects from the district heating network without any financial responsibilities towards the plant. Many of those consumers are living in buildings where heating network is installed so there is a question of passive use of the heating services of former heating consumers. Therefore, the relevant personnel of the plant should construct a detailed policy regarding regulation of consumers' rights and obligations when they use heating services.

WT strategies. The final step in creating the TOWS matrix is crossing the negative elements, weaknesses and threats, in which the WT_1 – cooperation with the local government in system renewal and WT_2 – introduction of a payment by consumption system strategies were generated.

Strategy WT_1 incorporates weaknesses of the company such as obsolete equipment (W_1), low level of automation (W_2), many failures (W_3), lack of financial resources (W_4), high preparation costs (W_6) and responds to the identified threats that are reducing the number of users (T_3) change of legislation (T_4) lower investment by state (T_5) climate change (T_7). Since it is a part of public sector, the management of the plant could address to local government for getting aid in renewing the current technology.

The quality of heating services will increase by modernizing the current technology that could prevent further loss of consumers. In addition, the level of energy efficiency of the heating system should improve by installing new heating network that could in return improve the quality of provided services. Moreover, this improvement of energy efficiency means rising awareness of climate change and the effect that use of coal and inadequate insulation produce. However, local municipalities usually do not possess high amount of money that is needed for renewal of the old district heating systems (Mazhar et al., 2018), so the disposable financial resources should be used in improving some part of the system.

Strategy WT_2 includes weaknesses obsolete equipment (W_1), low level of automation (W_2), many failures (W_3), lack of financial resources (W_4), high preparation costs (W_6) and responds to the threats including increase in energy prices (T_1), reduction of coal use (T_2), reducing the number of users (T_3), lower investment by state (T_5) and climate change (T_7). Current calculation payment system relies on data about heating area of each consumer, whether from private or public sector, and the price of heating services per square meter. However, this payment system is recognized as inefficient since both consumers and the plant are dissatisfied with the outcome. Consumers stress the fact that they are paying more than needed, while plant highlights that they are using more coal for less financial compensation. The solution to this problem is seen in constructing an effective payment system which could report about the quantity of heating energy that is consumed by each user. This win-win strategy would result in saving extra financial resources since the plant will charge their heating services according to the demand and the consumers would be able to control their heating demand as needed.

The formation of the hierarchical model is the initial step in the implementation process of the AHP methodology. The model presented in this study consists of four hierarchical layers. The first and the highest layer denotes the goal of the research expressed as finding the best strategy for improving the operation of the district heating plant. This goal is evaluated through the strengths, weaknesses, opportunities and threats of the company expressed in the SWOT analysis. SWOT elements in the model represent the lower layer in the AHP hierarchy and indicate the criteria according to which the decision on choosing the best strategy is made. The SWOT criteria are divided into a number of sub-criteria within each of four SWOT groups. These sub-criteria form the third hierarchical layer of the AHP model.

Table 1 TOWS matrix for generating strategies for strategic management of the district heating plant

		INTERNAL	
		Strengths (S)	Weaknesses (W)
		S_1 A satisfactory level of production capacity	W_1 Obsolete Equipment
		S_2 Built district heating system	W_2 Low level of automation
		S_3 Large number of users	W_3 Many failures
		S_4 Expert staff	W_4 Lack of financial resources
			W_5 Inadequate maintenance system
			W_6 High preparation costs
			W_7 Use of non-renewable energy sources
EXTERNAL	Opportunities (O)	SO strategies	WO strategies
	O_1 Heating price regulation	SO_1 Transition to the renewable energy sources	WO_1 Modernization of technology from the EU funds
	O_2 Specialized funds	SO_2 Finding a strategic partner	WO_2 Restoration of the obsolete equipment by taking loans
	O_3 Renewable energy sources		
	O_4 Gasification		
	O_5 Public-Private Partnership		
	O_6 Cooperation with the EU		
	Threats (T)	ST strategies	WT strategies
	T_1 Increase in energy prices	ST_1 Improving institutional measures	WT_1 Cooperation with the local government in system renewal
	T_2 Reduction of coal use		WT_2 Introduction of a payment by consumption system
	T_3 Reducing the number of users		
	T_4 Change of legislation		
	T_5 Lower investment by state		
	T_6 Outflow of skilled labour and unemployment		
	T_7 Climate change		

Source: Veličkovska, 2019

The fourth hierarchical layer is expressed in the form of alternatives that are, in this case, given in the form of strategies for improving the operation of the district heating plant. The interdependencies of the hierarchical layers are illustrated in Fig. 2 below.

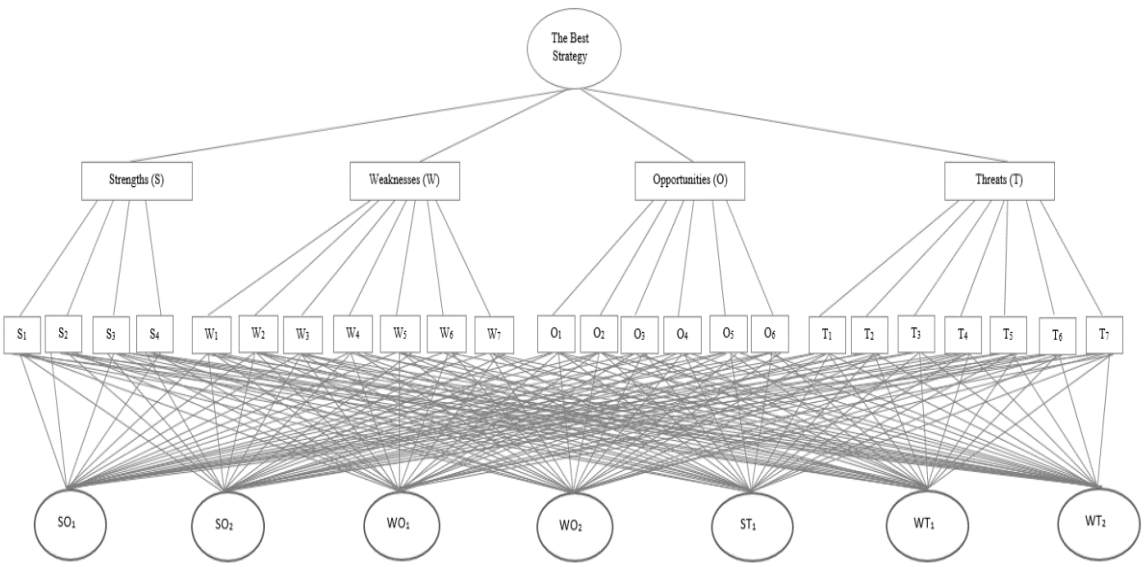

Figure 2 The structure of the AHP hierarchical model
Source: the author

3. Results

The first step in implementing AHP methodology is to calculate the priority weights of the strengths, weaknesses, opportunities and threats that were identified in the previous research. Experts from the district heating plant, who are very well informed about the current situation in the plant, estimated the weights of criteria, sub-criteria and alternatives. Scale for estimating the weights of criteria and sub-criteria is Saaty's. The results of the pairwise comparison suggest strong impact of the criterion weaknesses (0.445) on the final goal of the prioritization. In other words, weaknesses of the company are the criterion that, to the greatest extent, influence on the selection of the most appropriate strategy that will be implemented first. The obtained result was expected since the plant has suffered from inadequate investments in modern equipment and appropriate infrastructure for years. Reason for this is lack of own financial resources for realizing such great projects. The way in which the plant solves those internal problems determines how fast it will be developed. The second ranked criterion is opportunities (0.283) that are provided in the company's surrounding. Its high value implies that there are various directions for developing the plant that could be used in the form of introducing renewable energy for the district heating needs, regulating current heating prices, starting cooperation with the EU and other identified chances. Threats (0.165) are ranked as the third criterion in the pairwise comparison matrix. Threats reflect the unstable market and changing environment. Examples of those threats are possible changes of the government regulative regarding climate change and non-renewable energy sources. Another rising problem is losing a valuable number of current users which will reduce the demand for the district heating services. The fourth ranked criterion in the pairwise matrix represent strengths (0.107) that are manifested as high number of users, employed engineers that run the operating process and sufficiently good production capacity. Well-built district heating network is also a strength of the plant but in the same way is a weakness since the network covers 90% of the city but is in poor condition with many failures.

The next step is to generate pairwise comparison matrices for all sub-criteria that are presented as the third level in the AHP structural model. In total, four comparison matrices were generated, for each criterion, and experts evaluated their elements quantitatively. The results of the comparisons are showed in Table 2.

Empirical evidence of the comparison shows the reciprocal importance of sub-criteria on the local level. Then, global importance of sub-criteria are calculated by multiplying the local importance of the each sub-criterion with the importance of the relevant criterion. By observing the results of the local importance of the sub-criteria, it can be seen that the most influencing sub-criteria of each group criteria are arranged descending as $S_3>O_1>W_4>T_3$. After adding the value of the criteria to the value of the sub-criteria the same local sub-criteria remain as the most important but their values have adjusted causing change in their descending sequence to $W_4>O_1>S_3,T_3$. Sub-criterion S_3 and T_3 share the same weight (0.055). Comparatively with calculating pairwise matrix, the consistency ratio was determined for all criteria and sub-criteria matrices. CR for criteria is reported in Table 2, where it can be seen that it equals less than 10% which is the threshold for achieving consistency. CR for sub-criteria was also calculated and it equals less than 10% for all pairwise comparison matrices.

After calculating the importance of sub-criteria, the importance of each sub-criterion towards alternatives that are demonstrated in the Fig. 2 was considered. Using a quantitative scale, experts evaluated the relationship among all alternatives with respect to the perceived sub-criteria. According to the sub-criteria, alternatives that were highly rated are SO_1, WO_2 and WT_2. The last step in implementing AHP is performing final prioritization of alternatives with respect to the primary goal. The results of the final prioritization are compared with the results of the FAHP methodology.

Further prioritization of the employed alternatives is done using the AHP methodology in the fuzzy environment and the results are presented in the following part of the research. The basic step in applying FAHP is calculating priority weights of criteria that were presented in the Fig. 2. The difference related to the previously applied AHP can be found in the use of triangular fuzzy number (FTN).

Table 2 Results of the pairwise comparison of the each SWOT criterion and sub-criterion using the AHP method

SWOT groups - criterion	The importance of the SWOT criterion	SWOT sub-criterion	Local importance of SWOT sub-criterion	Global importance of SWOT sub-criterion
Strengths (S) CR=0.05	0.107	S_1	0.219	0.023
		S_2	0.177	0.019
		S_3	0.516	**0.055**
		S_4	0.088	0.009
Weaknesses (W) CR=0.08	0.445	W_1	0.179	0.080
		W_2	0.157	0.070
		W_3	0.125	0.056
		W_4	0.337	**0.150**
		W_5	0.089	0.039
		W_6	0.068	0.030
		W_7	0.044	0.020
Opportunities (O) CR=0.07	0.283	O_1	0.366	**0.104**
		O_2	0.200	0.057
		O_3	0.162	0.046
		O_4	0.080	0.023
		O_5	0.052	0.015
		O_6	0.140	0.040
Threats (T) CR=0.09	0.165	T_1	0.129	0.021
		T_2	0.201	0.033
		T_3	0.331	**0.055**
		T_4	0.159	0.026
		T_5	0.089	0.015
		T_6	0.052	0.009
		T_7	0.040	0.007

Source: the author

FTNs allow deeper analysis because the calculation procedure is done for lower (l), middle (m) and upper (u) priority weights. Pairwise comparison matrix for criteria presented in the Table 3 highlights weaknesses as the most important criterion in choosing the best alternative, followed by opportunities, threats and strengths successively.

After computing the fuzzy priority weights of the criteria, the next step is to calculate fuzzy local and global importance of sub-criteria.

Table 3 Results of the pairwise comparison of the each SWOT criterion and sub-criterion using the FAHP method

SWOT groups - criteria	The importance of the SWOT criteria	SWOT sub-criterion	Local importance of SWOT sub-criterion	Global importance of SWOT sub-criterion
Strengths (S)	(0.117, 0.098, 0.112)	S_1	(0.192, 0.218, 0.229)	(0.023, 0.021, 0.026)
		S_2	(0.173, 0.170, 0.187)	(0.020, 0.017, 0.021)
		S_3	(0.542, 0.525, 0.491)	(**0.064, 0.052, 0.055**)
		S_4	(0.093, 0.087, 0.093)	(0.011, 0.009, 0.010)
Weaknesses (W)	(0.437, 0.449, 0.417)	W_1	(0.172, 0.190, 0.192)	(0.075, 0.085, 0.080)
		W_2	(0.157, 0.159, 0.161)	(0.069, 0.071, 0.067)
		W_3	(0.122, 0.123, 0.132)	(0.053, 0.055, 0.055)
		W_4	(0.350, 0.336, 0.311)	(**0.153, 0.151, 0.130**)
		W_5	(0.085, 0.085, 0.091)	(0.037, 0.038, 0.038)
		W_6	(0.070, 0.067, 0.074)	(0.031, 0.030, 0.031)
		W_7	(0.045, 0.040, 0.040)	(0.020, 0.018, 0.017)
Opportunities (O)	(0.279, 0.287, 0.295)	O_1	(0.365, 0.360, 0.337)	(**0.102, 0.103, 0.099**)
		O_2	(0.192, 0.208, 0.208)	(0.054, 0.060, 0.062)
		O_3	(0.160, 0.165, 0.174)	(0.045, 0.047, 0.051)
		O_4	(0.085, 0.079, 0.081)	(0.024, 0.023, 0.024)
		O_5	(0.056, 0.050, 0.050)	(0.016, 0.014, 0.015)
		O_6	(0.142, 0.137, 0.150)	(0.040, 0.039, 0.044)
Threats (T)	(0.166, 0.166, 0.175)	T_1	(0.124, 0.121, 0.123)	(0.021, 0.020, 0.022)
		T_2	(0.203, 0.214, 0.214)	(0.034, 0.035, 0.038)
		T_3	(0.339, 0.336, 0.320)	(**0.056, 0.056, 0.056**)

		T_4	(0.159, 0.161, 0.167)	(0.026, 0.027, 0.029)
		T_5	(0.084, 0.081, 0.084)	(0.014, 0.013, 0.015)
		T_6	(0.050, 0.050, 0.052)	(0.008, 0.008, 0.009)
		T_7	(0.040, 0.037, 0.039)	(0.007, 0.006, 0.007)

Source: the author

The pairwise comparison matrix was evaluated with TFN values. The results of local and global pairwise comparisons, presented in Table 3, identify sub-criteria S_3, W_4, O_1 and T_3 as the most influencing for alternatives prioritization. Furthermore, FAHP method considers fuzzy pairwise comparisons among alternatives in relation to the sub-criteria. The final step in the AHP and FAHP methodology is to perform the prioritization of the proposed alternatives in order to select the best alternative for reaching the strategic management of the district heating plant. For that purpose, fuzzy priority weights of the alternatives were converted into crisp values so that the results of AHP and FAHP could be compared. The results of the prioritization are presented in the Table 4 for both AHP and FAHP methods. AHP method ranked alternative WT_2 (0.183) as the best alternative with respect to the goal of the prioritization. The second ranked is the alternative WO_1 (0.178), while the third ranked is the alternative WO_2 (0.169). Ranking performed using the FAHP method provides oscillations in the results in comparison with the AHP. The most preferred alternative is the alternative WO_2 (0.219), the second ranked alternative is the alternative WT_2 (0.194) and the third ranked is the alternative WO_1 (0.189). Other alternatives ST_1, WT_1, SO_1, and SO_2 are ranked as the 4th, 5th, 6th and 7th in both cases, AHP and FAHP. Empirical evidence suggest that alternatives emerged from the weaknesses of the district heating plant and threats and opportunities that come from the external sources need to be implemented with high priority.

Table 4 Final prioritization of alternatives for improving the operation of the district heating power plant using the AHP and fuzzy AHP method

Alternatives	AHP		Fuzzy AHP	
	Weight (*wj*)	Rank	Weight (*wj*)	Rank
SO_1	0.132	6	0.136	6
SO_2	0.060	7	0.065	7
WO_1	0.178	2	0.189	3
WO_2	0.169	3	0.219	**1**
ST_1	0.144	4	0.159	4
WT_1	0.134	5	0.137	5
WT_2	0.183	**1**	0.194	2

Source: the author

The sequence of their implementation is presented in the Table 4 in the ranking column. Priority weights for the alternatives WT_2 and WO_1 have approximate values so realizing them simultaneously should be considered. The same conclusion was reached for alternatives WT_1 and SO_1. It has to be highlighted that moving from a previous to the next strategy depends on the effects that current strategy is achieving on the plant's operation.

Fuzzy environment of the AHP methodology emphasises the strategy to restore the old equipment of the plant by using financial services from the bank. This strategy is ranked the first, since it is evident the problem of the outdated technology and following infrastructure that is needed for the heating supply. Since the lack of financial resources is another weakness of the plant, the capital for this investment needs to be acquired from external financing sources. Experts evaluated this strategy as the initial step in developing strategic management in the district heating plant. Most of the identified weaknesses will be solved by investing in technology and infrastructure. New technology would provide higher level of process automation and reduce the number of failures that are frequent in the heating season. The problem of frequent failures of the heating supply is causing many other challenges since all repairs take up financial and human resources. Therefore, the maintenance process is extended and production costs are increased due to the heating system failure and longer preparation time.

After implementing the strategy, the first ranked strategy to renew the technology and infrastructure, the next step is to change the collection policy of the district heating plant. This represents a significant responsibility for the management of the plant, since the current payment system is described as inadequate and unsustainable. The general problem is seen in the higher heat supply and lower payment by consumers, resulting in the deficit in the disposable financial resources. The proposed idea is to change from collection by heated area measured in square meters, to the collection by the provided heating temperature. This could result in large energy savings since all consumers will use the heating services only in the area that they utilize and set the temperature according to

their needs. In this way, consumers will have control over their consumption.

The new payment system will provide benefits for both, the heating supplier and the heating consumer. Since the local heating system covers 90% of total heat consumers, the district heating network is complex and long. Therefore, financial resources from the bank cannot be enough to solve all network problems at once because it would mean very high debt and insufficient resources to pay it off. So, the next strategy that would be implemented is the strategy relying on modernization of technology from the EU funds. As a country in the process of accession to the EU Serbia has achieved cooperation with the EU and has few energy projects that aim towards improving energy efficiency. The management of the district heating plant that is a part of the public sector in Serbia should plan to negotiate with the government to create the possibility to access the funds allocated for improving energy efficiency. These financial resources would be used to further modernize the technology needed for the heating supply.

The next problem that needs to be handled is the problem of losing consumers. Strategy that is constructed to solve this problem is the strategy regarding improvement of institutional measures. The plant is facing a big challenge that is lowering the number of heat consumers. The reasons for this unfavourable number are numerous and can be found in dissatisfaction of consumers arising from low quality services. Low quality of heating services is reported in periods of high failures of the heating network. Hansen et al. (2019) investigated the problem of heat loss in the heat distribution and in the households. Their study suggests that district heating network is competitive in the area where there is high heat demand and high density, but do not recommend the use of district heating network in low density areas where the demand for heat is low. The majority of the former heat consumers in the investigated area are living in buildings where district heating network exists and are still using the services from the plant in a passive form without paying any financial compensation. In addition, disconnection from the district heating grid is free of charge. Therefore, the experts from the plant should revise their consumer's behaviour policies and take into account the reported problems to find the right institutional measures in response.

Moreover, the management of the district heating plant should initiate cooperation with the local government to renew the district heating system. The district heating plant is the only one responsible for the heating season in the city so collaboration between the plant and the municipality could result in developing the infrastructure needed for improved heating supply. The outcome of this collaboration would be secured heating supply of the local population.

When all previous strategies are realized, the management of the plant could consider transition from coal as fuel for the district heating to renewable energy resources. This strategy is very attractive due to the rising climate problems and unsustainable resource use. Serbia owns coal mining companies and the use of coal is secured for years but the national energy policies report the need for increasing the share of renewables in the heating supply. Therefore, this strategy is in accordance with the energy goals of the country.

The least preferred strategy is finding a strategic partner. The experts from the plant evaluated this strategy as the last choice to improve the strategic management. If the management of the plant could improve the current technology and allocate financial resources for further development, there would be no need for partnership because the plant would have sustainable business results.

Conclusion

This work aimed to propose an integrated SWOT-AHP-FAHP framework for providing support in the decision-making process for solving problems related to efficient heat supply. The example of a district heating plant that was the subject of the research served to implement MCDM methods to reveal the leading challenges in the operating process, detect the most important opportunities provided in the external environment and notice the biggest threats. The main reason for employing MCDM methods can be found in the fact that this methodology is always a good choice when the decision has to be made in a complex environment. In the research, multi-criteria decision-making was used to guide the selection of the best strategy to improve the operation of the local district heating plant. So, before making any strategic decision regarding the plant it is necessary to perceive current inner situation in the plant. Since the plant is providing its services to the local population, public and private sector, the impact that outer environment is making on the

operating performances of the plant has to be considered. Therefore, SWOT is seen as a great tool for analysing internal and external environment of this energy system. The constructed hybrid model is seen as the first step in providing efficient heat supply in the district heating plant.

The main phases of this research are summarized in the following part.

As mentioned above, conducting the SWOT analysis represents the first phase in the research study. It was employed to gather data about the current situation in the internal and external environment of the district heating plant. Acquiring those data is of great importance because they provide many useful information for the decision makers and clarify their attitude towards the decision problem. The outcome of the SWOT analysis was used to construct TOWS matrix that represents the second phase in the research study. In this case, TOWS matrix was formed by pairing SO, WO, ST and WT elements that are integral parts of the SWOT analysis. The empirical evidence suggest seven alternatives that emerge as the result of combining elements in the TOWS matrix. All seven alternatives were interpreted in the form of strategies that are going to be used to solve the most important problems in the plant and to improve its operation. Described strategies cope with the most important question for the future of the plant such as the transition to the use of renewable energy sources instead of coal. This issue is related to the management of the natural resources and its rational use. Another burning question in this plant is the problem of the outdated technology and supporting infrastructure that cause many related issues in the operating process. The problem with the poor technology development in the plant is the reason for majority of the identified weaknesses. The SWOT analysis revealed another important difficulty for the plant that is further developing of customer and service policy since this area is missing the exact regulation of the customer's behaviour. Finally, the last discussed problem that is highly important is introducing the concept of payment by consumption system. This system allows the customers to control their consumption and optimize the heating temperature. It is already implemented in the EU and it should be implemented in the plant since it will make the balance between the input resources in the plant and outcomes, providing a large share of satisfied consumers.

The third phase in the research study is to construct a hierarchical model of the decision-making problem that is needed for describing the internal connections between criteria, sub-criteria and alternatives to the primary goal. The AHP hierarchical model consists of four levels. The results of the AHP method suggest SWOT criteria weaknesses (W) as the most important criteria for the final prioritization of alternatives, followed by opportunities (O). Furthermore, the outcome of the sub-criteria prioritization highlights S_3, W_4, O_1, and T_3 as the most influencing sub-criteria on the alternative's selection. Final prioritization of the alternatives revealed alternatives WT_2, WO_1, WO_2 as highly important for the goal of the prioritization that is to support strategic management in the district heating plant. The fourth phase represents the implementation of AHP method in the fuzzy environment using TFN. FAHP results provide the same highlights as AHP method. Empirical evidence suggest weaknesses (W) as determining criterion for the alternative's prioritization. The most influential criteria are S_3, W_4, O_1, and T_3, with variation in the priority weights in comparison with the AHP results. WO_2, WT_2 and WO_1 are ranged as the top three alternatives with the highest priority weights. Translating TFN values of the priority weights in fuzzy environment into the crisp values it was enabled to compare outcomes of the two methods. Except the change of the priority of top three alternatives, there are no major variations in the results obtained by the AHP and FAHP methods. The proposed strategies should be implemented simultaneously. Considering how effective the previous strategy was, the management should make a decision whether to implement the next strategy or to hold on the current.

The main scientific finding in this paper is recognized in constructing a multi-criteria decision-making model based on SWOT, AHP and fuzzy AHP methods. The value of this model can be found in its implementation across the energy sector in Serbia and other developing countries that are facing similar problems such as lack of financial resources, poor technology development and use of non-renewable energy sources. The model is highly flexible and allows to be adapted to different criteria and alternatives that emerge in heterogeneous decision-making problems. Regarding the future research, the author should consider applying other MCDM

methods to resolve similar problems that appear in the energy sector.SM

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✉ **Correspondence**

Ivana Veličkovska

Mathematical Institute of the Serbian Academy of Sciences and Arts
Kneza Mihaila 36, 11000, Belgrade, Serbia

E-mail: ivana993@turing.mi.sanu.ac.rs

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Profitability management of tourism sector in AP Vojvodina

Vera Mirović
University of Novi Sad, Faculty of Economics in Subotica, Subotica, Serbia
https://orcid.org/0000-0002-1465-4692
Branimir Kalaš
University of Novi Sad, Faculty of Economics in Subotica, Subotica, Serbia
https://orcid.org/0000-0002-9141-7957
Nada Milenković
University of Novi Sad, Faculty of Economics in Subotica, Subotica, Serbia
https://orcid.org/0000-0001-9810-3021
Jelena Andrašić
University of Novi Sad, Faculty of Economics in Subotica, Subotica, Serbia
https://orcid.org/0000-0003-3941-1184

Abstract
Tourism plays an increasingly important role in the economic flows of each country. Recognizing the tourist potential of AP Vojvodina is an important task for the creators of the economic policy of our country. In order to make a favourable tourism environment with quality tourist content and products, it is necessary for tourist entities to operate stably and successfully. The aim of this paper is to highlight the importance of financial performance of firms in tourism sector in terms of profitability. The subject of the paper is to analyse the effects of internal factors on profitability level of 3456 firms in tourism sector in AP Vojvodina for the period 2015-2019. The results of the analysis indicate that observed firms were profitable during the analysed period, where average ROA was 1.81% and average ROE was 3.4%. Empirical analysis shows that internal factors such as firm size, sales revenue, earnings before interest and taxes and financial stability have positive impact on profitability, while liquidity and debt negatively affect the profitability of firms in tourism sector.

Keywords
profitability, tourism, sector, AP Vojvodina

Introduction

The tourism sector has a significant role as a source of economic growth in most economies in the world (Dimitropoulos, 2017). Namely, tourism sector represents an important potential of any national economy where a positive trend in tourism revenue has a significant role in realizing macroeconomic goals and social welfare (Milenković, Andrašić & Kalaš, 2017). Rodríguez-Díaz and Rodríguez-Díaz (2018) indicate that governments favour this sector because of its significant contribution to the gross national product. Since an ever-increasing number of people wants to travel, primarily in foreign country, tourism manifests one of the fastest-growing industry in the world (Pavković, Jević, Jević, Nguyen & Sava, 2021). Tourism industry is among the world fastest growing industries, generating substantial economic benefits, as well as contributing to employment and stimulating investments (Dimitrić, Tomas Živković, & Blecich, 2019). Similarly, Bazargani and Kiliç (2021) argue that this sector is one of the main sectors of the world economy that contributes to employment, higher revenue level and promotion of economic prosperity. Sharpley (2020) highlighted the position of tourism sector in economic structure and concept of sustainable development based on the premise of economic

growth. Tourism is an important economic engine and enables socioeconomic development, generating employment opportunities (Usmani, Akram & Praveen, 2020).

The structure of this paper is as follows. After the introduction, there is a literature review which includes previous theoretical and empirical studies that have analysed profitability determinants in the tourism sector. The second part presents the characteristics and state of tourism sector in AP Vojvodina from the aspect of tourist arrivals, number of employees and financial performance of the observed firms. The third segment indicates data and methodology, and includes variables and econometric procedures for adequately created regression model. The last segment reports empirical results in terms of estimating the impact of internal factors on profitability in tourism sector of AP Vojvodina for the period 2015-2019.

1. Literature review

There are many empirical studies that have analysed profitability determinants in tourism sector (Agiomirgianakis, Magoutas & Sfakianakis, 2013; Ben Aissa & Goaied, 2016; Mijić & Jakšić, 2017; Alarussi & Alhaderi, 2018). Profitability is often measured by return on assets (Macas Nunes, Serrasqueiro & Sequeira, 2009; Stierwald, 2010; Skuflić & Mlinarić, 2015; Tan, 2017, Dimitrić et al., 2019).

Agiomirgianakis et al. (2013) analysed the profitability of 134 hotels in Greece for the period 2006-2010. Their results identified size and leverage as two significant factors that have positive impact on profitability of firms in tourism sector. Ben Aissa and Goaied (2016) investigated 27 Tunisian hotels for the period 2000-2010 and their results showed positive relationship between efficiency and profitability for the observed period. Further, their analysis indicate that debt has positive impact on profitability, while size negatively affect the profitability measured by ROA. Mijić and Jakšić (2017) investigated the relationship between indebtedness and profitability for companies in the Republic of Serbia for the period 2009-2013. Their findings showed negative correlation between these variables. Alarussi and Alhaderi (2018) investigated 120 companies listed on Bursa Malaysia from 2012 to 2014. Their findings showed a strong positive relationship between size, company efficiency and profitability, as well as a negative relationship between debt to leverage ratio and profitability. Finally, variable liquidity has no significant impact on profitability of the analysed firms in Malaysia for the observed period. Lado-Sestayo, Otero-González, Vivel-Búa & Martorell-Cunill, (2016) showed that profitability depends largely on the market structure and the level of demand of the tourist destination. Further, Lado-Sestayo and Vivel-Búa (2018) identified that higher profitability of hotels depend on characteristics, location, competitive environment and tourist destination. Menicucci (2018) researched 2366 hotels in Italy for the period 2008-2016 and found that business model, ownership structure and financial structure affect the profitability. Also, factors such as size, location, accommodation and internationalization have positive impact on profitability level.

2. Characteristics and state of tourism sector in AP Vojvodina

Tourism industry in Serbia and region countries such as Croatia, Hungary, Romania and Slovenia reflect great interest in business tourism development (Kalaš, Mirović &Pavlović, 2019).

Bearing in mind that tourism development requires natural resources, sustained environment, cultural and historic heritage, Serbia has a chance to improve competitive tourism position on the world level by developing tourism products (Pavlović & Đeri, 2016). For example, Markus, Perovic, Pekovic &Popovic (2019) indicate that from the earliest stages of tourism development, sport-recreational activities have a great role and significance in creating and designing tourist services. On the other hand, Moric, Pekovic, Vukčević, Perović & Grisbeck (2021) highlighted the importance of cultural tourism and community engagement. Development model of AP Vojvodina should focus on (Provincial Secretariat for Economy and Tourism, 2018):

a) agricultural production focused on high quality wine and other products with high added value in order to enable better position in tourism market at global level; b) develop brand elements, system of quality labels and protection mechanisms for all possible products in parallel; c) initiate urban rehabilitation and development of Novi Sad and other major urban centres of Vojvodina; d) improve the product of culture, presentation of cultural contents by applying modern technologies, and use national and EU funds; e) further develop the infrastructure and marketing of the navigable flows of the Danube, Sava, Tisa, Tamiš and canal network, because of their vitality for traffic access.

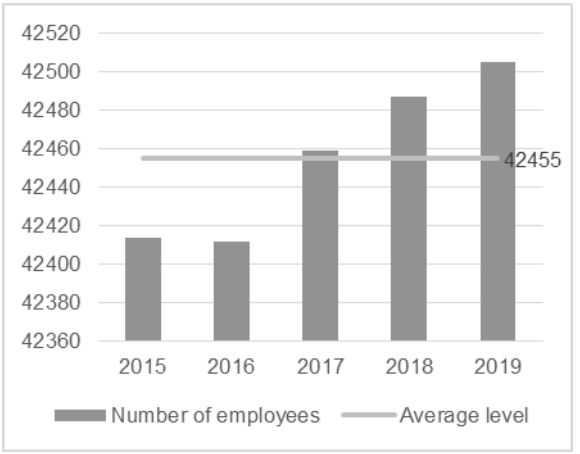

Figure 1 The number of employees in tourist sector in AP Vojvodina
Source: the authors

The average number of employees in tourist sector in AP Vojvodina is 42455 during the analyzed period 2015-2019. In last five years, the number of employees is increased by only 91 which is insignficant growth during the observed period.

Table 1 Tourist arrivals at regional level

Tourist arrivals	Belgrade region	Vojvodina region	Šumadija and Western Serbia region	South and East Serbia region
Domestic	201770	287419	950289	403954
Foreign	1056578	274238	309396	206339
Total	1258348	561657	1295685	610293

Source: the authors

Analyzing the number of tourist arrivals according to the regional approach, it is noticeable that the largest number of tourists visited Belgrade (1258348) in 2019. The next region is Šumadija and Western Serbia with 1295685 tourists, while the lowest number of tourists visited Vojvodina in the observed year. After presenting the position of tourist sector at the national level, the research analyzes two sector in tourism of AP Vojvodina: sector 55 (accommodation) and sector 56 (serving and preparing food and beverages).

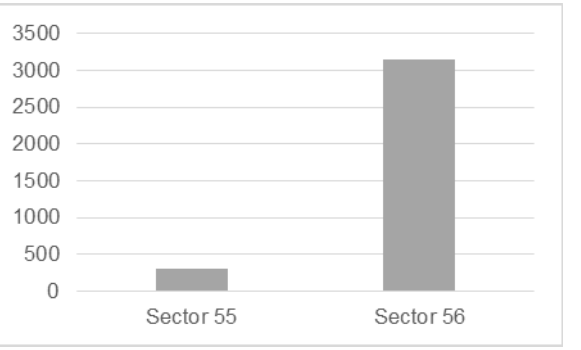

Figure 2 The number of employees by tourist sector structure AP Vojvodina
Source: the authors

Based on observed 3456 firms from tourism sector in AP Vojvodina, we can notice that sector 56 accounts for 3148 firms or 91.09% of the total number of firms in tourist sector.

2.1. Financial performance of tourism sector in AP Vojvodina

Profitability indicators are used to measure the ability of sale revenues and assets of the firms to achieve a positive business result. Profitability can be measured by gross profit margin, net profit margin, as well as return on assets and return on capital. Return on assets is an indicator of managerial efficiency that defines earning ability related to investment in total assets (Andrašić, Mijić, Mirović, & Kalaš, 2018).

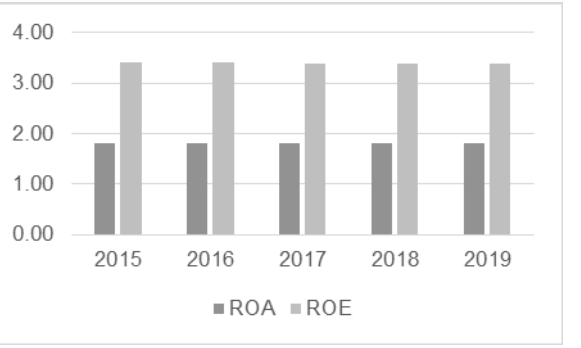

Figure 3 Profitability indicators of tourism sector in AP Vojvodina
Source: the authors

In order to define profitability level of firms from tourism sector in AP Vojvodina, we measured ROA and ROE as two most important indicators of profitability. The results of analysis manifest stable trend of both indicators, where ROA and ROE were at level of 1.81% and 3.4%.

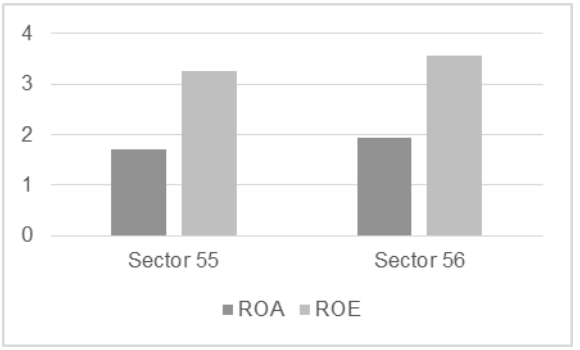

Figure 4 Comparative analysis of profitability in tourism sector in AP Vojvodina
Source: the authors

Figure 4 shows a comparative overview of companies from sector 55 and companies from sector 56 from the aspect of average profitability level. As it can be seen, firms from sector 56 were more profitable with average ROA of 3.56% and average ROE of 1.93%. On the other hand, firms from sector 55 had lower average return on assets and return on capital during the observed period.

3. Methodology and data

This study analyses 3456 firms from tourist sector in AP Vojvodina from 2015 to 2019. The sample of tourist sector includes firms from sector 55 (accommodation) and firms from sector 56 (serving and preparing food and beverages) which have the obligation to disclose their financial statements publicly.

Table 2 Variable definition

Variable	Note	Calculation
Dependent variable		
Return on assets	**ROA**	Net income/Total asset
Independent variables		
Firm size	**SIZE**	Logarithmic value of the total assets
Sales revenue	**SR**	(Sales revenue$_t$ – Sales revenue $_{t-1}$) /Sales revenue $_{t-1}$
Earnings before interest and taxes	**EBIT**	Operating revenues – Operating expenses
Current liquidity	**CL**	Current assets/Current liabilities
Debt	**DBT**	Total liabilities/Capital
Financial stability	**FS**	Long-term assets/Long-term debts

Source: the authors

The model can be presented as:

$$ROAt=\beta_0+\beta_1 SIZE_t+\beta_2 SR_t+\beta_3 EBIT_t+\beta_4 CL_t + \beta 5DBTt+\beta 6FSt\ldots+et$$

where:

ROA – return on assets; SIZE – firm size; SR – sales revenue; EBIT – earnings before interest and tax; CL – current liquidity; DBT – debt; FS – financial stability; β0 – the constant term; β – the coefficient of the independent variables; e – the error term of the equation

4. Empirical analysis and results

Before regression analysis, the study includes descriptive statistics of explanatory variables, as well as correlation analysis in order to determine the character and intensity of their relationship.

Table 3. Descriptive statistics

Variable	Mean	Maximum	Minimum	Std. Dev.
SIZE	28225	1288963	10	8.433
SR	16921.5	744814.01	4	4.577
EBIT	673.744	134972.52	-64495.01	7.156
CL	1.951	4.692	0.833	6.166
DBT	0.621	1.122	0.464	0.535
FS	0.200	0.719	0.006	2.813
ROA	1.81	7.661	-4.181	0.396

Source: the authors

Table 3 shows descriptive analysis of selected variables (company size, sales revenues, earnings before interest and taxes, current liquidity, debt, financial stability and profitability) for 3456 firms from the tourism sector in AP Vojvodina. Based on descriptive analysis, we can see that observed companies are liquid, with average current liquidity ratio 1.95. Also, observed firms had mean profitability level of 3.4%, while average values of debt and financial stability are below 1. This means that these companies do not have problems with debt and financial stability. Further, the highest standard deviation is identified at variables SIZE, EBIT and CL, which implies the largest oscillations in values for the selected period 2015-2019.

Table 4 Correlation matrix

Var.	ROA	SIZE	SR	EBIT	CL	DBT	FS
ROA	1.000	0.364*	0.359*	0.212*	-0.158*	-0.223*	0.135*
SIZE	0.364*	1.000	0.086*	0.032	0.077*	-0.001	0.027
SR	0.359*	0.086*	1.000	0.123*	-0.064*	-0.163	0.002
EBIT	0.212*	0.032	0.123*	1.000	-0.037*	-0.051*	0.249
CL	-0.158*	0.077*	-0.064*	-0.037*	1.000	-0.518*	0.086*
DBT	-0.223*	-0.001	-0.163	-0.051*	-0.518*	1.000	-0.099*
FS	0.135*	0.027	0.002	0.249	0.086*	-0.099*	1.000

Source: the authors

Table 4 presents the correlation between explanatory variables for companies from the tourism sector in AP Vojvodina. The results of correlation analysis show a statistically significant relationship between internal factors such as firm size, sales revenue, EBIT, liquidity, debt and financial stability and profitability measured by return on assets. Analysing the character of their relationship, we can see that company size, sales revenue, EBIT and financial stability are positively correlated with profitability, while the relationship between liquidity, debt and profitability is negative.

The application of the model should reveal how internal factors affect the profitability of companies from the tourism sector in AP Vojvodina. In order to ensure adequate modelling, it is necessary to perform testing potential multicollinearity, heteroscedasticity and model specification.

Table 5. Validity tests of model specification

Variable	VIF	1/VIF
SIZE	1.11	0.887
SR	1.36	0.726
EBIT	1.02	0.981
CL	1.38	0.727
DBT	1.01	0.988
FS	1.36	0.726
Mean VIF test	1.21	
Breusch-Pagan/Cook-Weisberg test	Chi2 (1) = 0.32	
	Prob > chi2 = 0.148	
Ramsey RESET test	F (3,3447) = 3.04	
	Prob > F = 0.2080	

Source: the authors

The results of multicolinearity, heteroscedasticity and model specification show that the presented model is adequately developed. The average value of VIF test is 1.21, which means that there is no problem of multicolinearity between selected variables. Also, the results of BP/CW test manifest that the null hypothesis about residual heteroscedasticity as well as the presence of a serial correlation between observed variables can be rejected. Finally, the results of the RR test demonstrate that regression model is properly specified since the value is above 0.05.

Table 6. Multiple regression model

Source	SS	df	MS	Number of observations	3456
Model	51.492	5	10.298	F (5,3450)	72.15
Residual	492.440	3450	0.143	Prob > F	0.000
Total	543.932	3455	0.157	R-squared	0.494
				Adj R-squared	0.487
				Root MSE	0.378

ROA	Coef.	Std. Err.	T	P>|t|	[95% Conf. Interval]	
SIZE	0.235	0.036	4.49	0.000	0.001	0.004
SR	0.111	0.002	2.56	0.001	0.002	0.003
EBIT	0.013	0.003	11.97	0.000	0.002	0.003
CL	-0.007	0.002	3.17	0.002	0.003	0.011
DBT	-0.256	0.026	-9.61	0.000	-0.307	-0.203
FS	0.001	0.003	0.44	0.659	0.004	0.007
C	0.271	0.021	13.02	0.000	0.229	0.311

Note: return on assets - ROA, company size – SIZE, sale revenues – SR, earnings before interest and taxes - EBIT , current liquidity – CL, debt – DBT, financial stability – FS

Source: the authors

The results of multiple regression model show that all explanatory variables, except variable FS, have a statistically significant impact on profitability of firms from the tourism sector in AP Vojvodina. Namely, variables SIZE, SR and EBIT have a positive effect on the ROA of observed firms, while CL and DBT negatively affect the profitability level measured by ROA. Analysing the intensity of the impact, the change in variables SIZE and DEBT leads to the largest change in ROA during the observed period. More

precisely, the growth of variable SIZE by 1% causes an increase in ROA by 0.23%, where higher level of debt by 1% leads to decrease in ROA by 0.26%. Further, the growth of variables such as SR and EBIT by 1% increase profitability by 0.11% and 0.01% respectively. On the other side, if firms increase liquidity level by 1%, their profitability will be smaller by 0.07%.

Conclusion

The subject of paper includes the analysis of tourist sector in AP Vojvodina for the period 2015-2019. The tourism sector covers sector 55 (accommodation) and sector 56 (servicing and preparing food, beverages) and includes 3456 firms. The sector 56 (accommodation) covers 3148 firms or 91.09% of the total number of observed firms, while sector 55 (servicing and preparing food and beverages) covers 308 firms or 8.91% of the total number of analysed firms. This research implies descriptive analysis of profitability of the observed firms during last five years. Also, correlation analysis and multiple regression are applied in order to identify potential relationship between internal factors and profitability, as well as their effects on business success. It can be noticed that firms from tourist sector were profitable, where average ROA was 1.81%. Further, the results revealed that firms from sector 56 were more profitable with average ROA of 3.56% and average ROE of 1.93%. The correlation analysis shows a statistically significant relationship between internal factors such as firm size, sales revenue, EBIT, liquidity, debt and financial stability and return on assets as a proxy for profitability. Results of multiple regression model show that growth of firm size by 1% increases profitability by 0.23%. Similarly, sales revenue and earnings before interest and taxes affect profitability positively. On the other hand, debt and liquidity have negative impact on profitability, where their growth by 1% decreases profitability by 0.26% and 0.07%. These results confirm interdependence between liquidity and profitability, where higher level of liquidity implies lower profitability. The contribution of this paper is to enable IT support to management of firms in tourism sector, whose internal factors are significant for profitability level in the tourism sector.SM

Acknowledgement

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✉ **Correspondence**

Branimir Kalaš

Faculty of Economics in Subotica
Segedinski put 9-11, 24000, Subotica, Serbia
E-mail: branimir.kalas@ef.uns.ac.rs

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According to Mirković (2001, p. 201), "The use of data warehouses may be limited, especially if they contain confidential data".

Mirković (2001, p. 201), found that "the use of data warehouses may be limited". What unexpected impact does this have on the range of availability?

If the author is not named in the introductory phrase, the author's last name, publication year, and the page number in
parentheses must be placed at the end of the quotation, e.g.

He stated, "The use of data warehouses may be limited," but he did not fully explain the possible impact (Mirković, 2001, p. 201).

➲ **Summary or paraphrase**

According to Mirković (1991, p. 201), limitations on the use of databases can be external and software-based, or temporary and even discretion-based.

Limitations on the use of databases can be external and software-based, or temporary and even discretion-based
(Mirković, 1991, p. 201).

➲ **One author**

Boškov (2005) compared the access range…

In an early study of access range (Boškov, 2005), it was found...

➲ When there are **two authors**, both names are always cited:

Another study (Mirković & Boškov, 2006) concluded that…

➲ If there are **three to five authors**, all authors must be cited the first time. For subsequent references, the first author's
name will be cited, followed by "et al.".

(Jovanov, Boškov, Perić, Boškov, & Strakić, 2004).

In subsequent citations, only the first author's name is used, followed by "et al." in the introductory phrase or in parentheses: According to Jovanov et al. (2004), further occurences of the phenomenon tend to receive a much wider media coverage.

Further occurences of the phenomenon tend to receive a much wider media coverage (Jovanov et al., 2004). In "et al.", "et" is not followed by a full stop.

➲ **Six or more authors**

The first author's last name followed by "et al." is used in the introductory phrase or in parentheses:

Yossarian et al. (2004) argued that…

… not relevant (Yossarian et al., 2001).

➲ **Unknown author**

If the work does not have an author, the source is cited by its title in the introductory phrase, or the first 1-2 words are placed in the parentheses. Book and report titles must be italicized or underlined, while titles of articles and chapters are placed in quotation marks:

A similar survey was conducted on a number of organizations employing database managers (Limiting database
access, 2005).

If work (such as a newspaper editorial) has no author, the first few words of the title are cited, followed by the year: (The Objectives of Access Delegation, 2007)

Note: In the rare cases when the word "Anonymous" is used for the author, it is treated as the author's name (Anonymous,
2008). The name Anonymous must then be used as the author in the reference list.

➲ **Organization as an Author**

If the author is an organization or a government agency, the organization must be mentioned in the introductory phrase or in the parenthetical citation the first time the source is cited:

> According to the Statistical Office of the Republic of Serbia (1978), …

Also, the full name of corporate authors must be listed in the first reference, with an abbreviation in brackets. The abbreviated name will then be used for subsequent references:

> The overview is limited to towns with 10,000 inhabitants and up (Statistical Office of the Republic of Serbia [SORS],
> 1978).
>
> The list does not include schools that were listed as closed down in the previous statistical overview (SORS, 1978).

➲ When citing **more than one reference from the same author**: (Bezjak, 1999, 2002)
➲ When several **used works by the same author were published in the same year**, they must be cited adding a, b, c, and so on, to the publication date:

> (Griffith, 2002a, 2002b, 2004)

➲ **Two or more works in the same parentheses**

When two or more works are cited parenthetically, they must be cited in the same order as they appear in the reference list, separated by a semicolon.

> (Bezjak, 1999; Griffith, 2004)

➲ **Two or more works by the same author in the same year**

If two or more sources used in the submission were published by the same author in the same year, the entries in the reference list must be ordered using lower-case letters (a, b, c…) with the year. Lower-case letters will also be used with the year in the in-text citation as well:

> Survey results published in Theissen (2004a) show that…

➲ To **credit an author for discovering a work**, when you have not read the original:

> Bergson's research (as cited in Mirković & Boškov, 2006)…

Here, Mirković & Boškov (2006) will appear in the reference list, while Bergson will not.

➲ When **citing more than one author**, the authors must be listed alphabetically:

> (Britten, 2001; Sturlasson, 2002; Wasserwandt, 1997)

➲ When there is **no publication date**: (Hessenberg, n.d.)

➲ **Page numbers must always be given for quotations**:

(Mirković & Boškov, 2006, p.12)

Mirković & Boškov (2006, p. 12) propose the approach by which "the initial viewpoint…

➲ **Referring to a specific part of a work**:

(Theissen, 2004a, chap. 3) (Keaton, 1997, pp. 85-94)

➲ **Personal communications, including interviews, letters, memos, e-mails, and telephone conversations**, are cited as below. (These are *not* included in the reference list.)

(K. Ljubojević, personal communication, May 5, 2008).

FOOTNOTES AND ENDNOTES

A few footnotes may be necessary when elaborating on an issue raised in the text, adding something that is in indirect connection, or providing supplementary technical information. Footnotes and endnotes are numbered with superscript Arabic numerals at the end of the sentence, like this.[1] Endnotes begin on a separate page, after the end of the text. However, *Strategic Management* Programming Board **does not recommend the use of footnotes or endnotes.**

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