International Journal of Production Management and Engineering

Special Issue: Advances in Engineering Networks
https://doi.org/10.4995/ijpme.2019.10795
Received: 2018-10-10 Accepted: 2019-05-01

Methodology to Validate Results from European Research Projects: The C2NET Case Study

Sanchis, R.[a1*], Andrés, B.[a2], and Poler, R.[a3]

[a]Research Centre on Production Management and Engineering (CIGIP). Universitat Politècnica de València. Calle Alarcón, 1 03801 Alcoy (Alicante), Spain.
[a1] *rsanchis@cigip.upv.es,* [a2] *bandres@cigip.upv.es,* [a3] *rpoler@cigip.upv.es*

Abstract: One of the main priorities of the European Commission is the utilisation of European Projects results in further research activities, or in developing, creating and marketing a product or process. For this reason, it is critical to test and validate European projects results before implementing them in real scenarios. In this paper, a general validation methodology addressed to the assessment of technological results has been defined. This general methodology offers the foundations to define specific validation methodologies to validate particular results of different Research Projects. As an example, the general methodology has been applied to define a specific one for the validation of an Optimiser developed within the European Research Project: Cloud Collaborative Manufacturing Networks (C2NET) to guarantee the proper operation of the research results and facilitate their later real implementation and exploitation.

Key words: Optimisation, C2NET, Validation, Methodology, Optimiser.

1. Introduction

In the global economy, there is an increasing interest in new organisational structures to flexible enough respond to market changes and at the same time to perform collaborative projects (Andrés *et al.,* 2015). Enterprises, especially European Small- and Medium-sized ones (SMEs), do not have access to advanced management systems and collaborative tools due to their restricted resources. SMEs manufacturing value chains are distributed and dependent on complex information and material flows requiring new approaches to reduce the complexity of manufacturing management systems. Motivated by this situation the European project: "Cloud Collaborative Manufacturing Networks" (C2NET) was born. C2NET is a European-funded project whose main goal is to create cloud-enabled tools to support the SMEs supply network optimisation of manufacturing and logistics assets based on collaborative demand, production and delivery plans (Andrés *et al.,* 2016). C2NET has the characteristics of an "industry cloud," in which groups of companies within a sector come together to leverage enhanced technologies and share best practices in a pooled-cost environment. C2NET develops solutions to help SMEs optimize their manufacturing and logistic supply chains by reducing the complexity currently surrounding manufacturing management systems. Moreover, it offers a platform on which products, processes and logistical data can be securely stored and shared in the cloud (Black, 2017).

Sanchis *et al.,* (2018) offers a brief description of the main four exploitable results (Figure 1): (i) the Data Collection Framework (DCF) in charge of gathering the necessary data for the other C2NET modules (Agostinho *et al.,* 2016 and Mohammed

To cite this article: Sanchis, R., Andrés, B., and Poler, R. (2019). Methodology to Validate Results from European Research Projects: The C2NET Case Study. *International Journal of Production Management and Engineering,* 7(Special Issue), 81-90. https://doi.org/10.4995/ijpme.2019.10795

et al., 2017); (ii) the Optimizer (OPT) whose main goal is the optimisation of several planning problems such as Aggregate Planning problems (AP), Material Requirement Planning (MRP) problems, … (Sanchis *et al.,* 2018); (iii) the Collaboration Tools (COT) to provide the necessary means to collaboratively solve agility issues in the supply chain (Benaben *et al.,* 2016) and (iv) the C2NET platform that hosts all the previous C2NET modules (Ramis-Ferrer *et al.,* 2016).

The DCF main objective is to enable the continuous data collection from both legacy and Internet of Things (IoT) systems. Data is collected from supply network partners through dedicated middleware at the company side and stored at the C2NET cloud platform in a reference form for proper sharing among remaining C2NET components, to enable enlarged partners' collaboration and optimisation of resources.

The OPT module solves planning problems and maximises the efficiency of supply network planning activities by computing production, replenishment and delivery plans to achieve shorter delivery times, faster speed and better consistency of schedules, better use of productive resources and more energy savings.

The COT module includes mainly six functional components: (i) the knowledge base in charge of structuring the collected data and information through the DCF, (ii) the modelling service in charge of formalizing the collaborative situation, (iii) the detection service dedicated to monitor the collaboration and detect if there is any unwished situation, (iv) the adaptation service, which suggests resolution processes in case of deviation (v) the assessment service in charge of the evaluation of the deviations, and (vi) the orchestration service in charge of supporting the design and orchestration of the collaborative processes.

And finally, the C2NET cloud-based platform that hosts the previous C2NET main three modules DCF, OPT and COT; and allows a secure and user control access to the C2NET features.

All these results have been tested in advance to their implementation in real companies. However, tests should be planned and structured in a proper way to record the results of such assessment and verify that such results accomplish with the expected objectives. This task often is performed on the fly without formal procedures defined. For this reason, the main objective of this paper is to define a general methodology to assess research results, more specifically technological ones, before their real implementation to guide researchers and developers in this activity. Moreover, an application of this methodology to the C2NET OPT is shown as an example.

This paper is organised as follows. Section 2 is focused on the C2NET OPT module characterisation as the validation methodology described in this paper is applied to this result. Section 3 describes the main phases to test and validate the research and technological results before implementing them in real scenarios. Based on this, Section 4 shows the application of the general validation methodology to assess the C2NET Optimiser Module. Finally, Section 5 provides the main conclusions.

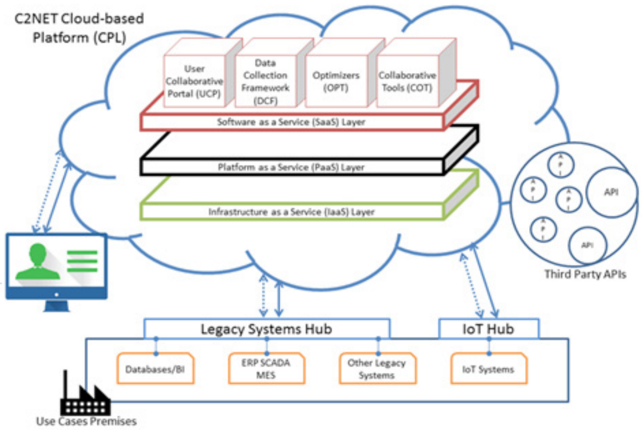

Figure 1. C2NET Project Main Results.

2. The C2NET Optimizer module

The OPT module provides advanced optimisation algorithms for single and collaborative computation of production, replenishment and delivery plans with the aim of optimising the use of manufacturing and logistics assets of the supply network from a holistic point of view. The OPT provides decision-makers with a set of tools to easily manage the decision rules and to re-calculate alternative plans in real time, increasing the efficiency of the supply network by the global optimisation of operations plans and schedules.

The C2NET OPT is composed of four main components (Figure 2):

(i) the *Optimisation Algorithms*, a set of algorithms, to support manufacturing networks in the optimisation of manufacturing and logistics processes. Currently, the C2NET OPT module has 48 different optimisation algorithms addressed to solve planning problems such as production sequencing, goods delivery, material requirement planning… (ii) the *Solver Manager* in charge of managing algorithms, and as such, it allows to create, edit, categorize and delete algorithms and objective functions. Moreover, it makes available to the components (iii) and (iv) (OPC and POMA), the set of methods that allow them to validate if an optimisation problem can be solved or which is the most appropriate algorithm to be applied depending on some criteria such as gap, solving time, etc.;

(iii) the *Optimisation Problem Configurator (OPC)* in charge of managing the optimisation problems and proposing solutions to optimise manufacturing and logistics plans based on the input data available; and (iv) the *POMA (Processes Optimisation of Manufacturing Assets) Manager* that controls the launching of optimisation problems defined in the OPC.

The OPT module interacts with other modules developed within the project. One of this modules is the Data Collection Framework (DCF) from which the OPT gathers the necessary input data to perform the optimisation and also returns the results to the DCF to be displayed to the users. The necessary input data to perform the optimisation come from different resources and each company has these input data available using different terminology. For this reason, the DCF hosts the Standardised Data Model, called STables. The objective of the STables, besides storing the input data for optimisation, is standardizing them to use always the same term for the same concept. In the example shown in Figure 3, there are 3 companies that use different concepts (inventory, stock, product stored…) to denote the number of products available in the inventory. These three concepts have the only name in the STables

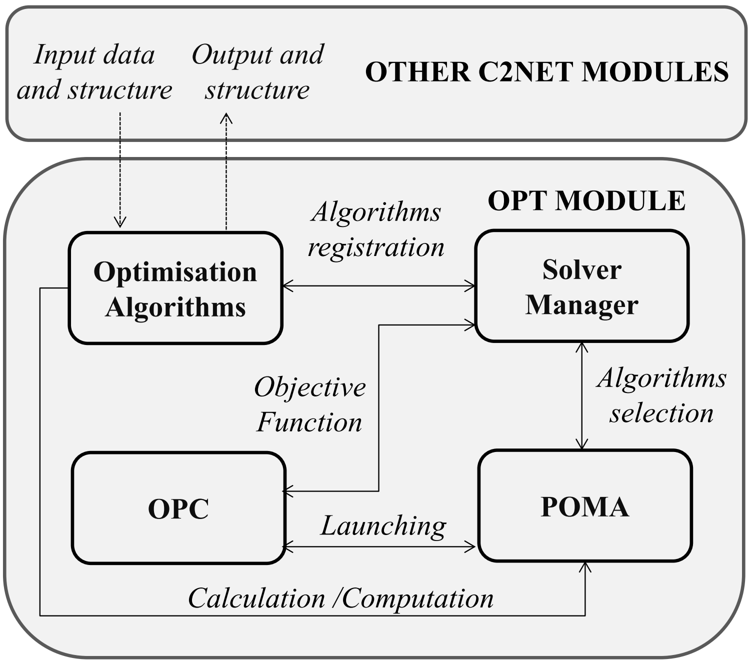

Figure 2. Components and relationships among the OPT module components (based on Sanchis *et al.,* 2018).

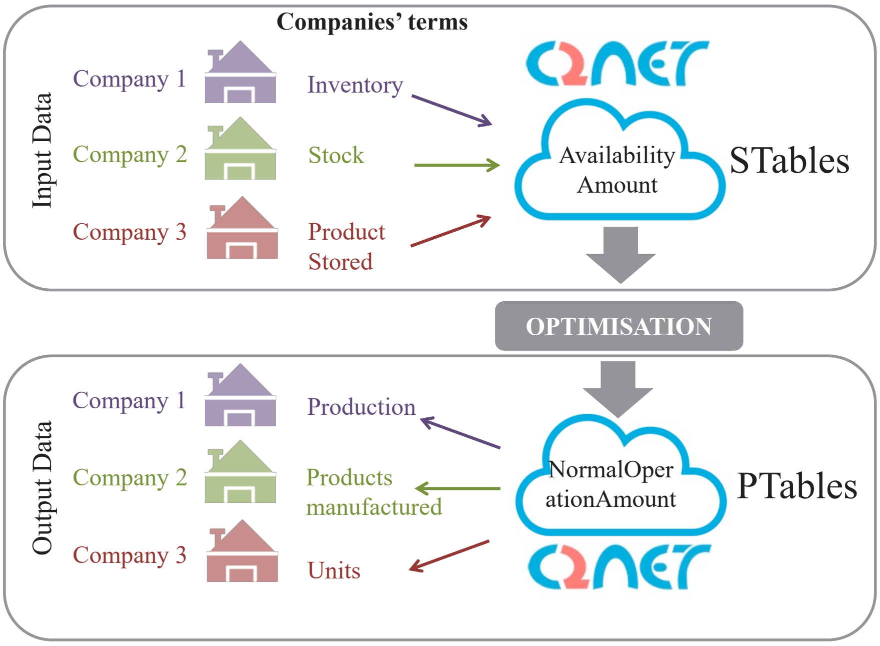

Figure 3. Input and output data management in C2NET.

of "AvailabilityAmount" and the optimisation algorithms use this concept for managing the data.

In the same way, the optimisation's results are stored in the Plan Data Model, also called PTables that is hosted in the DCF. Following with the example of Figure 3, one of the results of the optimisation performed is focused on planning the number of products to be manufactured in each period. This result is coined in the PTables as "NormalOperationAmount", while the enterprises receive this piece of information with their own terminology that is "production" for Company 1, "products manufactured" for Company 2 and "units" for Company 3. Therefore, both models: STables and PTables have twofold objectives: (i) to store the input (STables) and output (PTables) data sets and (ii) to standardise concepts to facilitate the optimisations while companies provide the data and receive the optimisation information in their "own language".

3. General Validation Methodology

One of the main priorities of the European Commission is the utilisation of European projects results in further research activities other than those covered by the action concerned, in developing, creating and marketing a product or process, in creating and providing a service, or in standardisation activities (European HelpDesk, 2018).

Therefore, in order to be able to exploit the results of European Projects, it is required to test and validate that the results achieved are suitable and appropriate before implementing them in real scenarios. One of the most common risks detected in European projects consists of difficulties in the implementation of the project results in real companies through piloting activities as they are not mature enough. For this reason, it is vital to test the viability and the correct running of the results before performing real tests in real companies. For this reason, the C2NET project defines two types of validation methodologies. One that is based on the validation of the project results from a technical, technological and scientific point of view and once that this methodology is fully completed, then the validation methodology is applied to industrial companies. Some phases of both validation methodologies are performed in parallel, however, it is important to implement results in the industry once that have been already fully proven. This paper describes the first of the validation methodologies as, although projects usually validate their results prior to real implementation, they do not usually define standardized procedures for this type of validations.

The phases of this methodology have been defined as generalist as possible and for this reason it is considered a meta-methodology, i.e., a high level methodology. Taking this into account, it is worth mentioning that this high level methodology has been applied to validate specifically the C2NET OPT module, that is a technological result. In other cases, where the results are of different nature, the methodology possibly needs some adaptation. The value of this high level methodology is based on the fact that the research results of a research project are usually developed by researchers who are experts in developing research solutions but are less familiar with validating and testing such results. That is why this methodology provides a high level perspective to support novel, junior, or even senior researchers with no previous experience in the validation phases, since they are more focused on the development than on assessing and putting the results on place.

The general phases defined to be followed in order to validate technological results are descried as follows:

Phase 1. Check the input and output data consistency

In order to assess the correct operation of a technological result, it is necessary that the result is nurtured from the appropriate input information. This means that the necessary input data should be easily accessible and with a reasonable cost. Other aspects to be analysed are the stability, uniformity, reliability of data in the long term. One of most common risk when a technological result is evaluated is related to the fact that enterprises wishes a specific output information but they are not able to provide the necessary input data to obtain the desired output information. In other cases, the information exists, but it is very costly to obtain it and its cost exceeds the benefits that the output information will provide to the enterprise. Therefore, it is important, in the first phases of a technological result development, to understand perfectly what the company needs but also which information the company may provide and if it is economical viable to obtain it.

In this phase it is also recommendable to analyse that the company has data records over time and the information is reliable, that it is standard and uniformly stored in the company's information systems. It is very common to find gaps of information during some specific periods, or sometimes, the information is registered in different units, terms… what complicates the identification and collection of the input data that the technological result needs for running properly.

The same applies for the output data in the sense that the solutions that the technical result offers should be in line with what the company was expecting. In this case, the communication and collaboration between the companies' users and the researchers and developers is essential during the phases of the technological result development. Moreover, in this phase it should be analysed that the outcomes offered by the technological result are easily understandable and consistent with the company's information systems.

Phase 2. Create realistic data sets.

Before performing real tests in companies, it is recommendable to create data sets similar to the ones that the company manages. In this way, researchers are simulating the normal operation of the technological result but with fake data in order not to focus efforts on obtaining real data that sometimes is complex and time-consuming. It is important to simulate real scenarios to study the behaviour of the technological result. Otherwise, the test will not be representative. In case that the technological result does not need input data for operating, realistic conditions under which the result has to work, should be simulated.

Phase 3. Identify the aspects to be analysed

Depending on the type of technological result, the aspects to be assessed will be different. For example, if the technological result is related to a videoconference system that allows synchronous communication between two parties, the test will be focused, among other aspects, on the speed, sound, image quality… It is important to define which aspects should be analysed to guarantee the proper functioning of the result. Moreover, it may happen that some aspects are key for the correct operation of the technological result and therefore their validation should be a priority, while other aspects can be classified as recommendable, and in this case, its validation will be useful but not critical.

Besides the definition of the aspects to be analysed, in this phase the target values for each aspect should be also set up. Following with the videoconference example, it is necessary not only to define that the image quality should be analysed but also to stablish the target values for each characteristic (e.g. number of pixels: 3840×2160 pixels; luminance: 550 cd/m^2; FPS: 100 Hz…).

Phase 4. Monitor the computation/running of the technological result

This phase is focused on the proper functioning and running of the technological result. Here, it is important to check that during the technological result running, the target values for each characteristic and aspect (defined in Phase 3) are achieved.

Moreover, it is also recommendable to perform tests under different circumstances (e.g. if the technological result needs internet connection, it should be advisable to test it with both cable and wireless connection) in order to check the proper running of the technological results in different situations.

Phase 5. Analyse the output data and results

The technological result could have different purposes. For this reason, this phase could vary depending on the function of the result. Anyhow, most of the research and technological results offer output information. If this is the case, it is also necessary to assess that the information obtained is the desired one and also congruent. For example, if the technological result that we are analysing is a IoT (Internet of Things) Hub, whose main purpose is to collect data from different physical resources (machines, vehicles…), this phase should focus on the correctness of the information that the hub has gathered. The information gathered should be exactly what the user was expecting and presented and organized as the user wishes. On the contrary, the causes by which the technological result does not offer the output information according to the users' requirements should be investigated.

But this phase is also focused on the analysis of the congruency of the output information. For example, if the user is expecting that the technological result offers information about when to order raw material to fulfil a specific order that should be delivered before 4th October, and the result provides a later ordering date, this solution is not consistent as the order of raw material should be done before 4th October. Therefore, when testing, it is recommendable to test under the conditions in which we know the different potential solutions to analyse the congruency of the output information.

Phase 6. Propose solutions for undesired situations

Undesired situations consist of any situation in which the technological result, or the input or output data present any deviation with regards to the expected ones. When the behaviour of the technological result is not the expected, it is advisable to propose solutions in order to return to the normal status of operation. Following with the example of the ordering date of raw material, if the solution is not feasible, the causes should be investigated and, once that the reason why the technological result is not offering the correct information, this situation should be corrected. In this example, the cause was related to a wrong definition of the calendar and this was why the order date was defined after the delivery date.

Sometimes, it is complex to find out the reason that causes the undesired situation. For this reason, in this phase, it is advisable to form multidisciplinary groups, formed even by end users, to detect the cause of the undesired situation as soon as possible, whereas the solution to the undesired situation is normally fixed by researchers and developers.

Phase 7. Identify new opportunities

Sometimes when a problem arises, and during the search for the solution, improvements and new opportunities are identified to enhance the technological result. Innovation arises for many reasons, but one of them is during the search for solutions to existing problems. Therefore, during the development of solutions to solve undesired situations, developers should be also receptive to new ideas that could improve the technological result, or even though, could promote the development of another new and innovative technological result.

As aforementioned, the methodology offers a set of systematic procedures as guidelines oriented to support researchers and developers who have to validate technological results. Depending on the nature of the results, the phases to be followed should need some adaptation, but these general phases serves as first attempt to develop more specific validation procedures.

4. Specific Validation Methodology of the C2NET Optimiser Module

Following the phases and guidelines defined in the methodology of section 3, this section shows the specific methodology that is created within the European Project C2NET in order to validate the C2NET OPT before implementing and validating it in real scenarios. Figure 4 shows the alignment between the phases of the general validation methodology and the particular steps defined to validate the C2NET OPT. As it can be seen in this figure, not all the general phases are covered by the steps of the specific methodology. This is due to the fact that phase 4, that consists of monitoring the computation/running of the technological result, is

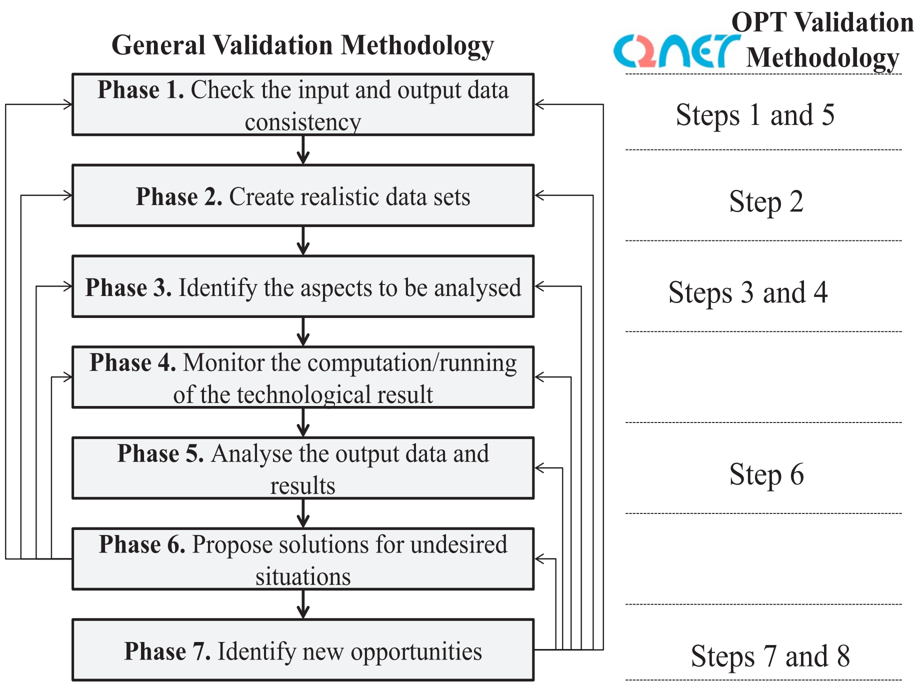

Figure 4. Alignment between the general validation methodology and the specific one applied for the validation of the C2NET OPT.

intrinsically developed in steps 3 and 4, since if the GAP is identified (see step 3) and the solving time is determined (see step 4) is because the optimisation has been performed. However, it would have been advisable to include a new step, before step 3, focused on analysing the smooth running of the C2NET OPT. The same occurs with phase 6, as in each of the steps defined in the specific validation methodology, if problems are detected, they are solved in each of the steps where they are found. There is not a separate step in which all the problems detected are analysed for proposing the most adequate solutions but, in all the steps, when a problem is identified, developers also focus on solving such a problem. However, it is worth mentioning that it would also have been advisable to do it in a single step to encourage the collaboration in the problems solving process what fosters innovation.

For this reason, as aforementioned, the general validation methodology has been defined as generalist as possible and it can be customized depending on the developers' requirements and/or the nature of the technological result to be assessed.

The work performed by the OPT consists of defining an optimisation problem. To compute the optimisation, it is necessary a set of input data sets (STables) and a suitable algorithm from the set of optimisation algorithms developed and managed

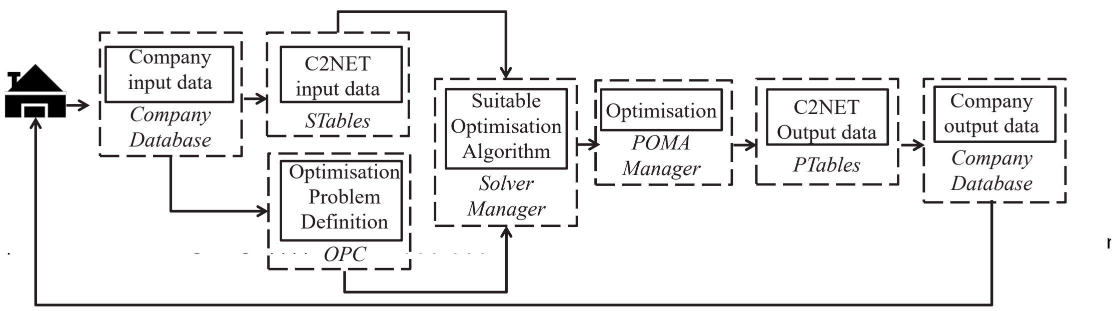

Figure 5. Work performed by the C2NET OPT.

in the Solver Manager. The POMA Manager is in charge of the optimisation and providing the set of outputs/results (PTables), as it is shown in Figure 5.

The validation methodology addressed to the C2NET OPT consists of 8 main steps:

Step 1. Check that optimisation algorithms are consistent with STables. The input data needed to perform the optimisation through the computation of the algorithms needs to be aligned with the needs of input information required by such optimisation algorithms. For this reason, the input data hosted in the STables and the necessary input information that needs the optimisation algorithms to perform the optimisation is mapped to detect any inconsistency. Table 1 shows a small example of this mapping.

Step 2. Create realistic data sets for the validation of the optimisation algorithms. Three size types of input data sets are created: small (SDS), medium (MDS) and large (LDS) data sets. Each of them is created considering realistic input values that offer realistic output results: SDS are used in a first stage for the computation of the optimisation algorithms and are composed by the minimum amount of input data sets necessary to generate feasible, logical, and valid solutions. They are input data sets that are simple enough to allow developers and researchers to detect any potential problem and challenge related to the development of the algorithms and its resolution. Subsequently, MDS and LDS are created through the extension of the SDS. Similarly to SDS, MDS and LDS are also input data sets that generate feasible and logical solutions. MDS include, on average, 11-40 products and periods and are used to test and validate if the solving time used to offer the results to the enterprises is reasonable (see step 4), and also to obtain the GAP (see Step 3). LDS comprise more than 40 products and periods, and are large enough to validate the algorithms with amounts of data which are similar to the ones that will be used by the companies when solving their plans through the computation of the developed algorithms.

Step 3. Identify the GAP for the algorithms using realistic data sets. The GAP is the difference between the result given by the optimal solution of a plan and the result provided by the algorithm. The realistic data sets are large enough to represent a consistent amount of input data so that the GAP computed for the algorithms is representative. The main drawback when computing the GAP is that for some of the developed algorithms there are no optimal algorithms or models, therefore the optimal solution is not known, hence the GAP cannot be accurately computed. Not all algorithms are optimiser, which means that for the heuristic and metaheuristic algorithms, the GAP is difficult to find out.

Step 4. Determine the solving time of the optimisation algorithms. The solving time is the time required to solve an optimisation problem in a successful scenario, i.e., in the case where a feasible solution is found. Realistic data sets are used as input data to identify the solving time. The solving time is one of the parameters that characterises the optimisation algorithm to be selected when the Solver Manager module needs to solve a specific plan.

Step 5. Generate and unify the PTables. STables correspond to the input data tables required by the optimisation algorithms in order to compute plans (defined optimisation problems), while Plan Tables (PTables) are the tables for the results or output data. PTables contain the results of the plans after

Table 1. Analysis of the consistency of the input data needed by the optimisation algorithms and the STables.

AlgorithmID	Type[1]	Table	Field	Consistent[2]
1	ID	Part	PartID	✓
1	ID	Part	AvailabilityAmount	✓
1	ID	Part	AvailabilityCost	✓
1	ID	Part	AvailabilityMaximumAmount	✓
…	…	…	…	…
10	ID	Production	ProductionID	✓
10	ID	Production	ProductionDate	✓
10	ID	Production_Part	ProductionID	✓
…	…	…	…	…

1. ID: Input Data; OD: Output Data.
2. Consistent between the STables and Optimisation Algorithms.

Table 2. Analysis of the consistency of the output data required by the enterprise and the PTables.

AlgorithmID	Type[1]	Table	Field	Consistent[2]
1	OD	S_MRP_A	PartID	✓
1	OD	S_MRP_A	PeriodID	✓
1	OD	S_MRP_A	AvailabilityAmount	✓
1	OD	S_MRP_A	BatchAmount	✓
…	…	…	…	…
10	OD	M_PSC_A	ProductionID	✓
10	OD	M_PSC_A	PersonID	✓
10	OD	M_PSC_A	PeriodID	✓
10	OD	M_PSC_A	LabourID	✓
10	OD	M_PSC_A	OperationTime	✓
…	…	…	…	…

[1] ID: Input Data; OD: Output Data
[2] Consistent between the PTables and Optimisation Algorithms

the execution of the optimisation algorithms. The PTables are built following the same logic as the used in the STables. The output data required by the enterprise should be aligned with the results offered by the optimisation algorithms and hosted in the PTables. Table 2 shows an example of the consistency of the optimisation algorithms with the PTables.

Step 6. Check the validity and feasibility of the results. After the computation of the optimisation, researchers and developers should check if the results offered by the optimisation algorithms (PTables) are valid and feasible. According to the inputs (STables), the output values given by the optimisation algorithms are analysed in order to identify potential infeasibilities or whether the solution provides a bizarre result that cannot be accepted by the company. An example of lack of validity and feasibility would be when the input data shows that the company has enough resources and capacity to produce a specific product, but the order to manufacture such products is delayed. In this case, the results are not validated and the optimisation algorithms definition should be reviewed to detect the issue that is causing the unsuitable solution.

Step 7. Modify current functions or develop new ones to make the optimisation algorithms more efficient and fast. New functions or extensions of the already developed algorithms are designed in order to (i) make algorithms more efficient and reduce the solving time; (ii) generate feasible solutions when infeasible results were previously generated; (iii) reduce the GAP of the algorithm; or (iv) include new restrictions that the companies require for their plans resolution.

Step 8. Identify potential new requirements and develop new algorithms. In case companies define a new plan (optimisation problem) that was not previously considered, and moreover, no algorithms are available to compute the plan, new algorithms should be developed. To do so, researchers and developers will seek on previous developed algorithms in order to identify similarities. Not starting from scratch saves time. In case there are no algorithms that can be adjusted (e.g., by adding new restrictions), developers will look in the literature for suitable developed algorithms that can be used/adapted to solve the plan defined by the company. If no algorithms are found, new algorithms need to be defined.

5. Conclusions

Before implementing the results developed within research projects in real companies, it is very important to validate them to guarantee that the results are mature enough to be applied in real scenarios. However, despite the importance of this fact, there are few research projects that define formal procedures that guide this prior validation. For this reason, a general validation methodology addressed to the assessment of technological results developed within European Research Projects has been defined. This methodology has been set up as generalist as possible to be applied to a wide range of results. However, depending on the nature of the research results, maybe this methodology needs some adaptation.

The general methodology has offered the foundations to define the specific validation methodology used to assess a result generated within the European Project: C2NET, that is the OPT module. This application shows that the general methodology could be customized depending on the researchers and developers' requirements and also the characteristics of the results to be validated. Therefore, the general methodology offers broad guidelines to support researchers in the definition of specific validation methodologies to validate research results and guarantee the creation and feasibility of a commercial product beyond the project.

Acknowledgements

The research leading to these results is in the frame of the "Cloud Collaborative Manufacturing Networks" (C2NET) project which has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 63690.

References

Agostinho, C., Pereira, J., Lorre, J.P., Ghimire, S., and Benazzouz, Y. (2016). A Distributed Middleware Solution for Continuous Data Collection in Manufacturing Environments. In *Enterprise Interoperability in the Digitized and Networked Factory of the Future*, 159-166.

Andres, B., Saari, L., Lauras, M., and Eizaguirre, F. (2016). Optimisation Algorithms for Collaborative Manufacturing and Logistics Processes. In *Enterprise Interoperability in the Digitized and Networked Factory of the Future*, 167-173.

Andres, B., Sanchis, R., and Poler, R. (2016). A cloud platform to support collaboration in supply networks. *International Journal of Production Management and Engineering*, *4*(1), 5-13. https://doi.org/10.4995/ijpme.2016.4418

Benaben, F., Jiang, Z., Wang, T., Lamothe, J., Agostinho, C., Ghimire, S., Melo, R., Benazzouz, Y., and Lorré, J.P. (2016). C2NET Project. Tools for Agile Collaboration. In *Enterprise Interoperability in the Digitized and Networked Factory of the Future*, 174-180.

Black, D. (2017). Collaborative Cloud under Development for Manufacturers in Europe. Available at: https://www.enterprisetech.com/2017/04/13/collaborative-cloud-development-smes-manufacturers-europe/

European HelpDesk. (2018). Available at: https://www.iprhelpdesk.eu/glossary/exploitation

Mohammed, W.M., Ferrer, B.R., Martinez, J.L., Sanchis, R., Andres, B., and Agostinho, C. (2017). A multi-agent approach for processing industrial enterprise data. In *International Conference on Engineering, Technology and Innovation (ICE/ITMC),* 1209-1215. https://doi.org/10.1109/ICE.2017.8280018

Ramis-Ferrer, B., De Juan-Marín, R., Miedes, E., Nieto, A., Martínez Lastra, J.L., and Peña-Ortiz, R. (2016). Towards a Cloud-based Platform for Enabling Supply Chain Collaboration. In *Enterprise Interoperability in the Digitized and Networked Factory of the Future*, 152-158.

Sanchis, R., Andrés, B., Poler, R., Mula, J., and Díaz-Madroñero, M. (2018). The C2NET Optimisation Solution. *Dirección y Organización*, *64*, 36-41.

