TUTORIAL – SESSION 4
IMPLEMENTATION OF THE VRP PROBLEM
(VEHICLE ROUTING PROBLEM)

Analytics

SESSION 4: OPTEX-GUI – LOADING MODELS

OPTΣX Mathematical Modeling System

SEMINARIO:
ICAS AVANZADAS DE OPTIMIZACIÓN PARA EL SECTOR PETROLERO

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INDUSTRIALGORITHMS
Solving Complex Supply & Production Chain Planning and Scheduling Problems

Invited Speaker:

Professor Ignacio Grossmann, Ph. D.
Center for Advanced Processes Decision-making (CAPD)
Carnegie Mellon University

Date: Friday February 5th, 2016
Time: 9:00 am a 5:00 pm
Place: Auditorio PEMEX, México D.F.
Attendance: Personal invitation

Ask for invitation:

Detailed programm: PDF DOWNLOAD

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OPTIMIZATION SOLUTIONS FOR OIL & GAS

	Decision Horizon	UPSTREAM EXPLORATION & PRODUCTION: Explore, Produce, Trade	UPSTREAM: Transport	MIDSTREAM REFINING & CHEMICALS: Store, Refine, Store	DOWNSTREAM MARKETING & SERVICES: Distribute
Strategic	Years	▪ Project & Budget Planning ▪ Staff Budgeting ▪ Inventory Budgeting and Positioning ▪ Delivery Planning ▪ Maintenance Planning ▪ Network Design and Sourcing	▪ Pipeline Network Design ▪ Sourcing ▪ Rail Fleet Sizing ▪ Vessel Fleet Sizing ▪ Long Term Purchasing	▪ Plant Sizing and Sourcing ▪ Long Term Production Planning ▪ Purchase & Storage Planning	▪ Pipeline Network Design ▪ Sourcing ▪ Rail Fleet Sizing ▪ Vessel Fleet Sizing
Tactical	Quarters, Months	▪ Project Planning ▪ Maintenance Scheduling ▪ Technician Planning ▪ Production Planning ▪ Trading and Risk Management ▪ Oil Blending	▪ Vessel Planning ▪ Rail Planning ▪ Empty Car Management ▪ Spot Cargo Management ▪ Trading	▪ Production Planning ▪ Inventory Planning	▪ Distribution Planning (vessel, rail, truck)
Operational	Weeks, Days, Hours, Minutes	▪ Project Scheduling, Monitoring and Rescheduling ▪Technician Dispatching ▪ Inventory Assignment ▪ Resources Allocation	▪ Berth Allocation ▪ Pipeline Scheduling ▪ Vessel Scheduling ▪ Rail Scheduling ▪ Staff Scheduling	▪ Refinery Planning and Blending Scheduling ▪ Production and Outbound Logistic Scheduling ▪ Pipeline Scheduling	▪ Berth Allocation ▪ Vessel Scheduling ▪ Rail Scheduling ▪ Truck Routing ▪ Vendor Management Inventory

Source: IBM

DOA invited you to visit http://ifors.org/icord2016/ and to participate in ICORD 2016 that will be held on June 9-10, 2016 at the facilities of Instituto Tecnológico Autónomo de México (ITAM) in México City.

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OPTEX Mathematical Modeling System

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BASIC TUTORIAL

1. **SESSION 1: INTRODUCTION**
   - Introduction to OPTEX (Section 1)
   - OPTEX-EXCEL-MMS (Section 2)
2. **SESSION 2: VRP MODELING IN EXCEL**
   - VRP: Vehicle Routing Problem (Section 3)
   - Implementing VRP Model using EXCEL (Section 4)
3. **SESSION 3: USING EXCEL TO LOAD DATA**
   - Industrial Data Information Systems –IDIS- (Section 5)
4. **SESSION 4: OPTEX-GUI – LOADING MODELS**
   - Loading the Model in OPTEX-MMIS (Section 6)
   - Verification of the Model in OPTEX-MMIS (Section 7)
5. **SESSION 5: Loading and Checking Industrial Data**
   - Implementation and Validation of IDIS- (Section 8)
6. **SESSION 6: Solving Mathematical Models**
   - Scenarios and Families of Scenarios (Section 9)
   - Solution of Mathematical Problems (Section 10)
   - Results Information System (Section 11)
7. **SESSION 7: SQL Servers**
   - Using SQL Servers for IDIS (Section 12)
8. **SESSION 8: Optimization Technologies**
   - Solving Problems using C (Section 13.1)
   - Solving Problems using GAMS (Section 13.2)
   - Solving Problems using IBM OPL (Section 13.3)

OPTEX Mathematical Modeling System

TUTORIAL
IMPLEMENTATION OF THE VRP PROBLEM
(VEHICLE ROUTING PROBLEM)

BASIC TUTORIAL

4. SESSION 4: OPTEX-GUI – LOADING MODELS

- Loading the Model in OPTEX-MMIS (Section 6)
- Verification of the Model in OPTEX-MMIS (Section 7)

This session is oriented to the user that has OPTEX installed in his PC.

LOAD OF MODEL AT OPTEX-MMIS

Below, it is analyzed the process of loading the VRP model into the Information System of Mathematical Models of OPTEX (OPTEX-MMIS), so the user must have installed OPTEX on his computer.

The process of loading the existing information in the EXCEL to OPTEX-MMIS template can be in multiple ways:

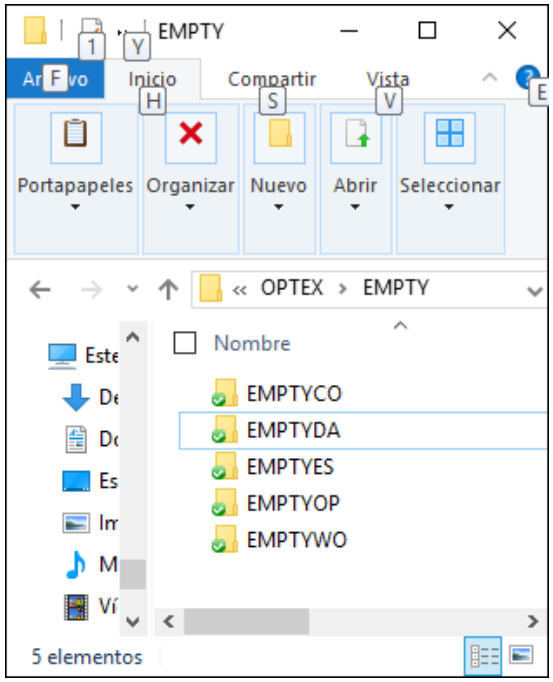
- **Manually: in this case the user loads each table stored in EXCEL, to do this creates tables in CSV format, eliminating the second row, and imports them to OPTEX-MMIS.**

- **Automatically: in this case used a service from OPTEX that allows to import all tables from the book with a single click.**

Given the didactic nature of this document, the first method should be used in a way such that the user becomes familiar with the different windows of work and the services offered by OPTEX in each of them.

ACCESS TO OPTEX-GUI

An OPTEX application called EMPTY, which can be used to load the VRP model in OPTEX, was included in the installation process of OPTEX.



ACCESS TO OPTEX-GUI

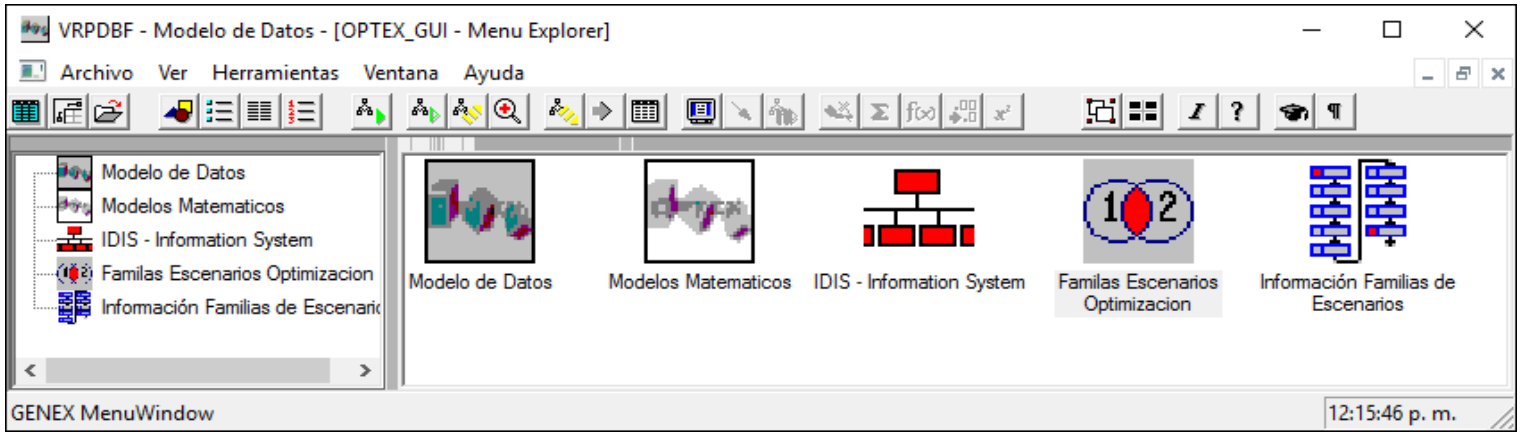
To access such application should be login to OPTEX-GUI under the EMPTY user name. The user must activate the program OPTEX_GraphicsUsersInterface.EXE, located in the directory /BIN/.

WORKING IN OPTEX-GUI

The login process will give the user access to a browser window of OPTEX from which you will have access to exploration of OPTEX-GUI menu, from there you can access the menu of exploration of mathematical models and data model menu, which give access to the tables that handle the corresponding to those existing in the EXCEL workbook. The load of elements at OPTEX-MMIS will be following the same order of loading of EXCEL tables.

OPTEX-GUI allows access to the four areas of application data:

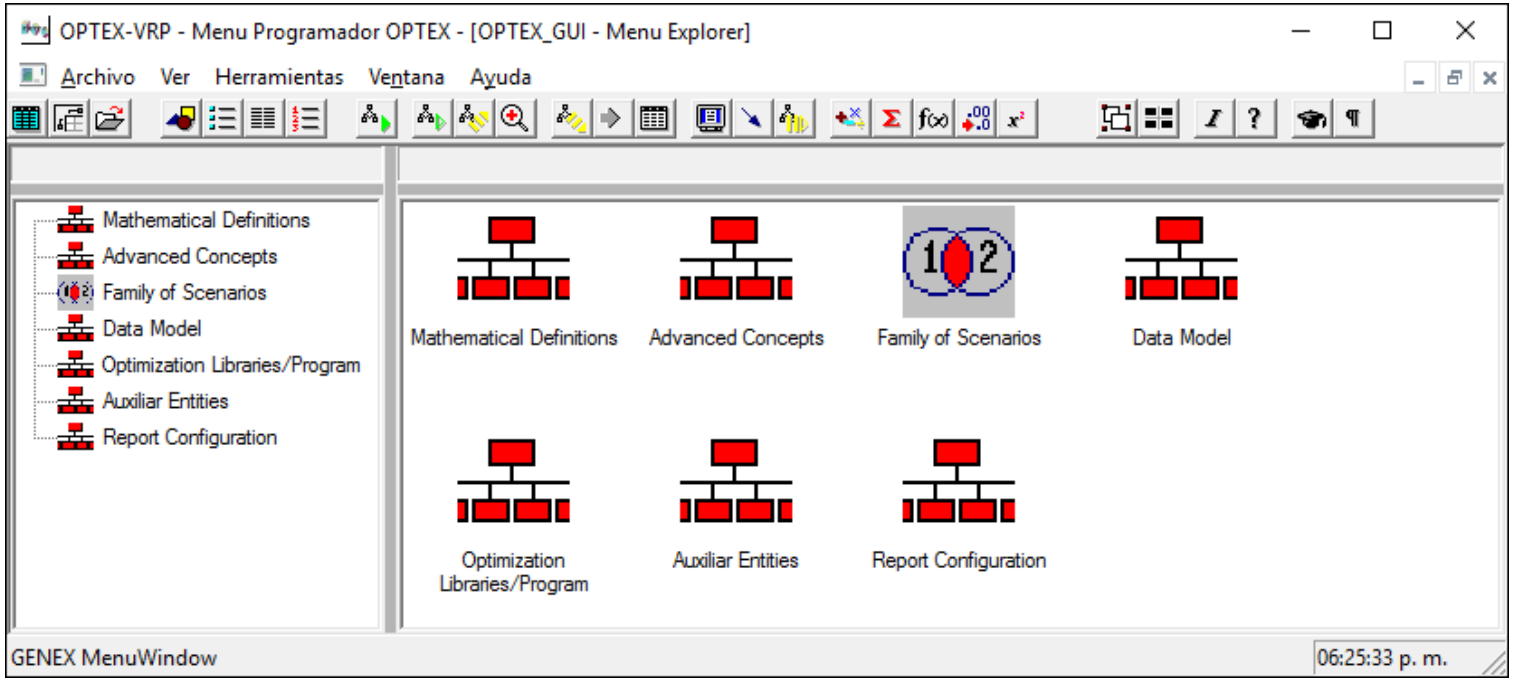
- **Data Model**
- **Mathematical models**
- **Permanent Industrial System**
- **Scenarios of Industrial System**



WORKING IN OPTEX-GUI

The load of model the user must access to the so-called Mathematical Models area, where you can access the tables associated with mathematical models and the tables associated to the data model, working in three sub-areas:

- **Mathematical Models**
  - **Mathematical Definitions**
  - **Advanced Concepts**
- **Data Model.**



WORKING IN OPTEX-GUI

IMPORTANT

The reader must take into account that by default OPTEX works using tables in DBase format, and that it is therefore convenient to understand management given to this type of table, explained in section 1 of the present document.

Additionally, for importing data should be aware that the process is slightly different for master tables and for secondary tables. You can import master tables without problem from any shell/container window that is related to the master table as main table; for the secondary tables they must be access from shell window that have as main data window the secondary table.

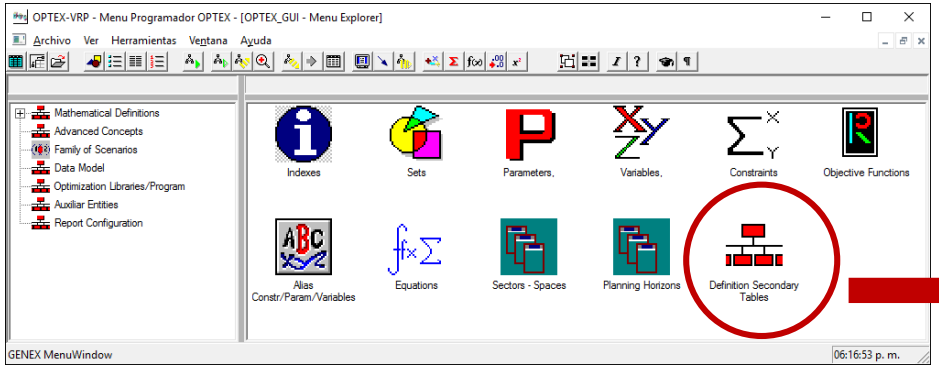
Therefore, a secondary table CAN NOT be imported from a window container that has as main data window a master window; this failure is due to secondary tables, that are opened from a master table, have filters that reject records that do not comply with this filter. To handle this situation, it is available at OPTEX of menus that give you direct access to secondary tables, so that the user makes use them when convenient.

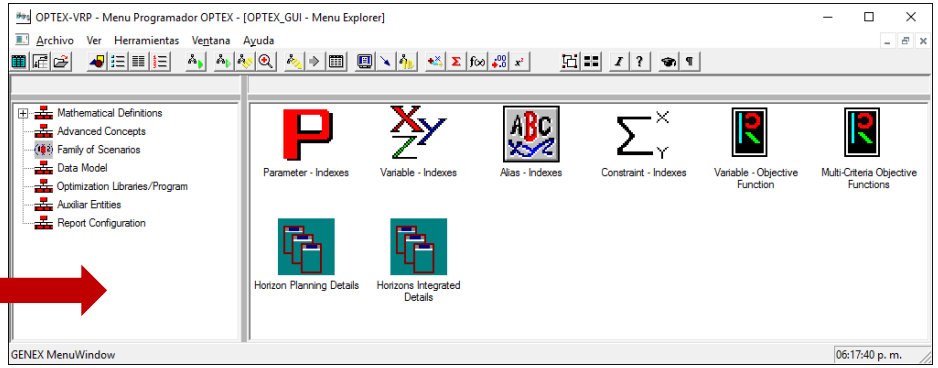
LOADING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

To load the tables related to the mathematical models the user should access the corresponding menus which are displayed in the following images.

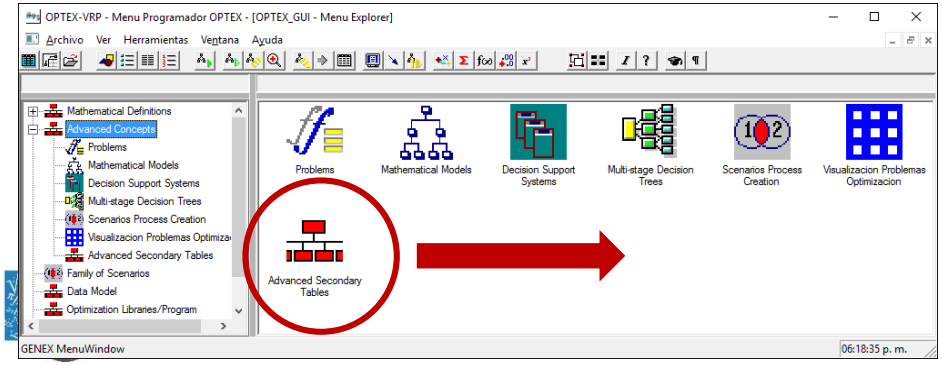
The menus on the left correspond to accesses to the master tables of mathematical elements/objects, and those on the right to access to secondary tables.

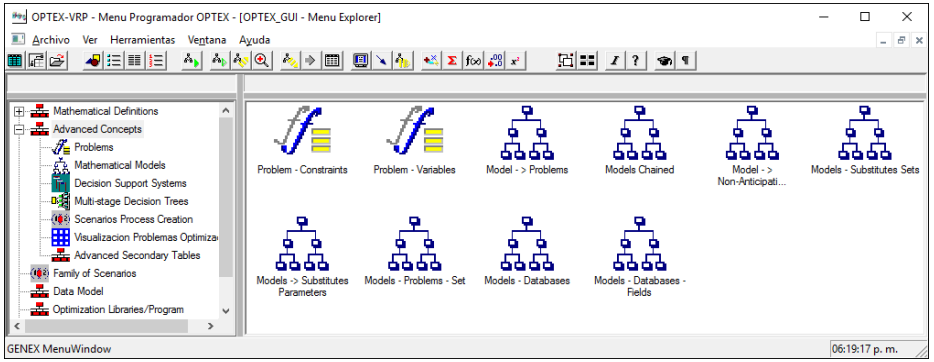
MATHEMATICAL DEFINITIONS





ADVANCED CONCEPTS

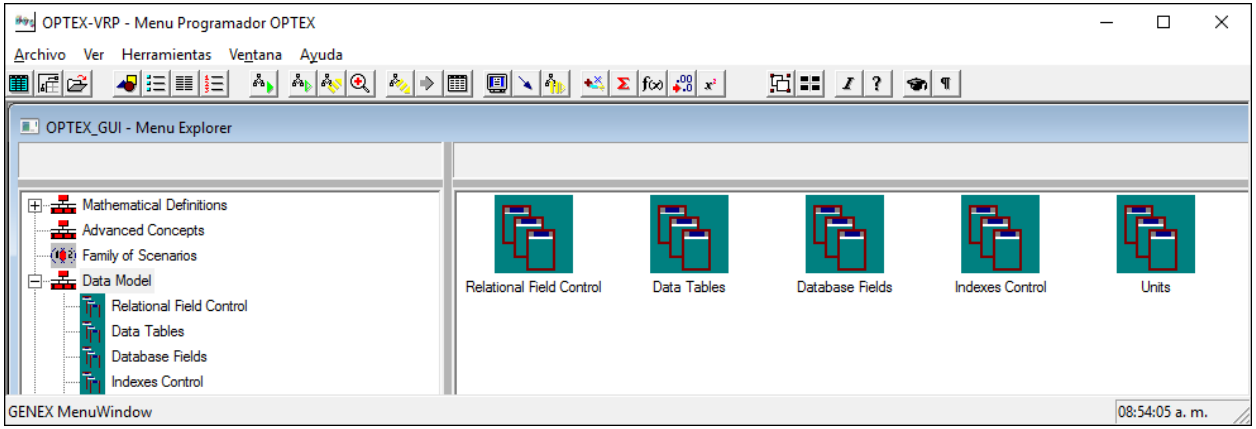




LOADING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

In the case of tables associated with the data model, all tables, master and secondary, they are accessed from the same menu.

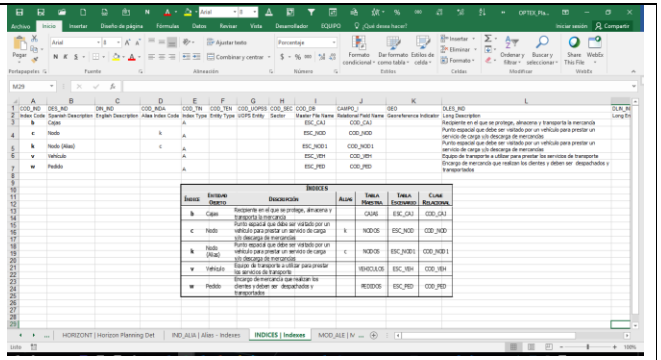
DATA MODEL



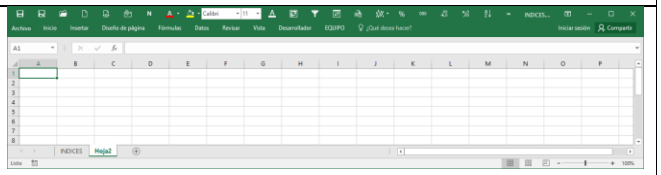
LOADING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

INDIVIDUAL LOAD

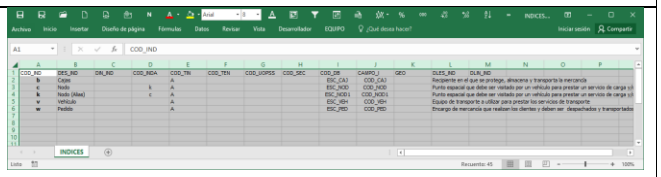
1. **Locate the table in the models template**



2. **Create a new EXCEL book**

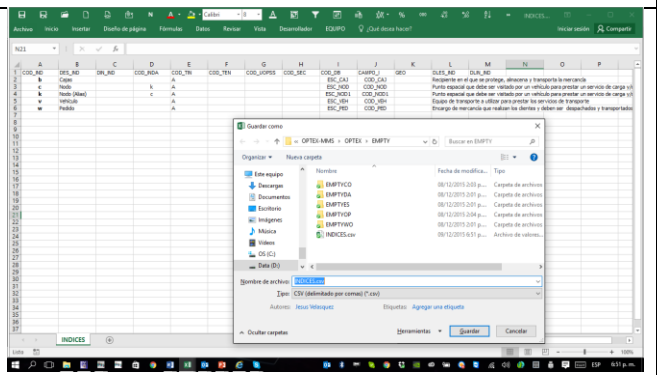


3. **Copy the table to the new book. You must delete the second row**

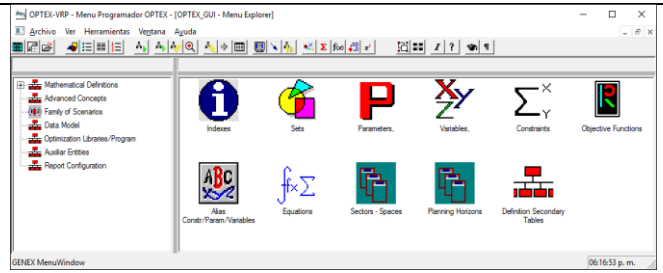


4. **Save the tables as a .CSV file**

   It is suggested to use the same name of the sheet of the template

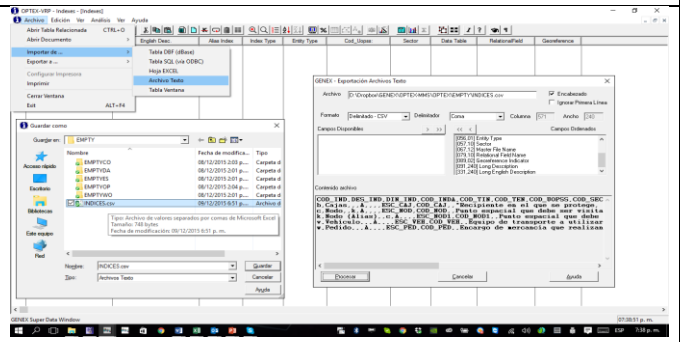


1. **Locate the destination table in the explorer of OPTEX-GUI**

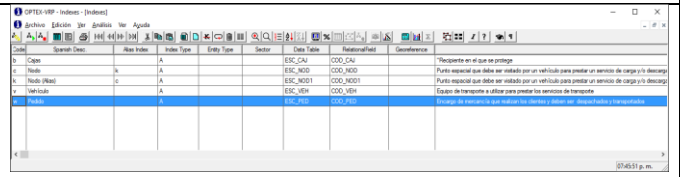


2. **Open the DBF table in OPTEX-GUI**

3. **Import the tables based on the service Import a text file**



8. **Check the loaded table in DBF format**

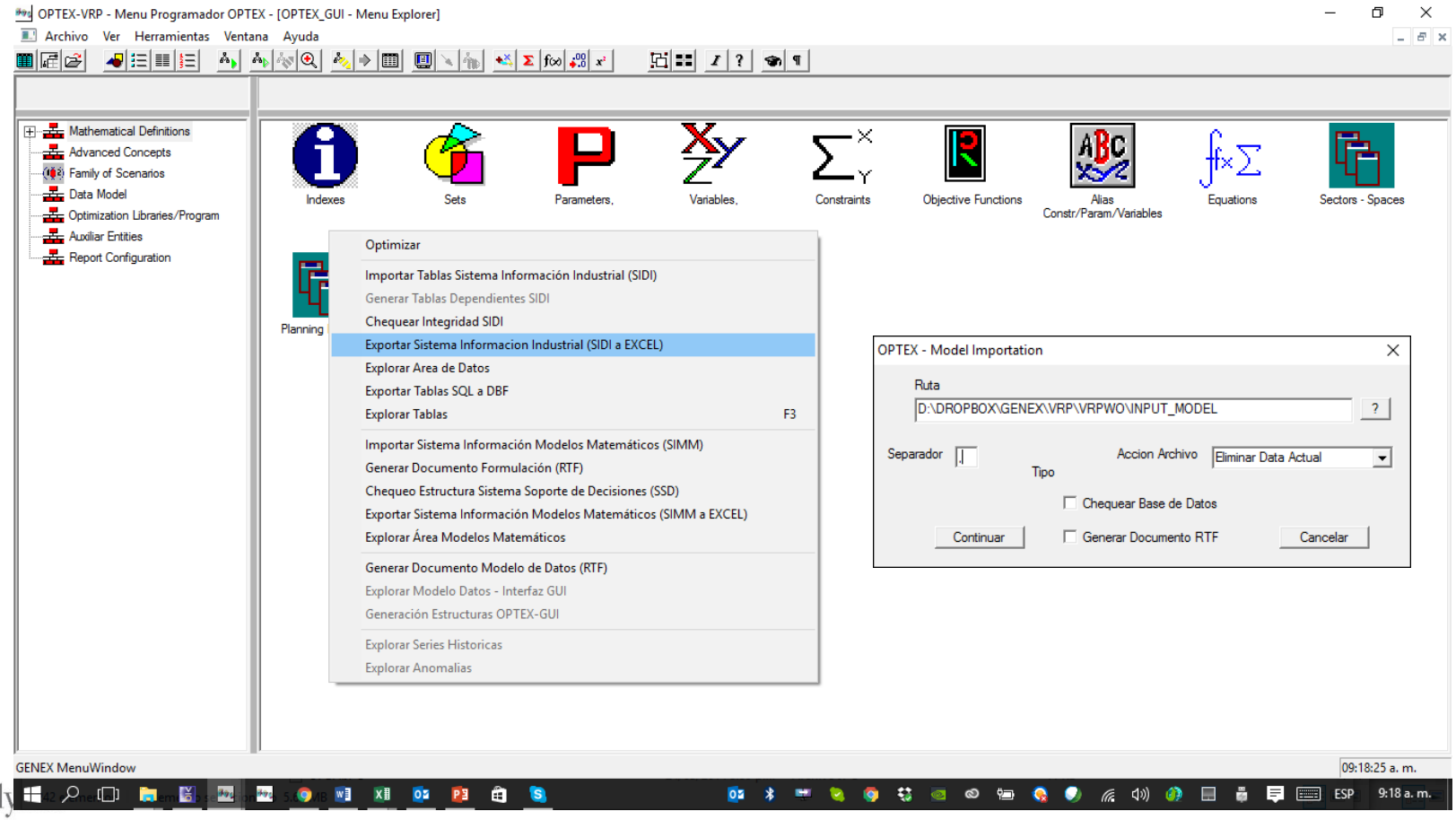


For the individual import of a table it is suggested to follow included in the Tutorial Manual (section 6.2.1.)

LOADING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

MASSIVE LOAD

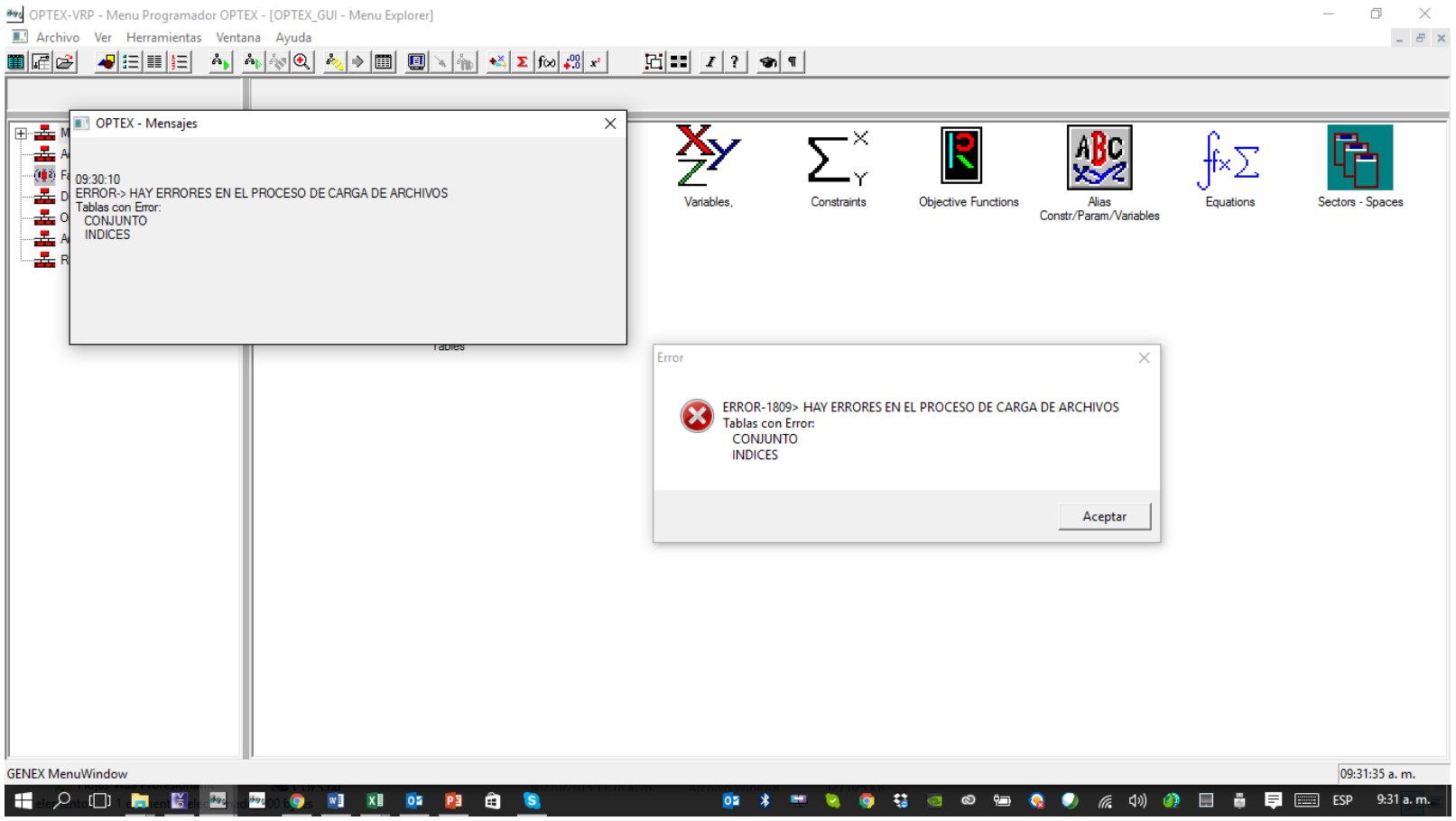
Alternatively, and in a more effective way, it is possible to load all the information contained in the EXCEL template, in one step, via of a specialized service of OPTEX for this purpose which is accessed via the right-click on the mouse when you are in the Explorer Menu of the mathematical models.



LOADING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

MASSIVE LOAD

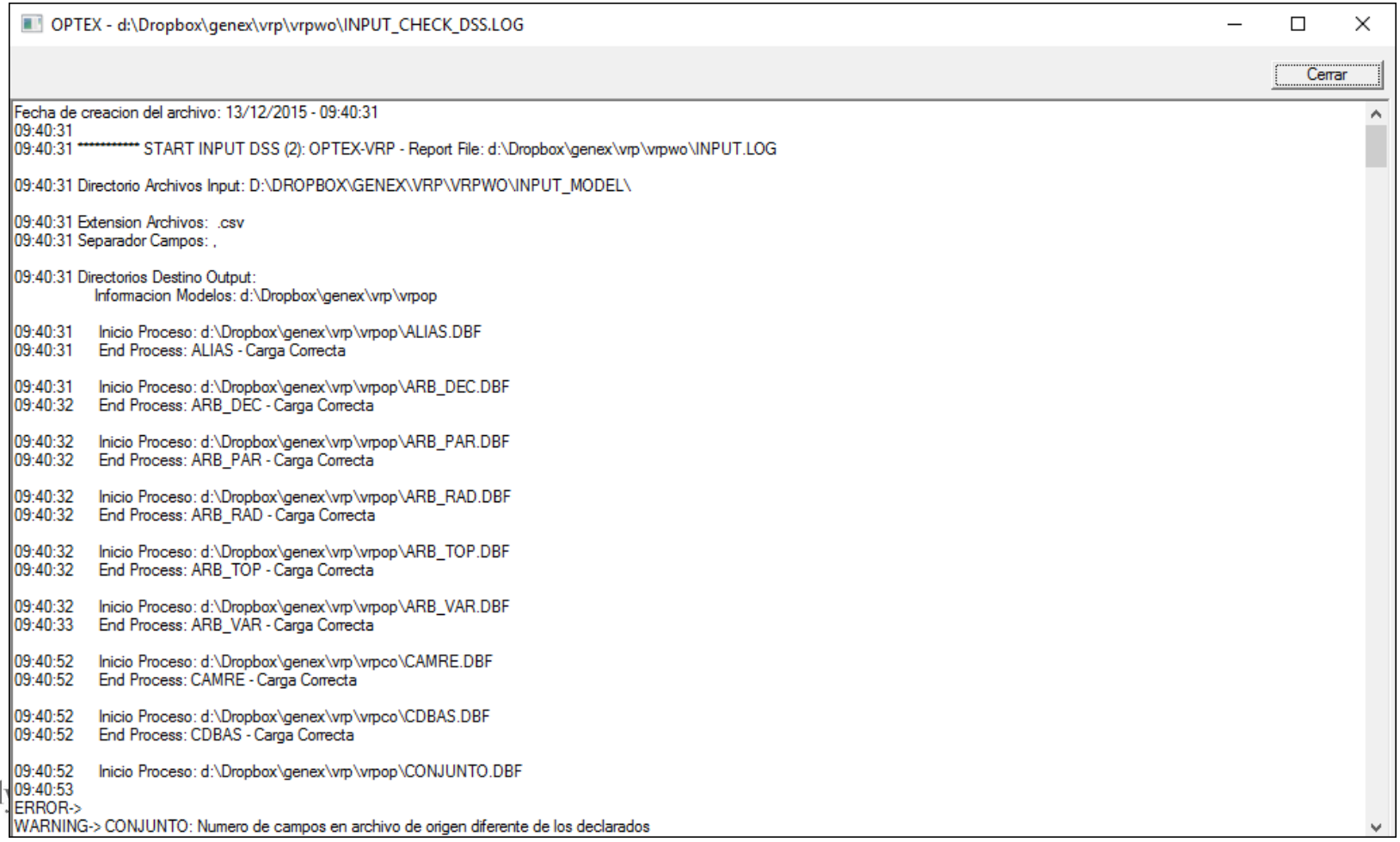
All CVSs tables should be located in the same directory with names equal to the sheets of the EXCEL template, which you can do with the OPTEX complements to export EXCEL templates to files CVSs. The user must choose the delimiter with which CVSs files were created, in this aspect should be careful in the drafting of the long descriptions, since they may contain common delimiters as the comma, semicolon,..., this confusion can cause errors in loading data. OPTEX will generate a report of errors.



LOADING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

MASSIVE LOAD

Subsequently, OPTEX will check the structure and the data store in the tables to verify the integrity of the MMIS; process report is located in the INPUT_CHECK_DSS. LOG file in the work directory of the OPTEX application; which can review with any text editor, e.g. NOTEPAD.



CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

Below, it is the process to be followed once all the tables that are part of the MMIS; this process is oriented to present the services provided by OPTEX to facilitate implementation, correction and the startup of the system of mathematical models. This will be followed as a guide errors reported in the massive process, corrections will be made in the EXCEL template.

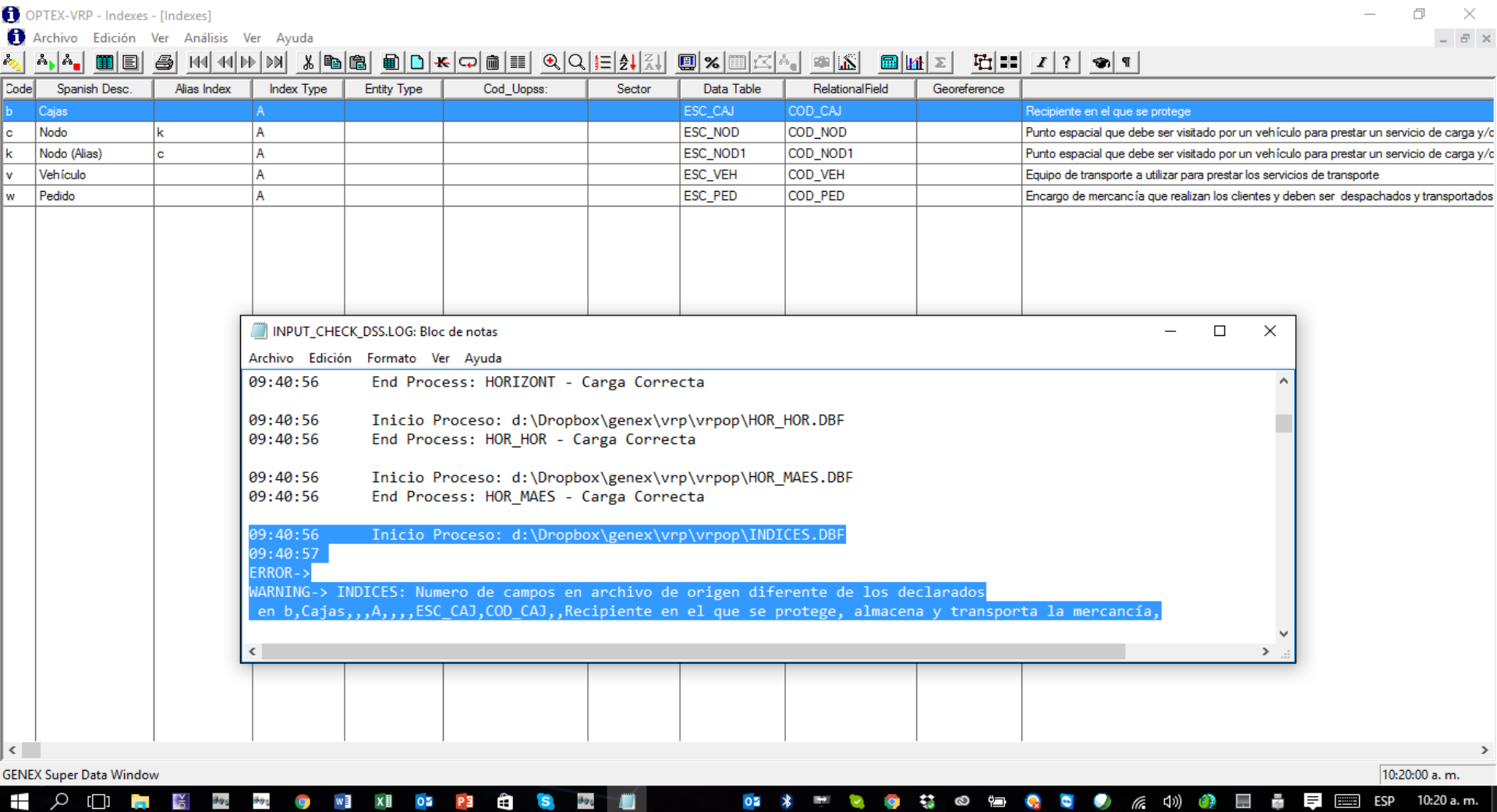
The template and the log file resulting from the review process are at the URLs:

- **http://www.doanalytics.net/Documents/OPTEX_Plantilla_Modelo_VRP-v03.xlsx**
- **http://www.doanalytics.net/Documents/INPUT_CHECK_DSS_3.LOG**

CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

INDEXes

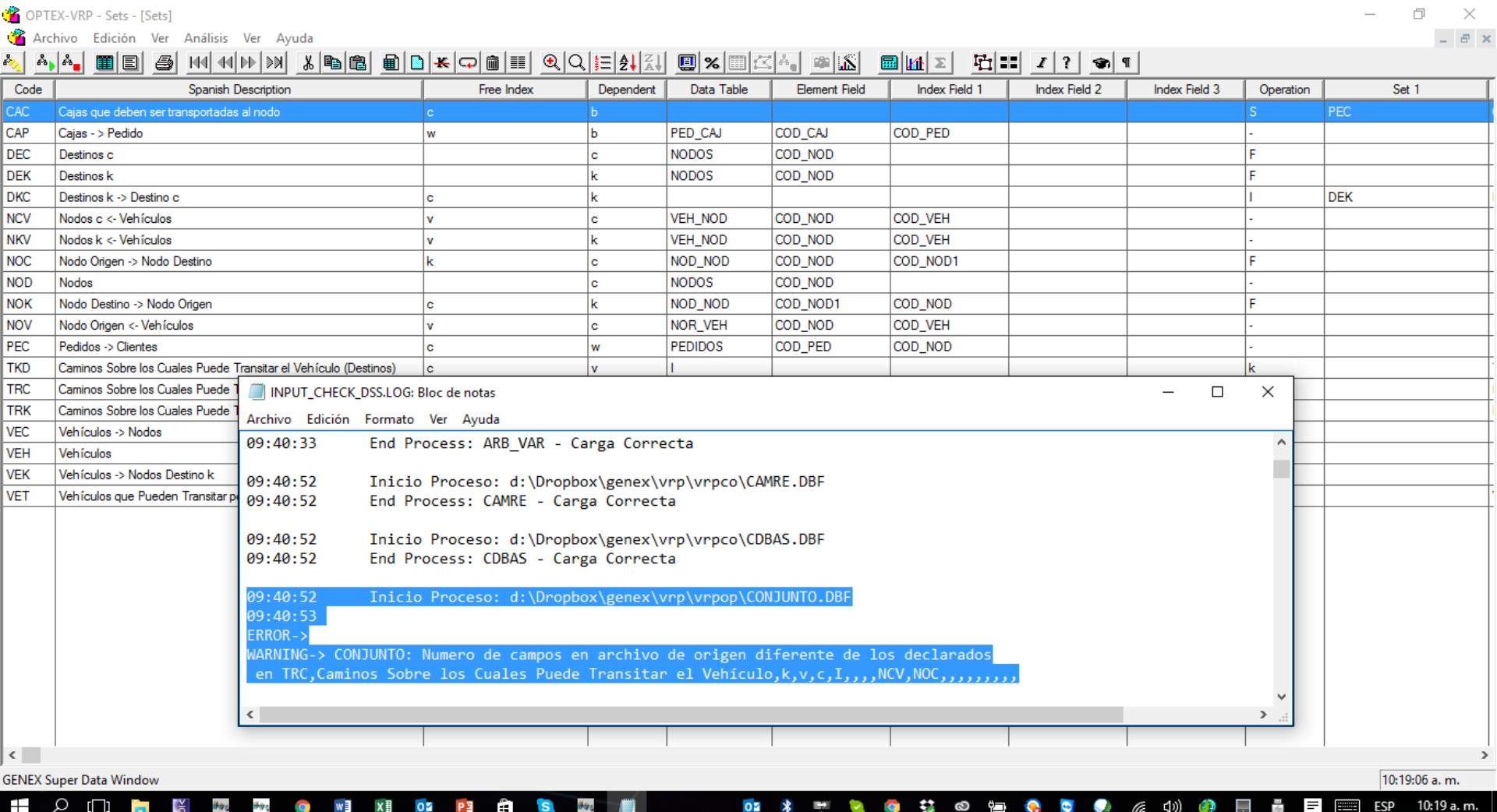
The following image presents the information load and the reported errors, which are related to the existence of commas in the DLES_IND field. The solution may be to change the delimiter or to remove commas from the long descriptions.



CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

SETs

The following image presents the information load and the reported errors, which are related to the existence of commas in the DLES_CON field. The solution may be to change the delimiter or to remove commas from the long descriptions.

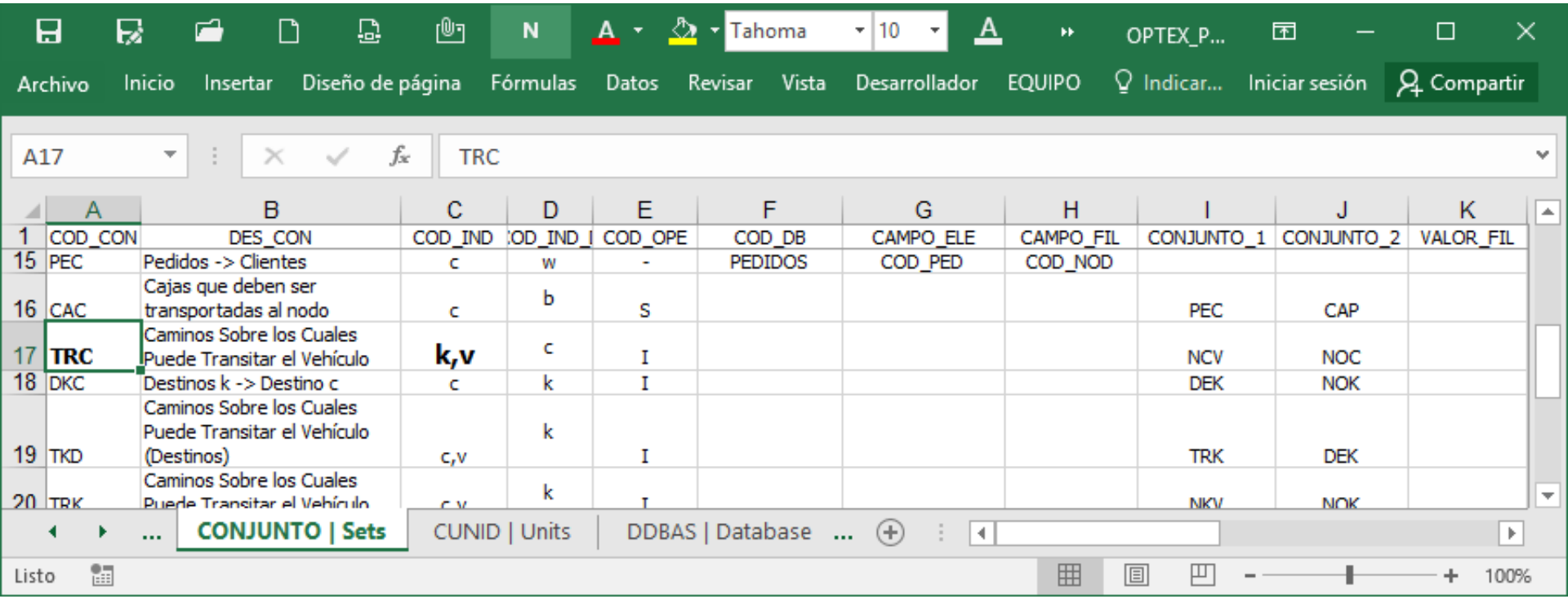


Code	Spanish Description	Free Index	Dependent	Data Table	Element Field	Index Field 1	Index Field 2	Index Field 3	Operation	Set 1
CAC	Cajas que deben ser transportadas al nodo	c	b						S	PEC
CAP	Cajas - > Pedido	w	b	PED_CAJ	COD_CAJ	COD_PED			-	
DEC	Destinos c		c	NODOS	COD_NOD				F	
DEK	Destinos k		k	NODOS	COD_NOD				F	
DKC	Destinos k -> Destino c	c	k						I	DEK
NCV	Nodos c <- Vehículos	v	c	VEH_NOD	COD_NOD	COD_VEH			-	
NKV	Nodos k <- Vehículos	v	k	VEH_NOD	COD_NOD	COD_VEH			-	
NOC	Nodo Origen -> Nodo Destino	k	c	NOD_NOD	COD_NOD	COD_NOD1			F	
NOD	Nodos		c	NODOS	COD_NOD				-	
NOK	Nodo Destino -> Nodo Origen	c	k	NOD_NOD	COD_NOD1	COD_NOD			F	
NOV	Nodo Origen <- Vehículos	v	c	NOR_VEH	COD_NOD	COD_VEH			-	
PEC	Pedidos -> Clientes	c	w	PEDIDOS	COD_PED	COD_NOD			-	
TKD	Caminos Sobre los Cuales Puede Transitar el Vehículo (Destinos)	c	v	I					k	
TRC	Caminos Sobre los Cuales Puede T									
TRK	Caminos Sobre los Cuales Puede T									
VEC	Vehículos -> Nodos									
VEH	Vehículos									
VEK	Vehículos -> Nodos Destino k									
VET	Vehículos que Pueden Transitar p									

CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

SETs

Given that the error occurs on the TRC set which is indexed by two indexes (k,v) and representation of this includes the separating comma, the required solution is to change the delimiter of comma (,) by semicolon (;) or another appropriate delimiter.



	A	B	C	D	E	F	G	H	I	J	K
1	COD_CON	DES_CON	COD_IND	COD_IND_I	COD_OPE	COD_DB	CAMPO_ELE	CAMPO_FIL	CONJUNTO_1	CONJUNTO_2	VALOR_FIL
15	PEC	Pedidos -> Clientes	c	w	-	PEDIDOS	COD_PED	COD_NOD			
16	CAC	Cajas que deben ser transportadas al nodo	c	b	S				PEC	CAP	
17	**TRC**	Caminos Sobre los Cuales Puede Transitar el Vehículo	**k,v**	c	I				NCV	NOC	
18	DKC	Destinos k -> Destino c	c	k	I				DEK	NOK	
19	TKD	Caminos Sobre los Cuales Puede Transitar el Vehículo (Destinos)	c,v	k	I				TRK	DEK	
20	TRK	Caminos Sobre los Cuales Puede Transitar el Vehículo	c,v	k	I				NKV	NOK	

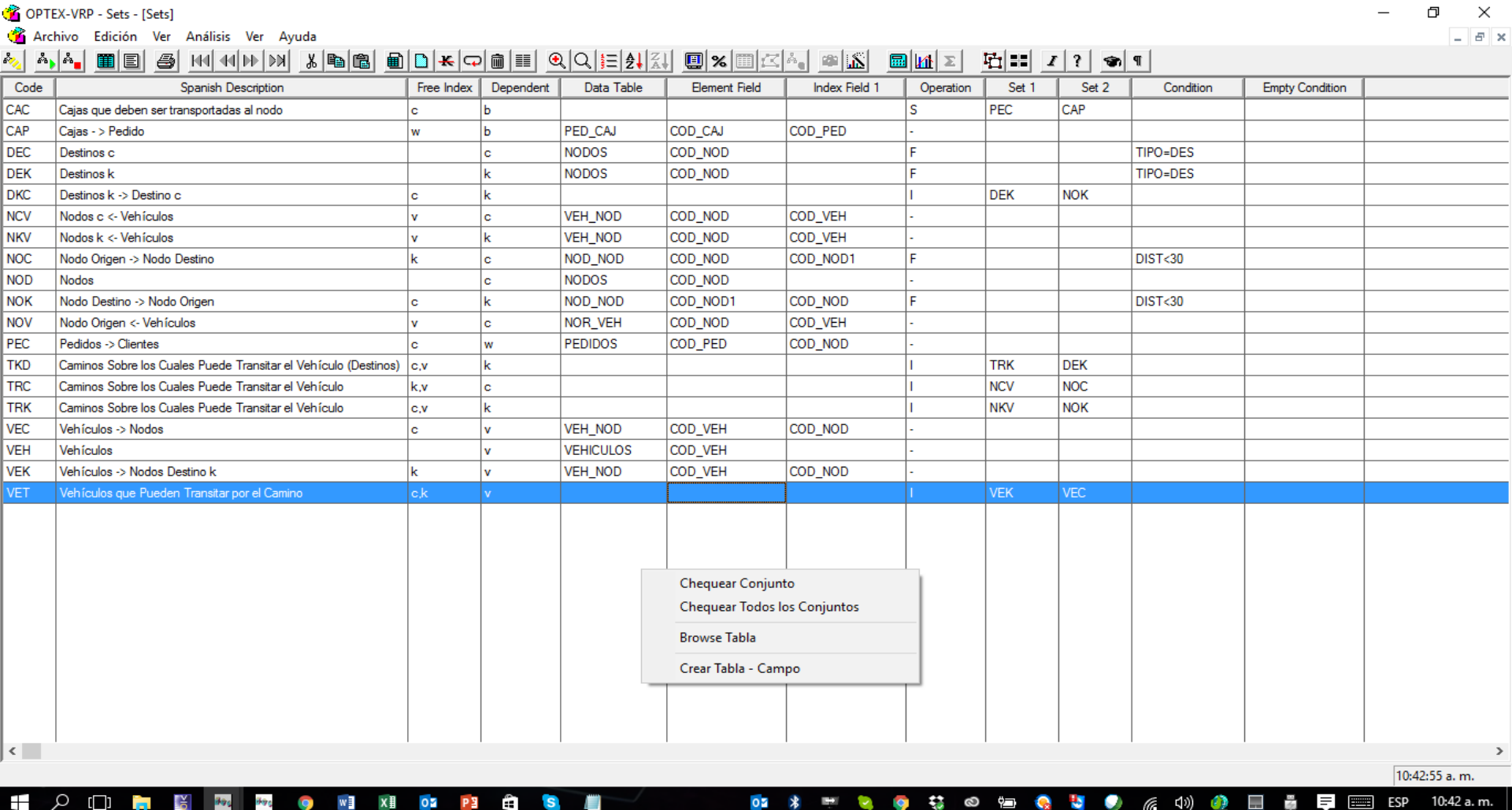
At this point, it is convenient to reimport the database of mathematical models using the semicolon (;) as a delimiter. This means repeats the process from the generation of CSV files. The following image shows the result of the process which no longer presents data from the EXCEL template import errors. The new report of the process is located in.

- http://www.doanalytics.net/Documents/INPUT_CHECK_DSS_2.LOG

CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

SETs

The next step is to review the sets which can be done through the special services offered by OPTEX which is accessed through the right-click of the mouse, as shown in the following image.

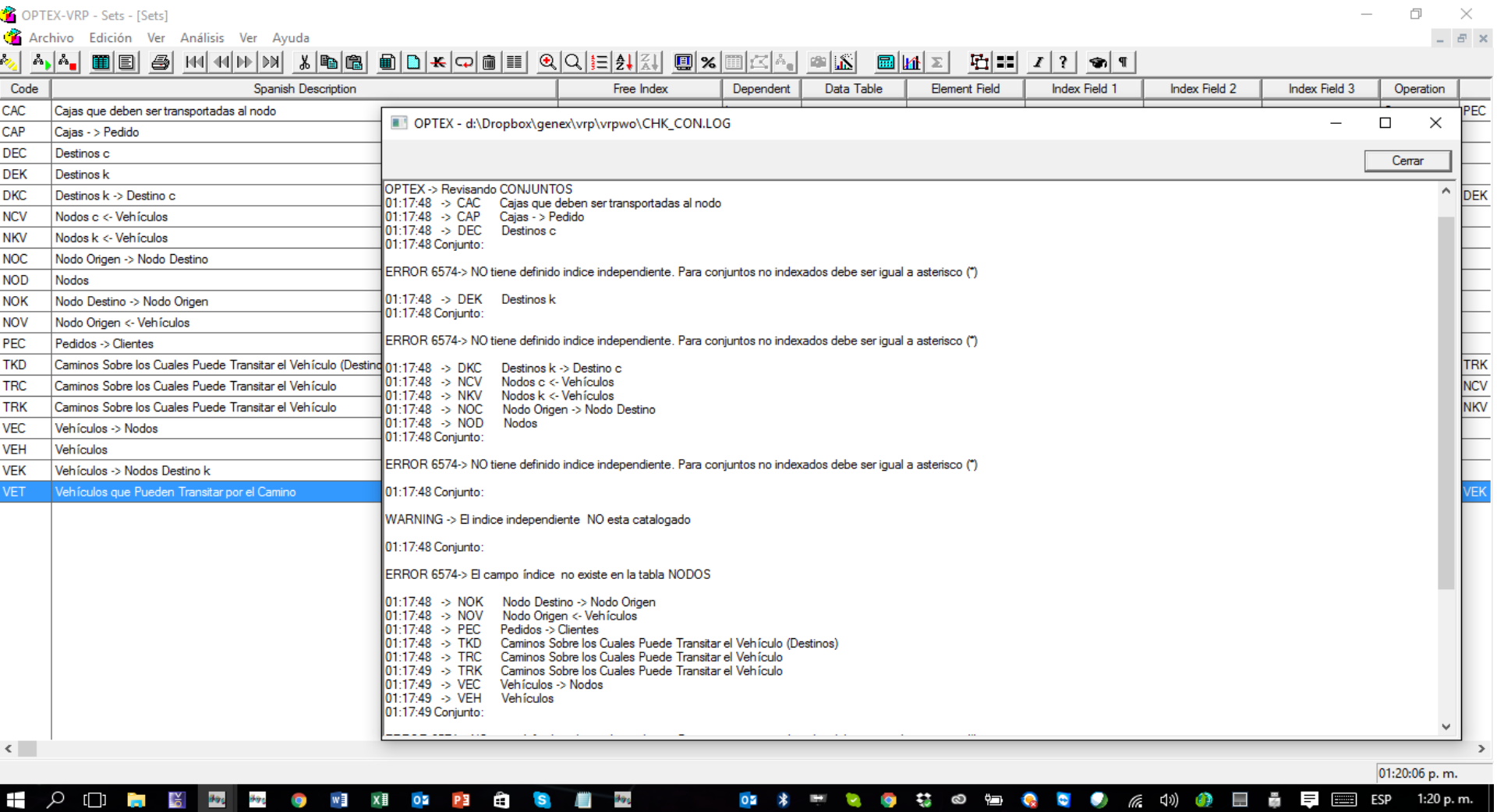


Code	Spanish Description	Free Index	Dependent	Data Table	Element Field	Index Field 1	Operation	Set 1	Set 2	Condition	Empty Condition
CAC	Cajas que deben ser transportadas al nodo	c	b				S	PEC	CAP		
CAP	Cajas - > Pedido	w	b	PED_CAJ	COD_CAJ	COD_PED	-				
DEC	Destinos c		c	NODOS	COD_NOD		F			TIPO=DES	
DEK	Destinos k		k	NODOS	COD_NOD		F			TIPO=DES	
DKC	Destinos k -> Destino c	c	k				I	DEK	NOK		
NCV	Nodos c <- Vehículos	v	c	VEH_NOD	COD_NOD	COD_VEH	-				
NKV	Nodos k <- Vehículos	v	k	VEH_NOD	COD_NOD	COD_VEH	-				
NOC	Nodo Origen -> Nodo Destino	k	c	NOD_NOD	COD_NOD	COD_NOD1	F			DIST<30	
NOD	Nodos		c	NODOS	COD_NOD		-				
NOK	Nodo Destino -> Nodo Origen	c	k	NOD_NOD	COD_NOD1	COD_NOD	F			DIST<30	
NOV	Nodo Origen <- Vehículos	v	c	NOR_VEH	COD_NOD	COD_VEH	-				
PEC	Pedidos -> Clientes	c	w	PEDIDOS	COD_PED	COD_NOD	-				
TKD	Caminos Sobre los Cuales Puede Transitar el Vehículo (Destinos)	c,v	k				I	TRK	DEK		
TRC	Caminos Sobre los Cuales Puede Transitar el Vehículo	k,v	c				I	NCV	NOC		
TRK	Caminos Sobre los Cuales Puede Transitar el Vehículo	c,v	k				I	NKV	NOK		
VEC	Vehículos -> Nodos	c	v	VEH_NOD	COD_VEH	COD_NOD	-				
VEH	Vehículos		v	VEHICULOS	COD_VEH		-				
VEK	Vehículos -> Nodos Destino k	k	v	VEH_NOD	COD_VEH	COD_NOD	-				
VET	Vehículos que Pueden Transitar por el Camino	c,k	v				I	VEK	VEC		

CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

SETs

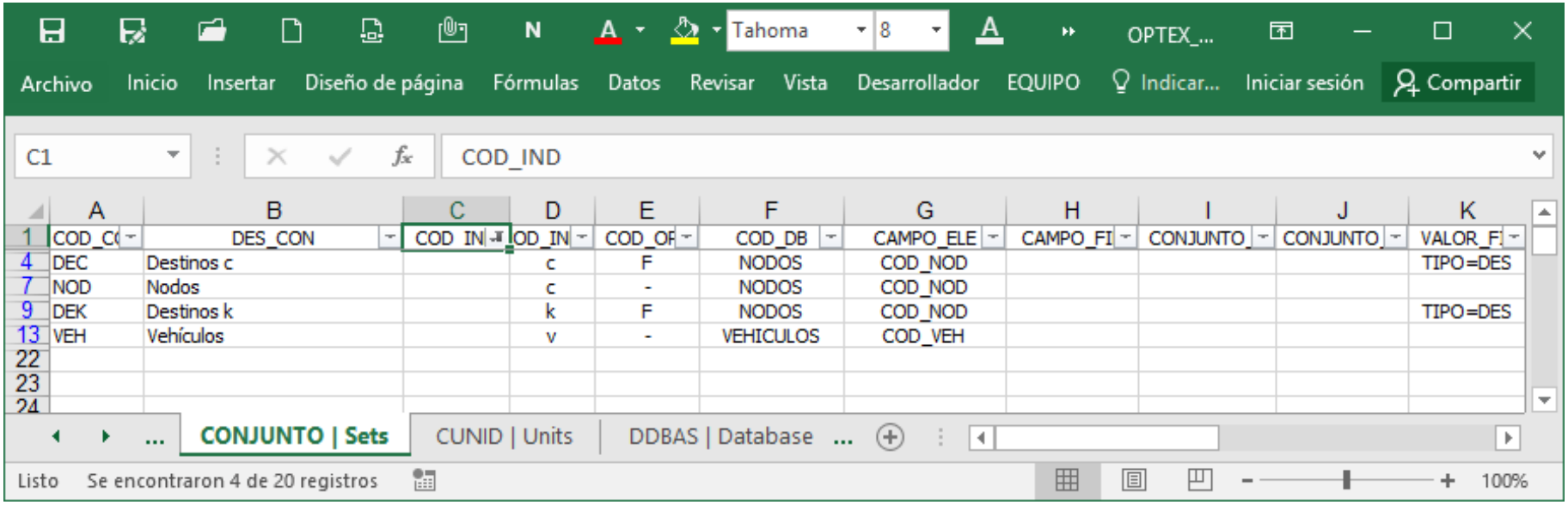
When you run CHECK ALL SETS (Chequear Todos los Conjuntos), OPTEX will generate a report which indicates the existing errors related to the table CONJUNTO (SET).



CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

SETs

Reported errors are due to that when the set is non-indexed (does not depend on any index) the corresponding field (COD_IND) should be filled with an asterisk (*). The image displayed in the EXCEL template sets with errors.

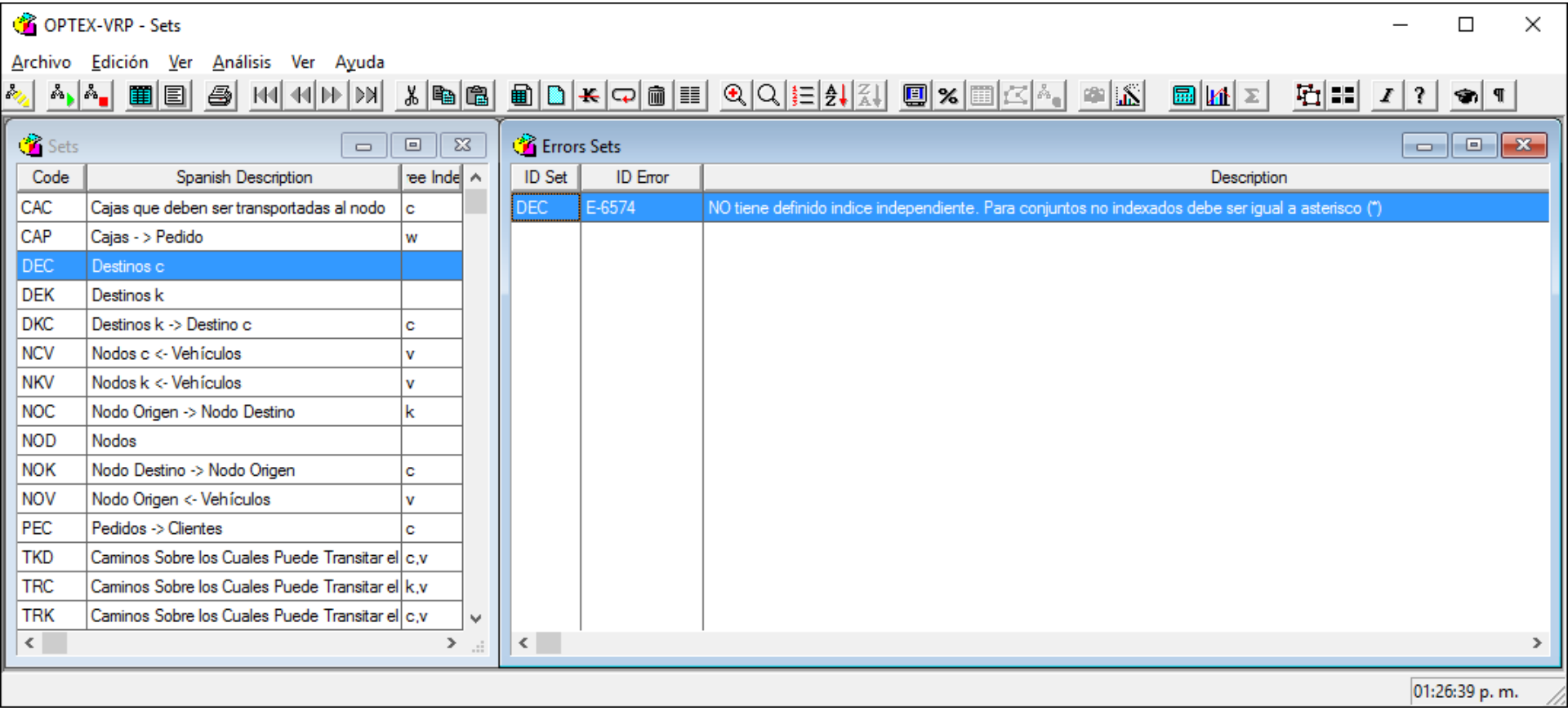


	A	B	C	D	E	F	G	H	I	J	K
1	COD_C	DES_CON	COD_IN	OD_IN	COD_OF	COD_DB	CAMPO_ELE	CAMPO_FI	CONJUNTO_	CONJUNTO_	VALOR_F
4	DEC	Destinos c		c	F	NODOS	COD_NOD				TIPO=DES
7	NOD	Nodos		c	-	NODOS	COD_NOD				
9	DEK	Destinos k		k	F	NODOS	COD_NOD				TIPO=DES
13	VEH	Vehículos		v	-	VEHICULOS	COD_VEH				
22											
23											
24											

CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

SETs

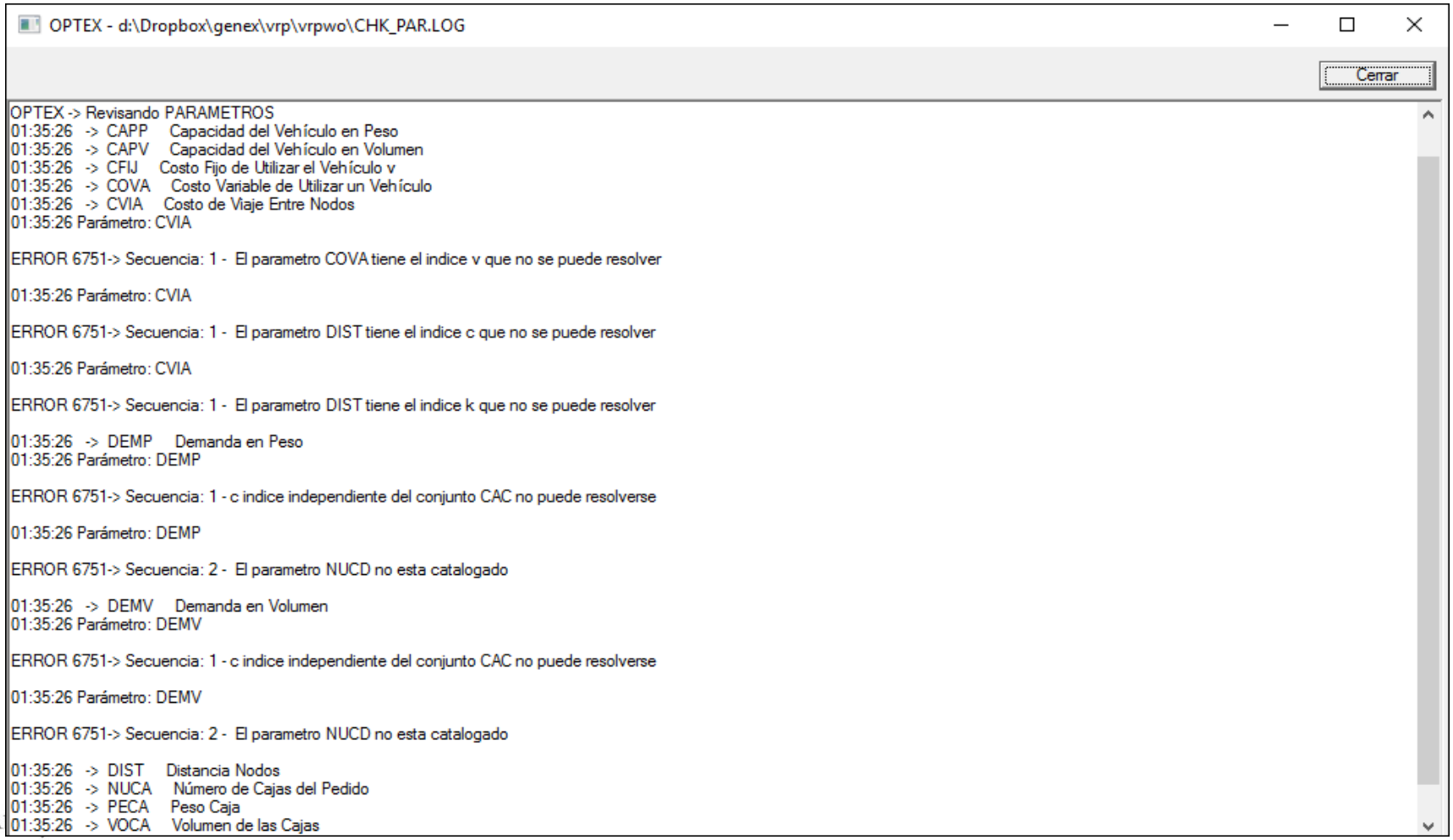
OPTEX stored in tables the errors found, so that the user can access from the associated container window. Errors are stored in tables called ERR_xxx where it is associated with the code of the mathematical entity, in this case the table used is ERR_CON which it is accessed from the File menu option OPEN TABLE RELATED (first button on the left of the toolbar), this at all master tables related to the mathematical elements.



CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

PARAMETERs

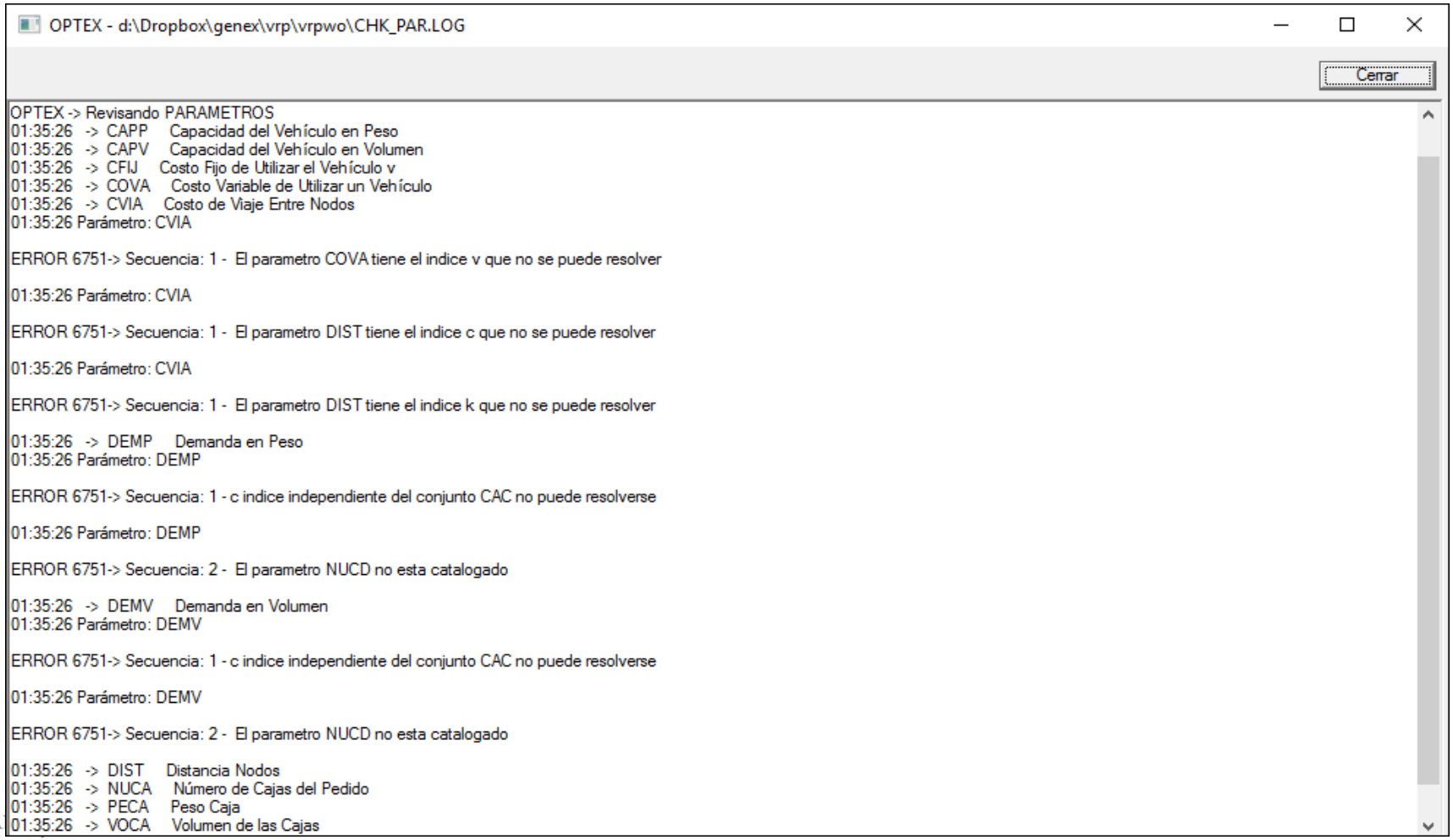
The image below presents reported errors in the load of the parameters which are related to the parameters CVIA, DEMP and DEMB. The errors presented for each parameter which are all due to that parameter indexes were not included in the table PAR_IND that contains the relationship between parameters and indexes.



CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

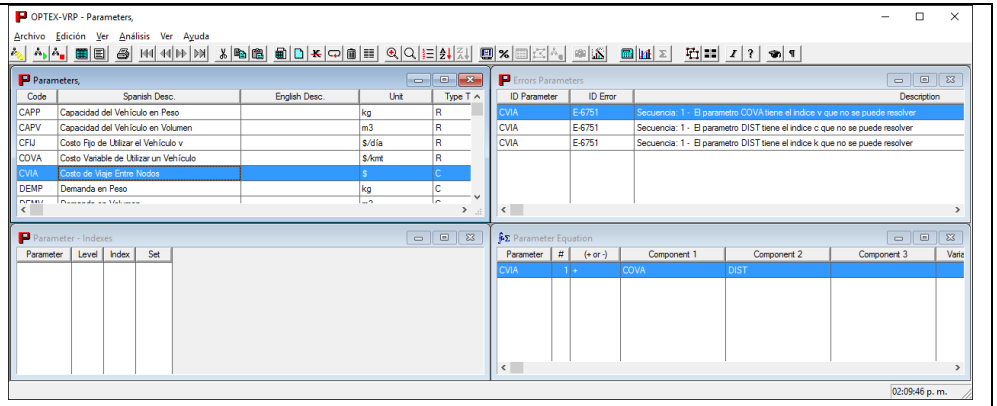
PARAMETERs

The image below presents reported errors in the load of the parameters which are related to the parameters CVIA, DEMP and DEMB. The errors presented for each parameter which are all due to that parameter indexes were not included in the table PAR_IND that contains the relationship between parameters and indexes.



1. PARAMETER: CVIA

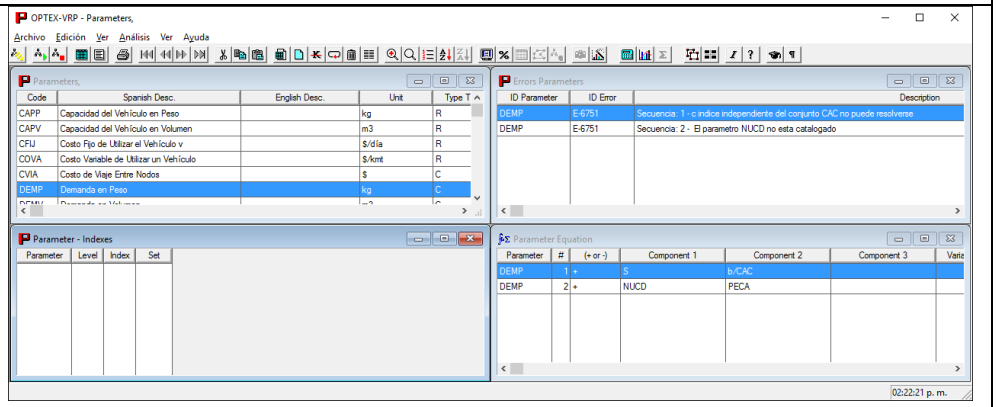
$$CVIA_{v,c,k} = COVA_v \times DIST_{c,k}$$



2. PARAMETER: DEMP

$$DEMP_c = \sum_{b \in CAC(c)} NUCD_{c,b} \times PECA_b$$

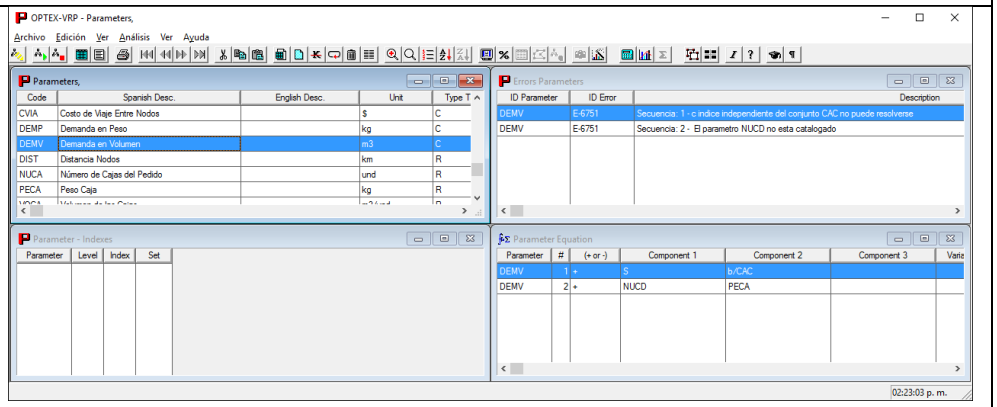
In addition, the **NUCD** parameter is not listed, since it was forgotten in the original formulation. It must be included the **NUCD** parameter in the system.



3. PARAMETER: DEMP

$$DEMP_c = \sum_{b \in CAC(c)} NUCD_{c,b} \times PECA_b$$

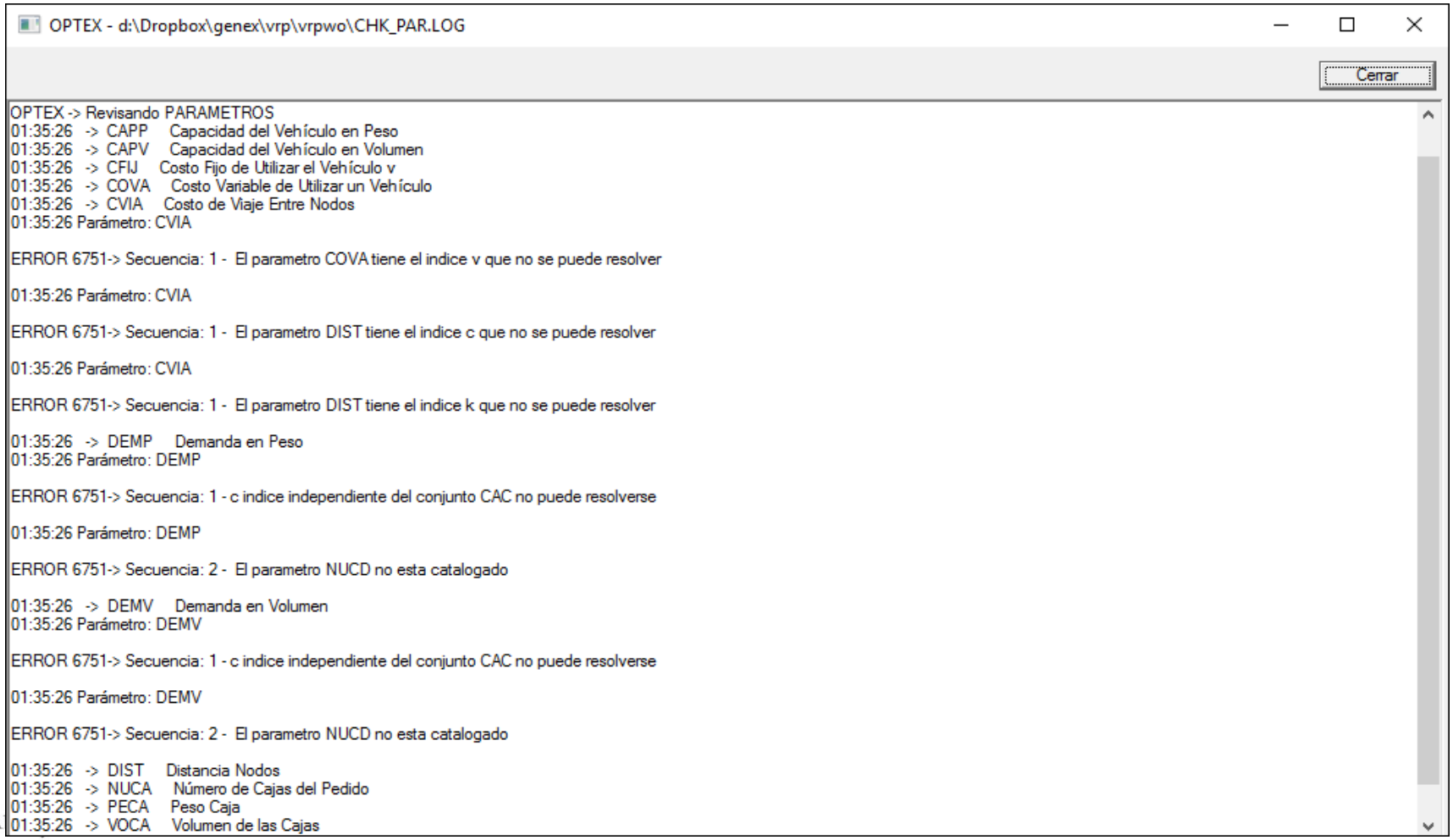
In addition, the **NUCD** parameter is not listed, since it was forgotten in the original formulation.



CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

PARAMETERs

The image below presents reported errors in the load of the parameters which are related to the parameters CVIA, DEMP and DEMB. The errors presented for each parameter which are all due to that parameter indexes were not included in the table PAR_IND that contains the relationship between parameters and indexes.



CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)
PARAMETERs

The correction related to the NUCD parameter is presented below

CALCULATED PARAMETERS		
PARAMETER	**DESCRIPTION**	**UNIT**
$NUCD_{c,b}$	**Boxes for customer c** Total of boxes (**b**) must be delivered to the client **c** $NUCD_{c,b} = \Sigma_{w \in PEC(c)} NUCA_{w,b}$ Parameters: **$NUCA_{w,b}$** Number of boxes **b** in the order **w** (und)	und

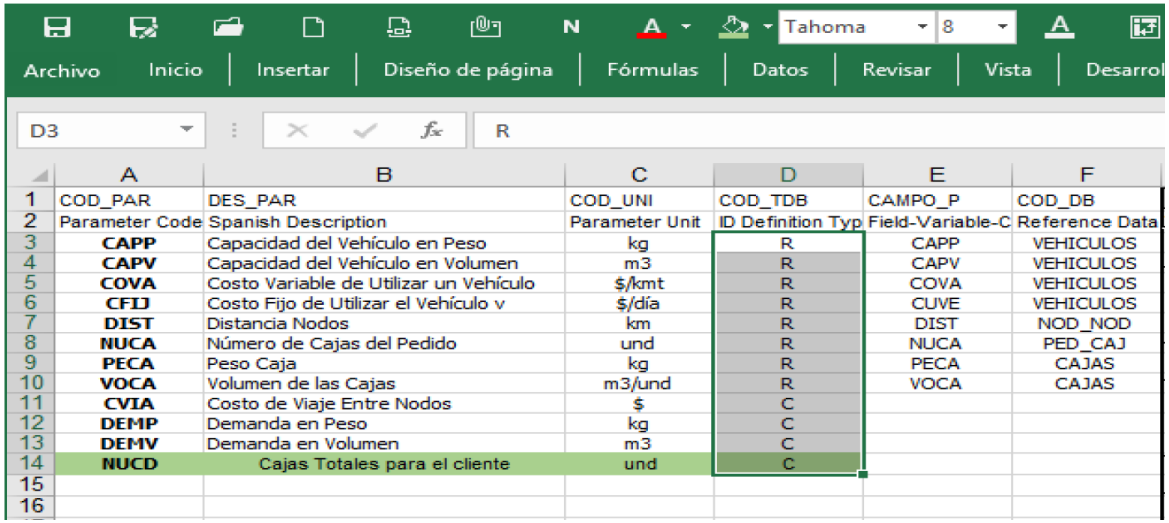
CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)
PARAMETERs

The correction related to the NUCD parameter is presented below

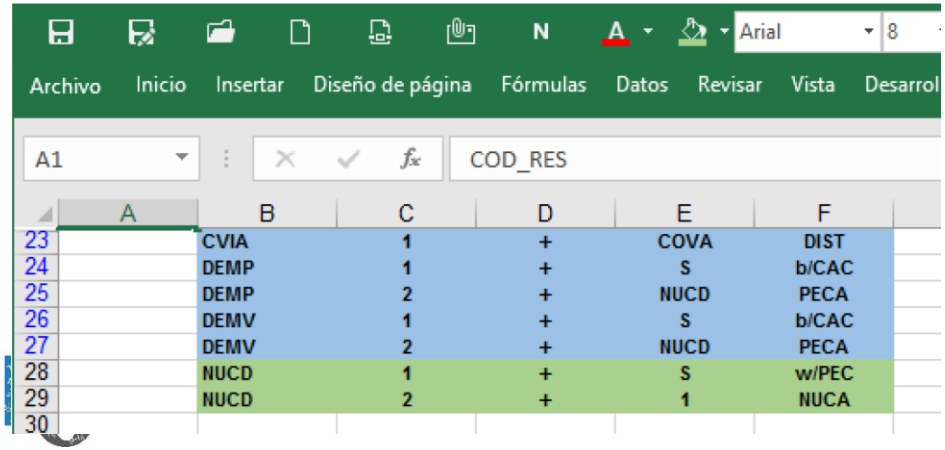
BASIC PARAMETERS				
PARAMETER	**DESCRIPTION**	**UNIT**	**TABLE**	**FIELD**
$CAPP_v$	**Capacity of the vehicle weight** Vehicle weight capacity measured in kilograms	**kg**	VEHICULOS	CAPP
$CAPV_v$	**Capacity of the vehicle in volume** Volumetric capacity of the vehicle, measured in cubic metres	**m3**	VEHICULOS	CAPV
$COVA_v$	**Variable costs using a vehicle** Cost per kilometer by using the vehicle	**$/kmt**	VEHICULOS	COVA
$CFIJ_v$	**Fixed cost for using vehicle v** Fixed cost of use the vehicle v	**$/día**	VEHICULOS	CUVE
$DIST_{c,k}$	**Distance nodes** Distance between the origin node and the destination node	**km**	NOD_NOD	DIST
$NUCA_{w,b}$	**Number of boxes of the order** Number of cases order that must be transported to the node	**und**	PED_CAJ	NUCA
$PECA_b$	**Weight box** Weight of boxes in kg	**kg**	CAJAS	PECA
$VOCA_b$	**Volume of boxes** Volume of the boxes in cubic meters	**m3**	CAJAS	VOCA
CALCULATED PARAMETERS				
PARAMETER	**DESCRIPTION**	**UNIT**	**FORMULA**	
$CVIA_{v,c,k}$	**Cost of travel between nodes** Cost of travel of the vehicle from source node to the destination node	**$**	$CVIA_{v,c,k} = COVA_v \times DIST_{c,k}$	
$DEMP_c$	**Demand in weight** The node demand expressed in kilograms	**kg**	$DEMP_c = \Sigma_{b \in CAC(c)} NUCD_{c,b} \times PECA_b$	
$DEMV_c$	**Demand in volume** Demand for the node, expressed as a volume	**m3**	$DEMV_c = \Sigma_{b \in CAC(c)} NUCD_{c,b} \times VOCA_b$	
$NUCD_{c,b}$	**Boxes total for customer c** Total of boxes (b) must be delivered at the client c	**und**	$NUCD_{c,b} = \Sigma_{w \in PEC(c)} NUCA_{w,b}$	

CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS) PARAMETERs

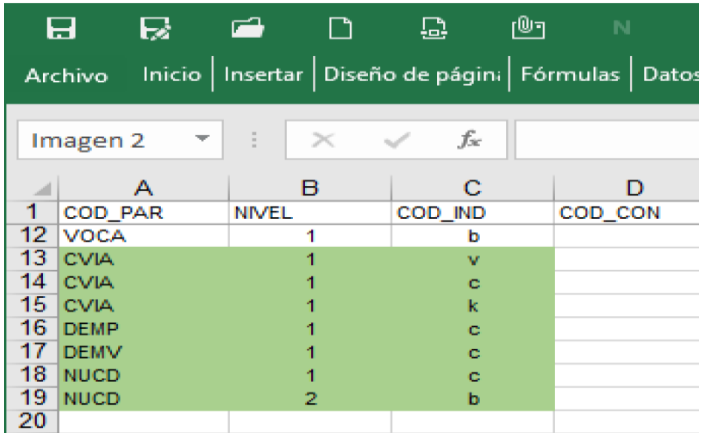
The following images show the corrections made in the EXCEL template.



	A	B	C	D	E	F
1	COD_PAR	DES_PAR	COD_UNI	COD_TDB	CAMPO_P	COD_DB
2	Parameter Code	Spanish Description	Parameter Unit	ID Definition Typ	Field-Variable-C	Reference Data
3	**CAPP**	Capacidad del Vehículo en Peso	kg	R	CAPP	VEHICULOS
4	**CAPV**	Capacidad del Vehículo en Volumen	m3	R	CAPV	VEHICULOS
5	**COVA**	Costo Variable de Utilizar un Vehículo	$/kmt	R	COVA	VEHICULOS
6	**CFIJ**	Costo Fijo de Utilizar el Vehículo v	$/día	R	CUVE	VEHICULOS
7	**DIST**	Distancia Nodos	km	R	DIST	NOD_NOD
8	**NUCA**	Número de Cajas del Pedido	und	R	NUCA	PED_CAJ
9	**PECA**	Peso Caja	kg	R	PECA	CAJAS
10	**VOCA**	Volumen de las Cajas	m3/und	R	VOCA	CAJAS
11	**CVIA**	Costo de Viaje Entre Nodos	$	C		
12	**DEMP**	Demanda en Peso	kg	C		
13	**DEMV**	Demanda en Volumen	m3	C		
14	**NUCD**	Cajas Totales para el cliente	und	C		
15						
16						



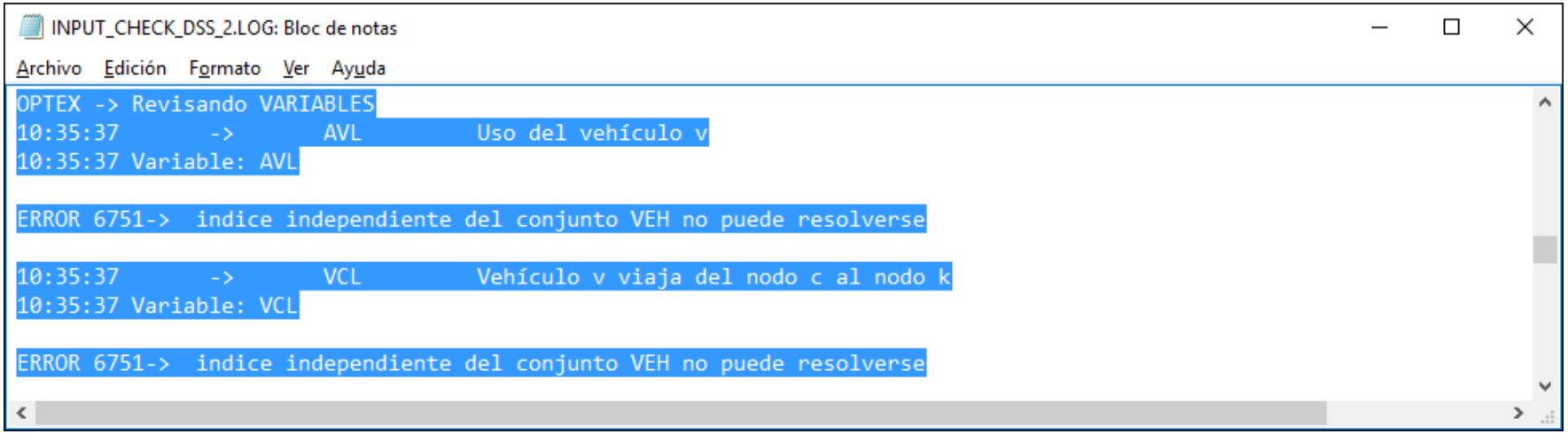
	A	B	C	D	E	F
23		CVIA	1	+	COVA	DIST
24		DEMP	1	+	S	b/CAC
25		DEMP	2	+	NUCD	PECA
26		DEMV	1	+	S	b/CAC
27		DEMV	2	+	NUCD	PECA
28		NUCD	1	+	S	w/PEC
29		NUCD	2	+	1	NUCA
30						



	A	B	C	D
1	COD_PAR	NIVEL	COD_IND	COD_CON
12	VOCA	1	b	
13	CVIA	1	v	
14	CVIA	1	c	
15	CVIA	1	k	
16	DEMP	1	c	
17	DEMV	1	c	
18	NUCD	1	c	
19	NUCD	2	b	
20				

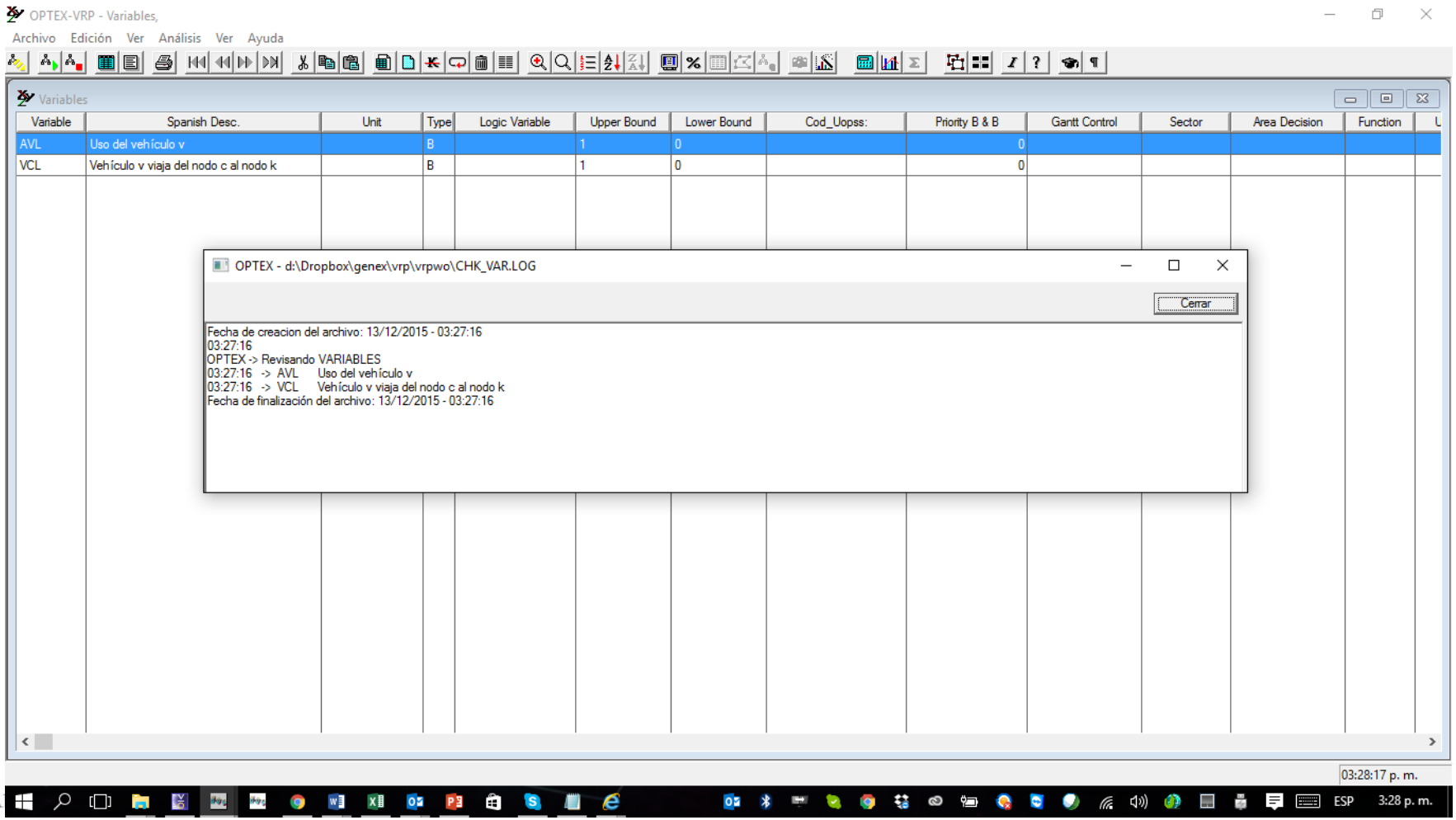
CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)
VARIABLEs

The following image shows errors reported in the load of the variables. These errors are generated by the error of not having defined for non-indexed sets the asterisk (*) to indicate this fact.



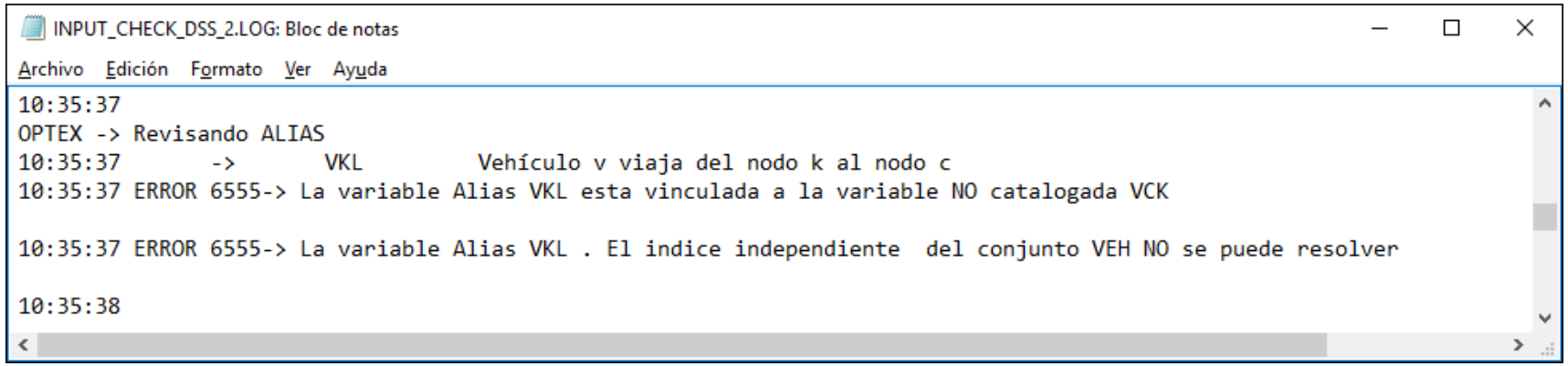
CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)
VARIABLEs

To correct the error in the sets definition, disappears the error in the variables, as you can see in the following image.



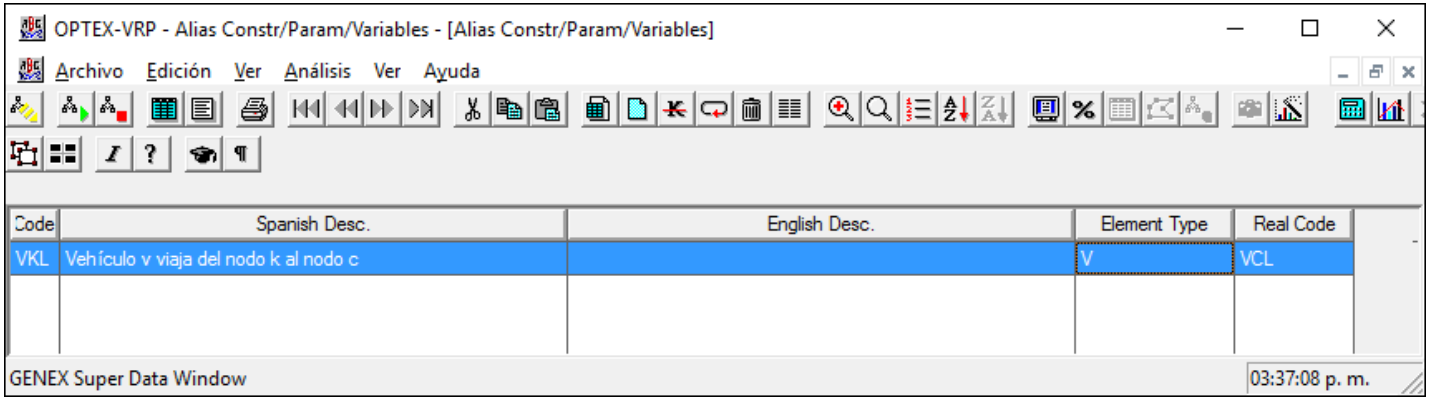
CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)
VARIABLEs ALIAS

The following image shows errors reported in the variable alias load. These errors are generated by the error of not having defined for non-indexed sets the asterisk (*) as the independent index; in addition, the variable alias is associated with a non-existent variable VCK.

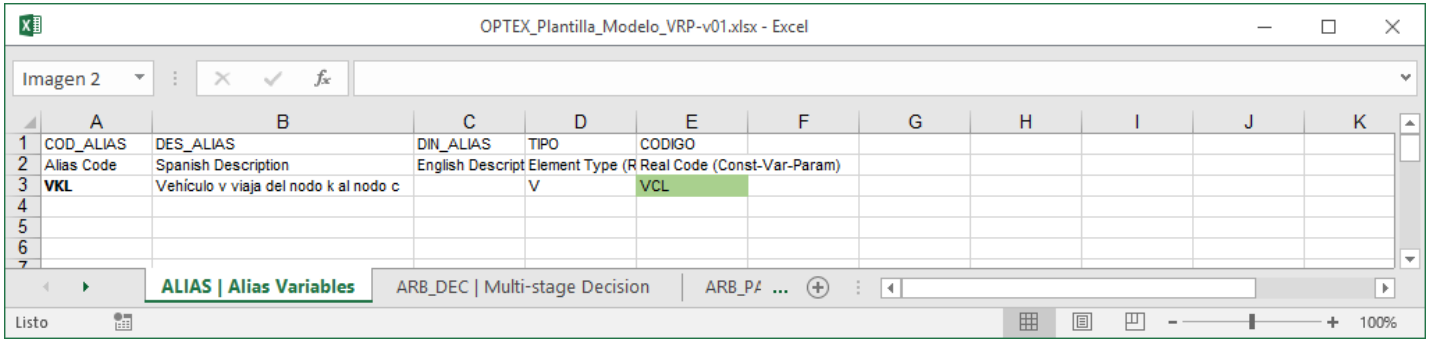


CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)
VARIABLEs ALIAS

The error can be corrected directly at OPTEX-GUI interface, as shown below.

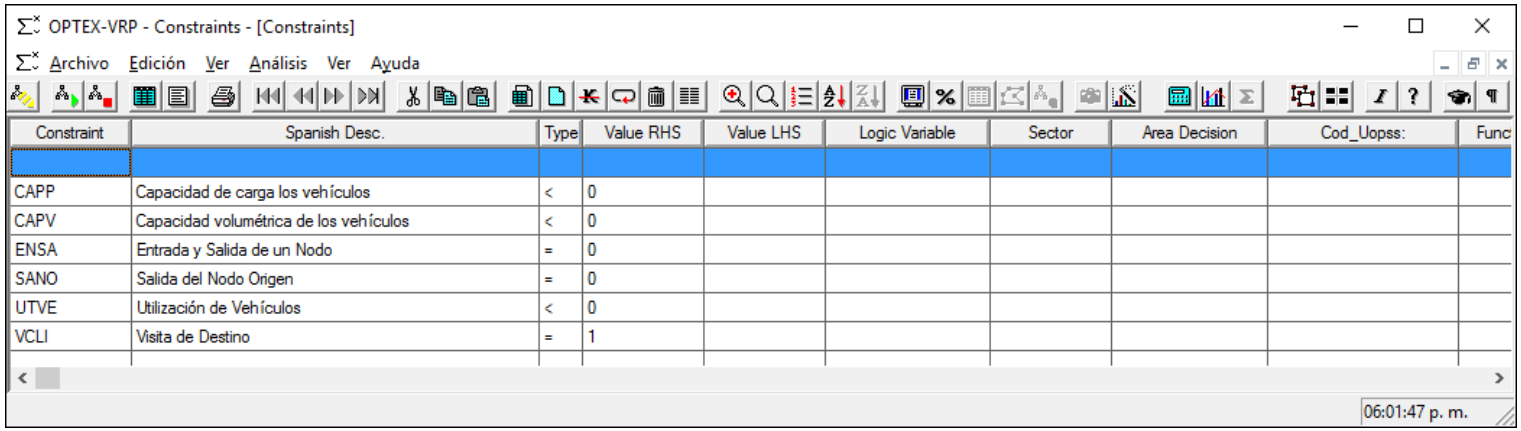


Then, the correction in the EXCEL template.



CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)
CONSTRAINTs

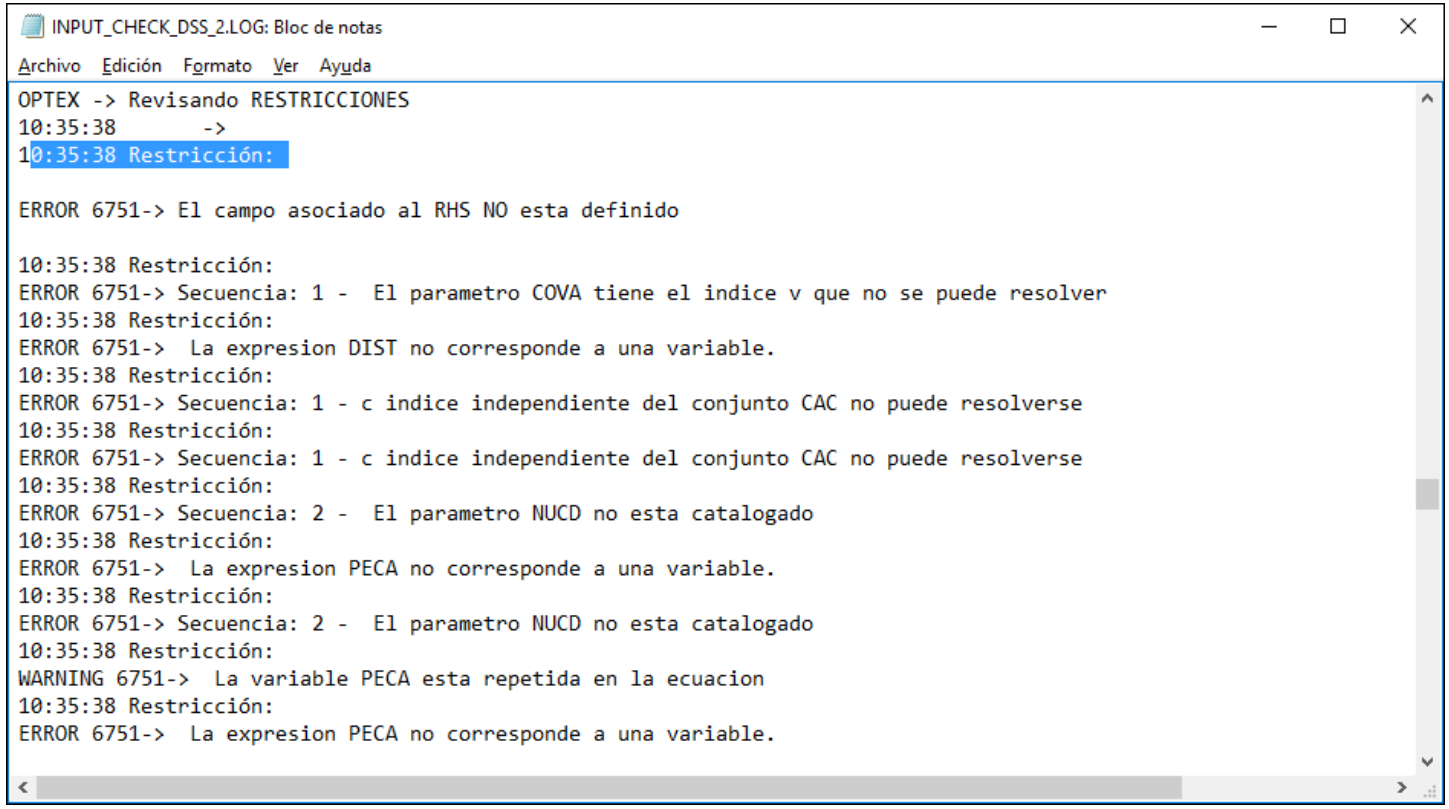
First error reported by OPTEX is related to the inclusion of an empty record, total or partially, in the table of constraints.



Constraint	Spanish Desc.	Type	Value RHS	Value LHS	Logic Variable	Sector	Area Decision	Cod_Uopss:	Func
CAPP	Capacidad de carga los vehículos	<	0						
CAPV	Capacidad volumétrica de los vehículos	<	0						
ENSA	Entrada y Salida de un Nodo	=	0						
SANO	Salida del Nodo Origen	=	0						
UTVE	Utilización de Vehículos	<	0						
VCLI	Visita de Destino	=	1						

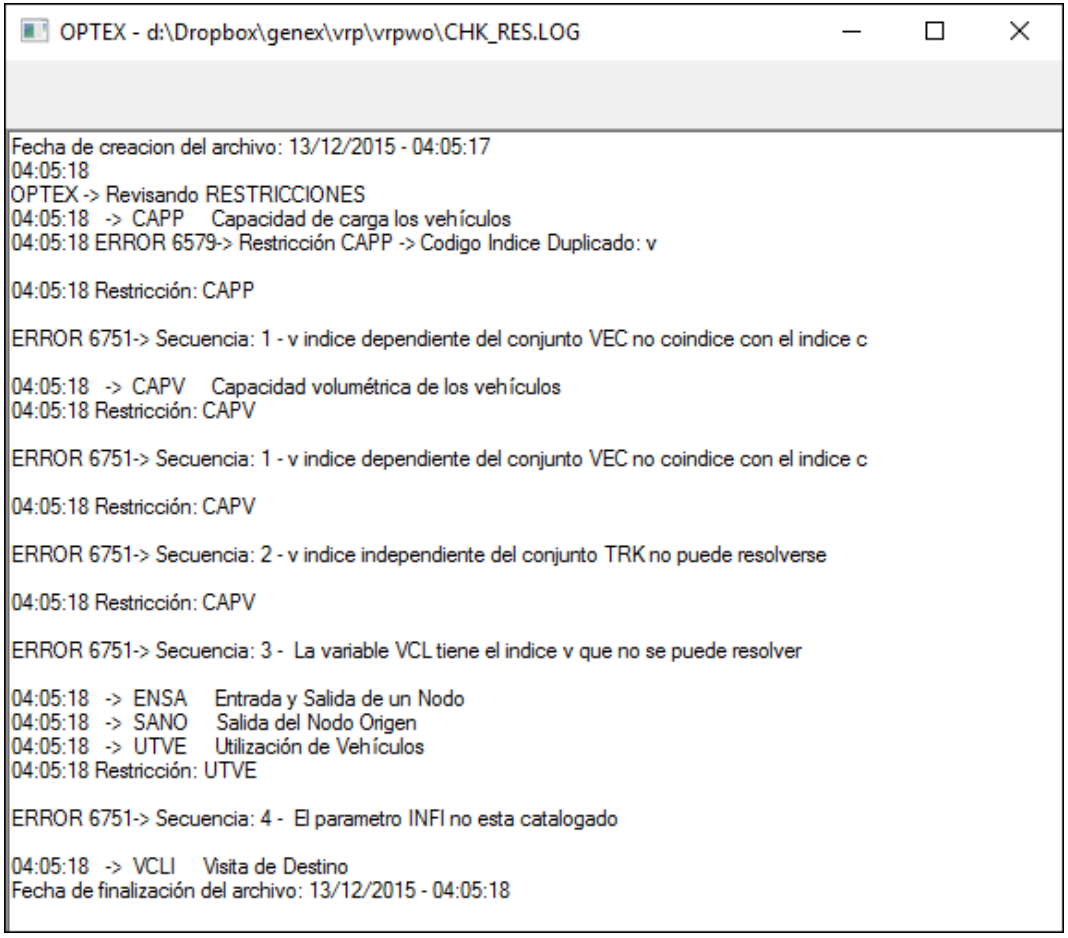
CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)
CONSTRAINTs

This can occur in any table, and is generated when the export macro included in the CSV file invalid records due to the existence of some element of "garbage", that falsely indicates the existence of information in the row, or column; This generates bugs that are resolved eliminating the empty record.



CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)
CONSTRAINTs

To review the constraints, first it is convenient to resolve errors in the sets, parameters, and variables, this can be done directly in the OPTEX-GUI interface or through the reprocessing of the EXCEL template. Once it has made this correction, the following image presents the bugs reported in the load of the following equations: CAPP, CAPV and UTVE.



CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

CONSTRAINTs

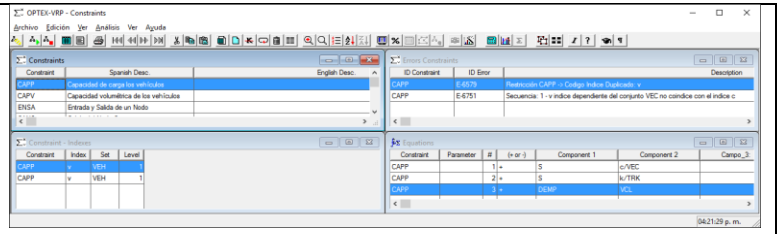
Then will review the errors presented for each constraint.

1. CONSTRAINT: $CAPP_v$

$$\sum_{c \in NCV(v)} \sum_{k \in TRK(c\,v)} DEMP_c \times VCL_{v,c,k} \leq CAPP_v$$

$$\forall v \in VEH$$

The reported error indicates that the index **v** is duplicated. The solution is to eliminate duplication and review leaving as the only mistake the fact that dependent index **v** of the **VEC** set not coincides with the index **c** over which the sum is defined, the right set is the **NCV.**

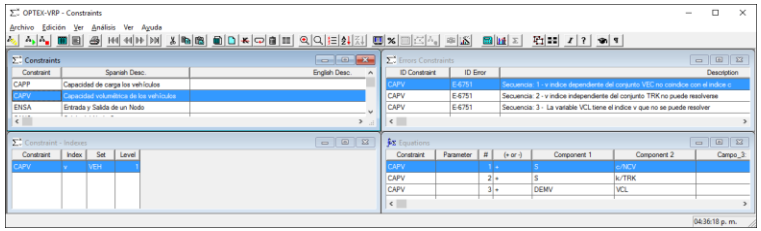


2. CONSTRAINT: $CAPV_v$

$$\sum_{c \in NCV(v)} \sum_{k \in TRK(c\,v)} DEMP_c \times VCL_{v,c,k} \leq CAPP_v$$

$$\forall v \in VEH$$

The reported error indicates that the index **v** has not been declared, should be included and correct the error of the **VEC** set similar to the previous case.

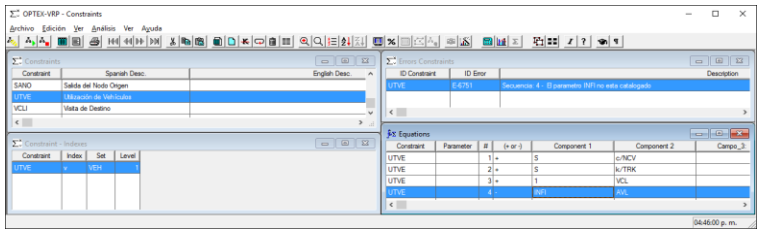


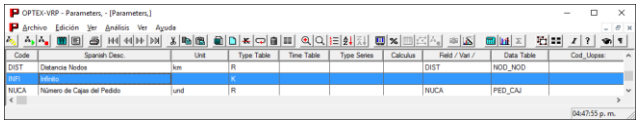
3. CONSTRAINT: $UTVE_v$

$$\sum_{c \in NCV(v)} \sum_{k \in TRK(c,v)} VCL_{v,c,k} - \infty \times AVL_v \leq 0$$

$$\forall v \in VEH$$

The reported error is related to the **INFI** (**"infinite"**) parameter, which has not been declared. The solution is to declare the parameter **INFI**, as a constant **K**, whose value is defined as **"default"**.

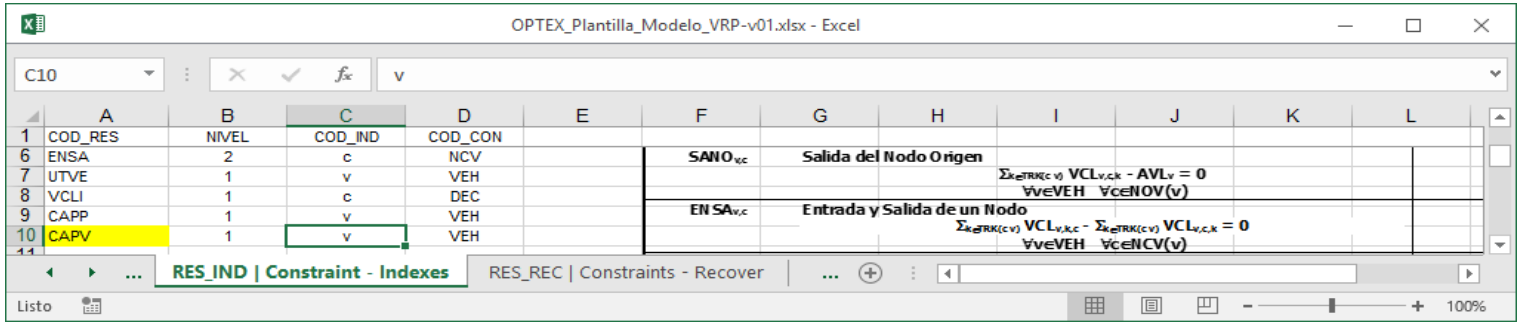


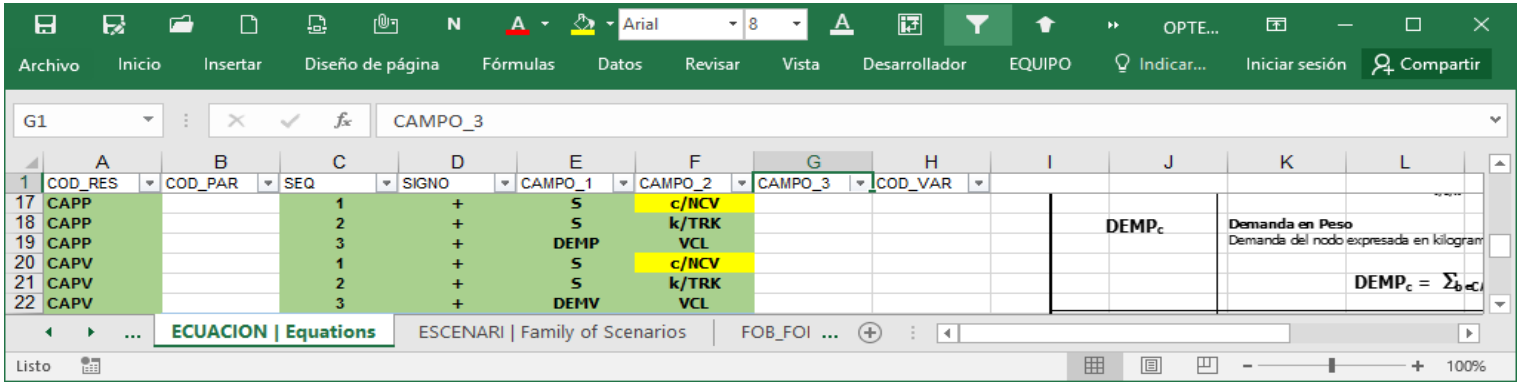


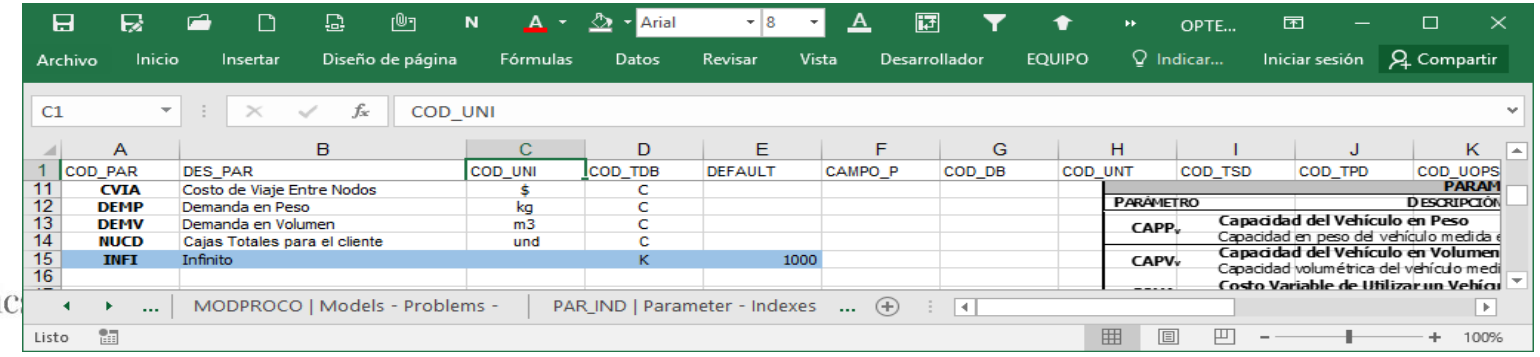
CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

CONSTRAINTs

The following images show the corrections made in the EXCEL template.

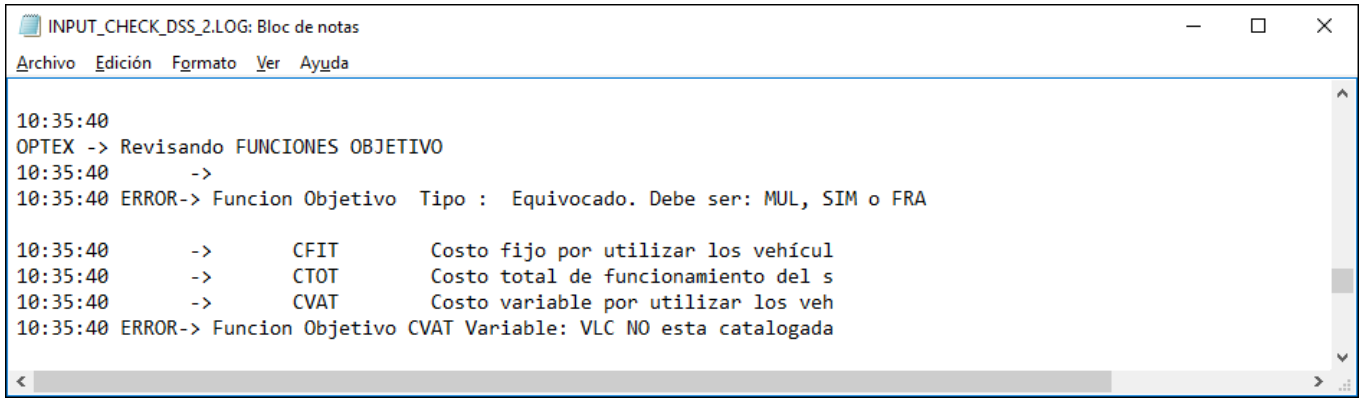




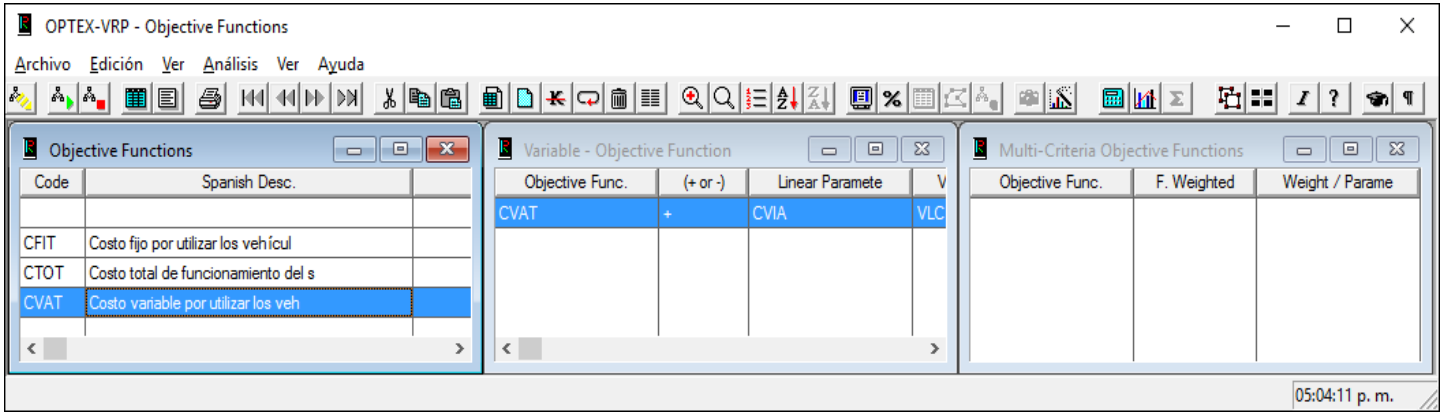


CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)
OBJECTIVE FUNCTIONSs

Bellow the errors reported by OPTEX for objective functions.

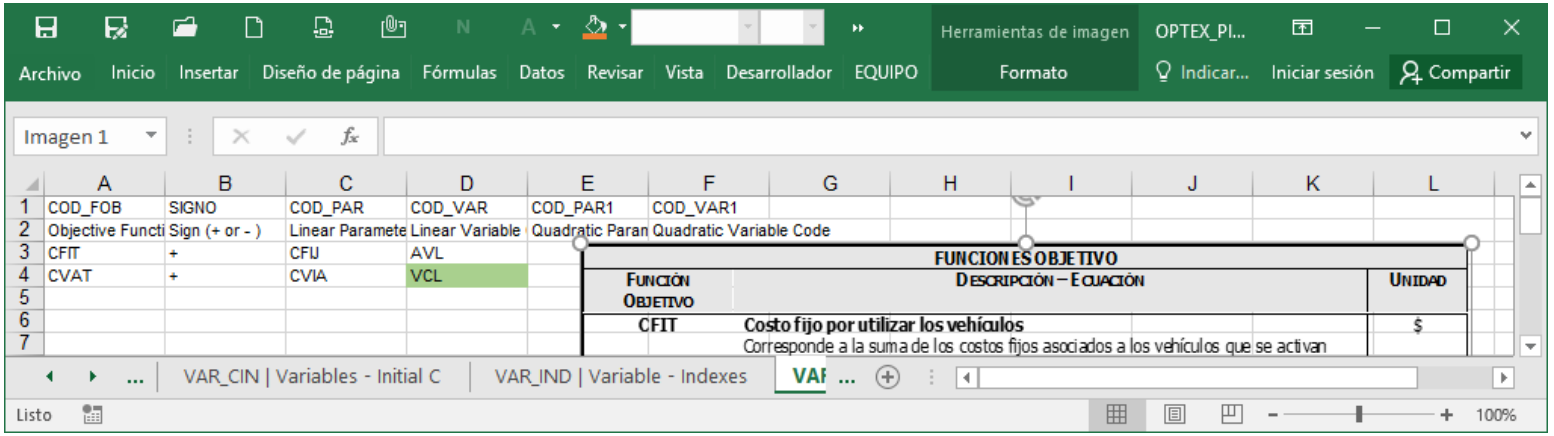


The first reported error is due to the blank line which is imported from the CSV file and the second to an error in the name/code of the VCL variable that was loaded as VLC



CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)
OBJECTIVE FUNCTIONs

Bellow the EXCEL template corrected



	A	B	C	D	E	F
1	COD_FOB	SIGNO	COD_PAR	COD_VAR	COD_PAR1	COD_VAR1
2	Objective Functi	Sign (+ or -)	Linear Paramete	Linear Variable	Quadratic Paran	Quadratic Variable Code
3	CFIT	+	CFU	AVL		
4	CVAT	+	CVIA	VCL		
5						
6						
7						

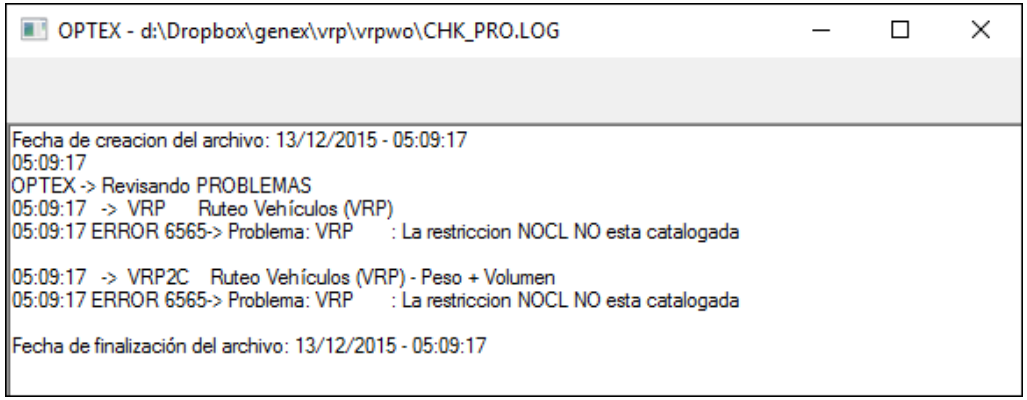
FUNCIONES OBJETIVO

Función Objetivo	Descripción – Ecuación	Unidad
CFIT	Costo fijo por utilizar los vehículos Corresponde a la suma de los costos fijos asociados a los vehículos que se activan	$

CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)

PROBLEMs

Related problems are associated with the inclusion of NOCL restriction that it is not considered in the formulation of the model. The solution is this case will be removed NOCL from the formulation.

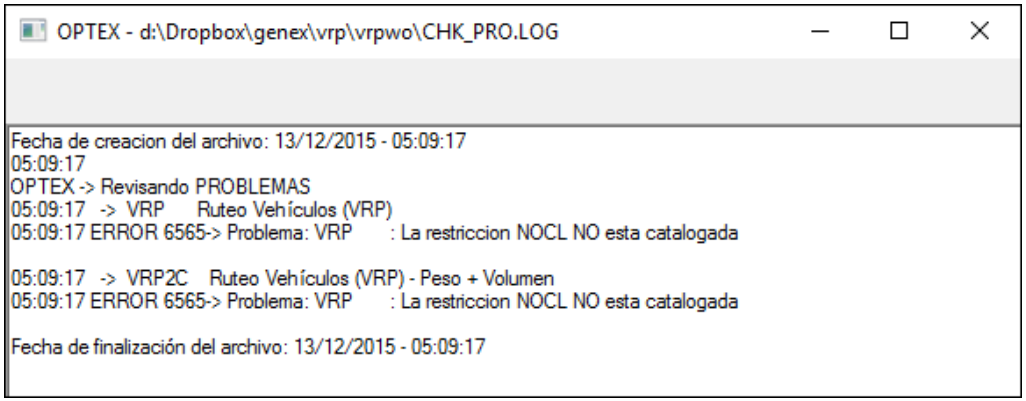


The table that defines the problem remains as shown below.

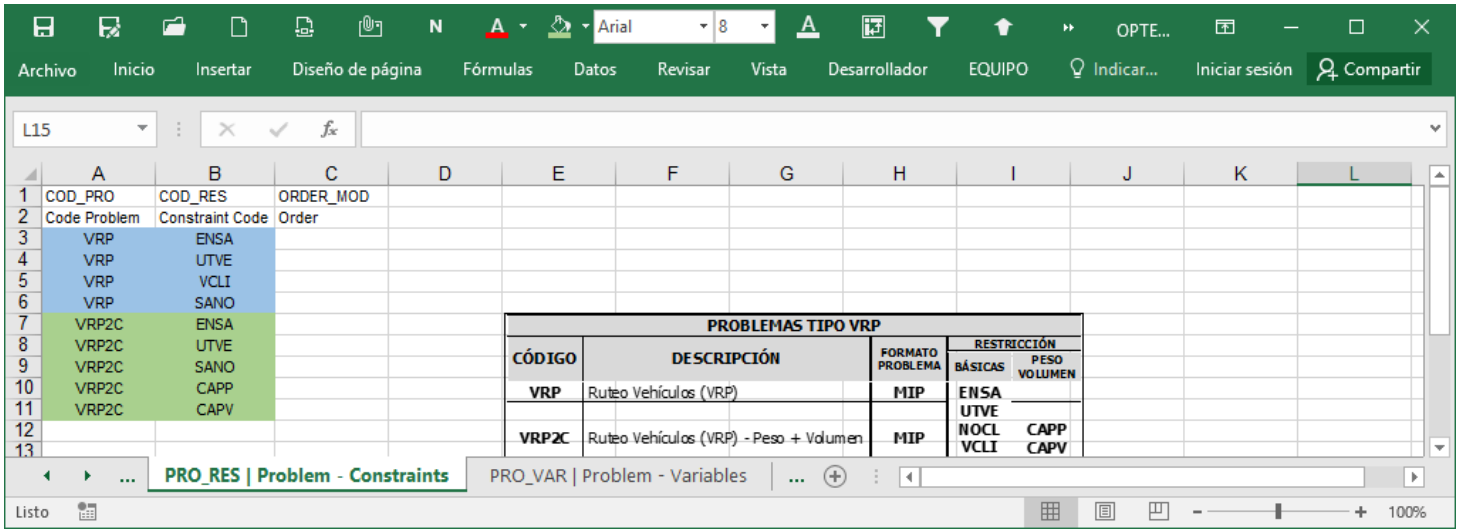
VRP TYPE PROBLEMS				
CODE	**DESCRIPTION**	**PROBLEM FORMAT**	**CONSTRAINTS**	
			BASICS	**WEIGTH VOLUME**
VRP	Routing vehicle (VRP)	**MIP**	**ENSA UTVE VCLI SANO**	
VRP2C	Routing vehicle (VRP) - Weigth + Volume	**MIP**		**CAPP CAPV**

CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)
PROBLEMs

Related problems are associated with the inclusion of NOCL restriction that it is not considered in the formulation of the model. The solution is this case will be removed NOCL from the formulation.



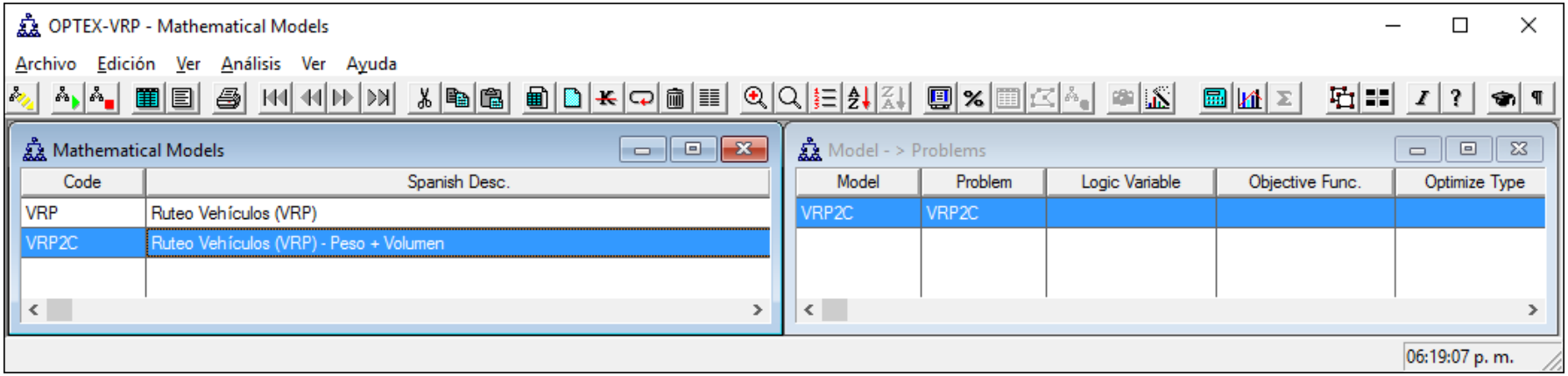
The following image shows corrections in the EXCEL template.



Analytics

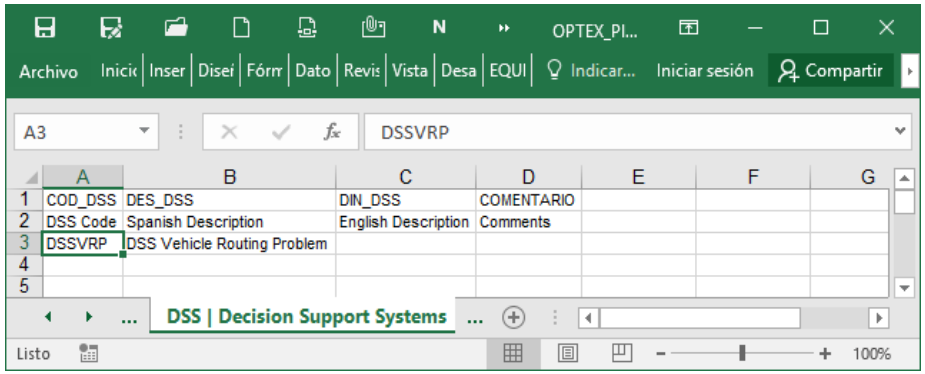
CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)
MODELs

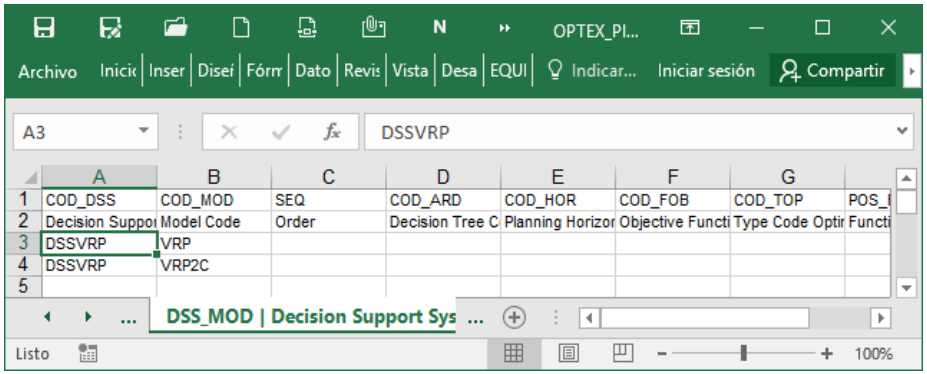
The models uploaded to the MMIS are below, it does not have errors.



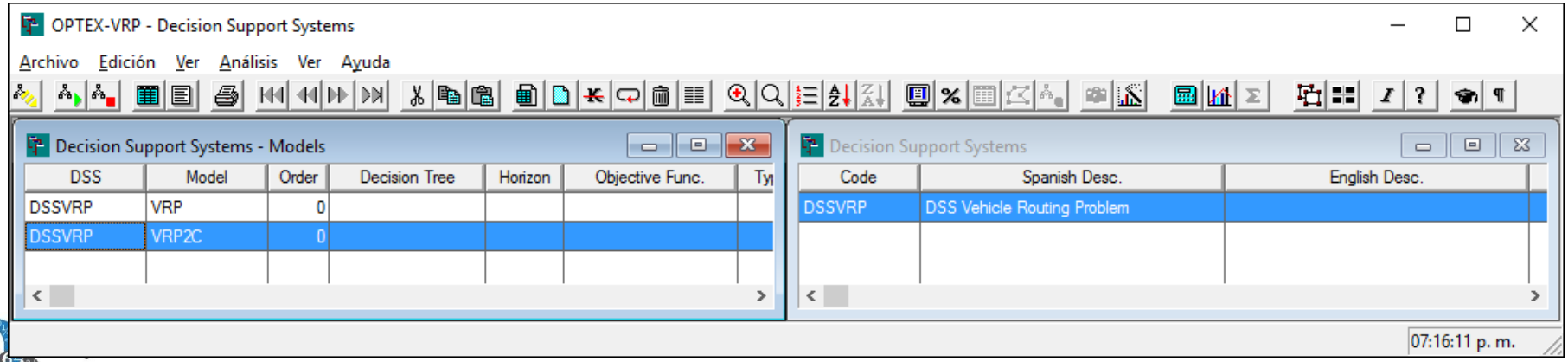
CHECKING THE MATHEMATICAL MODEL INFORMATION SYSTEM (MMIS)
DECISION SUPPORT SYSTEMs

Finally, a system of decision-support containing the two formulated models can comply. So it can be loaded into the EXCEL template in the DSS and DSS_MOD sheets.



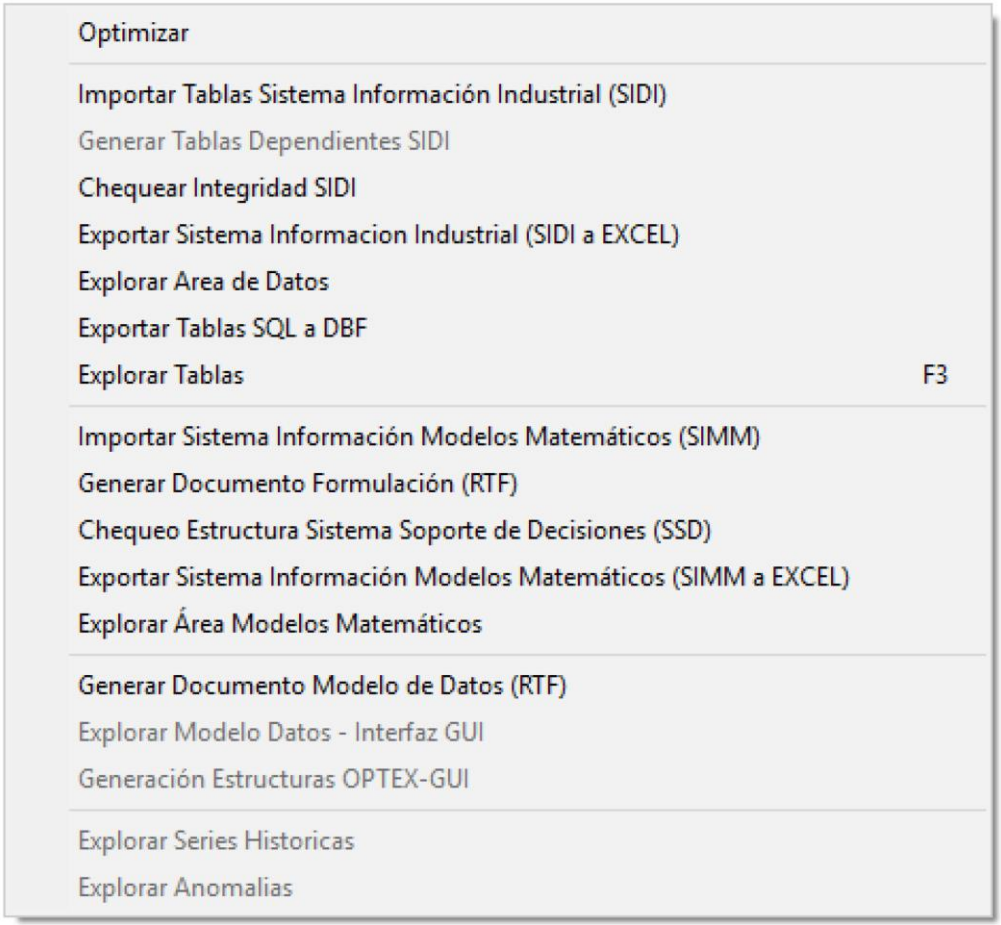


The following image shows the structure of the DSS in OPTEX-MMIS



SERVICES OFFERED BY OPTEX-GUI

OPTEX-GUI provides several services to support the mathematician modeler in the implementation of the models; to access to these services the user must click the right bouton mouse in the window of exploration of the mathematical models area. These services are presented in the following image and correspond to the third group of services:



SERVICES OFFERED BY OPTEX-GUI

IMPORT MMIS

This service has already been presented and was used for massive loads of the MMIS from files in CSV format.

GENERATION ALGEBRAIC FORMULATION IN RTF DOCUMENT

Generates a RTF document with all the algebraic formulation. This document can be edited with text editors such as MS-Word programs and other similar. The generated document can be downloaded from the URL:
http://www.doanalytics.net/Documents/INPUT_CHECK_DSS_2.LOG

CHECK MMIS STRUCTURE

This service has been used in the process of massive load of the MMIS which includes the check of the structure, the report is similar to those previously presented.

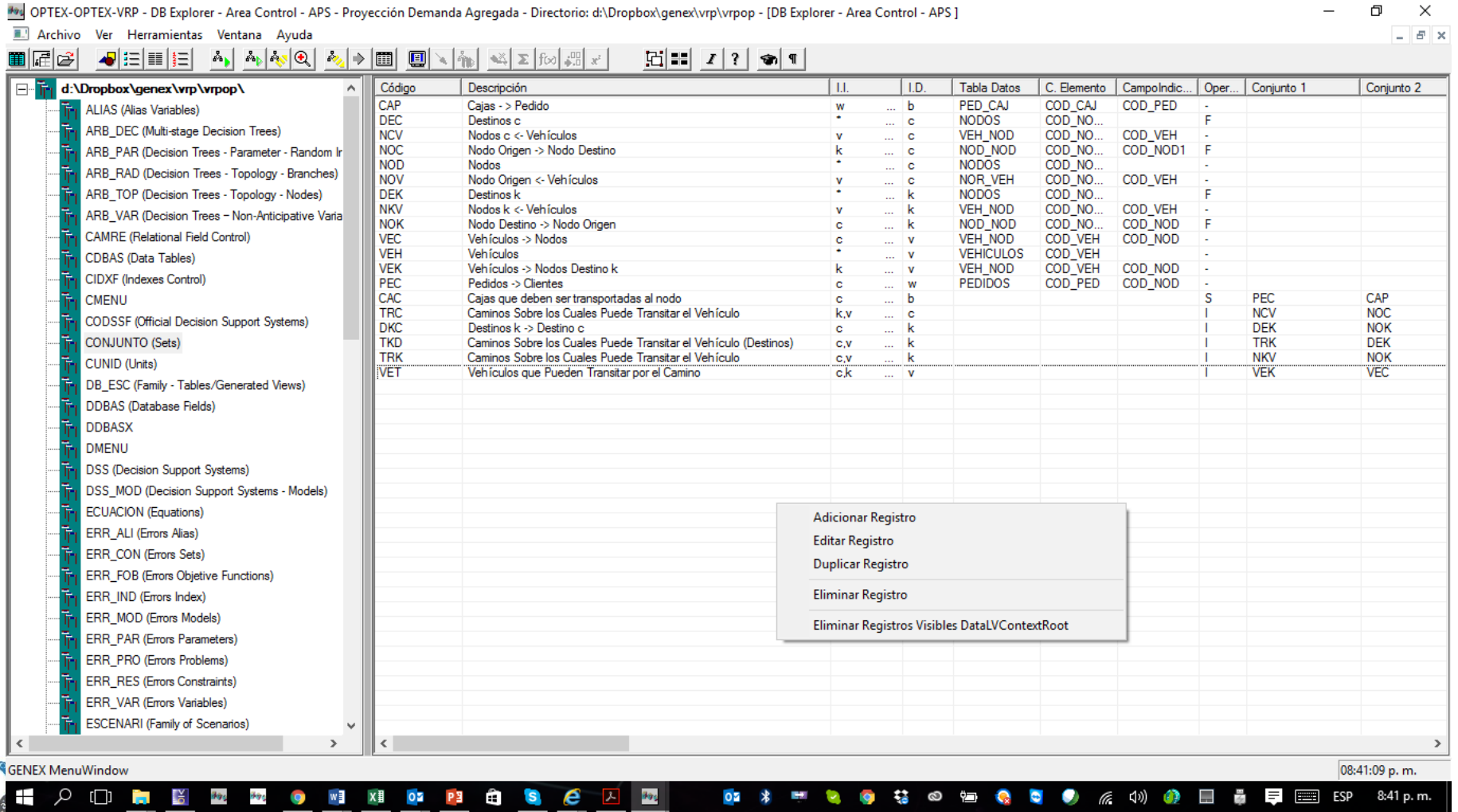
EXPORT OF THE MMIS TO EXCEL FILES

This service is in the process of adjustment.

SERVICES OFFERED BY OPTEX-GUI

EXPLORATION OF THE MMIS

It allows to directly explore all tables that comprise the MMIS and modify its content if deemed suitable, such as shown in the following image.



Analytics

"the computer-based mathematical modeling is the greatest invention of all times"

Herbert Simon
First Winner of Nobel Prize in Economics (1978)

"for his pioneering research into the decision-making process within economic organizations"