IEEE Access
Multidisciplinary ⋮ Rapid Review ⋮ Open Access Journal

Received January 14, 2021, accepted February 3, 2021, date of publication February 16, 2021, date of current version February 25, 2021.

Digital Object Identifier 10.1109/ACCESS.2021.3059895

A Disruptive Decision Support Platform for Reengineering the Strategic Transfer of Employees

MILJENKO HAJNIĆ[1] AND BILJANA MILEVA BOSHKOSKA[1,2]
[1]Faculty of Information Studies, 8000 Novo Mesto, Slovenia
[2]Jožef Stefan Institute, 1000 Ljubljana, Slovenia

Corresponding author: Miljenko Hajnić (hajnic.m@gmail.com)

The work of Biljana Mileva Boshkoska was supported by the HECAT project, funded within the European Union's Horizon 2020 research & innovation programme under grant number 870702, and was partially supported by the Slovenian Research Agency (ARRS) core research programme (P1-0383).

ABSTRACT The development of artificial intelligence and the digital transformation it has brought with it has encouraged the challenge of harnessing the potential to transform the human resources (HR) processes, systems and organisations through new digital platforms, applications and ways of delivering HR services. In view of this challenge, we present a method, implemented into a decision support (DS) platform, for employee transfer developed to solve three constraints. Firstly, selecting the most suitable employees for transfer to an organizational unit (OU), that is without the employment of new candidates. Secondly, enabling an exchange of employees between OUs, constrained with the employees' skills and OUs requirements. Thirdly, avoiding overlapping of employees in OUs for a previously defined timeframe. Finally, the travelling time and distance have to be within the given limits. We demonstrate that the proposed platform is designed to process all available information and human-defined rules to (i) support the HR managers in planning and organising their strategic activities in a timely manner, (ii) speed up the candidate selection process within the organisation for more than 82%, (iii) provide several best alternatives for staff deployment from the employees, (iv) reduce operational costs for more than 87%, and (v) reduce the administrative burden of HR management (HRM).

INDEX TERMS Decision support, identity and access management, human resources management, strategic management, redeployment.

I. INTRODUCTION

Staff redeployment is becoming a regular task for many large organisations and is subject to national and company regulations, which can significantly increase the cost of these frequent deployments [8]. Traditionally, the transfer of employees has been considered a one-off costly activity with insufficient analysis of alternative scenarios. Methods from multi-criteria decision analysis were used to translate the concept of combining expert knowledge with available technologies into a useful model [1], [10]. Others have used a multi-agent architecture to prepare a decision system that includes interaction with the various agents in the environment; or a multi-factor evaluation process to select the best people [5], [13]. Redeployment is frequently used as a possible way to reduce hiring costs and to positively influence employee morale [6]. To achieve such a view, many organisations have gained extensive experience in the use of computer systems in human resource management [14]. The development of artificial intelligence and the associated digital transformation brought two fundamental challenges to companies [12]. The first refers to the HR potential to help business professionals make the transition to digital thinking. The second relates to the HR potential to transform HR processes, systems and organisation through new digital platforms, applications and ways of delivering HR services.

In view of this challenge, we present a method for Decision Support System & Identity and Access Management (DSS IDAM) for employee transfer developed to solve three constraints. Firstly, selecting the most suitable employees for

The associate editor coordinating the review of this manuscript and approving it for publication was Frederico Guimarães.

transfer to an OU, without the employment of new candidates. Secondly, enabling an exchange of employees between OUs, given the employees' skills and OUs requirements. Thirdly, avoiding overlapping of employees in OUs for a previously defined time period. Finally, the travelling time and distance have to be within the given frames. The method has been implemented into a DS platform and has been tested in a real business enterprise that features a large number of employees working in geographically dispersed organisational units across the country. The developed platform processes all available information and human-defined rules to assist decision-makers in planning and organisation of strategic activities in a timely manner and reduce the administrative burden of HRM. It supports the HR department in its main task of managing employees as assets [2] by providing similar or better working conditions in the new position while maintaining the company's dynamism and the expected level of quality of work [8]. Finally, the platform aids in speeding up the candidate selection process, helps in providing several best alternatives for staff deployment and reduces operational costs.

The paper is organised as follows. In the following section, we introduce the real case study, for which we propose the DSS IDAM. In section III, we present the used methodology and methods and in section IV we present the results. Finally, in section V, we provide a conclusion and discussion.

II. A CASE STUDY OF A PUBLIC ORGANISATION

We have applied the digitalisation of the strategic redeployment of employees by employing a web-based DSS into the business process of a public organisation having around 3000 employees, divided into 235 organisational units (OUs) spread across the country. The organisation's total revenue is several billion euros per year, and more than 70% of all employees are directly involved in the business processes that have financial consequences for the organisation. One of the business policies is the frequent redeployment of the employees due to the need to avoid forming close personal connections among employees working in the same business processes as the prevention of possible corruptive activities. Such a policy has valid reasoning because it ensures a higher level of business security, higher expected income, and transparent realisation of income in accordance with rules that are equal for all stakeholders. The average number of transfers of an employee is calculated to be at least twice a year.

However, the redeployment is a particular task that requires many technical requests for checking the employees' security and information system access rights.

An accurate description of the process is given in **FIGURE 1**, which shows all concerned departments and their activities in the process of employee redeployment. The process starts in the HR department with the request for a redeployment of an employee, with previously defined requirements about employees' business and security policies, to a particular OU. Such decisions are based on multiple criteria such as employee experiences, professional

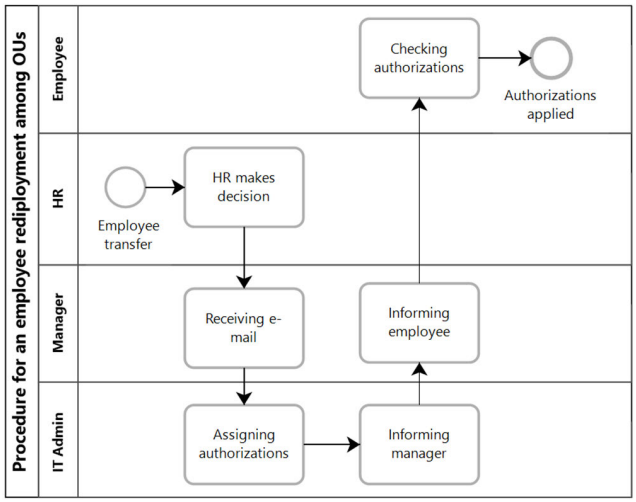

FIGURE 1. Simplified business process flowchart of transferring the existing employee to a new workplace.

qualifications, and completed educational programs, etc. All data on education, knowledge, skills, and experience are recorded in an organisation's database managed by the HR department. As soon as the managers in the HR department decide on the employee transfer to a specific OU, they insert the changes in the database and inform the employee's manager. Next, the employee's manager tells the IT administrators to prepare and update all the business applications in the Identity and access management system (IDAM) that the employee needs to use after a successful transfer.

The whole administrative procedure (HR and IT) can take up to several hours, even days, depending on the number of employees who have to change their workplace (OU) and the number of business applications they must use daily.

For example, consider a company's daily average of 35 requests for updating user accounts, which includes changing the place of work and authorisations, resetting passwords, creating and deactivating user accounts. On an annual basis, the cost of overheads of 35 employees, who daily wait for 1 hour to update the account access rights, could be shown as income that could have been achieved.

If an employee changes a workplace within one day, due to the dynamics of the business tasks, the change of information system (IS) access rights cannot be planned and implemented ahead but is carried out upon the request of the managing person. The cost of employees' management is also reflected through the overhead expense for employees while they wait for their user account to be updated. Consequently, the employees' work will reflect on the organisation's income which will be lower than the projected one.

To deal with organisation's needs to improve the decision process of choosing and granting access permissions to an appropriate person, as well as manage them within the organisation's resources in the best cost-effective, secure and consistent way, the Organization has to make strategic decisions, which are important, in terms of the actions taken, the resources committed, or the precedents set [11] and made

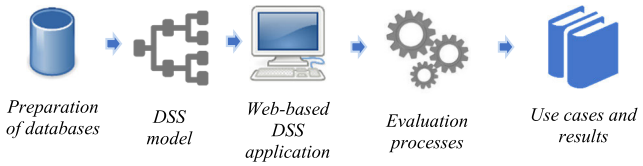

FIGURE 2. Schematic representation of the methodology for the development of a web-based DS model for the evaluation of an employee transfer.

by the organisation management board that directly affect organisational survival [7].

In this study, we reengineered the HR process for employee redeployment by introducing a web-based DSS IDAM platform for supporting the manager's decisions. The proposed web-based DSS IDAM platform supports HR in several aspects. It provides an evaluation of an employee following the required organisational needs. It supports HR by ranking the evaluated employees against the selected organisational unit. It checks employee's current access right and evaluates the usability of employee's roles for potentially new OU. In that way, the proposed DSS helps determine if the selected employee has fulfilled all technical and personal preconditions before the redeployment. All of these DSS characteristics speed up the primary business process, reduce the time between decisions for transferring an employee from one working place to another, decrease the cost of administration and finally increase organisation's revenue.

III. MODEL BUILDING METHODOLOGY

The methodology for developing the DS model for the evaluation of an employee transfer is schematically presented in **FIGURE 2**.

After obtaining data for all employees and available working positions in the OUs, we organised them into a database that served to derive the list of attributes, required for building the model using the DEX method [4], implemented into a DEXi software [3].

The developed platform was designed in four phases:

(i) Data preparation, identification, organisation of attributes and their scales,
(ii) definition of expert rules for the aggregation tables that describe the relevance between a job position and an employee, for which we used the expert knowledge of the HR department of the real company at hand,
(iii) defining the algorithm for sorting suitable employees for transfer,
(iv) integration of the DS model into a web-based DSS platform.

The web-based DSS platform enables two main functionalities: (a) transferring an employee to another OU, and (b) transposition or simultaneously switching two employees in two different OUs.

A. DATA PREPARATION, IDENTIFICATION, ORGANISATION OF ATTRIBUTES AND THEIR SCALES

The research in this paper is based on a real organisation's structure, business and access management processes, and

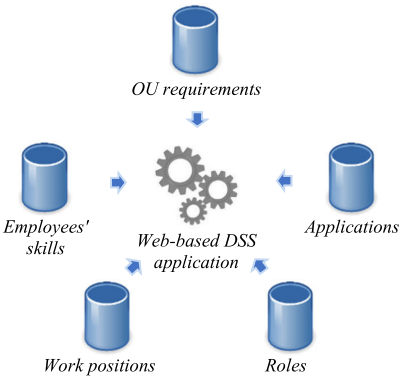

FIGURE 3. Schematic representation of the web-based DSS application.

the decision-making processes for risk assessment. We used real data set which we anonymised to provide full privacy of all entities. The anonymization requires that all data are processed before publishing them in a way which enables hiding, scrambling, blurring or modifying the original identity of the entity while keeping all necessary attributes for research purpose [9]. We have also avoided revealing statistical data that could be derived from data. In addition, the numbers of total employees, applications, business roles and workplaces are reduced to represent a sufficient number of entities for evaluating attributes and gaining final research conclusion. The used data sets are organised into 5 entity types, as presented in **FIGURE 3**:

– *Employee* (includes 2938 employees),
– *Organisational unit* (includes 235 OUs),
– *Business application* (includes 15 business applications)
– *Application role* (includes 30 business roles)
– *Work position* (includes 14 work positions)

Employee and *OU* are two primary entity types, while other entities are supportive entities that provide additional information to each primary entity type. Every entity type consists of many attributes.

The first step in the model building is selecting the relevant attributes, grouping them by context similarity and preparation of a tree of attributes. For that purpose, we asked the HR department to supply us with the list of all employees and working position requirements that we organised into a database. For each of the attributes that represent the characteristics of both the employee and the requirements of the working position, we defined ordinal qualitative scales. For example, the attribute *Employee IT Specific* skill has three classes: ''insufficient'', ''good'', ''very good'' and ''excellent''. We used between two and five ordinal classes for all attributes except for two nominal attributes, for which we used more than five classes. This is acceptable given the fact that the two nominal attributes describe the employee's (or OUs) work position, as well as the employee's field of education. Values in DEXi are colour coded. Red coloured values are least favourable, while green coloured values represent the most favourable values.

TABLE 1. Minimum and maximum values for each sub-attribute.

min	Value of attribute 1: *appropriate*	max
1	*Sub-attribute 1* ($1*n_{1,2}$)	1
1	*Sub-attribute 2*	2
1	*Sub-attribute 3*	2
1	*Sub-attribute 4*	2
1	*Sub-attribute 5*	1
1	*Sub-attribute 6*	1
6	**sum (1-6)**	**9**

min	Value of attribute 1: *excellent*	max
2	*Sub-attribute 1* ($2*n_{1,2}$)	2
2	*Sub-attribute 2*	2
2	*Sub-attribute 3*	2
2	*Sub-attribute 4*	2
2	*Sub-attribute 5*	2
1	*Sub-attribute 6*	2
11	**sum (1-6)**	**12**

TABLE 2. Example of E_1 and E_2.

min	Value of attribute 1: *appropriate*	max
1	*Sub-attribute 1* ($1*n_{1,2}$)	1
1	*Sub-attribute 2*	2
1	*Sub-attribute 3*	2
1	*Sub-attribute 4*	2
1	*Sub-attribute 5*	1
1	*Sub-attribute 6*	1
6	**sum (1-6)**	E_1

min	Value of attribute 1: *excellent*	max
2	*Sub-attribute 1* ($2*n_{1,2}$)	2
2	*Sub-attribute 2*	2
2	*Sub-attribute 3*	2
2	*Sub-attribute 4*	2
2	*Sub-attribute 5*	2
1	*Sub-attribute 6*	2
E_2	**sum (1-6)**	**12**

B. EXPERT RULES FOR THE AGGREGATION TABLES

Aggregation tables group the attributes according to their context encoding the expert knowledge of the HR department managers. The aggregation is defined with a tabular function, called a utility function. Each row in the utility function can be interpreted as an "*if-then*" decision rule. As soon as all utility functions are defined, the DEXi performs bottom-up aggregation of input attributes towards the final root attribute, resulting in an evaluation regarding the transfer of the employee in a given OU.

C. SORTING THE CANDIDATES FOR TRANSFER

DEX methodology is a qualitative one, and its main drawback is that it classifies several alternatives (candidates) in the same class, thus making them indistinguishable. To sort the alternatives which belong to the same class, we propose a new sorting algorithm. The steps of the algorithm are the following.

Step 1: Map all qualitative value scales to quantitative ones, preserving the preference order. For example, the set of value scales {"insufficient", "sufficient", "excellent"} may be mapped into a quantitative ordered scale {1,2,3}, respectively, where higher values are preferable.

Step 2: Starting from the root, for each aggregated attribute, and each of its possible values, prepare a table with aggregated sub-attributes along the whole decision tree. For each sub-attribute, find the minimum and maximum values for which the evaluation of the aggregated attribute still holds.

An example of an attribute with two qualitative values {"appropriate", "excellent"} is presented in TABLE **1**. Then, for each table find the sums of the minimum and maximum values, as shown in the last rows in TABLE **1**.

Step 3: To differentiate between two consecutive evaluations of an attribute (often called classes), for each class **j**, define the sum E_j such as (1):

$$E_j = n_{j,j+1} * a_1 + \sum_{i=1}^{k} a_i, \quad j = 1, .., r \tag{1}$$

where r is the number of consecutive classes, a_i are quantitative evaluations of sub-attributes, k is the number of sub-attributes, a_1 is the topmost sub-attribute that is multiplied with $n_{j,j+1}$, $n_{j,j+1}$ is the minimum slack value that leads to differentiating E_j and E_{j+1} and ensures that $E_j < E_{j+1}$. TABLE **2** presents the example of E_1 and E_2.

In TABLE **2**, the coefficients before values $n_{1,2}$ are quantitative evaluations of the parent attribute and $n_{1,2}= 1$.

Step 4: In the final step calculate the numerical value T of the alternative using the linear sum of all sub-attributes of the parent attribute using (2):

$$T = \sum_{i=1}^{p} E_i \tag{2}$$

where p is the number of sub-attributes to the parent attribute.

D. INTEGRATION OF THE DECISION SUPPORT MODEL INTO A WEB-BASED DSS PLATFORM

The aim of the developed DS model is to support the process of decision making in the human resources department, who represent the main uses of the algorithm for sorting and selecting the most suitable employee. Therefore, a new web-based user interface was created, which enables three main purposes. Firstly, it provides support in the evaluation of several employees regarding their appropriateness for moving to a selected OU on-the-fly and, secondly, delivers the evaluation results in the form of an ordered list.

The results are presented in a human-readable form and provide explanations for the proposed ordering of each employee. Thirdly, the developed interface visually displays all data and relationships between the employees on a geographical interactive map and as such, it provides a very user-friendly "look and feel" experience. It allows users to interact with the model and examine different scenarios of employee exchange among different OUs.

The user interface was created in collaboration with the users from the HR department through several iterative meetings. Most of the meetings were between the analyst and representatives of the company which made it possible to develop the content and design of the user interface according to the expectations of its users.

IV. RESULTS

In continuation, we present the developed DS model for employee redeployment, the algorithm for sorting employees with similar attribute values, the implementation of the DS

Attribute	Scale
Transfer evaluation of Employee	not recommended; acceptable; ***recommended***
Employee appropriate	not appropriate; appropriate; ***excellent***
Employee adequacy	not adequate; adequate; ***excellent***
Skills	insufficient; sufficient; ***excellent***
IT spec. skills	insufficient; sufficient; ***excellent***
Employee IT spec. skills	insufficient; good; very good; ***excellent***
OU IT spec. skills	not required; good; very good; ***excellent***
IT general skills	insufficient; sufficient; ***excellent***
Employee IT general skills	insufficient; good; very good; ***excellent***
OU IT general skills	not required; good; very good; ***excellent***
Language knowledge	insufficient; sufficient; ***excellent***
Employee Language knowl.	insufficient; good; very good; ***excellent***
OU language knowledge	not required; good; very good; ***excellent***
Driving licence	insufficient; sufficient; ***excellent***
Employee driving licence stat.	does not have driving licence; has driving licence
OU driving licence status	driving licence not mandatory; driving licence mandatory
Personal	insufficient; sufficient; ***excellent***
Disability status	not appropriate; ***appropriate***
Employee disability status	persons without disabilities; persons with disabilities
OU disability status	no restriction; restricted for persons with disabilities
Educational field	not appropriate; ***appropriate***
Employee educational field	Bio and med; Econ; ICT; Law; Mech; Soc; Tech; Trans
OU educational field	Bio and med; Econ; ICT; Law; Mech; Soc; Tech; Trans
Educational level	insufficient; sufficient; ***excellent***
Employee's educ.level	master; bachelor; upper secondary;lower secondary
Work position educ.level	master; bachelor; upper secondary;lower secondary
General work	insufficient; sufficient; ***excellent***
Work experience	insufficient; sufficient; very good; ***excellent***
OU work experience	not required; 5 years; 8 years; 10 years
Employee work experience	less than 5; >=5&<8;>= 8&<10;>= 10&<=20; 21+
Work position	not appropriate; ***appropriate***
Employee workposition	Adviser; Assist;Corresp;Dep.Dir;Director;Empl;Sen.exp. Expert;referent;HdOffice;HdReg.office;HdService;Insp;
OU workpositions	Adviser; Assist;Corresp;Dep.Dir;Director;Empl;Sen.exp. Expert;referent;HdOffice;HdReg.office;HdService;Insp;
Workhours	not appropriate; ***appropriate***
Employee's educ.level	primary or lower sec; upper sec; bachelor; ***master***
Employee workhours	8h - 1 shift; 24h - 3 shift
OU workhours	8h - 1 shift; 24h - 3 shift
Employee work experience	less than 40; 40+ years
Distance to workplace (OU)	not preferred; appropriate; good; ***preferred***
Applications roles	insufficient; acceptable; very good; ***excellent***
OU transfer ability	not suggested; suitable; ***suggested***
Outgoing OU transfer saturation	fewer; equal +/- 1; ***more***
Incoming OU transfer saturation	more; equal +/- 1; ***fewer***

FIGURE 4. A DEX model tree, its attributes and their value scales.

model into a web-based DSS IDAM, as well as the costs and saving achieved using DSS IDAM.

A. PRESENTATION OF THE MODEL FOR EMPLOYEE REDEPLOYMENT

The structure of the developed decision model is given in **FIGURE 4**.

It has 43 attributes, of which 26 are input and 17 are aggregated. Unlike traditional DEX models, here we aggregate two input attributes, one describing the employee skills and one of the required skills for the position in an organisational unit. The aggregated attribute evaluates the matching between them.

In the presented hierarchical model, the root attribute *Transfer evaluation of Employee* provides the final evaluation of the employee's qualification for redeployment in a particular OU. The evaluation aggregates the values of the attributes *Employee appropriate* and *OU transfer-ability,* which are evaluated using so-called utility functions. TABLE 2 shows the utility function for the final evaluation of the employee's redeployment into a new organisational unit. The sign "$*$" in TABLE 3 denotes any value of the attribute, and the sign "$>=$" denotes values "more or equally preferred to". Such utility tables are prepared for each aggregated attribute in the model. **APPENDIX A** describes details for each attribute in the model presented in **FIGURE 4** and **APPENDIX B** provides details on the evaluation of *OU transfer-ability*.

The processes of employee evaluation and transferability are the only part of the global business process of choosing the most appropriate employee for selected OU. For evaluating more employees in relation to a selected OU we need the ability to select the most suitable among many available employees. Hence, the need to sort all employees in order to choose the most appropriate one.

TABLE 3. Utility function for transfer evaluation of employee node.

Employee appropriate	OU transfer-ability	Transfer evaluation of Employee
not appropriate	*	not recommended
*	not suggested	not recommended
appropriate	>=suitable	acceptable
>=appropriate	suitable	acceptable
excellent	suggested	recommended

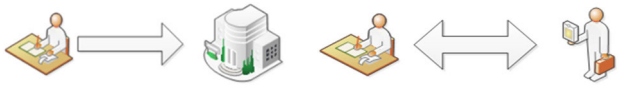

FIGURE 5. Employee redeployment to an OU (left) and simultaneous redeployment of two employees between their OUS (right).

B. SORTING EVALUATION RESULTS

There are two situations for employee redeployment, as presented in **FIGURE 5**. The first approach is used for the redeployment of an employee to OU presented in **FIGURE 5** (left). The second approach is used for the simultaneous redeployment of two employees between their organisational units shown in **FIGURE 5** (right). We used two different approaches for creating ordered lists for the two presented situations in **FIGURE 5**.

The use-case scenario "*transpose two employees*" occurs when two employees switch their workplaces as presented in **FIGURE 5** (right). Transposition of employees requires a precise selection of appropriate employees. A random transpose of two employees may lead to one or even both OUs to become ineffective. The reasons could be various, such as inadequate education field, lack of minimal work experience needed for operational activities in OU, lack of skills to do all of the daily tasks properly, etc. In this scenario, all attributes evaluations have been made in the same manner.

The transposition evaluation process does not need to evaluate *OU transfer saturation* and *OU transfer-ability* because the numbers of employees in both OUs is unchanged. However, the principle of choosing the best employees is different. The most important premise is the selection of most similar employees in other OU that could replace an employee almost instantly, without the need for extra education or with minimal intervention in employee's application roles. The calculation (3) of the transpose ordered list is obtained as an absolute value of the difference between the values of both employees:

$$T_r = E_1 - E_2 \tag{3}$$

Transpose sort value T_r is an output value which makes employee sorting possible. The smaller output value means the more similar employees by their attributes and hence more appropriate for transposition.

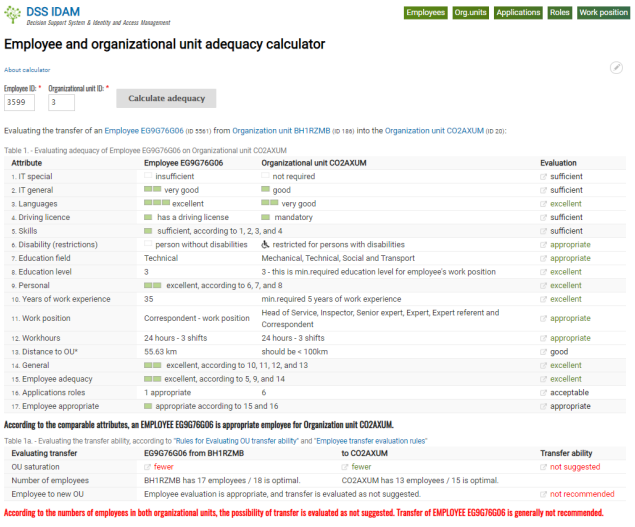

FIGURE 6. The DSS IDAM platform.

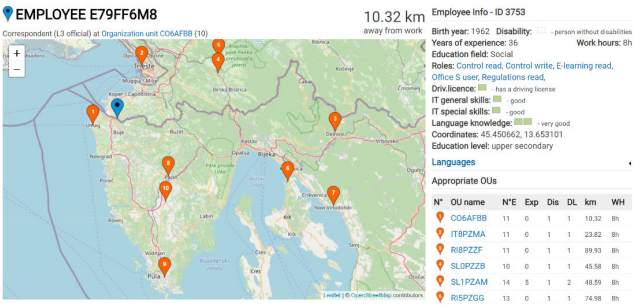

FIGURE 7. Interface screenshot: presentation of Employee entity and its attributes.

C. PLATFORM FOR TRANSFER OF THE MODEL TO HUMAN RESOURCES DEPARTMENT

To transfer the model to the Human resources department, we prepared a user-friendly platform, and an example of its usage is shown in **FIGURE 6**. The platform offers several views for representing the data (Employees, Org. Units, Applications, Roles and Work positions) as well as the Employee and organisational unit adequacy calculator.

FIGURE 7 represents an example of the *Employee E79FF6M8* evaluation (the number is given to protect the employee's personal data) in the web-based DSS application.

The blue map marker shows the geographical location of the employee's place of residence, while red map markers indicate the OU where the current employee works and suggest the nearest suitable organisational units to which the employee could be transferred. In addition to geographical information, the *Employee* main display shows all relevant attributes of the employee.

The recommendation of the suitable OU is based on the evaluated attribute values of the employee and the attributes of all other units (OU, Workplace, Applications and Business roles). The two most essential functions in this platform view are the *"Appropriate OUs"* and *"Transpose"*. The *"Appropriate OUs"* function, initiates a software

FIGURE 8. An ordered list of evaluation results of choosing (most) appropriate OU.

FIGURE 9. An ordered list of evaluation results of choosing (the most) appropriate employee for transposition.

program that uses the described decision model and performs thousands of calculations and evaluations in the background. The result is a list of sorted appropriate OUs with most appropriate OU on the top of the list, as presented in **FIGURE 8**.

Each row in **FIGURE 8** displays one result of evaluating (the most) appropriate organisational unit. In the third column in **FIGURE 8**, the ⓘ icon pop-ups extra information such as detailed evaluation display of each attribute and related explanation using *Utility function* decision rules. The meanings of the abbreviations in the first row are following: "RE" stands for Role evaluation, "DE" - Disability status evaluation, "DLE" - Driving licence evaluation, "EE" - Experience evaluation, "EL" – Educational level evaluation, "LE" – language knowledge evaluation, "IS" – IT special skills evaluation, "IG" – IT general skills evaluation, "Ap" – Appropriateness, and "TR" – Transfer adequacy evaluation. The number of green rectangles presents a graphical interpretation of evaluated numerical results.

The function *"Transpose"* is used for DS in choosing the most appropriate employee for transposition and the evaluation results of the platform are presented in **FIGURE 9**.

The web-based application has an additional built-in function of random employee and OU adequacy calculator. After every evaluation of employee adequacy on selected OU, the built-in calculator randomly selects a new pair of employee ID and OU ID, prepopulates them into their fields and automatically prepares the calculator to run a new round of calculation of the decision model rules. All explained functionalities are available in one mouse click.

D. COST AND TIME SAVINGS USING DSS IDAM

In the final research stage, we performed business processes improvement simulations and an analysis of cost reduction and time efficiency based on DSS IDAM. We used the average time required by an HR to process an employee transfer, the average number of transfers per year and the maximal operational costs in the HR for employee transfer. The time frame of one simulation cycle was 365 days and we performed 100 simulation cycles. Employees sample was 5800 (2900 employees changed their workplace twice a year). The performed simulations and analysis lead to the following conclusions:

- the time required for transferring an employee from one working place to other is reduced by 82.69% (time

recorded for completing one case were reduced from 83 minutes to 14,17 minutes per case),
- the operational costs have decreased by 87.64%.

V. CONCLUSION AND DISCUSSION

The development and implementation of IDAM into the core business processes of the enterprise can have a direct impact on business agility, productivity, user experience, security risks and compliance. Because there are many variations in the combination of processes and technologies, there is always a need to predict business outcomes and how they will be affected.

The proposed web-based DSS IDAM platform for assessing employees for specific organisational units or another entity has its place in organisations with a large number of employees, spread across a wide geographic area in many organisational units, or an organisation with a limited number of qualified employees who specialise in activities that require a specific set of skills. Quick and high-quality decisions are essential for the organisation in unpredictable circumstances, or when the business dynamics are dictated by business contracts that require a quick response and limitations that imply possible penalties due to time delay, or a company's income declines.

An operational application of the proposed DSS is applicable in many situations. For example, such DSS is useful in all state departments that collect the state revenue, such as taxation, food control, or customs, where it is of utmost importance to prevent the possible corruption and consequently avoid loss of income. Other examples are health care, general safety and security, where such DSS may aid in quick identification of a most suitable specialist (medic, epidemiologist, lifeguards, firefighters, inspectors, crime preventing and investigating officers, etc.) for saving lives and public safety.

A review of the literature showed different approaches and methods in dealing with HR day-to-day activities. They are generally oriented towards the problem of recruiting the most suitable new employee. The research carried out differs in that it focuses on the transfer of employees under restrictions and their fluctuation through organisational units is triggered by events related to the season (e.g. a tourist season), by the organisation's security policy or by any unforeseen event requiring immediate action and the transfer of employees to another organisational unit where current employees suffer due to increased activity.

A potential user of the proposed DSS IDAM platform may find it helpful if its organisational policy is aimed at preventing corruption and preventing undesirable relationships between employees and parties involved in business processes that could cause material damage to the corporate or government budget. We have implemented the proposed platform in such a way that it can be used to accelerate business processes in the selection of several suitable employees and, due to its effectiveness, increase the organisation's income or reduce operating expenses. Due to the specifics of the real-life circumstances of individual employees, although this approach is implemented as a support tool that quickly and efficiently suggests the most appropriate redeployment of employees, the final decision for redeployment should remain with the decision-maker.

VI. APPENDICES

A. EXPLANATION OF ATTRIBUTES

The attribute *Employee appropriate* evaluates the necessary characteristics of the employee to perform a business task in the deployed organisational unit. The evaluation value is based on the suitability of the candidate (*Employee adequacy*) and the evaluation of the current employee's authorizations (*Application roles*).

Employee adequacy evaluates the personal qualities of the employee to fit into a particular organisational unit based on the three attributes: *Skills*, *Personal* and *General work.*

In order to assess the match between the employee's skills and the requirements of the OU, we have introduced the *Skills* attribute. However, it is difficult to provide a model that would comprehensively assess the skills of all employees, as they differ both in quality and the requirement of the position. We have therefore limited our research to the skills that are most commonly used in our model organisation. Therefore, the attribute *Skills* aggregates the *IT special skills*, *IT general skills*, *Language knowledge*, and *Driving licence*.

We have introduced the attribute *Personal* to evaluate the correspondence between the employee's physical condition and formal education with the requirements of the OU and it evaluates the following attributes: *Disability status*, *Educational field*, and *Educational level*.

We have introduced the attribute *General Work* to evaluate the correspondence between the additional general characteristics of the employee and the requirements of the OU. The *General Work* attribute aggregates the valuation of the attributes *Work Experience, Work position, Working hours* and *Distance to the workplace.*

Evaluation of employee's *roles* is simple comparison process of employee's currently used applications and roles that are necessary for the complete execution of the daily tasks required by the applications of the respective OU.

B. EVALUATION OF OU TRANSFER-ABILITY

The requirement for evaluation of the attribute *OU transfer-ability* arises from the case when an employee may be *adequate* and *appropriate* for an OU. However, there might be a lack of free workplaces in the OU. Such scenario happens when the optimal number of employees in *Incoming OU* has been reached or the current, *Outgoing OU,* has fewer employees than optimally needed and leaving one employee to another OU could result in a critical deficiency of employees and business processes may be stopped any time or become ineffective in that OU. *Outgoing* OU denotes the unit that the employee leaves from, while *Incoming* OU denotes the unit to which the employee will be redeployed.

The evaluation of the attribute *OU transfer-ability* relies on the:

TABLE 4. Utility function—how OU saturation evaluation creates transfer-ability.

Outgoing OU saturation	Incoming OU saturation	OU transfer-ability
fewer	more	not suggested
fewer	equal +/-1	not suggested
fewer	fewer	not suggested
equal +/-1	More	not suggested
equal +/-1	equal +/-1	suitable
equal +/-1	fewer	suitable
more	more	not suggested
more	equal +/-1	suitable
more	fewer	suggested

TABLE 5. Description of the values scale of the attribute OU transfer-ability.

DEX value scale	Description
◆ not suggested	Transfer of an employee from the organisational unit that has fewer employees than optimally needed is not suggested. Transfer of employee to the organisational unit that has more employees than optimally needed is not suggested.
◆ suitable	Transfer of employee to or from an organisational unit that has an optimal number of employees (+/-1) is suitable.
◆ suggested	Transfer of an employee from the organisational unit that has more employees than optimally needed is suggested. Transfer of employee to the selected organisational unit that has fewer employees than optimally needed is suggested.

– Evaluating *Outgoing OU transfer saturation*
– Evaluating *Incoming OU transfer saturation*

OU Transfer saturation is defined as the current versus an optimal number of employees in the organisational unit. The optimal number of employees in an OU is defined by the Organization's management structure. It is usually constant, however, the Organization's management may decide to change its values due to various reasons such as improving the business dynamics, season's specific circumstances, etc. The current number of employees is always available from the organisation's evidence lists. *OU transfer saturation* may get a positive or negative value. A positive value means that an *Incoming OU* has fewer employees than optimally needed, and an *Outgoing OU* has more employees than optimally required. A negative transfer saturation value means that *Incoming OU* has more employees than optimally needed, and *Outgoing OU* has fewer employees than optimally required. The value scale of *OU Transfer saturation* is increasing for *Outgoing OU* from "*fewer*" to "*equal +/-1*" and "*more*", and is decreasing from "*more*" to "*equal*" and "*fewer*" for *Incoming OU*. Value *fewer* represents fewer employees than optimally needed. Value *equal +/-1* represents the optimal number of employees. Also, one employee fewer or more than equal is recognised as an optimal number of employees in the evaluation process.

TABLE 4 shows the utility function for the aggregation of *OU transfer saturation*.

The resulting attribute is *OU transfer-ability* and is determined based on the values of the input attributes *Outgoing OU* saturation and *Incoming OU* saturation.

Three ordered values for *OU transfer-ability* are provided as an evaluation result as presented in TABLE 5.

REFERENCES

[1] R. K. Ablhamid, B. Santoso, and M. A. Muslim, "Decision making and evaluation system for employee recruitment using fuzzy analytic hierarchy process," *Int. Refereed J. Eng. Sci.*, vol. 2, no. 7, pp. 24–31, 2013.
[2] E. Albrechtsen and J. Hovden, "The information security digital divide between information security managers and users," *Comput. Secur.*, vol. 28, no. 6, pp. 476–490, Sep. 2009, doi: 10.1016/j.cose.2009.01.003.
[3] M. Bohanec, "DEXi: Program for multi-attribute decision making. User's manual, version 5.04," Jožef Stefan Inst., Ljubljana, Slovenia, 2020. [Online]. Available: http://kt.ijs.si/MarkoBohanec/pub/DEXiManual504.pdf
[4] M. Bohanec, B. Zupan, V. Rajkovic, I. Bratko, and M. Žnidarsic, "DEX methodology: Three decades of qualitative multi-attribute modeling," *Informatica*, vol. 37, no. 1, p. 49e54, 2013.
[5] D. Chack, "Decision support system for human resource management of the organization," *Int. J. Manage. Res. Bus. Strategy*, vol. 2, no. 3, pp. 105–111, 2013.
[6] S. Choudhary, "A study on managing redeployment: An effective retention strategy," *Int. J. Commerce Manage. Res. Int.*, vol. 2, no. 7, pp. 1–6, 2016.
[7] K. M. Eisenhardt and M. J. Zbaracki, "Strategic decision making," *Strategic Manage. J.*, vol. 13, no. 2, pp. 17–37, 1992.
[8] Information Service Group (ISG). (2013). *Managing Employee Redeployment Creating Value Through Opportunity*. [Online]. Available: https://isg-one.com/docs/default-source/default-document-library/managing-employee-redeployment.pdf?sfvrsn=987af831_0
[9] M. Jändel, "Decision support for releasing anonymised data," *Comput. Secur.*, vol. 46, pp. 48–61, Oct. 2014, doi: 10.1016/j.cose.2014.07.001.
[10] E. Jereb, U. Rajkovic, and V. Rajkovic, "A hierarchical multi-attribute system approach to personnel selection," *Int. J. Selection Assessment*, vol. 13, no. 3, pp. 198–205, Sep. 2005.
[11] H. Mintzberg, D. Raisinghani, and A. Théoret, "The structure of 'unstructured' decision processes," *Administ. Sci. Quart.*, vol. 21, no. 2, pp. 246–275, 1976, doi: 10.2307/2392045.
[12] M. Thite, *E-HRM: Digital Approaches Directions and Applications*. Abingdon, U.K.: Routledge, 2019.
[13] W. Verina, M. Fauzi, F. Nasari, D. H. Tanjung, and J. Iriani, "Decision support system for employee recruitment using multifactor evaluation process," in *Proc. 6th Int. Conf. Cyber IT Service Manage. (CITSM)*, Aug. 2018, pp. 1–4, doi: 10.1109/CITSM.2018.8674277.
[14] O. Yabanci, "From human resource management to intelligent human resource management: A conceptual perspective," *Hum.-Intell. Syst. Integr.*, vol. 1, nos. 2–4, pp. 101–109, Dec. 2019, doi: 10.1007/s42454-020-00007-x.

MILJENKO HAJNIĆ was born in Zagreb, Croatia, in 1974. He received the bachelor's degree from the Zagreb University of Applied Sciences, in 2007, and the master's degree in computer software engineering from Algebra University College, Zagreb, in 2015. He is currently pursuing the Ph.D. degree with the Faculty of Information Studies, Novo Mesto, Slovenia.

Since 2010, he has been a Professional Specialist of computer engineering employed in a public administration. His main research interests include decision support systems, identity management, access management, information security, and human resources management.

BILJANA MILEVA BOSHKOSKA is currently an Associate Professor of data sciences with the Faculty of Information Studies, Novo Mesto, Slovenia, and a Researcher with the Jožef Stefan Institute, Ljubljana, Slovenia. She is also a Supervisor of six Ph.D. students. She has been involved in several national and H2020 projects. Her main research interests include decision support systems, data science, and hyper-performance computing.