

## MIREL CONCEPT-ALIGNED TOOL FOR ANALYSING EMPLOYEE PARTICIPATION IN PROJECTS – DATA VALIDITY IN THE TOOL

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**Purpose:** The main research purpose underlying this paper has been to develop and present solutions intended to support validation of the data entered in a tool created in line with the MiRel concept to help in analysing employee participation in the implementation of projects.

**Design/methodology/approach:** The study comprises analysing the manner in which the tool in question can be used and identifying the successive steps taken in order to generate a report of an intended format. Potential problems pertaining to the validity of the data entered in the tool, which may be encountered while individual steps are performed, have been defined. A supporting solution has been developed with reference to each of the problems identified as a means to ensure data validity. Furthermore, collective information panels have been proposed to inform the user about the potential occurrence of any of the problems previously defined.

**Findings:** Data validation supporting solutions can narrow down the range of values admissible to be entered by users or explicitly inform them that the values being entered are invalid. The range of admissible values can also be limited by means of the Data Validation mechanism combined with the Name Manager. The solutions intended to provide information about existing errors can make use of the Conditional Formatting mechanism, coupled with formulas based on standard built-in spreadsheet functions.

**Practical implications:** The solutions proposed in this paper support data validation in the tool in question. There are analogous solutions which can be applied in similar tools aimed at supporting data processing in a different scope within organisations.

**Social implications:** Once successfully applied, the solutions proposed in this paper make the tool in question more reliable and user-friendly. They make the tool easier to use to support data processing in organisations and less prone to problems.

**Originality/value:** The concept described in the paper is the author's original solution.

**Keywords:** spreadsheet, database, data processing, Microsoft Excel, project management.

**Category of the paper:** Case study and technical paper.

## 1. Introduction

Efficient implementation of processes in which information is generated, acquired, stored, processed, shared, interpreted, or utilised (Oleński, 2001, 2002) is currently considered to be one of the most crucial aspects in the operations of every organisation. It is for the rapid technological progress that, in terms of the support available for this group of processes, organisations can choose from an increasingly abundant range of solutions. Despite the ongoing development of the latter, spreadsheets remain to be a very popular group of tools used on a daily basis in businesses. And for many years, the dominant position within this group has invariably belonged to Microsoft's solution – Excel. Simon Cocking (Cocking, 2017) highlights seven factors of relevance to its popularity. These include the possibility of solutions being quickly created without waiting until the IT department becomes involved or its very high flexibility when in the hands of proficient users. Spreadsheets are commonly used by organisations in a multitude of areas, such as accounting, financial management, sales, or marketing (Jackson, Staunton, 2004; Kusztełak, 2020; Winston, 2019; Próchnicki, 2012), work time organisation (Zasadzień et al., 2017), quality management (Knight, 2009; Szczeńniak, Molenda, 2013; Szczeńniak, 2021), or organisation analysis at large. And since spreadsheets have proved remarkably useful in supporting the daily operations of various organisations, they have also become indispensable in supporting the process of education in economics (Barreto, 2015, 2023; Mangiero et al., 2010). An interesting concept is using spreadsheets to build solutions where data are stored as structures conforming with the relational data model (Tyszkiewicz, 2010; Sroka et al., 2015). Such a data structure is also envisaged as the underpinning of the author's signature concept known as MiRel (Szczeńniak, 2017, 2018a, 2018b, 2020a). An example of a tool created in line with this concept has already been described in the literature (Szczeńniak, 2023) as one intended to support the analysis of employee participation in the implementation of specific projects. Reliable functioning of such a tool is inextricably linked with the validity of the data entered, which is why a number of solutions aimed at supporting data validity in the said tool have been discussed further on in this paper.

## 2. General structure of the tool

The tool in question supports analysis of employee participation in the implementation of projects by automating the process in which a required report is generated based on data collected in a specific format. The tool features four entities: *Roles*, *Projects*, *Employees*, and *Employees\_Projects*. These entities are represented as tables, which is typical of

a conventional relational database. Each table is entered into a separate worksheet whose name corresponds to that of the table. With the tool in use, data are directly entered only in the *Roles* table. For purposes of the remaining tables, data are extracted automatically by means of adequate formulas from a form whose layout corresponds to the input data layout envisaged in the process. The final report is created on the basis of the data found in individual tables. The general concept of the tool has been schematically illustrated in Figure 1, while its details have been described in one of the author's previous articles (Szczęśniak, 2023). The paper in question thoroughly explains the solutions implemented for purposes of automation of the data transfer from the form proposed to adequate tables as well as the solutions applied to automate the report generation. Such a tool can only function properly if it has been fed with valid data. Therefore, what should be proposed is a number of solutions intended to support validation of the data entered in the tool.

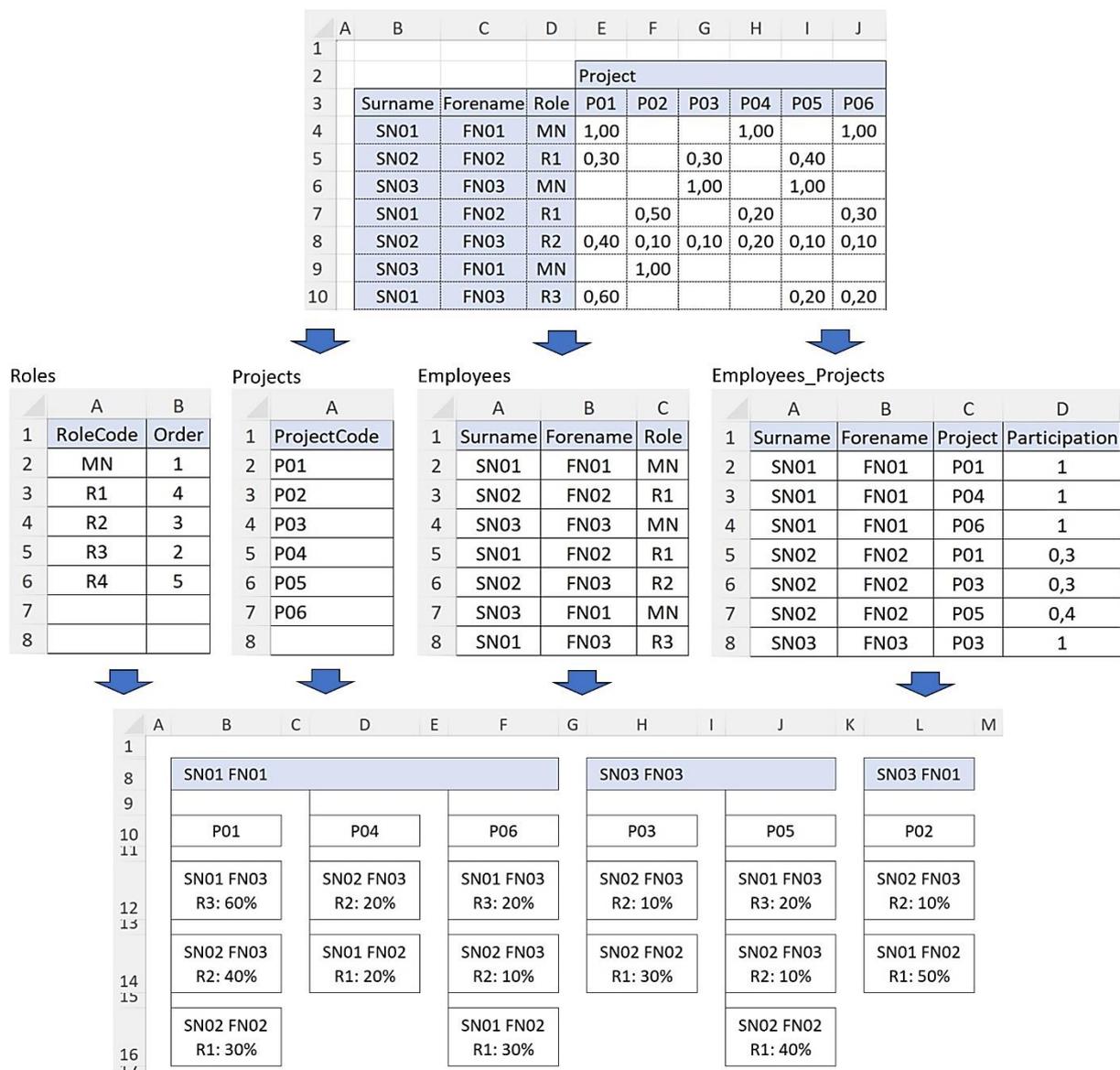


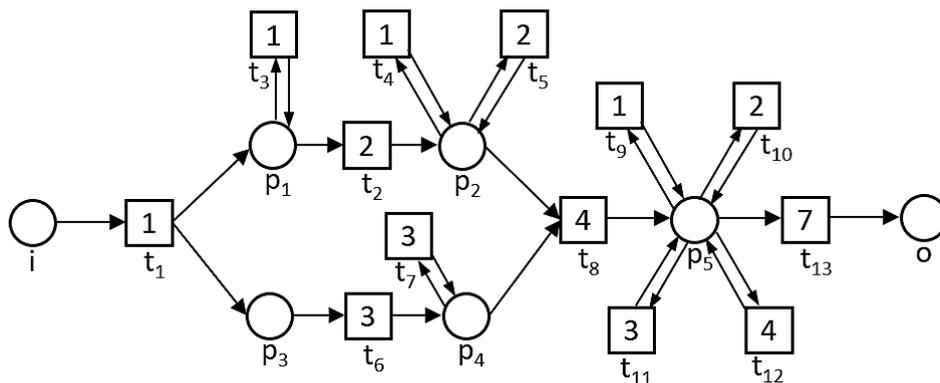
Figure 1. General concept of the tool.

### 3. Problems of data validity in the tool

In order to identify the potential irregularities that may emerge while data are entered in the tool, the process in which it is used has been analysed. Assuming that no data have been entered in the tool yet, the successive steps taken to generate a report of an intended format are as follows:

1. Entering individual roles and defining their order in the report in table *Roles*.
2. Entering project names in the form.
3. Entering surnames, forenames, and roles of employees in the form.
4. Entering employee participation in individual projects in the form.
5. Transfer of data from the form to the *Projects*, *Employees*, and *Employees\_Projects* tables.
6. Based on the data in the tables, generating the report in its final format.
7. Extracting the report from the tool to the target document.

The order in which steps 2 and 3 are performed is irrelevant. While entering data in the form, one can also enter consecutive roles in the table *Roles*. Steps 5 and 6 are executed automatically by means of mechanisms created using built-in spreadsheet functions combined with Conditional Formatting. They are executed automatically in the event that any changes have been made to the data entered in the tool under steps 1, 2, 3 and 4. Steps 1, 2, 3, 4 and 7 are performed by the user. The potential interactions with the tool have been depicted in Figure 2 as a labelled Petri net structure consistent with the WorkFlow net (Van der Aalst, 2016). In this diagram, the labels of the activities assigned to individual transitions refer to the corresponding steps.



**Figure 2.** Potential interactions with the tool.

As aforementioned, data are entered in the tool in steps 1, 2, 3 and 4. There are specific potential irregularities defined for these steps. In step 1, there is a risk that:

- a) An identical value of attribute *RoleCode* is entered more than once;
- b) A value of only one of the attributes is entered for the role added;
- c) Empty rows are left between successive roles in the table;

- d) No role with assigned order of 1 is entered;
- e) Order of 1 is assigned to more than one role.

In step 2, there is a risk that:

- a) The project name repeats itself;
- b) Empty columns are left between the project names entered.

In step 3, there is a risk that:

- a) The forename and surname combination repeats itself;
- b) A previously undefined role is entered;
- c) Only part of the attributes *Surname*, *Forename* and *Role* are entered for a given employee;
- d) No employee assigned a role with the assigned order of 1 is entered;
- e) Empty rows are left between the employees entered.

In step 4, there is a risk that:

- a) The sum of participation of an employee performing a role with an assigned order other than 1 is other than 1;
- b) The value entered for an employee performing a role with the assigned order of 1 is other than 1;
- c) The value entered for an employee performing a role with an assigned order other than 1 is not of the range (0, 1>;
- d) There is a project with unassigned participation of any employee performing a role with the assigned order of 1;
- e) There is a project with assigned participation of several employees performing a role with the assigned order of 1;
- f) Values are entered in a row where no employee has been entered;
- g) Values are entered in a column where no project has been entered.

#### **4. Solutions intended to support data validity in the tool**

In order to reduce the risk of data being entered incorrectly in the tool, a number of solutions intended to inform the user about a detected problem or directly restricting the possibility of entering invalid data have been proposed. As the means to ensure validity of the data entered in step 1, four columns, one cell, and one auxiliary table have been added in the worksheet *Roles*. The additional ranges along with the formulas applied in them have been shown in Figure 3.

	A	B	C	D	E	F	G	H	I	J	K
				FA1	FA2	FA3	FA4	FA5		FA6	
1	RoleCode	Order		111	112	113	114	115		R	R
2	MN	1		0	0	0	4	0		0	0
3	R1	4		0	0		3	0		0	0
4	R2	3		0	0		2	0		0	0
5	R3	2		0	0		1	0		0	0
6	R4	5		0	0		0	0		0	0
10				0	0		0	0		0	0
11				0	0					0	0

FA1	=IF(COUNTIFS(\$A\$2:\$A\$11;A2)>1;1;0)
FA2	=IF(AND(COUNTIFS(\$B\$2:\$B\$11;1)>1;B2=1);1;0)
FA3	=IF(COUNTIFS(B2:B11;1)=0;1;0)
FA4	=COUNTA(A3:\$A\$11)
FA5	=IF(AND(A2="" ;G2>0);1;0)
FA6	=IF(AND(A2="" ;COUNTA(\$A2:\$B2)>0;J\$1<>"O");1;0)

**Figure 3.** Solutions applied to ensure data validity in step 1.

Formula FA1, added in column I11, verifies the number of occurrences of the value of the attribute *RoleCode* entered in the current row. If the given value occurs more than once, the formula returns the value of 1. On such a basis, and with the use of Conditional Formatting, the corresponding value in the *RoleCode* column becomes highlighted in red, which means that problem *1a* has been found, i.e. problem *a* identified for step 1. Formula FA2, found in the next column I12, refers to problem *1e*. It verifies how many times the value of 1 has been entered in the *Order* column. If more than once, and at the same time, there is the value of 1 entered in the current row for the attribute *Order*, the formula returns the value of 1. With reference to it, all the recurring values of 1 in the *Order* column are highlighted in red. Provided that formulas FA1 and FA2 have been entered in all cells of the right columns, another formula, i.e. FC3, is found in but a single cell. This formula verifies how many times the number one has been entered as the value of the attribute *Order*. If no number one has been entered in the tool, the formula returns the value of 1. With reference to this value, the *Order* column header becomes highlighted in red using Conditional Formatting. This means that problem *1d* has occurred. The next two formulas are connected with problem *1c*. Formula FA4 counts how many roles have been entered in the rows starting from the next one to the table end. If this is a positive number, and at the same time, no role has been entered in the current row, formula FA5 returns the value of 1. With reference to this value, the empty rows between consecutive roles become highlighted in red. It has been assumed that rows containing roles are treated as the rows in which the primary key value has been entered, i.e. the value set for the attribute *RoleCode*. In relation to problem 2b, within range J1:K11 in the worksheet, an auxiliary table has been added with columns corresponding to the columns in the table *Roles*. The letter *R* in the auxiliary table's column header means that the values of the attribute in the corresponding column in the table *Roles* are not optional. The uniform formula designated as FA6 has been entered in the entire table. This formula checks if any values have been entered

in the current row, in any column, and if the corresponding cell in the table *Roles* remains empty. In the event that both these conditions have been satisfied, the formula returns the value of 1. With reference to all the values of 1 in the auxiliary table, the corresponding cells in the table *Roles*, i.e. those in which data are to be entered, become highlighted in red.

In order to ensure validity of the data entered in step 2, three auxiliary rows have been added in the worksheet *Form*. Both these rows and the formulas applied in them have been shown in Figure 4. Found in the first of them, formula FB1 is linked with problem 2a. This formula checks the number of occurrences of the project code entered in the current column. Where this number is larger than 1, the formula returns the value of 1. With reference to this value, and using Conditional Formatting, a code that occurs more than once becomes highlighted in red. Formulas FB2 and FB3 found in the next two auxiliary rows are linked with problem 2b. The former counts the project codes entered in the columns to the right of the current column. In the event that the value it returns is larger than zero and no project code has been entered in the current column, formula FB3 returns the value of 1. With reference to the values of 1 returned by the formula, the empty columns between consecutive projects are highlighted in red.

	A	B	C	D	E	F	G	H	I	J	X
1											
2				Project							
3	Surname	Forename	Role	P01	P02	P03	P04	P05	P06		
4	SN01	FN01	MN	1,00			1,00		1,00		
5	SN02	FN02	R1	0,30		0,30		0,40			
6	SN03	FN03	MN			1,00		1,00			
7	SN01	FN02	R1		0,50		0,20		0,30		
8	SN02	FN03	R2	0,40	0,10	0,10	0,20	0,10	0,10		
9	SN03	FN01	MN		1,00						
10	SN01	FN03	R3	0,60				0,20	0,20		
59			FB1								
60			FB2	I21	0	0	0	0	0	0	0
61			FB3	I22	5	4	3	2	1	0	0
62				I23	0	0	0	0	0	0	0

FB1	=IF(COUNTIFS(\$A\$2:\$A\$11;A2)>1;1;0)
FB2	=IF(AND(COUNTIFS(\$B\$2:\$B\$11;1)>1;B2=1);1;0)
FB3	=IF(COUNTIFS(B2:B11;1)=0;1;0)

**Figure 4.** Solutions applied to ensure data validity in step 2.

In order to ensure validity of the data entered in step 3, five columns, one cell, and one auxiliary table have been added in the worksheet *Form*. The ranges added along with the formulas applied in them have been shown in Figure 5. Formula FC1, found in the first of the additional columns, verifies whether or not the combination of values of the attributes *Surname* and *Forename* entered in the current row repeats itself across the entire table. Where the given combination occurs multiple times, the formula returns the value of 1, with reference to which the current row's cells in the columns *Surname* and *Forename* become highlighted in red, and this implies problem 3a. The next two formulas are related to problem 3d. Formula FC2 in

auxiliary column I32 returns a number which determines the order assigned to the role performed by the employee entered in the current row. With reference to the value in this column, formula FC33 verifies whether or not there is at least one role with the assigned order of 1. Where no such role exists, the formula returns the value of 1. With reference to this value, the cell containing the header *Role* becomes highlighted in red. The next three columns are linked with problem 3e. Formula FC4, found in the first of them, verifies whether or not an employee has been entered in the current row. A row with an employee previously entered is understood as a row containing values for the both attributes that form the primary key in the table *Employees*, namely *Surname* and *Forename*. Using the values returned by formula FC4, formula FC5 counts how many employees have been entered in the consecutive rows of the form. In the event that data of at least one employee have been entered in the consecutive rows, while no employee has been entered in the current row, formula FC6 returns the value of 1. With reference to this value, the empty rows between consecutive employees are highlighted in red.

	B	C	D	E	F	G	H	I	J	X	AV	AW	AX	AY	AZ	BA	BC	BD	BE	
1											FC1	FC2	FC3	FC4	FC5	FC6	FC7			
2			Project																	
3	Surname	Forename	Role	P01	P02	P03	P04	P05	P06		I31	I32	I33	I34	I35	I36	R	R	R	
4	SN01	FN01	MN	1,00			1,00		1,00		0	1	0	1	6	0	0	0	0	
5	SN02	FN02	R1	0,30		0,30		0,40			0	4		1	5	0	0	0	0	
6	SN03	FN03	MN			1,00		1,00			0	1		1	4	0	0	0	0	
7	SN01	FN02	R1		0,50		0,20		0,30		0	4		1	3	0	0	0	0	
8	SN02	FN03	R2	0,40	0,10	0,10	0,20	0,10	0,10		0	3		1	2	0	0	0	0	
9	SN03	FN01	MN		1,00						0	1		1	1	0	0	0	0	
10	SN01	FN03	R3	0,60				0,20	0,20		0	2		1	0	0	0	0	0	
52											0			0	0	0	0	0	0	
53											0			0			0	0	0	

FC1	=IF(COUNTIFS(B\$4:B\$53;B4;\$C\$4:\$C\$53;C4)>1;1;0)
FC2	=IF(D4<>"";VLOOKUP(Form!D4;Roles!\$A\$2:\$B\$11;2;FALSE);"")
FC3	=IF(COUNTIFS(AW4:AW53;1)=0;1;0)
FC4	=IF(AND(B4<>"";C4<>"");1;0)
FC5	=SUM(AY5:\$AY\$53)
FC6	=IF(AND(AY4=0;AZ4>0);1;0)
FC7	=IF(AND(B4="";COUNTA(\$B4:\$D4)>0;BC\$3<>"0");1;0)

**Figure 5.** Solutions applied to ensure data validity in step 3.

In relation to problem 3c, in the worksheet, an auxiliary table has been added within range BC3:BE53, containing cells that correspond to the cells of the form's range B3:D53. The letter *R* in the headers of the auxiliary table's columns means that the values in the corresponding columns of range B3:D53 are not optional. There is a uniform formula FC7 in all auxiliary table cells. It verifies whether or not any employee data have been entered in the current row. If so, then the formula returns the value of 1 in the event that the corresponding cell of range B3:D53 is empty. With reference to the values of 1 returned in the auxiliary table, the corresponding cells of the form become highlighted in red.

The solution applied in order to address problem 3b, identified for step 3, is the Data Validation mechanism combined with the Name Manager. It has made it possible to narrow down the values entered in the form in the *Role* column to those which can be selected from a drop-down list. The said list comprises only the roles which have previously been entered in the table *Roles*.

In order to ensure validity of the data entered in step 4, four columns, two rows, and two auxiliary tables have been added in the worksheet *Form*. The columns and rows added along with the formulas applied in them have been shown in Figure 6. The two auxiliary tables have been depicted in Figure 7.

	A	B	C	D	E	F	G	H	I	J	X	Y	BG	BH	BI	BJ	BK	
1																		
2				Project									FD1	FD2	FD3	FD4		
3		Surname	Forename	Role	P01	P02	P03	P04	P05	P06			I41	I42	I43	I44		
4		SN01	FN01	MN	1,00			1,00		1,00			1	0	1	0		
5		SN02	FN02	R1	0,30		0,30		0,40				4	0	1	0		
6		SN03	FN03	MN			1,00		1,00				1	0	1	0		
7		SN01	FN02	R1		0,50		0,20		0,30			4	0	1	0		
8		SN02	FN03	R2	0,40	0,10	0,10	0,20	0,10	0,10			3	0	1	0		
9		SN03	FN01	MN		1,00							1	0	1	0		
10		SN01	FN03	R3	0,60				0,20	0,20			2	0	1	0		
53														0	0	0		
64			FD7	I46	0	0	0	0	0	0	0							
65			FD8	I47	0	0	0	0	0	0	0							

FD1	=IF(D4<>"",VLOOKUP(Form!D4;Roles!\$A\$2:\$B\$11;2;FALSE);"")
FD2	=IF(AND(D4<>"",BG4<>1,SUM(E4:X4)<>1);1;0)
FD3	=IF(AND(B4<>"",C4<>"");1;0)
FD4	=IF(AND(BI4=0,COUNTA(E4:X4)>0);1;0)
FD7	=IF(AND(E3<>"",COUNTIFS(E4:E53;1,\$BG\$4:\$BG\$53;1)=0);1;0)
FD8	=IF(AND(E3="";COUNTA(E4:E53)>0);1;0)

**Figure 6.** Auxiliary columns and rows added in the worksheet *Form* to ensure data validity in step 4.

The fact that formulas FD1 and FD2 have also been added is linked with problem 4a. The former of these formulas returns the order assigned to the role performed by the employee entered in the current row. Where this order is other than 1, the latter of the formulas checks whether or not the sum of the values which determine the employee participation in individual projects equals 1. Where this is not the case, the formula returns the value of 1. With reference to this value, all cells in which it is possible to enter the values which determine the participation of the current employee are highlighted in red. Formulas FD3 and FD4, found in the next two columns, are connected with problem 4f. Formula FD3 verifies if an employee has been entered in the current row, and if this condition has been satisfied, it returns the value of 0. Where this is the case, and if any value determining the employee participation in a project has been entered in the current row, formula FD4 returns the value of 1. With reference to this value, all cells in which it is possible to enter the values which determine the participation of the current employee are highlighted in red. Added in the auxiliary row, formula FD7 checks whether or

not, for the project found in the current column, participation of at least one employee assigned a role with the order of 1 has been defined. If no such employee has been assigned the participation of 1, the formula returns the value of 1. With reference to this value, the cell which contains the project code to be found in the current column becomes highlighted in red. Formula FD8, found in the second auxiliary row, is linked with problem 4g. This formula checks whether or not there are any numbers determining employee participation entered in the column where no project name has been entered. Where this is the case, the formula returns the value of 1. With reference to this value, all cells of the current column where employee participation has been defined become highlighted in red.

	B	C	D	E	F	G	H	I	J	X	BL	BM	BN	BO	BP	BQ	CE	CG	CH	CI	CJ	CK	CL	CZ	
1																									
2				Project																					
3	Surname	Forename	Role	P01	P02	P03	P04	P05	P06		T41						T42								
4	SN01	FN01	MN	1,00			1,00		1,00		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	SN02	FN02	R1	0,30		0,30		0,40			0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6	SN03	FN03	MN			1,00		1,00			0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	SN01	FN02	R1		0,50		0,20		0,30		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
8	SN02	FN03	R2	0,40	0,10	0,10	0,20	0,10	0,10		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
9	SN03	FN01	MN		1,00						0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10	SN01	FN03	R3	0,60				0,20	0,20		0	0	0	0	0	0	0	0	0	0	0	0	0	0	
53											0	0	0	0	0	0	0	0	0	0	0	0	0	0	

FD5	=IF(E4<>"",IF(\$BG4=1;IF(E4<>1;1;0);IF(AND(E4>0;E4<=1);0;1));0)
FD6	=IF(AND(E\$3<>"";COUNTIFS(E\$4:E\$53;1;\$BG\$4:\$BG\$53;1)>1;E4=1;\$BG4=1);1;0)

**Figure 7.** Auxiliary tables added in the worksheet *Form* to ensure data validity in step 4.

Auxiliary tables T41 and T42 have been added to make sure that the cells which contain invalid data are distinctively highlighted. The former of them pertains to problems 4b and 4c. The uniform formula FD5 which the table contains verifies whether or not the role entered in the current row has been assigned the order of 1. Where this is the case, the formula checks if the value which determines the employee participation in projects, found in the corresponding cell of the form, equals 1. If the order is other than 1, the formula checks if the corresponding value is larger than 0 and smaller than or equal to 1. Where the adequate condition is not satisfied, formula FD5 returns the value of 1, with reference to which the corresponding cell in the form becomes highlighted in red. Additionally, in order to address problems 4b and 4c, the Data Validation mechanism has been applied to make sure that, within range E4:X53 of the form, one can only enter numbers from 0 to 1. The latter of the auxiliary tables is connected with problem 4e. For each corresponding cell in the form, formula FD6, which the table contains, checks if, in the column where the given cell is found, there is more than one value of 1 which determines the participation of an employee to whom a role with order 1 has been assigned. Where this is the case, and if the same cell also contains the value of 1, determining the participation of such an employee, formula FD6 returns the value of 1. With reference to this value, the corresponding cell in the form becomes highlighted in red.

On account of the considerable number of problems which may emerge while data are being entered, the mere highlighting of the error containing cells may prove ambiguous and insufficient. In order to make the information about errors more accurate and to streamline the process of data entry in the worksheets *Form* and *Roles*, dedicated information panels have been added, providing details of the problems identified and signalling whether or not a given problem has actually occurred. Each occurrence of any of the problems entails the value of 1 being present in any of the auxiliary ranges added. Table 1 summarises the links between individual problems and specific ranges added. In order to determine whether or not a given problem has actually occurred, one should sum up the values in the auxiliary range with which it is connected. Any result other than 0 means that the problem exists.

**Table 1.**

*Problems identified in the sphere of data validity and the auxiliary ranges with which they are linked*

<b>Problem</b>	<b>Auxiliary range</b>
Recurrent role code (1a)	Roles!D2:D11
Missing values of attributes – role (1b)	Roles!K2:K11
Empty rows – Roles (1c)	Roles!H2:H10
No order of 1 (1d)	Roles!F2
Several occurrences of order of 1 (1e)	Roles!E2:E11
Recurrent project name (2a)	Form!E60:X60
Empty columns – Form (2b)	Form!E62:X62
Recurrent combination of Surname and Forename (3a)	Form!AV4:AV53
Missing values of attributes – employee (3c)	Form!BC4:BE53
No employee performing role with order of 1 (3d)	Form!AX4
Empty rows – Form (3e)	Form!BA4:BA52
Incorrect employee participation sum (4a)	Form!BH4:BH53
Incorrect participation determining values (4b, 4c)	Form!BL4:CE53
Project with no employee with order of 1 (4d)	Form!E64:X64
Several employees with order of 1 in project (4e)	Form!CG4:CZ53
Participation defined in row with no employee (4f)	Form!BJ4:BJ53
Participation defined in column with no project (4g)	Form!E65:X65

An example of a form containing data entered incorrectly has been provided in Fig. 8. In the event that a specific problem has been found, an adjacent cell becomes highlighted in red. In other cases, where problems are considered potential, yet they have not occurred, adjacent cells are highlighted in green.

	B	C	D	E	F	G	H	I	J	X	DB	DC
2				Project						Problem		
3	Surname	Forename	Role	P01	P02		P04	P05	P06		2a	0
4	SN01	FN01	MN	1,00			1,00		1,00		2b	1
5	SN02	FN02	R1	0,30		0,30		0,40			3a	0
6	SN03	FN03	MN	1,00		1,00		1,00			3c	0
7	SN01	FN02	R1	1,00	0,50		0,20		0,30		3d	0
8	SN02	FN03	R2	0,40	0,10	0,10	0,20	0,10	0,10		3e	0
9	SN03	FN01	MN		1,00						4a	1
10	SN01	FN03	R3	1,00							4b or 4c	0
11											4d	0
12											4e	2
13											4f	0
14											4g	1

**Figure 8.** Sample section of the worksheet *Form* containing data entered incorrectly.

## 5. Conclusions

The solutions discussed in the paper show that one can successfully design user data validity supporting mechanisms in a spreadsheet tool, created in line with the MiRel concept, which automates data processing while employee participation in the implementation of projects is being analysed. Such mechanisms are capable of limiting the range of values admissible to be entered by users or explicitly informing them about invalidity of the values being entered. The range of admissible values can be narrowed down by means of the Data Validation mechanism combined with the Name Manager. The solutions intended to provide information about existing errors can make use of the Conditional Formatting mechanism, coupled with formulas based on standard built-in spreadsheet functions. The extent of the functions actually used in these formulas is relatively narrow, including IF(), COUNTIFS(), AND(), COUNTA(), VLOOKUP(), or SUM(). It is doubtless that using data validity supporting mechanisms exerts a considerable effect on the functional reliability of the given tool in its entirety. None of the solutions proposed in this paper require the use of any code written in any programming language. The foregoing clearly implies that such solutions can be successfully developed by persons who are familiar with spreadsheets, but who have no command of programming.

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## References

1. Barreto, H. (2023). Using Excel to Teach Principles of Microeconomics. In: M. Maier, P. Ruder (Ed.), *Teaching Principles of Microeconomics* (pp. 257-269). Edward Elgar Publishing.
2. Barreto, H. (2015). Why excel? *The Journal of Economic Education*, 46(3), pp. 300-309.
3. Cocking, S. (2017). Seven Reasons why Excel is still used by half a billion people worldwide. *Irish Tech News*, <https://irishtechnews.ie/seven-reasons-why-excel-is-still-used-by-half-a-billion-people-worldwide/>, 16.05.2024.
4. Jackson, M., Staunton, M. (2004). *Zaawansowane modele finansowe z wykorzystaniem Excela i VBA*. Gliwice: Helion.
5. Knight, G. (2006). *Analyzing Business Data with Excel*. Sebastopol: O'Reilly Media.
6. Krivokapić, J., Todorović, I., Komazec, S., Marič, M., Miloš, J. (2014). *Using Spreadsheet as a Tool in Organizational Analysis*. 33rd International Conference on Organizational Science Development FOCUS 2020 March 19th– 21st 2014, Portorož, Slovenia.
7. Kusztelak, P. (2020). *Microsoft Excel w pracy finansisty. Analiza i modelowanie danych finansowych*. Warszawa: PWE.
8. Mangiero, G.A., Manley, J., Mollica, J.T. (2010). Improving pedagogy through the use of dynamic Excel presentations in financial management courses. *American Journal of Business Education (AJBE)*, 3(1), pp. 91-106.
9. Najihah, J., Hanyza, A. (2019). Usage of Microsoft Excel Spreadsheet as Accounting Tools in SME Company. *INWASCON Technology Magazine, Vol I*, pp. 23-25, doi:10.26480/itechmag.01.2019.23.25.
10. Oleński, J. (2001). *Ekonomika informacji. Podstawy*. Warszawa: PWE.
11. Oleński, J. (2002). *Ekonomika informacji. Metody*. Warszawa: PWE.
12. Próchnicki, W. (2012). *Zastosowanie Excela w pracy analityka finansowego, specjalisty ds. controllingu i analityka sprzedaży*. Gliwice: Helion.
13. Sroka, J., Panasiuk, A., Stencel, K., Tyszkiewicz, J. (2015). Translating Relational Queries into Spreadsheets. *IEEE Transactions On Knowledge and Data Engineering*, 27(8), pp. 2291-2303.
14. Szczęśniak, B. (2017). Microtools Based on the Relational Data Model - representation of entities in a spreadsheet. *17th International Multidisciplinary Scientific GeoConference SGEM 2017*, 17(21), ISBN: 978-619-7408-01-0, 29 June - 5 July, Albena, Bulgaria, pp. 447-454.
15. Szczęśniak, B. (2018a). Microtools Based On The Relational Data Model - transition from type II to type I of entity representation. *18th International Multidisciplinary Scientific GeoConference SGEM 2018*, 18(2.1), ISBN: 978-619-7408-39-3, 02-08 July, Albena, Bulgaria, pp. 553-560.

16. Szczeńśniak, B. (2018b). Microtools based on the relational data model - conformity between foreign and primary keys. *XV International Conference Multidisciplinary Aspects of Production Engineering (MAPE)*, 1(1), ISBN: 978-83-65265-25-8, 5-8 September, Zawiercie, Poland, pp. 491-497.
17. Szczeńśniak, B. (2020a). Microtools based on the relational data model for improvement of information processes - multiplicity of relationships, and mandatory nature of relationships and attributes. In: K.S. Soliman (Ed.), *Education Excellence and Innovation Management: a 2025 Vision to Sustain Economic Development during Global Challenges* (pp. 10537-10544). Proceedings of the 35th International Business Information Management Association Conference (IBIMA), 1-2 April 2020 Seville, Spain.
18. Szczeńśniak, B. (2021). MiRel concept-conforming tool for supporting service quality measurement by the SERVQUAL method. In: K.S. Soliman (Ed.), *Innovation management and information technology impact on global economy in the era of pandemic*. Proceedings of the 37th International Business Information Management Association Conference (IBIMA), 30-31 May 2021, Cordoba, Spain, pp. 12207-12218.
19. Szczeńśniak, B., Molenda, M. (2013). *Spreadsheet application supporting the x-r control chart*. Conference Proceedings of the 22th Conference Modern Mathematical Methods in Engineering (3mi), ISBN: 978-80-248-3234-0, June 3-5, Horni Lomna, Czech Republic, pp. 128-134.
20. Szczeńśniak, B. (2023). MiRel concept-aligned tool for analysing employee participation in projects. *Scientific Papers of Silesian University of Technology. Organization and Management Series*, vol. 185, pp. 455-470. <https://doi.org/10.29119/1641-3466.2023.185.25>
21. Tyszkiewicz, J. (2010). *Spreadsheet As a Relational Database Engine*. Proceedings of the 2010 ACM SIGMOD International Conference on Management of data, ISBN: 978-1-4503-0032-2, June 2010, Indianapolis, USA, pp. 195-206.
22. Van der Aalst, W. (2016). *Process Mining - Data Science in Action*. Springer.
23. Winston, W.L. (2019). *Analiza marketingowa. Praktyczne techniki z wykorzystaniem analizy danych i narzędzi Excels*. Gliwice: Helion.
24. Zasadzien, M., Szczeńśniak, B., Skotnicka-Zasadzien, B. (2017). *Implementation of maintenance employees' work time scheduling*. Piman Limpaphayom, Gordon Huang (Eds.). Proceedings of the Second International Conference on Economic and Business Management (Febm 2017), Shanghai, October 21-23, 2017. Atlantis Press, pp. 226-231.