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APPLICATION OF THE MAMDANI FUZZY INFERENCE SYSTEM TO MEASURING HRM PERFORMANCE IN HOTEL COMPANIES – A PILOT STUDY

Abstract. *A new method based on fuzzy logic principles for measuring HRM performance is proposed where the Mamdani Fuzzy Inference System (MFIS) as a measurement tool is used with the intention to provide a contextual approach (hotel industry) and in which a score for HRM indicators is calculated for each activity. A survey of HR managers was conducted and an expert group was included to create rules for evaluating HRM performances. Four models where domain, functions and membership rules are set for each HRM activity could be used as a template for measuring HRM performance in middle-sized hotel companies.*

Keywords: *human resource management, HRM performance measurement, hotel industry, Mamdani Fuzzy Inference System*

The purpose of this paper is to provide a different methodological framework for measuring human resource management (HRM) performance that is appropriate and useful for the hotel industry. A new method for measuring HRM performance based on fuzzy logic principles is proposed where the Mamdani Fuzzy Inference System (MFIS) as a measurement tool is used with the intention to provide a contextual approach (hotel industry) and in which the HRM score calculated for each functional category (activity) is focused on determining the validity of the fuzzy logic perspective in this field. A survey of HR managers (N = 32) was conducted and an expert group (N = 5) was included to create rules for evaluating HRM performances. Four models with domain, functions and membership rules are set for each HRM activity (recruitment, rewarding, development and retention) and the proposed methodological framework provides a template where the categories of low, average and high performance in four HRM activities in hotel companies are objectively defined. The MFIS' validity as an instrument

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for measuring HRM performance is confirmed and the paper encourages researchers to consider different approaches and methods when evaluating HRM performances. However, in future research, instead of calculating the MFIS model value average, a final MFIS model should be developed where the MFIS model for each activity would represent an input variable and should be tested on a larger sample. This study is important for positivist quantitative studies because it allows one to except and measure the 'grey zone' of reality and can be useful for comparison analysis and HRM benchmarking.

Introduction

There is a gap between scientific conclusions on human resource management (HRM) and the actual state in practice (Yeung, 2011; Huselid, 2011) and we should worry about the fact that HR managers are unfamiliar with many of the basic research findings in the field (Rynes et al., 2002). In the hotel industry, research has focused on measuring and questioning the weakness and performance of HRM (Kelliher and Johnson, 1987; Hoque, 1999; Haynes and Fryer, 2000; Lucas, 2002; Tsaur and Lin, 2004; Cho et al., 2006; Chad and Katou, 2007; Quintana-Deniz, et al., 2007; Yang and Fu, 2009; Choi and Dickson, 2010; Boella, Goss-Turner, 2013) where the configuration of research philosophy, theories and methodology are similar models from studies made in other sectors. Commitment to a particular research philosophy, ways of understanding and defining HRM concepts and performance concepts, and the quality of methodological frameworks are basic elements of measuring HRM performance at the scientific level. The focus should be on creating an approch or or developing measurement tools which are more applicative and useful in practice. Research philosophy and theory frameworks are not starting points of HR managers measurement process, which is more concentrated on obtaining results upon which they can position themselves within organisational and broader context. In the hotel industry, the strongest influences on HRM decision-making relate to the product market and ownership and a particular approach to HRM and business strategy (quality oriented) can be universally relevant within the industry (Hoque, 2000). Management style, stakeholders' needs and the perception of the key indicators of HRM operations are also elements determining HRM performance measurement in practice. Although measuring HRM performance in practice and for scientific purposes is not harmonised, what is ultimately most important is that they both serve HR leaders and decision-makers.

The complexity of measuring HRM performance is evident in the small progress made in establishing *ways* to measure the HR system (Guest, 2011),

where the key problems relate to the lack of consensus on what constitutes the correct set of HRM practices (Guest, et al., 2013). Even when the same HR practices are included in different studies, researchers may still employ dissimilar measurements (Becker and Gerhart, 1996). Various theories (e.g. contingency theory, system theory, institutional theory, the perspective of the role of behaviour, resource-based theory, attribution theory, industrial relations, the AMO framework, and stakeholders' theory) have provided bases for understanding and defining HRM wherein different approaches to measurement are developed (e.g. HR accounting, HRM balanced scorecard, universalistic, contingency and configuration approach). Despite their varying characteristics, common to all approaches to HRM evaluation is the fact they are developed on a classical set of theory principles and Boolean logic where exact determination if an element belongs to a set or not. In reality, this relationship is not always clear and exact, e.g. the answer to the question of whether HRM is successful or not does not have to be in the very domain *yes* or *no*. The intention of this paper is to move from boxes of Boolean logic (from the *yes* or *no* domain) towards fuzzy logic (within the *yes* or *no* domain). Although this study is purely positivist and seeks an exact (grade) determination of HRM activity performance in the circumstances of the hotel sector, by using the Mamdani Fuzzy Inference System (MFIS) as a measurement tool the 'grey zone' between *yes* or *no* answers is taken into account. Therefore, the basic research question of this study is: in what measure could this methodological perspective (fuzzy logic background and MFIS as a measurement tool) be useful to both scientists and HR managers? This paper is organised so that the next section provides an analysis of up-to-date approaches to measuring HRM, chronologically and according to their shared characteristics, with a focus on their logical background and differences. The next section shows a methodology framework, explains the MFIS application and gives the results. The implications for scientists and managers together with suggestions for future research are provided in the last section.

Theoretical framework

Approaches to measuring HRM

There are many reasons to measure HRM (Paauwe, 2004; Pološki Vokić, 2011), although they are growing in popularity by providing evidence that HRM systems contribute to organisational performance. Various theoretical frameworks have been discussed and surveys made in various national, sectoral and organisational contexts where the hotel industry formed part of these samples. Since the 1990s, progress has been made in HRM research

within the hotel industry. Approaches to measuring HRM in general, such as in the hotel industry, have changed from measuring the efficiency of HRM operations, developing 'best practice' indexes and creating HR multi-perspective scorecards to developing complex causal chain models. Chronologically, there are three phases (Boudreau and Ramstad, 2003):

The first phase – *HR accounting (HRA)* in the given period – showed the added value resulting from investments in various activities related to HRM end-users. Philips et al. (2001) distinguish three approaches to HRM accountability (1. Early approaches (1960s–1970s): HR Human Resource Management by objects (MBO), Employee attitude surveys, HR case studies and HR auditing, 2. Solid, value-added approaches (1970s–1980s): HR key indicators, HR cost monitoring, HR reputation and Competitive HR benchmarking and 3. Leading-edge approaches (1980s–1990s): Return on Investment (ROI) process, HR effectiveness index, Human capital measurement, HR profit centre). Developing bundles of key HR activities was very popular and involved defining a list of appropriate activities and its indicators whose sums indicate the aggregate value of HRM performance (e.g. Guest and Peccei, 1994; MacDuffie, 1995). Leading-edge approaches include more composite methods such as HR profit centre and ROI processes where Fitz-Enz's (2000) study on the ROI of human capital is the most popular. In this group, it is important to mention Svieby's Intangible Assets Monitor (1997), Watson Wyatt's Human Capital Index (1999), Mayo's Human Capital Monitor (2001) and the Guthrie Index of HRM Performance.

The second phase – *HR Dashboard* – initially focused on creating adapted versions of Kaplan and Norton's (1992) balanced scorecard for HRM based on a a) customer, b) internal/business process, c) innovation and learning, and d) financial perspective to better account for the importance of human resources. Later, Paauwe (2004) developed the 4logic HRM scorecard which is not based on a set of predefined best practices, but on achieving four fits: strategic, horizontal, organisational and environmental, where every performance perspective and every logic (strategic, societal, professional and delivery) has its own distinct set of criteria, which helps management make choices and monitor and evaluate the actions chosen. In the same period, Bowen and Ostroff (2004) introduced the concept of Strength of the HRM System and argued that a strong HRM System (when it is perceived with high distinctiveness, consistency and consensus) leads to strong situations that send a consistent message to employees about the kind of behaviours valued by the organisation and allow employees to perceive what is required and enable them to adopt the desired behaviours. In two studies, Coelho et al. (2012) confirmed that the Strength of the HRM System is empirically supported.

The third phase – *Causal Chain* – developed various models in linking

HRM variables and employee variables to financial outcomes (e.g. Boselie et al., 2005; Katou and Budhwar, 2010). Measuring HRM was initially concentrated on measuring the efficiency of HRM operations, where the focus on the HR function was observed exclusively, which could omit the value of talent. The 'best practice indexes' limitation is in using a single description of HR practices to represent an entire organisation, with the HR scorecards measuring only the "learning and growth" category while causal chains simplify reality (Boudreau and Ramstad, 2003).

According to their shared characteristics, all approaches are grouped into five clusters (Pološki Vokić, 2011): 1) measuring HRM using accounting principles (HR accounting, HR cost monitoring, HR auditing, HR cost-benefit analysis, return on investment (ROI) in HR); 2) measuring HRM using management techniques (HR case studies, HR profit centre, HR management by objectives, HR key indicators, HR scorecard, HR benchmarking); 3) measuring of individual HRM activities (by quantitative indicators); 4) aggregate evaluation of HRM (HR effectiveness index, HR profit and loss account); 5) measuring the HRM department (measuring service, quality and productivity).

In the most of these approaches, multivariate statistical methods are used (e.g. factor analysis, regression analysis, cluster analysis, path analysis and SEM) to group variables and explain the relationships between them, in which causality determination is based on probability theory where Boolean algebras are used for all. Much of what counts as social science today is based on Boolean logic with two true values 0 and 1 (Arfi, 2010). It relies on the fundamental binary relationship between an object o and a set A and there is nothing in between. That relationship of belonging is described as a *characteristic function*. If X is a universal set and $A \subseteq X$ is a subset, then characteristic function $\chi : X \rightarrow \{0,1\}$ to arbitrary element of the universe $\chi \in X$ joins the value 1 if $\chi \in A$, and value 0 if $\chi \notin A$ (true or false). On the contrary, in fuzzy sets which Zadeh (1965: 338) defined as "a class of objects with continuum of grades of membership", an element is allowed to partially belong to a set where a two-part set {0, 1} is transformed into an interval [0, 1]. Fuzzy sets are, therefore, generalisations of classical sets (Lelli, 2001) or an extension of classical set theory (Zimmerman, 2010) and in the last five decades have advanced in different ways and disciplines such as computer science, medicine, robotics, expert system and operations research such as in management science.

Measuring HRM with fuzzy logic

Fuzzy logic, in contrast to Boolean logic, allows answers to be ambiguous where boundaries are not sharply defined. The purpose of using the

instruments of linguistic fuzzy modelling is, on one hand, for exact mathematical data processing that excludes an unwanted subjective influence and, on the other, the natural expression of expertly defined vague evaluations using natural language (Zemkova and Takasova, 2011). Instead of the characteristic of crisp sets used in Boolean logic, fuzzy logic uses *membership of fuzzy sets* $\mu : A \rightarrow [0\ 1]$, where the [0 1] is a closed set of all real numbers between 0 and 1. A set A together with the corresponding membership function $\mu_A\ (x)$ is called fuzzy set $(A, \mu_A\ (x))$ which is abbreviated to only A, where $\mu_A\ (x)$ is interpreted as a possibility that element x belongs to fuzzy set A. If $\mu_A\ (x) = 1$, then x certainly belongs to fuzzy set A, if $\mu_A\ (x) = 0$, then x certainly does not belong to fuzzy set A, and if $0 < \mu_A\ (x) < 1$, then there is $\mu_A\ (x)$ degree of membership that element x belongs to fuzzy set A (Tsoukalas and Uhrig, 1996).

In studies in the tourism context, fuzzy logic and its different measurement instruments have been used, e.g. to apply a general fuzzy control model to service quality processes in the hospitality industry (Petrovic-Lazarevic and Wong, 2000), for forecasting tourist arrivals (Hadavandi, et al., 2011), for testing models of certain factors affecting the quality-customer relationship (Mousavi et al., 2011), for analysis of tourism destination competitiveness (Huang and Peng, 2012) and to select a cruise port of call location (Wang et al., 2014). In general, it is used for evaluating single HRM activity, in comparison to this pilot study in which is used for the aggregate measurement of HRM performance. Hong and Lee (1996) proposed a general learning method as a framework for automatically deriving membership functions and fuzzy 'if-then' rules from a set of given training examples. Lovrich et al. (1999) formulated a new approach to evaluating recruiters. Petrovic-Lazarevic (2001) used an analytic hierarchy procedure with a focus on the candidate selection process in order to minimise subjective assessment while selecting the right candidate for a vacant job position. The process of matching an employee with a certain job was performed through a competency-based fuzzy model in Golec and Kahys' paper (2007). By employing the fuzzy Delphi technique, Toloie-Eshlaghy and Peydaie (2011) created a model of human resources excellence in the Iranian public sector. Zemkova and Talasova (2011) demonstrated the different possible applications of fuzzy sets in HR management with attention paid to employee evaluation.

Different fuzzy tools (e.g. Fuzzy Rasch, the fuzzy-AHP method and evolutionary fuzzy systems) have been used in previous studies to evaluate the possibility of each of those values and allow the incorporation of unquantifiable information, incomplete information, unobtainable information and partial facts into the decision model (Kroemar et al., 1999). The fuzzy inference system (also called fuzzy-rule-based systems, fuzzy expert systems,

fuzzy modelling, fuzzy associative memory, fuzzy logic controllers, and simply fuzzy systems) is one of the fuzzy measurement tools that has been successfully applied in fields such as automatic control, data classification, expert systems, computer vision and decision analysis (e.g. Ohdar and Ray, 2004; Carrera and Mayorga, 2008). Until now it has not been used in measuring HRM performance in general and in the hotel business environment as a specific part of tourism. Only large hotel companies can allow themselves to experiment with HRM practices (Hoque, 1999) and in large hotel companies there is a formal HRM department, which is the biggest reason this paper is concentrated on the hotel industry and not on other entities in tourism.

Methodology

Rresearch instrument

The questionnaire created for HRM managers is used for collecting quantitative data on the four HRM activities actually engaged in (recruitment, rewarding, development and retention) on which HR managers have the greatest influence. There are three reasons for choosing these HR activities: 1) they are the most frequently observed activities in research which most often appear in 'bundles' of HRM practice significant for company performance (Boslie, et al., 2005); 2) in Croatia, so far only companies with more than 500 employees have been found to have implemented and regularly carry out a whole range of HRM activities (Pološki Vokić and Vidović, 2008) and they are at the beginning of their HRM evaluation practice (Pološki Vokić, 2011) 3) in Croatia, only 15% of total hotel capacities are those of international hotel brands, indicating HRM is formalised to a smaller extent.

The questionnaire consists of 23 open questions (quantitative indicators of HRM activities). It is an objective rating scale based on indicators according to Philips (1996), selected in cooperation with HR managers in hotel companies and adjusted to the Croatian hotel sector. This scale is developed in such a way as to collect data on full-time and seasonal employees, such as front-line and back-room employees, with the aim to aggregate each activity separately and together into a single firm-level measure of HR practice. There are 16 indicators of four HRM activities defined as key indicators for the Croatian hotel sector (Table 3).

Data collection procedure and sample characteristics

With the aim to establish the actual state of HRM in the Croatian hotel industry, statistical units of the research are hotel companies with over 50

employees. In 2012, there were 93 active hotel companies (Register of legal entities of the Croatian Economic Chamber) at the national level. The first step in data collection entailed interviews with HR managers about their perceptions of HRM within their hotel organisation. It should be noted that HR managers in Croatian hotel companies do not easily accept the fact that an 'outsider' is measuring their work, and at the start of the survey they mainly emphasised that information about HRM is a trade secret. The second step was to send out questionnaires to HR managers in hotel companies. The final sample was 32, representing a return rate of 34.4%. In the field of HRM practice/organisational performance link in the hotel sector, the return rate is 36%–37.1% (Hoque, 1999; Cho et al., 2006). The third step involved interviews with five experts with long-term experience as HR managers in hospitality (four of them were from hotel companies and one has a proper HR agency). After the fuzzy inference system procedure was explained, the expert group received a detailed explanation about their role in the step of aggregation where they had to create 'if-then' rules in terms of low, middle and high HRM performance. The fuzzy inference systems were developed with the MatLab 9.7 mathematical software.

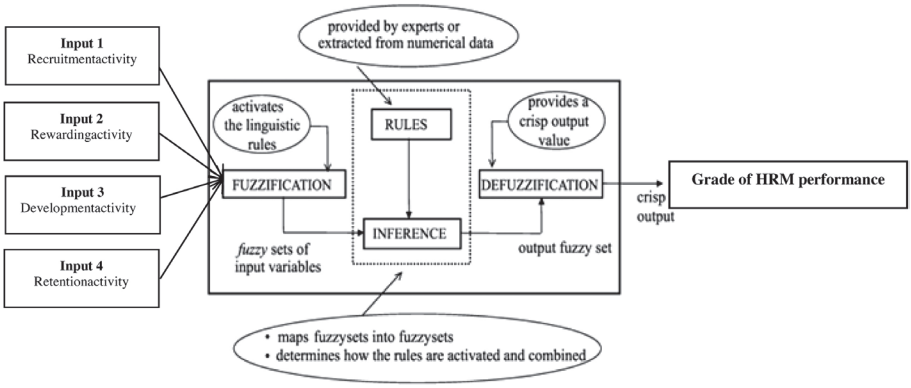
In the sample, hotel companies which employ between 101 and 200 persons dominate (30% of them) followed by hotel companies employing 50 to 100 persons (22%). Further, 13% of them are in the category between 401 and 500 employees and over 500 employees. Just one hotel company from the sample was in the category between 301 and 400 employees. The majority of ownerships were domestic and private (46%) and the majority of the companies are situated form in the Adriatic region (81%). Women dominate in HRM positions, making up 67% of the sample (Table 2). The average age of an HR manager is 42 years, while the average time spent working in the hotel companies is 14 years and in HRM it is 11 years. The majority of HR managers in the sample are highly educated, showing the domination of HR managers whose university education is in the fields of law (39%) and economics and business administration (23%).

Data analysis

The fuzzy inference system represents a formal mathematical model for shaping human knowledge and conclusions when the numerical data are uncertain or linguistic or, generally speaking, if the data are of a different character and are imprecise, approximate or insecure. According to the way outputs are determined, there are two types of fuzzy inference system: 1) *Mamdani-type inference* – in which the fuzzy sets from the consequent (the final part of the fuzzy rule) of each rule are combined through the aggregation operator and the resulting fuzzy set is defuzzified to yield the output

of the system; and 2) *Sugeno-type* – in which the consequent of each rule is a linear combination of the inputs where the output is a weighted linear combination of the consequents. In this study, the Mamdani inference system is used where the HRM performance of hotel companies is calculated using four inputs (four HRM activities). It is chosen because it greatly simplifies the computation which is performed over four steps: fuzzification, rule evaluation, aggregation and defuzzification (Picture 1).

Picture 1: FUZZY INFERENCE SYSTEM APPLICATION



Source: adapted from Letichevsky et al. (2007).

In the *first step* (fuzzification of the input variables), to each input variable (HRM activity) several categories are joined, to which the membership function is added, defined in the domain of that variable, with (true) values in the interval [0 1]. In the *second step,* namely rule evaluation, fuzzified inputs are applied to the antecedents of the fuzzy rules. Because fuzzy rules have multiple antecedents in this study, the fuzzy operator AND is used to obtain a single number that represents the result of the antecedent evaluation. Formulation of the fuzzy rule by the expert group is based on their experience and knowledge. The *third step* is aggregation of the rule outputs. This is a process of unifying the outputs of all rules. The final, *fourth* step is defuzzification where the input is a fuzzy set (HRM activity) and the output is a single crisp number (grade of performance) and rules are evaluated.

Results

The results of this study are divided into three parts: 1) descriptive analysis of HRM activities (Table 1); 2) developing the FIS methodological framework as a tool for measuring HRM performance (Tables 2 and 3); and 3) testing its validity (Table 4).

Table 1: DESCRIPTIVE STATISTICS OF HRM INDICATORS

HR activities	Quantitative indicators	Arithmetic mean
Recruitment	Recruitment costs of employees	5,955.93 USD*
	Vacant position filling time for seasonal employees	32 days
	Vacant position filling time for full-time employees	21 days
	Rate of growth of employees in total	3.35%
Rewarding	Percentage share of total labour costs in operative costs	31%
	Monthly gross (1) salary per employee without manager's contracts	899.20 USD
	Monthly gross (1) salary per employee with manager's contracts	1,281.27 USD
	Percentage of total costs of benefits in total salary amount	8.6%
	Total costs for additional services to employees	17,421.08 USD
Development	Percentage of educational costs in total salaries	1.6%
	Number of educational hours per employee annually	2hrs
	Annual number of hours of front line employees spent in additional education	44hrs
	Annual number of hours of professional support employees spent in additional education	19hrs
Retention	Number of highly educated employees who left a hotel company of their own free will	2
	Number of operational employees who left a hotel company of their own free will	3
	Number of career development programme participants	48

Source: Dropulić Ružić et al. (2016).

For each HRM indicator, the arithmetic mean is calculated and indicators with a monetary value expressed in Croatian kunas are converted into US dollars according to the bank exchange rate on the 19/05/2015. A further step (fuzzification) implies domain determination, which is illustrated in Table 4 for each HRM activity. Relative values are calculated for the following indicators: a) recruitment costs of employees; b) monthly gross salary per employee with manager's contracts; c) number of highly educated employees who left the hotel company of their own free will; d) number of operational employees who left the hotel company of their own free will; and e) number of career development programme participants.

Table 2: FUZZIFICATION OF HRM ACTIVITIES

HRM activities	Input variables	Domains of input variables	Fuzzy sets of input variables
RECRUITMENT	Recruitment costs of employees/the total number of employees	5.9–74 USD	(Small, mf1) (Average, mf2) (High, mf3)
	Vacant position filling time for seasonal employees	3–120 days	(Short, mf1) (Average, mf2) (Long, mf3)
	Vacant position filling time for full-time employees	3–90 days	(Short, mf1) (Average, mf2) (Long, mf3)
	Rate of growth employees in total	0–25%	(Low, mf1) (Average, mf2) (High, mf3)
REWARDING	Percentage share of total labour costs in operative costs	0–45%	(Small, mf1) (Average, mf2) (High, mf3)
	Monthly gross (1) salary per employee without manager's contracts/the total number of employees	440–1320 USD	(Small,mf1) (Average, mf2) (High, mf3)
	Monthly gross (1) salary per employee with manager's contracts/ the total number of employees	734–1760 USD	(Small, mf1) (Average, mf2) (High, mf3)
	Percentage of total costs of benefits in total salary amount	0–25%	(Small, mf1) (Average, mf2) (High, mf3)
	Total costs for additional services to employees/the total number of employees	0–220 USD	(Small, mf1) (Average, mf2) (High, mf3)
DEVELOPMENT	Percentage of educational costs in total salaries	0–5%	(Small, mf1) (Average, mf2) (High, mf3)
	Number of educational hours per employee annually	0–42 h	(Small, mf1) (Average, mf2) (High, mf3)
	Annual number of hours of front line employee spent in additional education	0–100 h	(Small, mf1) (Average, mf2) (High, mf3)
	Annual number of hours of professional support employee spent in additional education	0–53 h	(Small, mf1) (Average, mf2) (High, mf3)

HRM activities	Input variables	Domains of input variables	Fuzzy sets of input variables
RETENTION	Number of highly educated employees who left a hotel company of their own free will/the total number of employees	0–4%	(Small, mf1) (Average, mf2) (High, mf3)
	Number of operational employees who left a hotel company of their own free will/the total number of employees	0–13%	(Small, mf1) (Average, mf2) (High, mf3)
	Number of career development programme participants/the total number of employees	0–10%	(Small, mf1) (Average, mf2) (High, mf3)
	Output variable	**Domain of output variable**	**Fuzzy sets of input variable**
	Performance	1–3	(Low, mf1) (Average, mf2) (High, mf3)

Source: Dropulić Ružić et al. (2016).

In the aggregation process, the formation of 'if-then' rules was assisted by the expert group. There are 89 rules for four HRM activities. In creating them, the experts took account of the hotel company size and the characteristics, problems and challenges of HRM in that environment. Examples of the first and the last rules are given:

Rule 1. IF the recruitment cost of employees is average AND vacant position filling time for seasonal employees is long AND vacant position filling time for full-time employees is long AND the growth rate of employees is low, THEN the recruitment performance level is low.

Rule 89. IF the number of highly educated employees who left the hotel company of their own free will is low AND the number of operational employees who left the hotel company of their own free will is low AND the number of career development programme participants is high, THEN the retention performance level is high.

Most of the rules (32) were developed for rewarding activity, which has the most indicators, then for development activity (23), recruitment activity (21) and, finally, for retention activity with 13 developed rules. In addition, weights were given to all rules and their logic was checked by a calculation of the means. Deffuzification of the fuzzy sets of HRM activities resulted in a single crisp number, in the shape of grade 3, where all values *above* 3 imply a high performance, 3 implies an average performance and *under* grade 3 implies a low performance. Table 3 presents the values of the quantitative HRM activity indicators which imply an average performance (grade 3).

Table 3: INDICATOR VALUES OF AVERAGE PERFORMANCE

HRM activity	Quantitative indicators	Values of average performance (=3)
Recruitment	Recruitment costs of employees	76 USD
	Vacant position filling time for seasonal employees	61days
	Vacant position filling time for full- time employees	46 days
	Growth rate of employees in total	12.5%
Rewarding	Percentage share of total labour costs in operative costs	22.5%
	Monthly gross (1) salary per employee without manager's contracts	880 USD
	Monthly gross (1) salary per employee with manager's contracts	1,247.03 USD
	Percentage of total costs of benefits in total salary amount	12.5%
	Total costs for additional services to employees	110 USD
Development	Percentage of educational costs in total salaries	2.5%
	Number of educational hours per employee annually	21h
	Annual number of hours of front line employee spent in additional education	50h
	Annual number of hours of professional support employee spent in additional education	26h
Retention	Number of highly educated employees who left a hotel company of their own free will	1.8%
	Number of operational employees who left a hotel company of their own free will	6.3%
	Number of career development programme participants.	4.7%

Source: Dropulić Ružić et al. (2016).

According to deffuzification of the fuzzy sets of input variables:

- recruitment *activity* in the hotel company sample profile could be categorised as successful (high performance) if the staff recruitment costs (per employee) are USD 76, vacant position filling time for seasonal employees *is shorter* than 61 days, vacant position filling time for full-time employees *is shorter* than 46 days, and if the overall growth rate of employees is 12.5%;
- the high performance of *rewarding activity* in a hotel company could be successful if the share of total labour costs in operating costs *is higher* than 22.5%, gross (1) salary per employee without the manager's contracts *is higher* than USD 880, gross (1) salary per employee with the manager's contracts *is higher* than USD 1,247.03 and the share of the total

costs of benefits within the total amount of salary *is higher* than 12.5%;
- the activity of *development* in hotel companies could be successful if the total costs for additional services to employees are *higher* than USD 110, the share of educational costs in total salaries is *higher* than 2.5%, the number of educational hours per employee annually is *higher* than 21 hrs, the annual number of hours of a front-line employee spent in additional education is *higher* than 50 hrs, and the annual number of hours of a professional support employee spent in additional education is *higher* than 26 hrs;
- *retention activity* is based on relative values where their averages are taken into account. For example, if a hotel company's proportion of highly educated employees who left the hotel company of their own free will *is below* 1.8%, the share of operational employees who left the hotel company of their own free will *is lower* than 6.3%, and the share of employees involved in the progression of the programme/career development is *above* 4.7%, this activity is in the domain of high performance.

The validity of the four FIS models for the four HRM activities was tested by a simulation, which entailed two steps. In the first step, the functioning of these four models was tested upon the entry of the optimal (e.g. high number of hours of employee education) and the worst HRM practice indicators (e.g. too long a time for recruitment, without employees in the career programme). These simulated models confirm that the grade for the lowest (failed) performance is 2.3 and that for the highest is 3.68. When the MFIS model calculates a score in the range 2.3–3.00, the performance of those HRM activities in a hotel company will be categorised as low. When the grade is 3.00, the performance is average, while in the range between 3.01–3.68 the performance is high. In other words, according to the assessment unsuccessful HRM practices are classified under 3, and successful HRM ones are scored above 3. In the process of creating the fuzzy models, the Mamdani method was employed which uses fuzzy values in the deffuzification step compared to the Sugeno method which uses average weights to calculate the exact value (Kaur and Kaur, 2012). The Sugeno method would allow maximum (5) and minimum values (1) to be obtained as a range that is most common used, so the recommendation for future research is to test the suitability of the Sugeno method and the functioning of the min/max range. The intention of this study was to contribute to developing evidence-based management in HRM in the hotel business, with special focus on HRM evaluation and it should be noted that the involvement of the group of experts as a key determinant of the Mamdani method explains why this type of FIS is used in this study. The second step in confirming the validity confirmation was to test these models on hotel companies from the sample.

In this step, ten hotel companies from the research sample were arbitrarily and randomly chosen (Table 4).

Table 4: AGGREGATE GRADE OF HRM PERFORMANCE

Hotel company number	Recruitment activity grades	Rewarding activity grades	Development activity grades	Retention activity grades	Aggregate grades of activity performance by hotel company
1.	3.58	2.99	2.33	3.26	**3.04 (high)**
2.	3.68	3.00	3.00	2.86	**3.13 (high)**
3.	3.09	2.61	3.01	3.00	**2.92 (low)**
4.	3.00	2.67	2.46	3.67	**2.95 (low)**
5.	3.00	2.75	2.82	3.00	**2.89 (low)**
6.	2.61	2.87	3.08	2.96	**2.88 (low)**
7.	3.03	3.00	3.00	3.15	**3.04 (high)**
8.	3.00	3.00	3.10	2.86	**2.99 (low)**
9.	3.09	3.03	3.00	3.09	**3.05 (high)**
10.	3.00	2.61	2.36	3.14	**2.77 (low)**
	3.10 (high)	**2.85 (low)**	**2.81 (low)**	**3.09 (high)**	

Source: Dropulić Ružić et al. (2016).

The highest performance was in recruitment activity in the first hotel company while the lowest was the activity of development in the same company. The aggregate grade of HRM performance is calculated as the average of all activity performances within a hotel company and, in this example, *low performance* is dominant. In addition, the performances of HRM activities across ten hotel companies were calculated, where it is evident there is a high performance in recruitment and retention activities. It is important to highlight that these results should not be generalised, they represent one-third of the sample and should be taken as confirmation of the validity of the ranges, membership functions and rules which were established for four HRM activities in the hotel business context.

Theoretical implications

At the scientific level in the HRM field, huge progress has been made on probability and classical set theory principles of measurement. This study should be regarded for its intention from a different angle'. Organisations are individually different and struggle with various internal and external situations and an attempt is made to move beyond Boolean logic boxes for measuring HRM performance and direct methodological frameworks to the measurement by contingency (situational) approach. A developed approach

to measurement is focused on functional HRM and, although it does not evaluate the contribution or HRM added-value effect in a hotel company and does not provide an understanding of decisions taken, it can be useful for those with an intention to express HRM in financial terms, which Toulson and Deewe (2004) see as a prerequisite for earning credibility. Although based on quantitative indicators, this approach is 'softer' and useful for positivist studies because it allows one to except and measure the '"grey zone' of reality. In contrast to statistical methods where values of input variables are 'rounded off' and averages are used, in fuzzy logic the assessed value output variables are in great measure equivalent to reality because different conditions, problems and challenges are taken into account in the process of creating rule/rules and it handles the concept of partial truth where the truth value may range between completely true (e.g. successful) and completely false (unsuccessful). Fuzzy set theory gives an answer to how much a variable is in a set while probability theory concentrates on how probable it is that a variable is in a set.

Langley (1999) encouraged strategic HRM scholars to increase the diversity of methodological approaches to more often include methods capable of generating new insights about processes and complex dynamics, in addition to the dominant approach of testing variance theories. An analysis of the 'black box' (HRM practice-performance link) falls into the category of testing variance theories (Morris, 2005) and, after three decades of research, authors (Guest, 2011; Guest et al., 2013; Jackson et al., 2014) still stress the importance of providing an explanation for 'how' the black box happens. Establishing causality, levels of analysis, data aggregation and measurement validity are many of the methodological challenges for strategic HRM, similar to those in other areas of management (Jackson et al., 2014). The contribution of this study lies in developing a methodological framework of data aggregation of HRM performance in the hotel business context. It includes the MFIS method which allows new insights into HRM evaluation processes by creating rules where an expert group and their knowledge and experience in practice played an important role. To bridge the gap between science and practice, HR managers need to be informed about the best available scientific evidence concerning workplace issues ('evidence-based management', EBM) (Rynes et al., 2001; Cohen, 2007; Rynes, 2007). Practitioners are in this study included in the decision-making process about research problems; they are asked to discuss the relationships between proposed indicators, to estimate all possible scenarios related to the performance of certain HR activities and all other details important for measurement.

With this research, the validity of MFIS as an instrument for (aggregate) measuring HRM performance is confirmed. The creation of four fuzzy inference systems where domain, membership functions and rules are set for

each HRM activity could be used as a template for measuring HRM performance in hotel companies. It should be highlighted that 87% (28 companies) of this sample are middle-sized hotel companies with fewer than 500 employees so it could prove useful, especially for that hotel company profile. At the scientific level, MFIS could be used as a data aggregation tool in the HRM field, such as for HRM benchmarking. It could help provide an explanation of 'how' to improve the weaknesses of quantitative HRM performance measurement in the hotel industry.

Practical implications

If HR managers do not find a suitable way to measure and present the success of their work, it can hardly be expected that they will be included in strategic decisions of the company (Yeung, 2011). According to the attitudes to this research and problems related to the calculation of some indicators during filling the questionnire, in Croatian hotel companies from the sample a lack of HR managers' agility for their work evaluation is evident. This study was made with the intention to encourage opening new boxes of thinking in the HRM performance measurement field with a focus on its applied purpose. The advantages of using Mamdani-type fuzzy inference in the HRM dataset in this study included: no limitation on the number of input and output variables, the possibility to include values of different character variables in the model, the possibility to process imprecise variable values, and the involvement of the expert group. Besides the methodological implications, the results could help provide practitioners in middle-size hotel companies with a direction for the four HRM activities. In the Croatian context, development activity could be taken as an example. Pološki Vokić (2008) concluded that only 41.5% of hotel companies in the sample (N = 48) had increased their spending on training and development (T&D) compared to their operating costs in the last two years and those who provided an answer here on average invested in 2006 in their employees' T&D only 0.99% of their yearly earnings. According to this study, development activity could be estimated as averagely successful if the share of educational costs in total salaries is 2.5%. However, when interpreting these results the figure should be used with caution because, for benchmarking purposes, all indicators should be standardised.

It is also important to highlight the limitation that refers to the HRM concept (functional categories of HRM) which usually has more than four activities (planning, job analysis, job design, recruitment, selection, training, rewarding, and retention and job career). Kohont, Svetlik and Bogičević Milikić (2015) wrote about evolution of the personnel function in Slovenia and Serbia and concluded that since 2000 there has been a clear shift towards

an HRM model associated with the devolution process, a change which is much more pronounced in Slovenia than in Serbia. Croatia has passed through the same process of HRM evolution and from business community which wasn't recognise the importance of HRM development (Pološki, Vidović, 2004), it slowly moves to phase of awareness of human resource importance. In many hotel companies, HRM is less formalised because of which HRM practice in this research was reduced to four key activities that should be taken as a limiting factor on a full HRM profile analysis in the hotel business community. It is recommended to take an aspirational framework for strategic HRM (Jackson et al., 2014) as a template for defining the HRM concept in research where the full range of HRM activities, appropriate for the research context, should be included. A fuzzy inference system is used to analyse quantitative indicators of HRM activities where the limiting factor is the final step where the four FIS systems (for each HR activity – recruitment, development, retention and rewarding) are aggregated in their average calculations. In future research, instead of calculating the FIS model value average, a new FIS model should be developed where the FIS model for each activity would represent an input variable. Moreover, the methodological framework should test the suitability of the Sugeno method that employs weighted averages to calculate the exact value (Kaur and Kaur, 2012). To improve the methodology developed in this study, first these fuzzy inference systems should be tested on a larger sample and in different hotel industry environments (e.g. western European countries). Second, it is important to prepare a quality list of key HRM indicators and combine them with the estimated satisfaction levels of HR managers, employees and guests in the hotel business context. This methodological framework arises from the positivist research perspective and is mainly focused on determining the implementation of HRM activities. Third, more standardised interviews should thus be used before data collection, in which practitioners should be asked about details and factors important to them for good measurement of HRM. In addition, the expert group should have more members and line managers should be included. During the rule creation process, practitioners should be asked what it would take for them to apply evidence-based management (Cohen, 2007); in other words, what would be important to them to apply the results based on measuring by MFIS.

Conclusion

The aggregate measurement of HRM performance is a major challenge in black box research and, after the huge achievements made by classical statistical methods (based on probability theory), many limitations and challenges remain that need to be faced. This paper promotes approach to the

measurement of HRM performance based on fuzzy set theory where the Mamdani Fuzzy Inference System is used as a tool for the first time with the intention to provide a contextual approach (hotel business) in which a score for HRM indicators (items) is calculated for each activity. The framework of 'if-then' relations between key activities (recruitment, rewarding, development, retention) in middle-sized hotel companies is given while different conditions and challenges from practice are taken into account in the process of an expert group creating rules to contribute to reduce the gap between science and practice and for encouraging evidence-based management. For four HRM activities which are measured by 16 indicators, 89 rules are developed. Most of the rules (32) are developed for rewarding activity, then for development activity (23), while in third place there are rules for recruitment activity (21) and, finally, for retention activity 13 rules are developed. In addition, weights were given to all rules, and their logic was checked by calculation of the means. This pilot study provides a framework in which the relations between quantitative indicators for low, average and high HRM performance are defined as follows:

- recruitment *activity* in the hotel company sample profile could be categorised as successful (high performance) if the costs of staff recruitment (per employee) are USD 76, vacant position filling time for seasonal employees *is shorter* than 61 days, vacant position filling time for full-time employees *is shorter* than 46 days and if the total growth rate of employees is 12.5%;
- the high performance of *rewarding activity* in a hotel company could be successful if the share of total labour costs in operating costs *is higher* than 22.5%, gross (1) salary per employee without manager's contracts *is higher* than USD 880, gross (1) salary per employee with manager's contracts *is higher* than USD 1,247.03 and the share of total costs of benefits in the total amount of salary *is higher* than 12.5%;
- the activity of *development* in hotel companies could be successful if the total costs for additional services to employees are *higher* than USD 110, the share of educational costs in total salaries is *higher* than 2.5%, the number of educational hours per employee annually is *higher* than 21 hrs, the annual number of hours of a front-line employee spent in additional education is *higher* than 50 hrs and the annual number of hours of a professional support employee spent in additional education is *higher* than 26 hrs; and
- *retention activity* is based on relative values where their averages are taken into account. For example, if a hotel company's proportion of highly educated employees who left the hotel company of their own free will *is below* 1.8%, the proportion of operational employees who left the hotel company of their own free will *is lower* than 6.3%, and the share of

employees involved in the progression of the programme/career development is *above* 4.7%, then this activity is in the domain of high performance.

The final output of the four fuzzy sets of HRM activities resulted in a single crisp number, in the shape of grade 3, where all values *above* grade 3 imply a high performance, grade 3 implies an average performance and *under* grade 3 implies a low performance. These findings introduce researchers and practitioners in hotel companies to a new phase of measurement of HRM and could serve them in developing HRM benchmarking, for comparative analysis of HRM performance within the hotel sector, across hotel sectors in a different country setting with a special focus on middle-sized hotel companies and could be regarded as a template for developing a new method for the aggregate evaluation of HRM.

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