

# A Performance Evaluation Model of a Job Title using Fuzzy Approach

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**Keywords:** Human Resources Management, Performance Evaluation, Fuzzy Logic.

**Abstract:** Performance evaluation is described as comparing the performance of workers and the work standards and handling the necessary activities in a systematic way to attain these standards. What makes performance measure a necessity is its focus on performance of personnel as an objective measure of whether the company goes in the correct direction or not. This is because the most important problem encountered in organizations is the difficulty in the determination of how successful the personnel are in the satisfaction of their duties and what are their capabilities in their jobs. Besides performance evaluation is a decision making process which involves uncertainty. To overcome the uncertainty and evaluate the workers performance objectively, a performance evaluation model is developed of which the criteria are defined as the fuzzy numbers and the linguistic variables. The scope of the study is to determine the performance evaluation criteria of a purchasing specialist and weight for evaluating this job title.

## 1 INTRODUCTION

Human resource management is associated with a larger productivity and efficiency, better customer service, increased firm value, profitability and organizational survival (Stavrou et al., 2007). Performance evaluation, one of the most important tools of modern human resource management, is a crucial management process for both personnel and organization. In performance evaluation, the aim is to understand the current situation of an individual and organization and react according to this situation. As shown in a research, performance evaluation information is used specifically in four area; decisions demanding inter-personal comparisons (salary determination, promotion etc.), decisions demanding personal comparison (feedback, personal educational need, etc.), decisions orientated to the continuation of the system (target determination, human force planning, etc.) and documentation (Gürbüz and Albayrak, 2014).

What makes performance measure a necessity is its focus on performance of personnel as an objective measure of whether the company goes in the correct direction or not. This is because the most important problem encountered in organizations is

the difficulty in the determination of how successful the personnel are in the satisfaction of their duties and what are their capabilities in their jobs. Every worker has different expectations from the future, senses of duty, capabilities, knowledge and talent, and working discipline. These differences caused by the nature of human separate the performances of them as well. Some personnel can completely satisfy the duties expected from them while some can not. Thus, managers want to know the capabilities of the personnel under their order and their success in their jobs. Because of that, to monitor whether the personnel work in accordance with the targets determined, the performance evaluation criteria are required (Kılıç, 2011).

Performance evaluation criteria generally depend on the individual's characteristics, behavioral criteria, and the results and aims about the job. But there are two common important problems about the criteria used to evaluate workers' performance. First of all, the criteria used in performance evaluation are assumed to be related only with job. It is crucial to define the indicators describing the aims of work performance. There is not a universal criteria bundle. The work analysis is the main guide to identify the performance criteria for a certain job title. If a criterion isn't related with the work, then it shouldn't be a part of performance evaluation. Secondly, when

a criterion is selected to evaluate the work performance, the measurements should be correct and precise. In this study, a model is proposed to identify and objectively weight the criteria for each job position as explained above.

One of the most difficult functional areas for evaluation is still the purchasing department. Due to the increasing competition in the globe, organizations are required to evaluate their internal operations and decrease the costs by making them excellent. One of the biggest element of cost is purchasing spend, which is generally equal to 40–70% of a firm’s sales volume (depending upon the degree of vertical integration in the industry), and thus is a source of increasing competitive advantages (Saranga and Moser, 2010). The role of purchasing comprises of communicating with suppliers to decrease redundancies and increase efficiencies in the supply chain. The strategic role of purchasing makes it crucial to measure its performance (Easton et al., 2002).

Due to the reasons of mentioned explanation and understanding the model better, the criteria for purchasing specialist position are identified and weighted.

In the second part of the study, the methodology, Fuzzy Analytic process, is explained. In the third section, the proposed performance evaluation model is detailed. The last section of the study is comprised of the results and comments about the application.

## 2 FUZZY ANALYTIC HIERARCHY PROCESS METHOD

In Analytical Hierarchy Process (AHP), a flexible and structured methodology, complex decision variables are structured into a hierarchical framework to solve and analyze them (Borouhaki and Malczewski, 2008). Human thinking and judgment are ambiguous and it is not meaningful to represent them with point numbers. Interval judgments better represent them than precise value judgments. Thus, the priority between decision variables is decided according to the triangular fuzzy numbers. The final priority weights are found with synthetic extent analysis method and this is called as fuzzy extended AHP (Chan and Kumar, 2007). Thus, using fuzzy theory in AHP is more reasonable and effective than classic AHP.

There are various AHP methods related to the fuzziness, while the most popular one is Chang’s approach. Chang established the extent analysis

method (EAM) for synthetic values of pair wise comparisons with the use of triangular fuzzy numbers (TFNs) (Heo et al., 2012).The triangular fuzzy conversion scale, given in Table 1, is used in the evaluation model of this paper.

Table 1: Triangular fuzzy scale of preference.

Relative importance	Definition	Fuzzy Scale	Fuzzy Reciprocal Scale
1	Equally Importance	(1,1,1)	(1,1,1)
3	Moderate Importance	(1,3,5)	(1/5,1/3,1)
5	Strong Importance	(3,5,7)	(1/7,1/5,1/3)
7	Demonstrated Importance	(5,7,9)	(1/9,1/7,1/5)
9	Extreme Importance	(7,9,9)	(1/9,1/9,1/7)

Let  $X = \{x_1, x_2, \dots, x_n\}$  be an object set, and  $U = \{u_1, u_2, \dots, u_m\}$  be a goal set. According to the method of Chang’s extent analysis, each object is taken and extent analysis for each goal,  $g_i$ , is performed, respectively. Therefore, m extent analysis values for each object can be obtained, with the following signs:

$$M_{g_i}^1, M_{g_i}^2, \dots, M_{g_i}^m \quad i = 1, 2, \dots, n \quad (1)$$

Where all the  $M_{g_i}^j$  ( $j = 1, 2, \dots, m$ ) are triangular fuzzy numbers.

The steps of Chang’s extent analysis can be given as in the following:

*Step 1:* The value of fuzzy synthetic extent with respect to the  $i$ th object is defined as

$$S_i = \sum_{j=1}^m M_{g_i}^j \otimes [\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j]^{-1} \quad (2)$$

To obtain  $\sum_{i=1}^m M_{a_i}^j$ , perform the fuzzy addition operation of m extent analysis values for a particular matrix such that

$$\sum_{j=1}^m M_{g_i}^j = (\sum_{j=1}^m l_j, \sum_{j=1}^m m_j, \sum_{j=1}^m u_j) \quad (3)$$

and to obtain  $[\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j]^{-1}$ , perform the fuzzy addition operation of  $M_{g_i}^j$  ( $j=1,2, \dots,m$ ) values such that

$$\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j = (\sum_{i=1}^n l_i, \sum_{i=1}^n m_i, \sum_{i=1}^n u_i) \quad (4)$$

and then compute the inverse of the vector in equation (4) such that

$$[\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j]^{-1} = \left( \frac{1}{\sum_{i=1}^n u_i}, \frac{1}{\sum_{i=1}^n m_i}, \frac{1}{\sum_{i=1}^n l_i} \right) \quad (5)$$

Step 2: The degree of possibility of  $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$  is defined as

$$V(M_2 \geq M_1) = \sup_{y \geq x} [\min \mu_{M_1}(x), \mu_{M_2}(y)] \quad (6)$$

and can be equivalently expressed as follows:

$$V(M_2 \geq M_1) = \text{hgt}(M_1 \cap M_2) = \mu_{M_2}(d) \begin{cases} 1, & \text{if } m_2 \geq m_1 \\ 0, & \text{if } l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & \text{otherwise} \end{cases} \quad (7)$$

where  $d$  is the ordinate of the highest intersection point  $D$  between  $\mu_{M_1}$  and  $\mu_{M_2}$  (see figure 1).

To compare  $M_1$  and  $M_2$ , we need both the values of  $V(M_2 \geq M_1)$  and  $V(M_1 \geq M_2)$ .

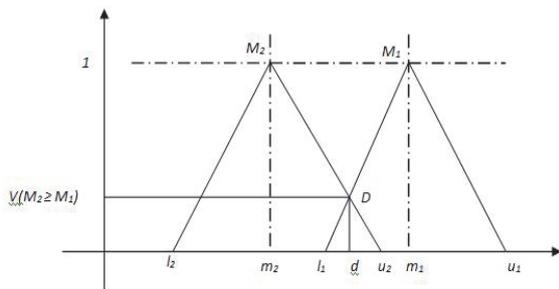


Figure 1: The intersection between  $M_1$  and  $M_2$ .

Step 3: The degree possibility for a convex fuzzy number to be greater than  $k$  convex fuzzy numbers  $M_i$  ( $i=1, 2, \dots, k$ ) can be defined by.

$$V(M \geq M_1, M_2, \dots, M_k) = V [ (M \geq M_1) \text{ and } (M \geq M_2) \text{ and } \dots \text{ and } (M \geq M_k) ] \quad (8) = \min V(M \geq M_i), \quad i = 1, 2, \dots, k$$

Assume that

$$d'(A_i) = \min V(S_i \geq S_k). \quad (9)$$

For  $k = 1, 2, \dots, n; k \neq i$ . Then the weight vector is given by

$$W' = (d'(A_1), d'(A_2), \dots, d'(A_n))^T; \quad (10)$$

where  $A_i$  ( $i = 1, 2, \dots, n$ ) are  $n$  elements.

Step 4: Via normalization, the normalized weight vectors are

$$W = (d(A_1), d(A_2), \dots, d(A_n))^T \quad (11)$$

where  $W$  is a nonfuzzy number (Kahraman et al., 2004).

### 3 PROPOSED PERFORMANCE EVALUATION MODEL

The determination of personnel to be hired and/or fired is a troublesome issue for many companies. Both hiring and firing operations require a correct measure and evaluation system. A company that has enough and correct information about the personnel can easily decide on a fair wage-increase policy and the personnel to be hired. Performance evaluation studies are crucial for these kinds of purposes as well as in the determination of training needs and career planning (Özdemir, 2002).

The scope of the study is to determine the performance evaluation criteria of a purchasing specialist and weight for evaluating this job title. The application of the model is made at a company in automotive supplier industry at Kocaeli. After meeting with the executives of the company, the boundary of the study has been determined and a team has been created including an academic expert, production manager, HR manager, purchase manager, and logistics and supply manager.

First of all, the aim, importance and framework of the study has been discussed, then the criteria found by brainstorming has been noted in the team's meeting that was organized to discuss the criteria to be used in performance measure. The criteria draft has been evaluated again; whether they can be measured, or they can be represented by another criterion and whether there are any missing criteria has been discussed. After this evaluation, the criteria are finalized. Every criterion has been described in

detail to prevent any misunderstanding about their meaning during their usage.

The proposed model makes the performance evaluation by using three main criteria. These main criteria are Decision Making and Leadership, Communication and Relations and Technical skills.

The Decision Making and Leadership, and Communication and Relations criteria and their sub-criteria can be mutually used in the evaluation of all job titles. The sub-criteria under the main criterion of Technical skills changes according to the job title. To make the model more understandable, the weights used in the performance evaluation of the job title "Purchasing Specialist" are identified. The sub-criteria under technical skills are flexible enough to be used for another job title. The hierarchy belonging to the proposed performance evaluation of "Purchasing Specialist" in the model can be seen in Figure 2.

The decision structure has two levels;

First level (Level of determinants), determinants of the performance evaluation are determined as Decision Making and Leadership (DML), Communication and Relations (CR) and Technical Skills (TS).

Second level, this level consists of 16 sub-criteria. Six sub-criteria about Decision Making and Leadership are Problem solving and result orientation (PS), Agility (AG), Adaptability (AD), Team building and management (TB), Project management (PM) and Strategy Elaboration (SE). Four sub-criteria about Communication and Relations are dealing with organization (DO), Communication (C), International Mindset (IM) and Interpersonal Skills (IS). Six sub-criteria about Technical Skills are Negotiation Practice (NP), purchasing tools practice (PT), financial awareness (FA), Supply chain knowledge (SK), Legal awareness (LA) and Budget management (BM). The explanation of sub-criteria is given below:

#### **Decision Making and Leadership:**

1) Problem solving and result orientation (PS): Ability to detect, design and implement solutions adapted to situations and people (evaluate, diagnose) applying QRQC (Quick Response Quality Control). Identification and weighting of important parameters, identification of causes, priorities and development of solutions. Ability to achieve results regardless of circumstances, but not at any cost. Focus on pragmatic and practical tasks and ability to act in the field. Willingness and ability to meet commitments.

2) Agility (AG): Ability to combine speed and rationality in decision making followed by the implementation of an action plan. Ability to react to requests and situations within the required time constraints. Capability to manage a heavy work load in a stressed environment and ability to deal with urgencies.

3) Adaptability (AD): Ability to adapt easily to different working environments. Functioning in a matrix environment or with occasional apparently contradictory issues. Analysis of problems from several points of view, including the points of view of others.

4) Team building and management (TB): Ability to manage and coach people, to create a team spirit, to establish (common and individual) objectives and to assess performance and competences. Efficient delegation of appropriate tasks. Management of structural conflicts. Ability to select and recruit team members. Integration of the team inside the structure. Focus on people development. Gathering of different personalities and mobilization of them towards common objective.

5) Project management (PM): Ability to plan resources in order to manage a project successfully according to standards (quality, cost, delivery) for customer satisfaction. Establishment of clear, realistic timeframes for goal accomplishment.

6) Strategy Elaboration (SE): Ability to anticipate future evolutions (helicopter view), to define vision, objectives, strategic action plans and milestones in order to meet objectives and to implement their strategic plans.

#### **Communication and Relations:**

1) Dealing with organization (DO): Ability to deal with organizational complexity, internal and external stakeholders.

2) Communication (C): Ability "get the point across" and to get the "buy-in" of the target audience. Selection of the most pertinent information, reliable sources, appropriate population, the best medias. Definition and organization of the content (according to different cultures and levels) at the appropriate time. Enhancement of information sharing and feedback. Openness to listen to other options and to take them into consideration. Ability to analyze complicated situations.

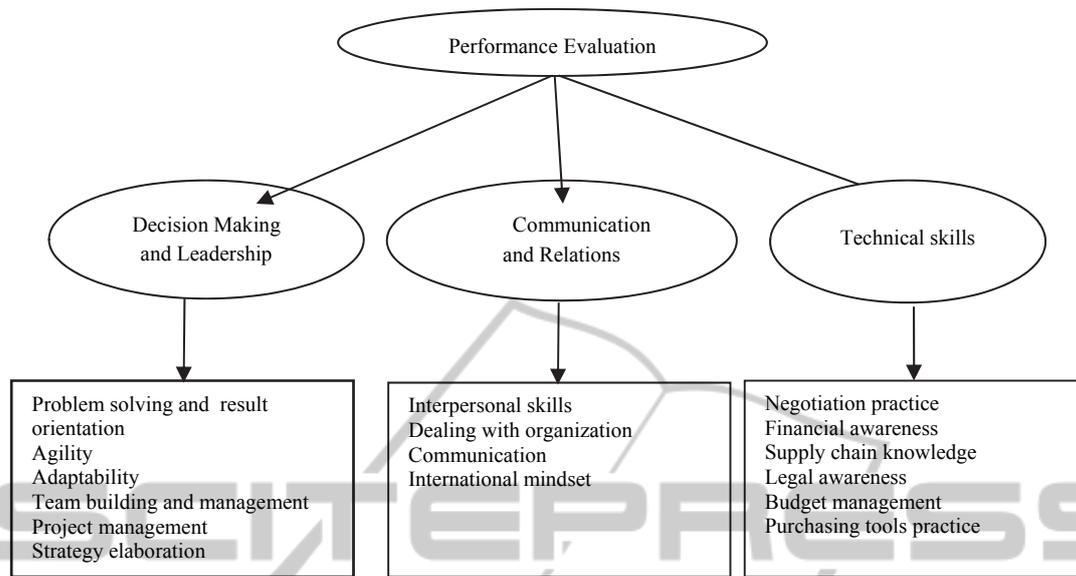


Figure 2: Hierarchies in the AHP.

- 3) International Mindset (IM): Ability to work with people from different cultures. Integration of other cultural values and systems and development of cultural of open mindedness. Ability to think global, act local.
- 4) Interpersonal Skills (IS): Ability to develop interactive listening skills and to give constructive reinforcement. Ability to deal with interpersonal conflict. Ability to influence in a positive way the work of colleagues through enthusiastic communication.

**Technical Skills:**

- 1) Negotiation practice (NP): Ability to prepare the negotiation strategy and tactics base on assessment of company’s levers versus suppliers. Knowledge of his/her limits and supplier’s decision drivers. Ability to conduct the negotiation in a professional manner ensuring a win-win deal. Ability to obtain closure.
- 2) Purchasing tools practice (PT): Knowledge of purchasing tools: methodology tools (commodity matrix, system audit, process audit, initial assessment, etc), analysis tools (market surveys, etc), transaction tools (weekly report, EDI, MRP system, etc)
- 3) Financial awareness (FA) : Understanding of financial reports. Understanding of management accounting and different methods to establish a price and to evaluate the financial health of a supplier.

- 4) Supply chain knowledge (SK): Ability to use supply chain knowledge to contribute to the optimization of the supply chain together with logistics department and supplier.
- 5) Legal awareness (LA): Ability to formalize the contractual relationship in all domains (confidentiality, development, supplies, equipment etc). Ability to manage supplier disputes and major crises with the help of the legal counsel. Ability to use the law to elaborate his/her commodity strategy.
- 6) Budget management (BM): Ability to evaluate all necessary resources and their costs in order to achieve a target. Ability to manage a budget. Evaluation and anticipation of the financial impact of new decisions. Management of situation changes and minimization of excess costs.

The triangular fuzzy conversion scale, given in Table 1, is used in the evaluation model of this study. Fuzzy pair-wise comparisons of three main decision criteria on “Performance Evaluation” are presented in Table 2. Then the sub-criteria are pair wise compared in Table 3-5 respectively and weights are calculated.

Table 2: Fuzzy linguistic preference relation decision matrix of three main criteria.

	DML			C			TS		
DML	1	1	1	1/5	1/3	1	1/7	1/5	1/3
C	1	3	5	1	1	1	1/5	1/3	1/1
TS	3	5	7	1	3	5	1	1	1

Table 3: Fuzzy linguistic preference relation decision matrix of decision making and leadership.

	PS			AG			AD			TB			PM			SE		
PS	1	1	1	1/7	1/5	1/3	1/5	1/3	1	3	5	7	1	3	5	5	7	9
AG	3	5	7	1	1	1	1	3	5	3	5	7	3	5	7	7	9	9
AD	1	3	5	1/5	1/3	1	1	1	1	3	5	7	1	3	5	5	7	9
TB	1/7	1/5	1/3	1/7	1/5	1/3	1/7	1/5	1/3	1	1	1	1/5	1/3	1	3	5	7
PM	1/5	1/3	1	1/7	1/5	1/3	1/5	1/3	1	1	3	5	1	1	1	1	3	5
SE	1/9	1/7	1/5	1/9	1/7	1/5	1/9	1/7	1/5	1/7	1/5	1/3	1/5	1/3	1	1	1	1

Table 4: Fuzzy linguistic preference relation decision matrix of communication and relations.

	DO			C			IM			IS		
DO	1	1	1	1/5	1/3	1	3	5	7	1	3	5
C	1	3	5	1	1	1	5	7	9	3	5	7
IM	1/7	1/5	1/3	1/9	1/7	1/5	1	1	1	1/5	1/3	1
IS	1/5	1/3	1	1/7	1/5	1/3	1	3	5	1	1	1

As seen in Table 2;  $S_{DML} = (0.060, 0.103, 0.273)$ ,  $S_{CR} = (0.099, 0.291, 0.819)$  and  $S_{TS} = (0.224, 0.605, 1.522)$  are calculated. Then  $W' = (0.089, 0.655, 1.000)$  is obtained and priority weights vector of each main criteria is  $W = (0.051, 0.376, 0.573)^T$ . Similarly priority weights vector of each main sub-criteria is seen in Table 3,  $W = (0.2347, 0.3411, 0.2700, 0.0491, 0.1052, 0)^T$ , in Table 4  $W = (0.351, 0.493, 0, 0.156)^T$  and in Table 5  $W = (0.368, 0.291, 0.065, 0.072, 0, 0.204)^T$ .

Table 6 shows overall or global importance levels of for the main criteria and sub-criteria. According to these results, performance

evaluation of purchasing expert is evaluated as following:

It is further observed that the priority of the main criteria “Technical Skills” with %57 is highest followed by “Communication and Relations” with %38 while “Decision Making and Leadership” is just %5.

In case of sub criteria the priority is highest for “Negotiation practice”, “Purchasing tools practice” and “Budget management” respectively under “Technical Skills”; “Communication” and “Dealing with organization” among “Communication and

Table 5: Fuzzy linguistic preference relation decision matrix of technical skills.

	NP			PT			FA			SK			LA			BM		
NP	1	1	1	1	3	5	3	5	7	5	7	9	7	9	9	3	5	7
PT	1/5	1/3	1	1	1	1	3	5	7	3	5	7	5	7	9	1	3	5
FA	1/7	1/5	1/3	1/7	1/5	1/3	1	1	1	1/5	1/3	1	5	7	9	1/7	1/5	1/3
SK	1/9	1/7	1/5	1/7	1/5	1/3	1	3	5	1	1	1	1	3	5	1/5	1/3	1
LA	1/9	1/9	1/7	1/9	1/7	1/5	1/9	1/7	1/5	1/5	1/3	1	1	1	1	1/7	1/5	1/3
BM	1/7	1/5	1/3	1/5	1/3	1	3	5	7	1	3	5	3	5	7	1	1	1

Table 6: Global importance levels of sub-criteria.

Global importance of three main criteria	Global importance of sub-criteria	Weights
Decision Making and Leadership (0.051)	PS (0.235)	0.012
	AG (0.341)	0.017
	AD (0.270)	0.014
	TB (0.049)	0.002
	PM (0.105)	0.005
Communication and Relations (0.376)	DO (0.351)	0,132
	C (0.493)	0,185
	IM (0)	0,000
	IS (0.156)	0,059
Technical skills (0.573)	NP (0.368)	0,211
	PT (0.291)	0,167
	FA (0.065)	0,037
	SK (0.072)	0,041
	LA (0)	0,000
	BM (0.204)	0,117

relations”; “Agility”, “Adaptability” and “Problem Solving and Result Orientation” among “Decision Making and Leadership”.

#### 4 CONCLUSIONS

Performance evaluation study should focus on personnel. In organizations, performance evaluation starts and ends with human component along with the systems related to human. Personnel can easily

disrupt the organization’s structure when they are incompatible with the other people in the working environment. Thus, performance evaluation which tries to increase the harmony of personnel with organization has a great importance for organizations (Boduroglu, 2013).

Besides being the most important part of an effective human resource management strategy, performance evaluation is one of the most important elements to reach the objectives of organizational management. Performance evaluation should be used as a tool to direct, stimulate, increase the motivation and the trust of workers through the organization. The most important part of the evaluation is to make it as objective as possible.

The contributions of this study into the literature can be summarized as follows; 1. The proposed model can be used for other job titles in companies by allowing flexibility in the criteria under the main criterion of technical skills. 2. The current performance evaluation models don’t weight the criterion assuming that they all have the same importance. The proposed model has such a structure and objectivity to satisfy this lack of current models. 3. Performance evaluation is a decision making process which involves uncertainty. To overcome the uncertainty and evaluate the workers performance objectively, a performance evaluation model is developed of which the criteria are defined as the fuzzy numbers and the linguistic variables.

The evaluation process of the performance can be thought as a complex multi-criteria decision making problem considering multiple factors and sub factors affecting the evaluation. Fuzzy AHP method enables decision-makers to realize a hierarchical structure and an effective vague

assessment of main and sub factors' weights. Hence, we used a fuzzy approach for the evaluation of personnel performance. By utilizing fuzzy AHP method, the weights of sub factors are determined subsequently.

By applying the model into a company operating as an automotive supplier, it has been shown that the model can be used in practice without any difficulty. During the application, the weighing of the specific criteria used in the performance evaluation of to purchasing specialist has been done. The main criteria are ordered as Technical Skills, Communication and Relations and Decision Making and Leadership as a result of the evaluation. The most important sub-criteria are identified as Negotiation practice, Communication and Purchasing tools practice.

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