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Executive Summary

This document corresponds to the last deliverable related to the "*Communication and Dissemination"* task of the European funded project COCOP (deliverable D7.6), and it includes:

- the description of the dissemination strategy implemented in the COCOP project, in terms of:
  - the objectives of the dissemination (*why*, mission & vision)
  - the topics of dissemination (*what*)
  - the target audience (to *whom*)
  - the timing (*when*)
  - the dissemination tools and channels (*how* to reach the target audience)
  - the responsibilities for dissemination (*who*)
  - the rules for performing the dissemination activities
  - the way to evaluate and assess the impact of the dissemination activities
- an overview of the dissemination activities carried out during the whole project. The monitoring of them has been a continuous process along the project and its evaluation has been done by the measurement of the metrics defined for five Key Performance Indicators (KPIs): KPI1- Awareness through the website and social media, KPI2- Awareness of the Scientific Community interest, KPI3- Awareness of the industrial Community interest, KPI4- Coordination with other research projects and KPI5- COCOP final workshop interest

Proper dissemination and communication are a key in order to ensure the maximum impact of the COCOP project. The main goal of the dissemination activities performed has been to increase the visibility of the COCOP project on selected communities and target groups, at both European and international level, in order to promote the implementation and use of the project results (exploitation), always taking into account confidentiality and IPR protection aspects. All partners of the consortium have contributed to the COCOP dissemination, according to their foreseen role and effort and using all available tools and channels.

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1 Introduction

European process industry, which represents 20% of the European manufacturing base, faces a strong need to increase product quality and reduce operating costs and environmental footprint. COCOP aims at contributing to satisfy this need and to strengthen the global position of the European process industry, proposing a plant-wide monitoring and control by using the model-based, predictive, coordinating optimisation concept in integration with plant's automation systems.

A complex plant comprises of continuous and batch unit processes with a dynamic behavior, so a plant-wide monitoring and control is a requirement for achieving economically and environmentally efficient operation. But plant-wide optimisation is a huge problem and difficult to solve. The COCOP concept is based on the **decomposition-coordination optimisation** of the plant operations: the overall problem is decomposed into unit-level sub-problems, so that the solutions of sub-problems are coordinated to plant-wide optimal operation using high-level coordination, enabling real-time optimisation of the plant.

The COCOP solution can be applied to any large industrial production site because it relies on general methods such as modelling of dynamics, data analysis and optimisation, but the project has researched, demonstrated and validated the concept on two pilot cases (copper and steel manufacturing process). In addition, the transferability to other sectors (waste water treatment processing, chemical and glass manufacturing) has been analysed.

COCOP project also combined the technological development with a **social innovation process** of co-creation and co-development for improving effectiveness and impact of the innovations, their implementation process and the related organisational and personnel development.

The use of the COCOP solution can provide different:

- *Economic benefits*: increasing the productivity and reducing operation costs due to an optimal performance of the processes that allows reducing the energy consumption, the raw materials use, the number of defects/rejects, etc.
- *Environmental benefits*: increasing the sustainability of the process industry (i.e. reduction of pollution, greenhouse gas emissions and energy/raw materials consumption) as well as being better prepared to meet existing and emerging regulatory mandates in terms of environment, quality or safety aspects.
- *Social benefits*: improving the personnel development and the working conditions of plant operators by using the new process-control tools which support operating work and enable operators to understand the functioning of the whole plant. In addition, the new tools could be used for the operators training in the form of on-the-job-learning.

COCOP offers therefore: (i) new tools to the process industry to improve its competitiveness and the operators working conditions and competences, (ii) new solutions to the automation systems suppliers to integrate them in their systems and provide a more added-value product and (iii) a methodology for combining technological innovation with a social innovation process of co-creation and co-development that could be applied to any sector.

Dissemination and communication of the project (both within and beyond the project's own community) have been key activities during the development of the project, in order to maximise impact of the COCOP project and facilitate the exploitation activities.

This document is organised in the following sections:

- Section 1: introduces the main goals and features of the project (done within this chapter)
- Section 2: contains the information about the scope and objectives of this deliverable
- Section 3: presents the Dissemination and Communication plan of the project, illustrating the objectives of the dissemination and the main elements of the dissemination strategy (subject, timing, target audience, tools and channels and the dissemination management policy)
- Section 4: presents the activities carried out during the whole project and some future planned activities
- Section 5: presents the planned activities after the end of the project

2 Scope and objectives of this deliverable

This deliverable D7.6 of the WP7 of the COCOP project is associated to the *task 7.1. Communication and Dissemination*. It is related to the other two deliverables regarding the dissemination and communication plan previously submitted (D7.2 and D7.3):

- The first deliverable (D7.2) was focused on the definition of the COCOP dissemination strategy and the planning of the actions for the first half of the project
- The second deliverables (D7.3) included a description of the dissemination and communication activities performed in the first half of the project and the action plan for the second half of the project
- This final deliverable (D7.6) includes a survey of the dissemination and communication activities carried out along the whole project lifetime. Due to its relationship with the previous deliverables, this document has the same structure as these and reports the same information in an aggregate way.

The Dissemination and Communication plan of the project represented the strategic vision of the partners in terms of dissemination of the COCOP project itself, and of its achievements and outputs as well. The main objective of the planned dissemination activities has been to increase the visibility of the COCOP project on selected communities and target groups, at both European and international level, in order to ensure the maximum impact of the project and to promote the exploitation of the project results.

This deliverable outlines the dissemination strategy implemented in the COCOP project, in terms of the dissemination key elements:

- the objectives of the dissemination (mission, vision)
- the subjects of dissemination (what)
- the timing of the dissemination (when)
- the target audience (to whom)
- the dissemination tools and channels (how)
- the responsibilities for dissemination (who)
- the rules for performing the dissemination activities
- the way to evaluate and assess the impact of the dissemination activities

3 Dissemination and Communication Plan

3.1 Dissemination goal and strategy

The final goal of the dissemination and communication activities has been to promote the COCOP project and spread the COCOP's results to the largest possible concerned audience (at the national, European and international level) in order to encourage the implementation and use of the project results (exploitation), always taking into account the confidentiality and IPR protection aspects.

In more detail, the objectives of the dissemination have been:

- To raise public awareness about the project, its progress and results within defined target groups
- To disseminate the fundamental knowledge, the methodologies and technologies developed during the project
- To exchange experience with projects and groups working in the field in order to join efforts, minimize duplication and maximize potential
- To pave the way for a successful (commercial and non-commercial) exploitation of the project outcomes

The objective of the dissemination strategy was to identify and organise properly the activities needed to achieve these objectives. The following sections describe the main pillars of the dissemination strategy: (i) subjects (*what* to disseminate), (ii) target audience (*who* would most benefit from the project results and who would be interested in learning about the project findings), (iii) the timing (*when* dissemination should take place); (iv) tools and channels (*how* to reach the target audience) and (v) dissemination management and policy.

3.2 Subject of Dissemination

The following general subjects of dissemination were identified:

- COCOP project itself: goals, approach, pilot cases and expected benefits
- The application of the decomposition-coordination optimisation method
- The social innovation methodology applied to the pilot cases
- The techniques and methodologies used for the technical development of the project in all the involved areas (software architecture, simulation, modelling, data analytics, machine learning, monitoring, control, automation, optimisation, LCA, ...)
- The achieved results and the validation of the COCOP approach in two pilot cases (steel and cooper)
- The transferability to other sectors such as the water treatment processing, chemical and glass manufacturing industry
- The sustainability indicators and Key Performance Indicators in the process industry

3.3 Timing of Dissemination

Dissemination activities were planned in accordance with the stage of development in the project. The most relevant dissemination activities have been performed once the intermediate and final results were available, and they are expected to continue after the end of the project in order to disseminate the last results obtained in the project. It is also important to take into account that plant owners' investment decision might require extensive time, so timely communication on the project results can ease the successful commercialisation of the results.

The dissemination followed the AIDA principle: *Awareness to* attract the attention of the target audience, *Interest* of the target audience, *Desire* of the target audience to know more about the project and *Action* to lead the target audience towards get involved in the project and to promote its results to facilitate their exploitation. According to this principle, three phases were considered:

- Initial phase (*awareness*) (month 1 - month 9): focused on increasing the visibility of the project and mobilising stakeholders and multipliers. At this phase, the main activities were related to the implementation of the dissemination tools (website, social networks, visual identity), preparation of dissemination material, general presentations of the COCOP project and launching of the COCOP Special Interest Group.
- Intermediate phase (*Interest/Desire*) (month 10 - month 30): focused on informing and engaging to the target stakeholders when preliminary results become available. At this phase, the project results and their future applications were presented in journals and conferences/events to specialized audience with the objective of stimulating the interaction with the concerned scientific and industrial community and determining the stakeholders' expectations.
- Final phase (*Action*) (month 31 - 42 and during one year after the end of the project): focused on encouraging further exploitation of the COCOP outcomes (transfer to other industries, replicability, etc). At this phase, the results of the implementation of the COCOP approach at the two pilot cases and the transferability analysis are being presented in journals, conferences and industrial events. One of the main dissemination actions at this phase has been the organization of the COCOP workshop at the end of the project, as it is explained later.

3.4 Target audience

Considering the goal of the COCOP project, the target audience for the dissemination activities was divided in the following groups:

1. *Industrial Community* → raise awareness of and interest in the project results to promote the exploitation and co-operation opportunities.

   As explained in the introduction, COCOP aims at strengthening the global position of the European process industry and proposes a plant-wide monitoring and control by using the model-based, predictive, coordinating optimisation concept in integration with plant's automation systems. So, from the exploitation side, the target audiences from the industrial community are:

a. Process industry: European process industry represents 20 per cent of the European manufacturing base (both in turnover and employment). Approximately 450000 companies generate €1600 billion in turnover and providing 6.8 million jobs (https://www.spire2030.eu/what/walking-the-spire-roadmap/spire-Roadmap). Although the dissemination strategy addressed the Process Industry in general, it paid special attention to the sectors directly involved in the project: (i) steel (with more than 500 plants in Europe), (ii) copper (with 40 Outotec Flash smelter plants in the world), (iii) chemical (with more than 3000 chemical production sites in Europe) and (iv) water (with more than 175 large urban wastewater treatment). The message for this audience is:

> *"Increased economic competitiveness and reduced environmental impact due to novel plant-wide control. Complex process industry plants can be operated optimally by the operators advised by a coordinating, real-time optimisation system."*

b. Process automation industry for process industry clients: automation solution suppliers are a large industry with essential offerings to the process industry and upstream manufacturing industry. The European automation industry employs more than 100.000 people and the European industrial process automation market is €10 billion (processit.eu, 2013). The message for this audience would be:

> "*Plant-wide monitoring and control by an open advisor system."*

2. *Scientific Community* (universities and research centres) → enlarge the knowledge and facilitate the communication among European researchers in the research field of the COCOP project (industrial process modelling, control and optimisation; social innovation and co-creation).
3. *"Internal" Community* (COCOP partners) → maximise the dissemination effectiveness. Ensuring effective internal communication and dissemination among the consortium partners is a key element for two reasons. Firstly, some of the partners are potential users of COCOP project results themselves, and secondly, they represent "influencers" due to their great position on the associated industrial sectors. Particularly COCOP consortium partners comprise important market players in various segments and this constitutes a natural channel for the dissemination of the project and its results to other potential users. Therefore, it is important to communicate information about the project and its results to partners' managers, consultants and people responsible for their marketing and sales and to encourage them to share this information further to their customers and business partners.
4. *EU projects working in a similar domain* → minimize duplication and define synergies and collaboration opportunities. Especially the SPIRE community is of interest here, with projects like ProPAT, Consens, MONSOON, FUDIPO, CoPro and MORSE.
5. *Standardisation bodies* (ISA, OPC Foundation) → support exploitation by modifying relevant standards, if needed.
6. *Policy makers* → raise awareness of the relevance and economic impact of exploited research results obtained by EU-funding (the European Commission's DG develops policies and actions for the re-industrialisation of Europe and an innovative, modern, and sustainable economy).

7. *Students* → promote the COCOP research field (industrial process modelling, control and optimisation).
8. *General public* → let them become aware of the positive impacts generated and the relevance of EU funded research for the industry

Dissemination activities were tailored in such a way to reach the audiences most efficiently through appropriately selected dissemination tools and channels.

3.5 Dissemination tools and channels

This section describes the main tools and channels that have been implemented/used by the COCOP partners for the dissemination of the project, together with the main purpose of each one of them. Some of the tools are of general purpose, while other ones are oriented to specific target groups.

3.5.1 COCOP Web page

The COCOP website (www.cocop-spire.eu) is the main interface for communication to the public. The main requirements for the website were: it should contain information on the COCOP objectives, the partnership, the proposed activities and the foreseen/achieved results; it should allow the visitors to have access to the dissemination material and host a blog to facilitate the interaction with interested parties; it should use affordable methods to increase page ranking on search engines to maximize its visibility.

3.5.2 Social networks

In order to reach a broad target audience while establishing two-ways communication channels, the presence of the COCOP project in social media was encouraged, following the recommendations published in the "*social media guide for EU funded R&I projects*[1]" released by the European Commission in April 2018.

A Twitter account (https://twitter.com/CocopSpire) is used as an instant dissemination instrument for reaching the general public. In order to reflect the relation of the project with the SPIRE community and the H2020 programme, the guideline is to include, whenever possible, the references to @Spire2030 and @EU_H2020 in the COCOP tweets. On the other hand, a LinkedIn (https://www.linkedin.com/in/cocop-project-eu-377251138/) page is used for reaching stakeholders and industry professionals. Official LinkedIn groups were joined to raise awareness among automation professionals and Process Industry. The website has direct access to these social networks by clicking over the icons situated on a visible part of the website. In this way, it is easy for every user to participate in this when the website is visited.

Finally, to try to reach the largest possible audience, YouTube is used for the publication of videos produced within the course of the project, provided that this does not imply any property right conflict.

[1] http://ec.europa.eu/research/participants/data/ref/h2020/other/grants_manual/amga/soc-med-guide_en.pdf

3.5.3 Visual Identity and dissemination material

The visual identity (logo and style) of the project helps external audience to easily identify COCOP and contributes to the project visibility by providing a clear identity from the very beginning of the project. Communication and dissemination tools (such as project website, Twitter and LinkedIn page), dissemination material (such as flyers, presentations, posters and videos) and deliverables apply the visual identity defined for the project.

Partners agreed to produce different dissemination material along the project lifetime, such as:

- Project flyers (hardcopy and/or electronic version) in order to provide our audiences with an attractive and written project overview and summary of the main project objectives and results. The flyers can be distributed in printed form (handed out at conferences or other events) or in electronic version (PDF file).
- Short project presentations (electronic version) describing the objectives and the main achieved results in order to present the project in different forums, such as internal presentations inside of the partners, presentations at schools/universities/events, visits with clients, etc.
- Videos to communicate the project's vision, objectives and results.

Finally, the deliverables also offer a good means for disseminating the performed activities and achieved results. Public deliverables are accessible for the external community, meanwhile confidential deliverables are used to spread the knowledge inside the partners´ organizations.

3.5.4 Special Interest Group (SIG)

A "COCOP Special Interest Group" was defined to engage stakeholders with the COCOP consortium. The SIG is an informal group of external stakeholders interested in the project (e.g. possible beneficiaries, end users, etc.). The members of the SIG receive information about relevant news, events and results of the project. Participation in this group is under accepted subscription and is managed through the website to ease the contact of the interest people/entities.

3.5.5 Channels offered by the European Commission and SPIRE

The COCOP consortium has used the tools offered by the European Commission and A.SPIRE in order to maximise the diffusion of the project. A.SPIRE is the European Association which is committed to manage and implement the SPIRE Public-Private Partnership. It represents innovative process industries, 20% of the total European manufacturing sector, and more than 130 industrial and research process stakeholders from over a dozen countries spread throughout Europe. A.SPIRE's offers different communication tools/channels for dissemination of project outputs such as:

- A dedicated page on the SPIRE website where information about all SPIRE projects and links to project-dedicated websites are published
- A section of the SPIRE website, SPIRE Newsletter and Twitter account where project related announcements can be published
- Annual projects brochure
- SPIRE event (such as Impact workshop, SPIRE projects' conference, etc.)

3.5.6 National and European technology platforms and associations

The link of the COCOP partners with a number of relevant national/European platforms and associations, closely related with the COOCP objectives, provides a great chance for disseminating the project activities and increasing the number of reached stakeholders. The Annex I collects information of some of these platforms and associations together with the type of involvement of the partners. A complete list of the related platforms and associations where the partners are involved is available in the collaborative tool (Confluence) of the project.

3.5.7 Scientific and trade journals

Scientific publications are an effective way to disseminate high-level project information and to attract the interest of representatives of the various target groups. Similarly, publications in trade journals can attract the attention of potential beneficiaries of the COCOP results. The industrial and academic partners have published and presented scientific advances, individually and in collaboration, in scientific journals and trade magazines, taking into account confidentiality and IPR protection aspects. As reported in previous deliverables, a list of scientific and trade journals where COCOP papers could be submitted was elaborated by partners at the beginning of the project.

3.5.8 National and international conferences

National and international conferences are a good opportunity to share the results with experts in the field and, therefore, to achieve an effective dissemination of the project. Partners have presented the project in different conferences by means of talks and or/posters. A list of suitable conferences for the project presentation is also available in the collaborative tool of the project.

3.5.9 Exhibitions, trade fairs and workshops

Finally, workshops and large events, such as exhibitions and trade fairs, have been attended by the partners to disseminate both the techniques developed during the project and the results obtained, among the target beneficiaries of the COCOP project.

3.5.10 Events organised by COCOP

During the second part of the project, dissemination events coordinated with other SPIRE projects were encouraged to increase the networking opportunities and the interest and impact of the dissemination activities. Following this strategy, the COCOP final workshop was organized in collaboration with the FUDIPO project, with the aim of showing the results obtained and giving the opportunity to meet potential interested clients (either on public or private field), investors and researchers.

3.5.11 Media and social media coverage

COCOP news in the media (newspapers, magazines, radio, etc) can inform to general public about the project and reflected the impact of EU research and innovation funding on European industry and environment.

3.5.12 Other activities

Presentations of the project in the university world in order to promote the research fields of the COCOP project.

Direct proactive communication with stakeholders during visits/meetings and internal meetings inside of the partners organizations to raise awareness of the goal/benefits of the project.

3.6 Dissemination management

There is a special section in the collaborative tool of the project (Confluence) that was created for the management of the dissemination activities (planning, monitoring, evaluation, dissemination material storing, etc.) as is shown in Figure 1.

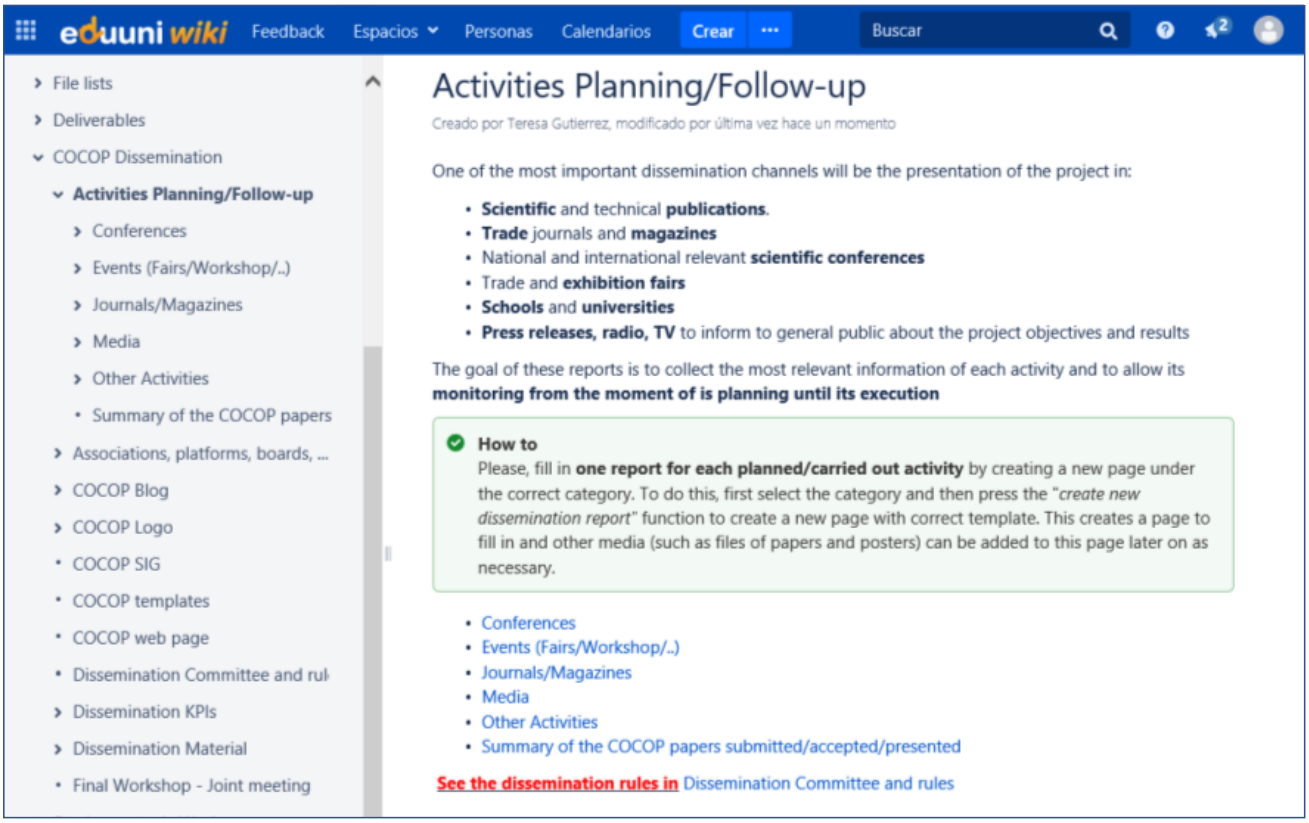


Figure 1. Section for the dissemination management in the collaborative tool (Confluence)

3.6.1 Distribution of responsibilities

According to the Article 29.1 of the Grant Agreement "*each beneficiary must — as soon as possible —'disseminate' its results by disclosing them to the public by appropriate means (other than those resulting from protecting or exploiting the results), including in scientific publications (in any medium)*". Therefore, every possible opportunity has been embraced, by individual partners or on collective basis through joint appearance by more than one partner, to make COCOP project known among technicians and general public as well.

TECNALIA has been the Dissemination and Communication Manager of the project, coordinating and supervising all the dissemination activities. Besides, all consortium partners have contributed to the COCOP dissemination, in accordance with their expected role and effort and using all available tools

and channels (participating and making presentations at conferences and workshops, publishing papers, networking, attending fairs and showcases where technical achievements and prototypes were shown to stakeholders, etc.), in order to promote the adoption of the project results and successful commercialization of COCOP outputs in the future.

In addition, a "Dissemination Committee" was established for the approval of the dissemination activities of the project, with special attention to the approval of publications. This Committee is formed by one person of each partner.

3.6.2 Dissemination policy and rules

Dissemination activities in COCOP project have been deeply joined with the intellectual property rights protection and confidentiality aspects that are clearly stated in the articles 23a and 36 of the grant agreement respectively and adjusted in the Consortium Agreement. It is important to find out a good equilibrium among the interests of academia and industry partners. Usually, the academia partners tend to publish all information they have at disposal, which is caused by academia common motivation systems, while the industrial partners' decision whether, when and where to publish can depend on commercial considerations.

The basic regulation of the dissemination activities in the consortium agreement states that:

During the Project and for a period of 1 year after the end of the Project, the dissemination of own Results by one or several parties including but not restricted to publications and presentations, shall be governed by the procedure of Article 29.1 of the Grant Agreement subject to the following provisions:

- *Prior notice of any planned publication shall be given to the other Parties at least 45 calendar days before the publication.*
- *Any objection to the planned publication shall be made in accordance with the Grant Agreement in writing to the Coordinator and to the Party or Parties proposing the dissemination within 30 calendar days after receipt of the notice. If no objection is made within the time limit stated above, the publication is permitted.*

An objection is justified if:

(a) the protection of the objecting Party's Results or Background would be adversely affected
(b) the objecting Party's legitimate academic or commercial interests in relation to the Results or Background would be significantly harmed.

The objection has to include a precise request for necessary modifications.

If an objection has been raised the involved Parties shall discuss how to overcome the justified grounds for the objection on a timely basis (for example by amendment to the planned publication and/or by protecting information before publication) and the objecting Party shall not unreasonably continue the opposition if appropriate measures are taken following the discussion.

The objecting Party can request a publication delay of not more than 90 calendar days from the time it raises such an objection. After 90 calendar days the publication is permitted, provided that Confidential Information of the objecting Party has been removed from the Publication as indicated by the objecting Party.

A Party shall not include in any dissemination activity another Party's Results or Background without obtaining the owning Party's prior written approval, unless they are already published.

The project partners must follow the open access principle, according to the article 29.2 of the grant agreement. According to the article 29.4 of the Grant Agreement, unless the Commission requests or agrees otherwise or unless it is impossible, it is necessary to include the European emblem and the following statement of financial support in all the dissemination documents and applications for protection of results:

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723661".

When displayed together with another logo, the EU emblem must have appropriate prominence.

According to the article 29.5, any dissemination of results must include the following Disclaimer excluding Commission responsibility:

"This [insert type of activity] reflects only the author's views and the Commission is not responsible for any use that may be made of the information contained therein"

Finally, in addition to the acknowledgement to the EU, all the dissemination material must include:

- the acronym of the project: COCOP
- the logo of the project, if feasible
- the project's website URL (www.cocop-spire.eu)

3.6.3 Dissemination activities planning and follow-up

As described in the previous sections, a key element for the dissemination of the project results is their presentation in: scientific and technical publications, trade journals and magazines, relevant national and international scientific conferences, workshops, exhibitions, fairs and the media (Press releases, radio, TV, etc).

For the planning and follow-up of these activities, a section in the collaborative tool of the project was designed in order to create and store the "Dissemination report" of each activity (see Figure 1). The goal of these reports is to collect the most relevant information of each activity and to allow its monitoring from the moment of is planning until its execution. In this way, the partners started filling the report as soon as they decided to perform an activity, and then, when the activity was performed, they finished the report.

Five different types of reports were defined depending on the type of activity: (i) paper on a journal/magazine, (ii) presentation in a conference, (iii) participation in an event (fair, workshop, etc), (iv) presence in the media (press, TV, etc.) and (v) any other type of activity. The templates for each one of the reports, showing a filled report as example, are included in the Annex II, but mainly they include:

- general information about the event (name, type, scope, audience, etc)
- information about the dissemination action (title, topic, authors, etc)
- feedback gathered by the respective partners from the target audience (if applicable) and eventually gained contacts for further dissemination/exploitation purposes

3.6.4 Evaluation and assessment

The evaluation of the COCOP dissemination activities and the assessment of their impact have been carried out through different means. On the one hand, the partners established five Key Performance Indicators (KPI) together with associated metrics and a numerical target for each one of the metrics (see Table 1). The numerical targets for the first half of the project were defined in the first release of the Dissemination and Communication plan (D7.2), and its fulfilment was analysed in the second deliverable D7.3. The target values for the whole project were defined in D7.3, as shown in Table 1. These values were estimated taking into account the individual partner´s input and considering a minimum threshold to have proper dissemination.

Table 1. Key Performance Indicators with metrics and numerical targets for the evaluation of the dissemination activities

ID	Indicator	Metrics	Target Value (M1-M42)
KPI1	Awareness through the website and social media	Number of visits on the project website	160 visits per month
		Number of posts on the blog of the website	1 post per month
		Number of members of the COCOP debate group in LinkedIn	100
		Number of contributions to LinkedIn/Twitter	125
		Number of presentations uploaded to the Website/SlideShare	5
		Number of videos uploaded to Website/YouTube	6
KPI2	Awareness of the Scientific Community interest	Number of papers in scientific journals	8
		Number of presentations in scientific conferences/workshops	16
KPI3	Awareness of the industrial Community interest	Number of papers in trade journals	7
		Number of participations at events with industry (fairs, exhibitions, workshops,…)	12
		Number of Interest expressions from industry to receive more information + industrial members of the Special Interest Group (SIG)	25
KPI4	Coordination with other research projects	Number of participations in joint forums with other national/international projects	10
KPI5	COCOP final workshop	Number of people attending the final COCOP workshop	70

A section of the collaborative tool of the project collects the table of the KPIs and the target values, together with the actual and planned values. During the WP7 meetings and six-monthly project progress meetings, the actual and planned values of the KPIs were reviewed to analyse whether it was feasible to reach the threshold or whether it was needed to adopt some kind of contingency plan. The final performance of the KPIs is analysed in section 4 (Table 9).

On the other hand, an internal evaluation of the project dissemination effectiveness was carried out by the partners at the middle of the project, by means of a questionnaire, in order to detect the potential weaknesses and propose further actions to improve the dissemination plan. The questionnaire implemented in Confluence consisted of the following questions:

- *Q1. Do you think the individual target groups are being addressed by means of proper communication channels and tools?*
- *Q2. Do you think the COCOP web page provides useful content to all the identified target groups?*
- *Q3. Do you think the dissemination material is suitable and enough?*
- *Q4. Do you think the blog is a useful tool to exchange opinions about COCOP topics both inside and outside of the consortium?*
- *Q5. Do you think, the number of dissemination activities towards research community (i.e. number of papers in journals, workshop and conference proceedings, etc.) is sufficient?*
- *Q6. Do you think, the number of dissemination activities towards the industrial community sufficient (i.e. number of presentations at industrial events) is sufficient?*
- *Q7. Do you think, the number of dissemination activities towards the general public (web activities, social media, presentations) is sufficient?*
- *Q8. Do you think, the dissemination activities are carried out timely, in accordance with the schedule of principal project outcomes?*
- *Q9. Do you have any suggestion to improve the dissemination of the COOCP project?*

Overall, the evaluation was positive detecting as key points: i) the usefulness of the web blog to promote the COCOP web-page; ii) the convenience of increasing the activity in twitter (to disseminate the publication of deliverables and papers, attendance to events, technical achievements and prototypes,... and also support other related SPIRE projects) and uploading presentations and videos with the achieved results in the web; iii) the relevance of the activities oriented to the process industries as well as automation industry target groups; and iv) the need of increasing the number of publications. These results were considered in the definition of the action plan for the second half of the project.

Finally, the final workshop organised by the consortium was evaluated by means of a questionnaire to participants.

4 Work done during the project

This section describes the main dissemination and communication activities carried out during the whole period of the project (from month 1 to month 42).

4.1 Design of the COCOP logo and visual identity

The COCOP logo (Figure 2.a) was designed by a professional marketing company at the beginning of the project and is inserted in all the deliverables, reports and dissemination material/tools. The logo includes the name of the project. Figure 2.b shows the project style defined for COCOP presentations.

a) b)

Figure 2. a) COCOP logo; b) COCOP project style

4.2 Implementation and update of the COCOP Web page

The COCOP website www.cocop-spire.eu is available from the month 3 of the project and it was described in the deliverable D7.1. *Project website*. The webpage provides links to the H2020 and SPIRE webpages and to the COCOP Twitter account and LinkedIn page.

Oriented to the dissemination, the website provides essential information related to the project and the partners through different sections (see Figure 3):

- *Home* → provide an overview of the project
- *Project details* → provide a description of project objectives, pilot cases and work packages
- *Consortium* → present the involved partners
- *Documents* → present a short summary of all the released deliverables and provide access to public documents of the project (public deliverables, papers, posters, etc.) and dissemination material (flyers, presentations and videos)
- *News* → provide general information about events (both internal and external) related to the project
- *Events* → provide information about events organised by the consortium (meetings and dissemination events)

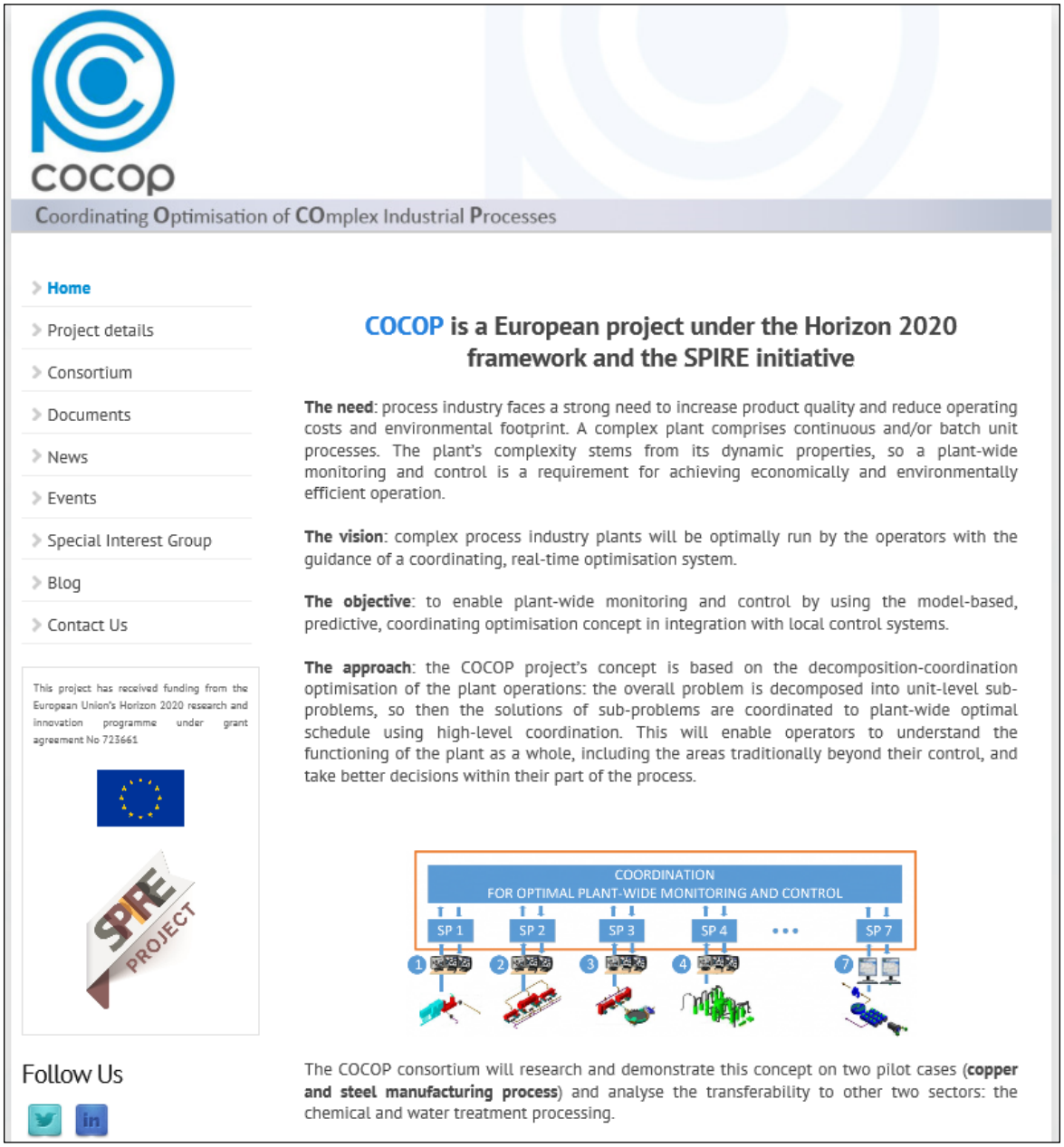


Figure 3. COCOP webpage Home screenshot. At the bottom: footer with the partners and general information of the project included in all the sections

- *Special Interest Group* → manage the subscription of the interested people/organisations for the SIG
- *Blog* → allow sharing information related to the COCOP topics and facilitating the interaction with the interested parties. The target audience of these posts are scientific-technical community, developers, providers, and general public.

  In order to avoid the risks of having an open access blog (without any control of the messages that are posted), only the COCOP partners have access to upload posts in the blog and the discussion with the external community is activated in the "*COCOP debate group*" created in LinkedIn, as it is explained later. Figure 4 shows the working scheme: the full text of the post is uploaded in the website blog that provides a link to the new conversation started in the COCOP debate group and reciprocally the new conversation has a link to the post of the website blog.

Figure 4. Working scheme of the COCOP blog

The blog started in March 2017 with the post titled "*Efficient plant operation – a plant-wide approach*" (Figure 5) to encourage the discussion about the COCOP approach: plant-wide monitoring using the decomposition-coordination optimisation concept.

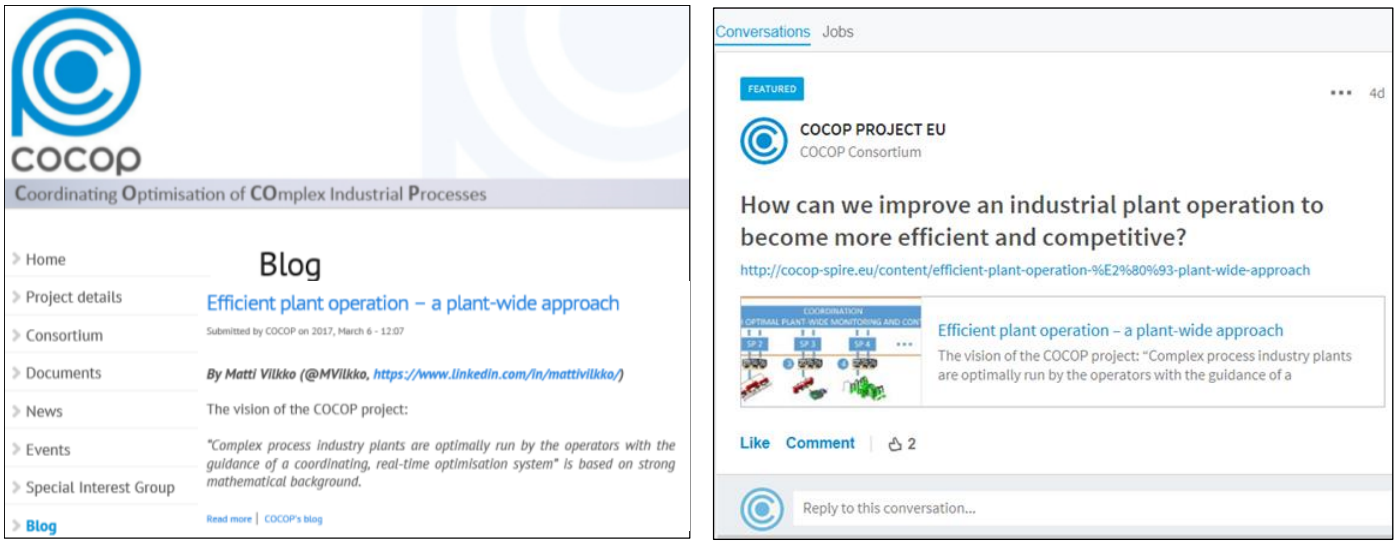


Figure 5. First post of the COCOP project: post in the website (on the left) and conversation in the linkedIn COCOP debate group (on the right)

The website was updated regularly by the webmaster with new contents such as summaries of the released deliverables, information about project meetings and dissemination events participated by the partners, new dissemination material, etc. In addition, at the beginning of each month, a new post in the blog (and its corresponding conversation in the COCOP debate group) was published, with information about technologies related to the COCOP goals/activities (tools, new trends, etc.) or information about the project (deliverables, main results, etc.). Table 2 details the 29 posts published in the COCOP blog (www.cocop-spire.eu/blog).

Table 2. Posts published in the COCOP blog

Nº	Post Title	Partner	Date
1	Efficient plant operation – a plant-wide approach	TAU	March 17
2	Process control and optimisation in the Chemical process industry	DSM	April 17
3	Threats and challenges in the Special Bar Quality steel sector	SIDENOR	May 17
4	Digitalization in copper smelting - taking the next big step	OUTOTEC	May 17
5	Key Performance Indicator (KPI) and impact evaluation in distributed production systems – The importance of feedback	OPTIMATION	June 17
6	Data Analysis for optimized water processing as a roadmap to a smart city	MSI	July 17
7	Optimising process operations – Model Predictive Control	2-control	August 17
8	Industrial data mining in Process Industry	BFI	Sep. 17
9	Industry 4.0: key features and benefits	TECNALIA	Oct. 17
10	A New Innovation Paradigm Based on Social Innovation	TUDO	Nov. 17
11	System requirements specification for COCOP system ready – The use of Software Development methodologies in EU research projects	IDENER	Dec. 17
12	Online LCA models enable daily process optimisation in terms of environmental impacts	VTT	Jan. 18
13	The Beauty of Automation System Architectures	TAU	Feb. 18
14	Process control and optimisation: on commonalities between methodologies	DSM	March 18
15	Knowledge management in COCOP	BFI	April 18
16	Optimising Process Conditions: neural network based modelling	DSM	May 18
17	The COCOP implementation workflow	VTT	June 18
18	Human Factors Requirements as Product of a Social Innovation Process	TUDO	July 18
19	Soft sensing: for critical and not on-line available measurements	TECNALIA	August 18
20	How to involve business perspective in a research and development project?	OUTOTEC	Sep. 18
21	Coordinating Optimisation of complex plants and Advisory Tools	2-control /TECNALIA	Oct. 18
22	Plant-wide process control in the process industry: barriers to implementation	DSM/MSI /OUTOTEC	Nov. 18
23	Digital Twins	IDENER	Feb. 19
24	Is your organisation prepared for digital transformation?	VTT	April 19
25	Implementing Vendor-neutral, Scalable Communication in Industry	TAU	May 19
26	COCOP: Surface Quality in Steel bars a route from the liquid Steel to the industry 4.0	SIDENOR	June 19
27	Surrogate models: improving the exploitation of your sophisticated models	BFI	July 19
28	Transferring R&D results to other sectors. How can it be done? A COCOP use case	MSI	Sep. 19
29	The Low-Carbon Industry	TECNALIA	Nov. 19

Analysis of the COCOP website visits (until the middle of March 2020)

COCOP have used Google Analytics to monitor the behaviour of the website. This allowed the project to steer the strategy with the main aim of reaching the right audience. From the analytics collected over a period of 38.5 months (since the beginning of January 2017, when the website was created, until the middle of March 2020, when this report was prepared), it can be seen that the total number of visits to the COCOP website has been 12900 with about 9700 different users and an average session duration of 00:01:42. Figure 6 shows the monthly evolution of the number of users and sessions along this period and Figure 7 the channels used for the access to the website and the evolution of the number of users per day. It was observed that, in general, the blog posts publication marked the highest number of visits to the website during each month. The blog posts and their specialized contents also helped to position the project and its SEO (Search Engine Optimisation). The publication of such dedicated, focused content, helped the project to increase the visits that came from search queries as demonstrated in Figure 7: about 61% of the visitors to the COCOP website came through organic searches, 33% through a direct access and 3.5% from the social networks.

With more than 29000 page views, Figure 8 shows the most visited pages of the website. After the homepage with the 17% of visitors, the third position corresponds to the page with the deliverables (6.5%), followed by the objectives section (5.5%) and the consortium description (3.7%). The sixth position achieved by the blog together with the high number of visits to different posts (for instance, the Industry 4.0 post, with more than 3000 visits, occupying the 2nd position) confirm the high impact of the blog.

Finally, Figure 9 shows the percentage of visits per country. The first position is occupied by the USA (20%) and is followed by India (13.7%). Then, 3rd, 4th and 5th positions are occupied by countries with partners in the COCOP consortium: Spain (8.1%), Finland (5.5%) and Germany (3.9%) respectively.

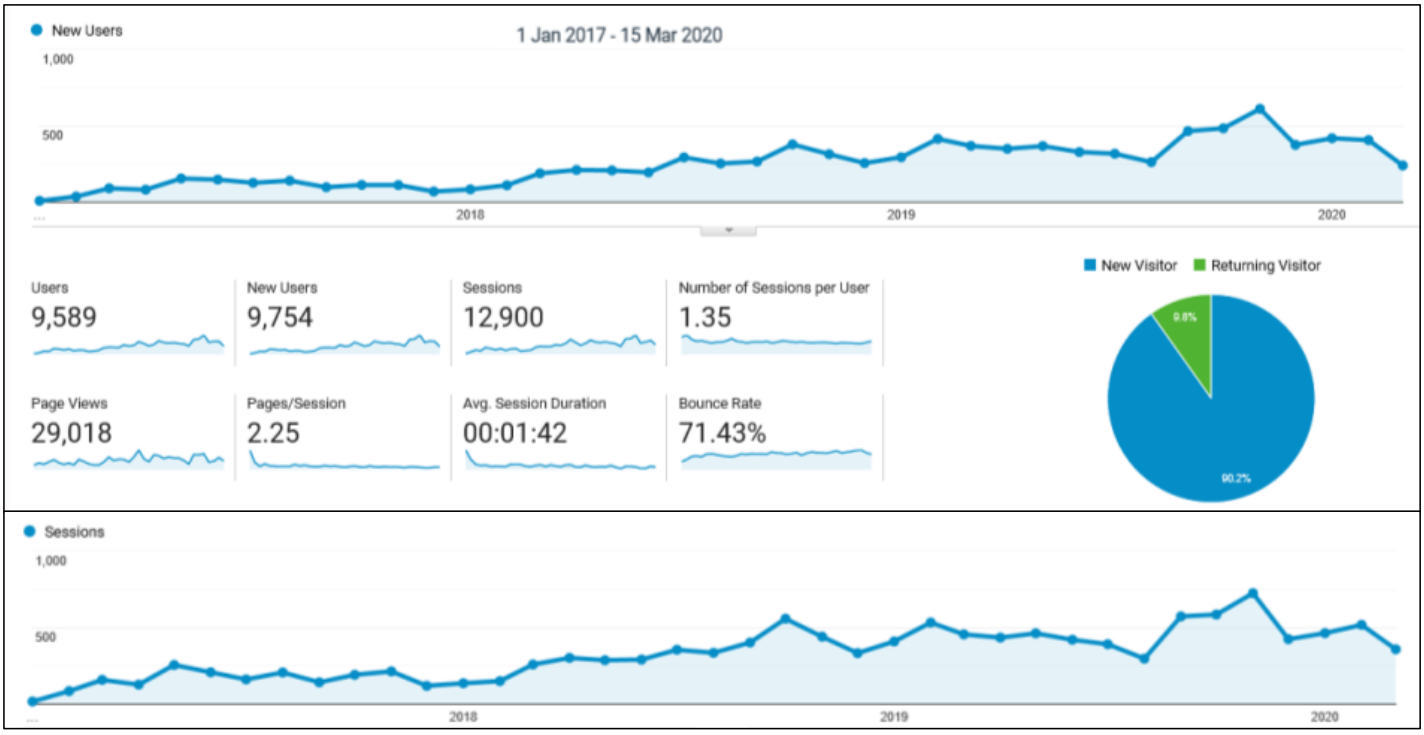


Figure 6. Users (top) and sessions (bottom) monthly evolution to COCOP website (1st January 2017- Middle March 2020)

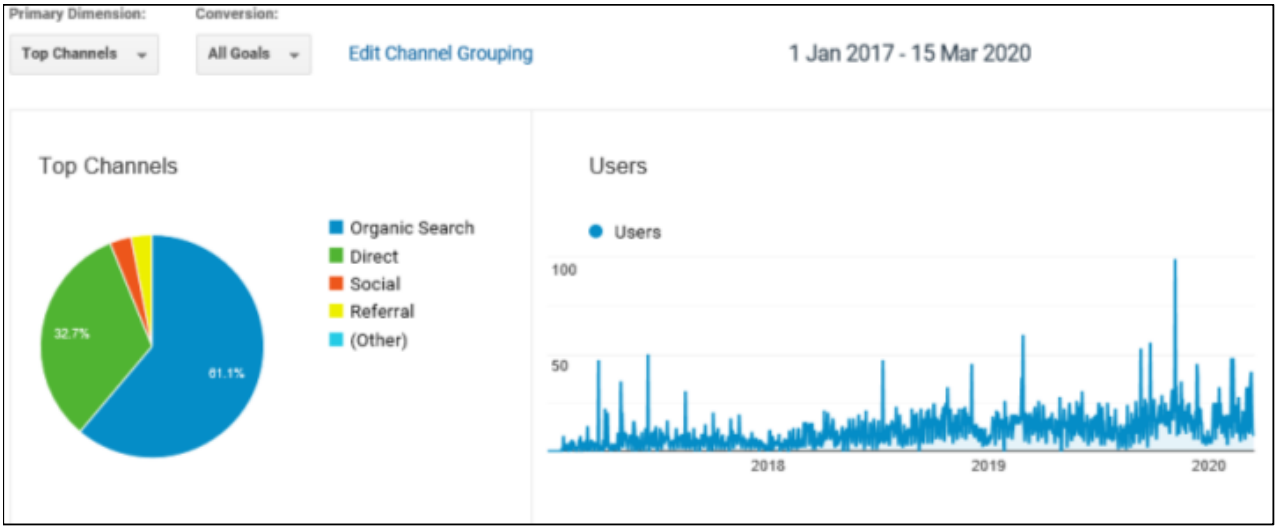


Figure 7. Traffic in COCOP website

	Page Title	Page Views	% Page Views
1.	Home | COCOP SPIRE H2020 Project	4,888	16.84%
2.	Industry 4.0: key features and benefits | COCOP SPIRE H2020 Project	3,163	10.90%
3.	Deliverables | COCOP SPIRE H2020 Project	1,880	6.48%
4.	Objectives | COCOP SPIRE H2020 Project	1,610	5.55%
5.	Consortium | COCOP SPIRE H2020 Project	1,078	3.71%
6.	Blog | COCOP SPIRE H2020 Project	1,077	3.71%
7.	News | COCOP SPIRE H2020 Project	1,036	3.57%
8.	Process control and optimisation in the Chemical process industry | COCOP SPIRE H2020 Project	897	3.09%
9.	Project meetings | COCOP SPIRE H2020 Project	807	2.78%
10.	Special Interest Group | COCOP SPIRE H2020 Project	678	2.34%

Figure 8. Most visited pages of COCOP website

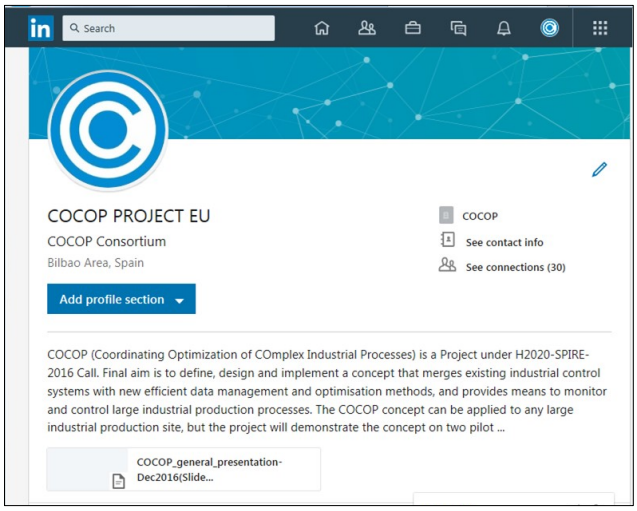
	Country	Users	% Users
1.	United States	1,962	20.01%
2.	India	1,345	13.72%
3.	Spain	793	8.09%
4.	Finland	540	5.51%
5.	Germany	379	3.86%
6.	United Kingdom	343	3.50%
7.	Malaysia	310	3.16%
8.	France	234	2.39%
9.	Italy	223	2.27%
10.	Netherlands	177	1.81%

Figure 9. COCOP website users by country

4.3 COCOP at social networks

The Twitter account for the project @CocopSpire and the LinkedIn profile (COCOP) were created at the end of the month 3 (see Figure 10). Tweets and posts have been published monthly, mainly to publish announcements/milestones/events of the project and spread the blog posts, including the URL to the corresponding information on the COCOP website in order to generate interest also on additional content of the website, and thus increase awareness of the project. In addition to the above, COCOP partners have used their respective Twitter channels to directly promote events and news concerning COCOP.

@CocopSpire



https://www.linkedin.com/in/cocop-project-eu-377251138/

Figure 10. COCOP Twitter account and LinkedIn profile

In order to raise awareness among interested stakeholders, four official LinkedIn groups were joined: Industrial Automation and Process Controls Network, Industry 4.0, Automation Project Management and Steel making and casting.

In addition, a COCOP debate group was created in LinkedIn: "*COCOP: Process Industry Automation and Optimisation*" (https://www.linkedin.com/groups/8596768). The main goal of this group was to promote discussion and share information on the topics related to industrial process simulation, modelling, monitoring, control, automation and optimisation. As it was explained above, this group was used as discussion platform for the posts of the website blog. Currently, this group has 58 members (see Figure 11).

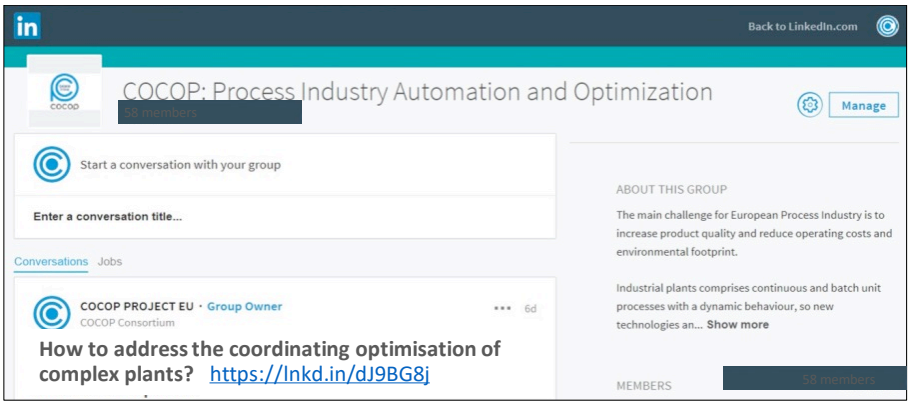


Figure 11. COCOP debate group in LinkedIn

Finally, at the month 24, a COCOP page was created in ResearchGate to promote the visibility of the project results inside of the scientific community (see Figure 12). From its creation, it has been periodically updated with information related to blog posts, papers and posters of the project.

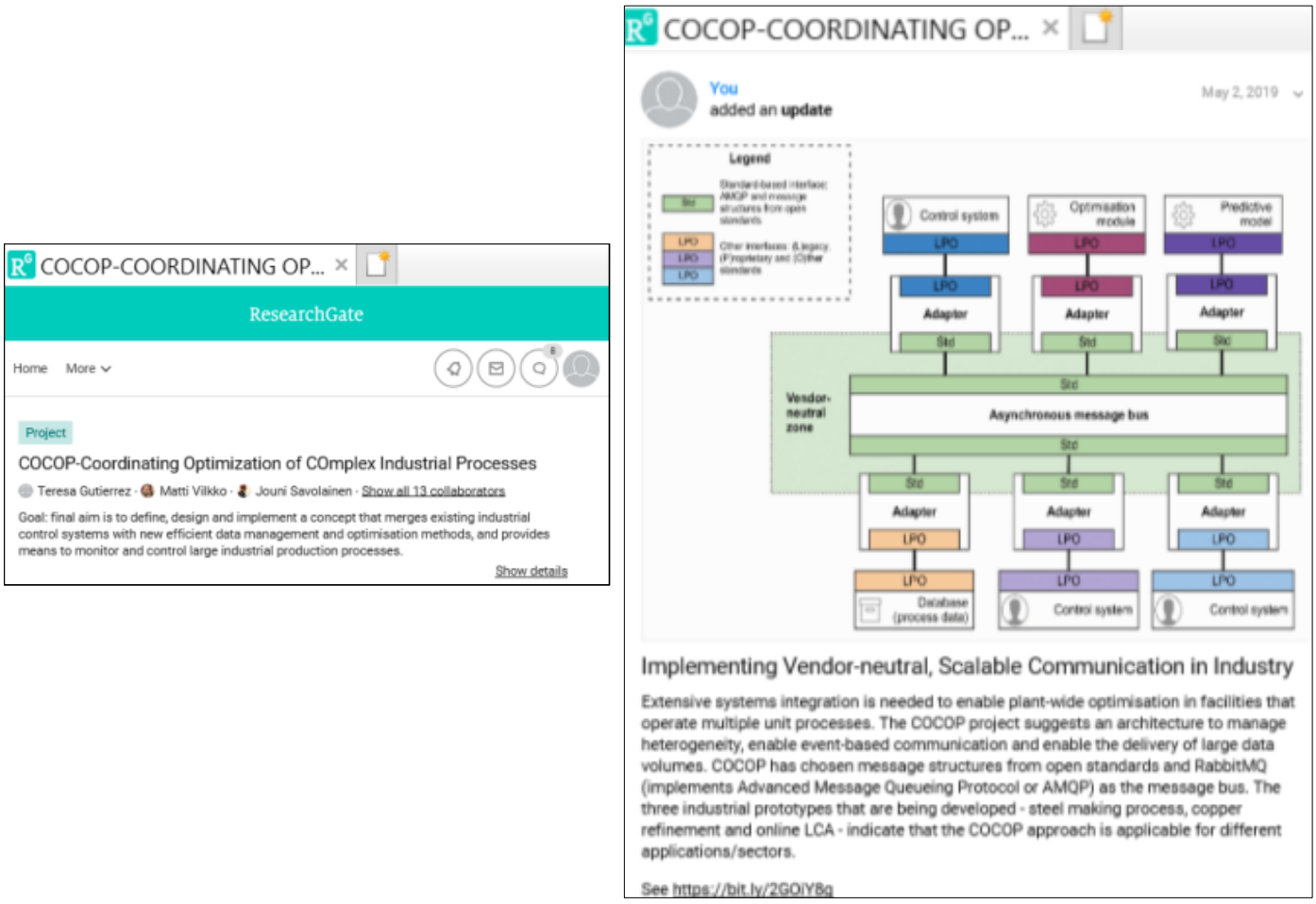


Figure 12. COCOP page in ResearchGate updated with posts and papers information

Analysis of the twitter activity

As shown in Figure 10, until the time of writing this deliverable, 75 tweets have been published and the twitter account counts 75 followers. Figure 13 depicts the activity of the project's twitter account during the last month (about 4000 impressions, tweeter impressions are the number of times a tweet shows up in somebody's timeline) and lists the top tweets of the project with the largest number of impressions. The first position is occupied by the tweet related to the presentation of the COCOP architecture during the DigOp2018 workshop (4278 impressions), followed by the one presenting the video "*COCOP in a nutshell*" (3463 impressions), the one associated to the post "*Plant-wide process control in the process industry: barriers to implementation*" (3473 impressions) and the one corresponding to the presentation of COCOP in the final workshop of the MONSOON project (2976 impressions).

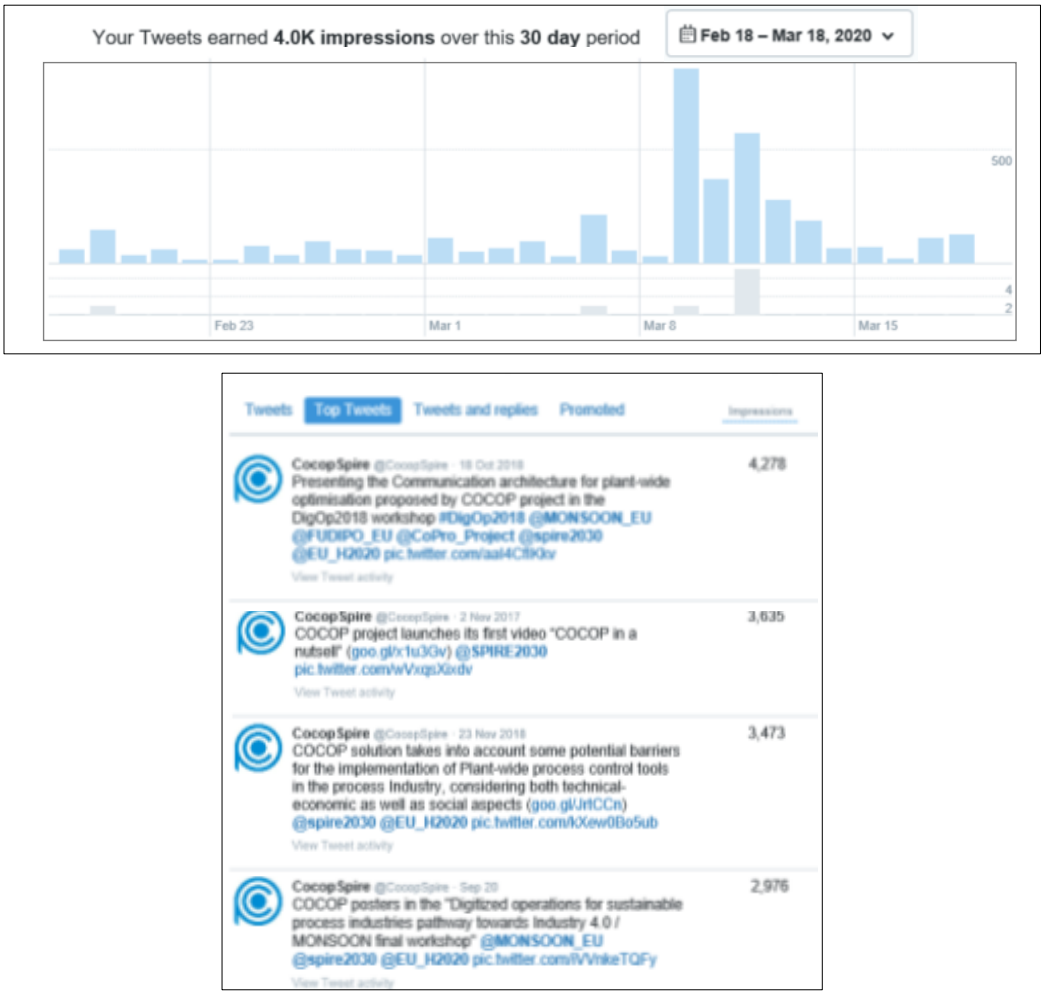


Figure 13. COCOP Twitter activity registry during the last month (18 Feb – 18 March 2020) and the four tweets of the project with the highest number of impressions

4.4 Preparation of dissemination material

This section describes the main dissemination materials produced along the project:

- *Project flyers:* a first flyer of the COCOP project was produced at the beginning of the project (Month 3). It presents the goals, the approach, the consortium and the main (expected) benefits (see Figure 18 in the annex III). 1.500 copies of the flyer were printed and distributed between the partners and an electronic version is available in the COCOP website.

  At the end of the project two new flyers were produced, one for each pilot case (steel and copper) (see Figure 19 and Figure 20 in the annex III). Both share common information of the project (goals, approach, consortium), but each one has a specific section to describe the objective and the tools implemented for each case. It was decided to make two different flyers with the purpose of giving the partners a more useful tool for the dissemination of the results of the project among their reference market sectors and potential customers, that could be only interested in one of the sectors. Partners can print these flyers to hand out at conferences or other events. They can be also downloaded from the project website.

- Short project presentations (electronic version): several presentations have been prepared and uploaded in the project website along the project. At the beginning of the project (Month 3), a general presentation describing the motivation, the objectives, the approach, the pilot cases, the potential impact and the consortium of the project. At the middle of the project, a presentation describing the COCOP architecture. And at the end of the project, three new presentations to describe the two pilots cases (goals, implemented models and tools and results obtained) and the results of the co-creation process implemented in the COCOP project. In addition, a "summary" presentation (project goal, approach, main results obtained, consortium, etc) was prepared to present the project in future meetings/events.
- Videos: different types of videos have been produced and uploaded in the project website. Two videos were produced by a professional marketing company (see Figure 14):
  - "*COCOP in a nutshell*" (4 minutes) was produced in October 2017 and describes the objectives, approach, pilot cases and potential benefits of the project. It has been used to disseminate the project in different events. It was also published on YouTube.
  - "*COCOP transfer to Water Treatment Processing*" (1.5 minutes) was produced in September 2019 and describes the COCOP concept and its transfer to the water treatment industry. It was also published on YouTube.

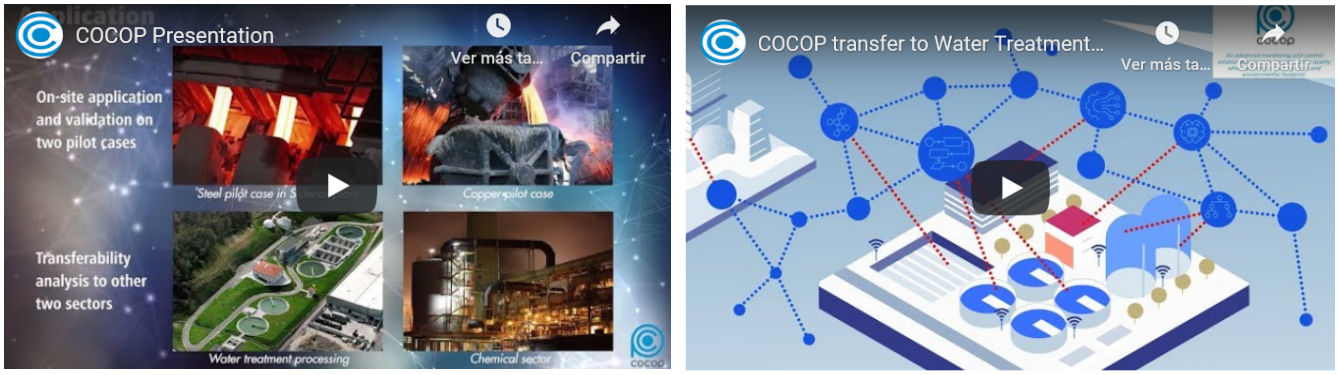


Figure 14. COCOP videos produced by a professional marketing company: "COCOP in a nutshell" (on the left), "COCOP transfer to Water Treatment Processing" (on the right).

The partners also produced several videos along the project to show demos of new tools or summarise relevant deliverables:

- "*On-line LCA model into ACT demo*" (5 minutes) was produced in February 2018 to show an example of the integration of the new on-line LCA model into a DCS system, as the ACT platform of OUTOTEC used in the copper pilot case.
- "*Summary of the D4.4. Modelling guideline document and demonstration development kit*" (7 minutes) was produced in April 2018 and summaries the main contents of that deliverable, focusing on *"What needs to be done when the COCOP concept is applied to a given plant".*
- *"Summary of the D3.7 Software architecture description for the runtime system"* (5 minutes) was produced in October 2018 and presents a simplified summary of that deliverable, focused on the COCOP architecture.
- *"Summary of the D3.5 Interface and protocol definitions"* (2 minutes) was produced in October 2018 and presents a simplified summary of that deliverable, focused on communication protocols and message formats.

Finally, at the end of the project, the partners recorded a video presenting in detail the results obtained in the project. To make it easier for visitors to access the part that is most interesting to them, the video is divided in five parts: short introduction of the project, COCOP architecture, Steel pilot case, Copper pilot case and Co-creation process.

- Posters: at the end of the project, six posters related to the main aspects and results of the project were produced and can be downloaded from the COCOP website (see figures in annex IV): i) *COCOP in a nutshell*, ii) *COCOP Architecture,* iii) *COCOP Steel pilot case*, iv) *COCOP Copper Pilot Case: Scheduling,* v) *COCOP Copper Pilot Case: Peirce-Smith Converter Advisor and* vi) *Combining Technological and Social Innovation in COCOP.* These posters can also be printed in A4 format to hand out at meeting/events.

Finally, during the project period 15 public deliverables (see Table 3) have been prepared and released for the public.

Table 3. List of public deliverables produced by the COOCP consortium during the first period

Deliverable Title	Deliverable description
D2.2. Impact evaluation criteria (March 2017)	This document includes a description of the relevant impact evaluation criteria (KPIs) defined to measure the success of the COCOP implementations at the pilot sites of Boliden (copper production) and Sidenor (steel production).
D2.3. System Requirements Specifications (September 2017)	This report presents a snapshot of the use cases of the two pilot cases of the project and requirements for the system. This information w*as* updated during the execution of the project in order to accompany the different developments achieved and reflect the new discoveries found during the work.
D3.1. Software architecture description for runtime system (March 2018)	This report presents the general COCOP system architecture, focused on laying out the fundamental architecture directions both for the internal composition as well as external integrations.
D3.3. Pre-processing tools for collected data (September 2018)	The field of data processing covers a wide range of methods and functionalities. This deliverable covers only a small part of the available functions that are used in COCOP project.
D3.5. Interface and protocol definitions (March 2018)	This document covers two core aspects in order to enable systems integration: communication protocols and message formats. Existing legacy systems may provide data access interfaces in various formats, so additional interfaces are specified to enable common formats for interoperability. Interface wrappers or adapters are used for legacy system integration*. A summary video of the deliverable is also available in the web page*.
D3.7. Software architecture description for the runtime system (update) (September 2018)	This report describes the COCOP run-time system architecture and details implementing integrations to existing systems as well as how control applications are created. It is the second updated version of t*he* deliverable describing the software architecture (D3.1). *A summary video of the deliverable is also available in the web page.*
D4.2. Near-online sustainability indicators (September 2017)	This deliverable reports the principles of LCA (Life Cycle Assessment) and the data needed for the environmental sustainability indicators that enable near-online LCA for the steel and copper pilot cases. The LCA indicators take into account the value chain from raw material extraction to the end of the production process.

Deliverable Title	Deliverable description
D4.4. Modelling guideline document & demonstration development kit (March 2018)	This report helps a stakeholder of an industrial plant to assess, whether the COCOP methodology fits in a targeted process, and guides in the system development, commissioning and maintenance. The guideline addresses the question "*What needs to be done when the COCOP concept is applied to a given plant*?" from several different angles. A *summary video of the deliverable is also available in the web page.*
D4.6. Modelling guideline document and demonstration development kit -Update (January 2019).	This deliverable continues the work reported in D4.4. The work progressed on two fronts: simulation tools supporting COCOP (review of numerous simulators is provided) and the COCOP implementation workflow that was extended with two activities: the Digital Maturity Analysis and Human Factors Milestones. Together with D4.4, this guideline pursues three important success factors for the COCOP installations: outstanding technical capability, full acceptance of the plant personnel, and environmental sustainability.
D6.1. Co-creation, combining technological and social innovation (March 2020)	This report analyses and summarizes the co-creation process (effectiveness and efficiency), mainly focusing on factors for a successful integration of key personnel and end users in the innovation process, and delivering a model for combined technological and social innovation in the process industry (and its transferability to other branches).
D7.1 Project website (December 2016)	Description of the COCOP web page
D7.2. Master Dissemination and Communication Plan (March 2017)	This deliverable includes the formulation of the COCOP dissemination strategy and the action plan focused on the first half of the project (month 1-21)
D7.3. Master Dissemination and Communication Plan – Update (June 2018)	This report represents the second release of the "Master Dissemination and Communication Plan", including an overview of the dissemination activities carried out during the first half of the project (month 1-21) and the action plan for the second half (month 22-42).
D7.6. Dissemination and communication actions survey (March 2020)	This deliverable represents the last report related to the "Master Dissemination and Communication", including a review of the COCOP dissemination strategy and a survey of the dissemination and communication activities carried out along the whole project lifetime.
D7.7. Transferability assessment analysis (March 2020)	This report describes the results of the transferability analysis of the COCOP solution towards four potential sectors: waste water treatment, chemical processing and glass manufacturing industry.

4.5 Creation and management of the Special Interest Group (SIG)

After agreeing the rules for the management of the SIG and implementing the mechanism for the subscription of the members in the web (http://www.cocop-spire.eu/content/special-interest-group), the COCOP SIG was launched in April 2017 (Month 7). At the end of the project, the SIG is composed of 35 members from 17 different countries, most of them European countries (like Belgium, Finland, France, Germany, Greece, Italy, Netherlands, Spain, Sweden, etc) but also from outside (like Canada, South Korea and Venezuela). They cover different profiles: companies related to different sectors (chemical, pulp, aluminum, copper, etc.), providers of solutions for process control, Machine Learning and Industry 4.0 and twelve Research Institutes (Universities and Research centers) interested mainly on the areas of automation solutions, data mining and Industry 4.0.

4.6 Preparation of contributions for dissemination channels offered by other entities

Different material has been prepared to disseminate the project through the channels offered by other entities, such as:

- A short description of the project together with the logo and link to the COCOP web page was published in the projects page of the SPIRE website (https://www.spire2030.eu/projects/our-spire-project)
- A summary of the project for the Edition no. 12 of the SPIRE newsletter in May 2017 (https://www.spire2030.eu/news/press-office/newsletter)
- Information of the project for the 2nd quarter bulletin of EUWIN (European Workplace Innovation Network) in June 2017 (http://uk.ukwon.eu/File%20Storage/ 5989654_7_EUWIN- Second-quarter%20bulletin-June-2017.pdf)
- A short description of the project for the annual SPIRE projects brochure in July 2017 (https://www.spire2030.eu/sites/default/files/pressoffice/publication/20170504%20-%20Booklet%202016%20-%20final.pdf)
- A short description and links to COCOP from the partners homepages (such as http://sfs.tu-dortmund.de/cms/en/projects/cocop.html)

4.7 Publications in scientific and trade journals and books

Table 4 provides the main details of the publications in journals and books carried out by the partners throughout the project: seven already published and three under the review process.

4.8 Presentations at national and international scientific conferences

Table 5 collects the main information of the presentations of the project performed by the partners at different national and international scientific conferences, fifteen in total. All these actions required the submission of papers that were later published in the conference proceedings. Table 7 lists all the papers of the COCOP published/presented in scientific journals or conferences.

4.9 Participation at exhibitions, fairs and workshops

As shown in Table 6, the partners have also participated in different:

- Events organised or promoted by the EC or other research projects in order to improve business opportunities through networking and better awareness of the technologies and services offered by COCOP
- Workshops and exhibitions at which the COCOP was mainly presented to potential customers

As it was explained in the previous section, the full dissemination report of each activity (journals, conferences, workshops, exhibitions, etc) is stored in the collaborative tool of the project.

Table 4. COCOP publications in scientific and trade journals

No.	Journal/Magazine information			Paper information			
	Journal Name	Type	Journal topics	Paper title	Paper topics	Main Partner	Status/ Date
1	SIDENEWS	Trade	Steelmaking	*Complex industrial process optimisation*[2]	General presentation of the project focused on the steelmaking pilot case	TECNALIA	Published December 2016
2	Automaatioväylä	Trade	Process automation	*COCOP – next generation plant-wide optimisation*[3]	Overall introduction to the COCOP concept	VTT	Published February 2017
3	Journal of Business Research	Scientific	From business research to actual business situations	*Gamification of production and logistics operations: Status quo and future directions*	Gamification; production; logistics; operations; design research; organization theory	TAU	Published September 2018
4	Materials & Techniques - Journal of industrial materials, their implementation techniques & use	Scientific	Materials and materials processing	*A New Innovation Paradigm: Combining Technological and Social Innovation*	Social innovation, steel sector, human factors requirements	TUDO	Published March 2019
5	International Journal of Technology Transfer and Commercialisation	Scientific	Knowledge/technology transfer processes, strategies, implementation	*Sociotechnical perspectives on digitalisation and Industry 4.0*	Sociotechnical systems, social innovation	TUDO	Published May 2019

[2] http://www.siderex.es/wp-content/uploads/2016/12/Siderex-diciembre.pdf
[3] http://www.automaatiovayla.fi/lehti/verkkolehti/

No.	Journal/Magazine information			Paper information			
	Journal Name	Type	Journal topics	Paper title	Paper topics	Main Partner	Status/ Date
6	Atlas of Social Innovation - 2nd Volume: A world of new practices	Scientific	Practices of social innovation from a global perspective	*The social character of digitalization in industry*[4]	Social innovation	TUDO	Published September 2019
7	Automaatioväylä	Trade	Process automation	*ICT-arkkitehtuuri suurten laitosten koordinoivaan optimointiin*	COCOP architecture	TAU	Published October 2019
8	Frontiers in Education	Scientific	Assessment, testing and applied measurement	*Human Factor Requirements to Improve Technological Innovation*	Social Innovation, Human Factors, Co-Creation, Education and Training	TUDO	Submitted September 2019
9	Computers in Industry	Scientific	Trends in and options for the use of Information and Communication Technology in industry	*Unified Integration Approach for Plant-wide Coordination and Online Life Cycle Assessment*	System architectures, information systems, systems integration, process control, cyber-physical systems, online LCA	TAU	Submitted March 2020
10	International Journal of Information Systems and Project Management	Scientific	Information systems management and project management	*Digital maturity analysis as a means for creating a shared understanding for digital transformation*	Digital transformation and digital maturity	VTT	Submitted March 2020

[4] https://www.socialinnovationatlas.net/fileadmin/PDF/volume-2/01_SI-Landscape_Global_Trends/01_09_Innovation-Reloaded_Kohlgrueber-Schroeder.pdf

Table 5. COCOP presentations at scientific conferences

No.	Conference information				Presentation information			
	Conference Name	Where/When	Scope	Type & Size of audience	Presentation Type	Presentation Title	Presentation topics	Main partner
1	NPCW – 21 Nordic Process Control Workshop	Turku, Finland January 2018	European	Universities & industrials ~100	Paper Presentation	*Industrial implementation of non-linear model based controllers*	ModelBuilder and Non-linear MPC	2-control
2	HICSS 51 - Hawaii International Conference on System Sciences 2018	Hawaii, USA January 2018	International	Researchers & practitioners ~50 in session ~1000 in total	Paper Presentation	*Gamification of the work floor: a literature review of gamifying production and logistics operations*	Gamification; information systems; industrial work	TAU
3	SAM 12 – the 12th Society and Material International Conference	Metz, France May 2018	International	Companies, universities, research institutions ~100	Paper Presentation	*A new innovation paradigm: Combining Technological and Social Innovation*	New innovation paradigm, plant wide digital optimisation of processes, designing new working practices	TUDO
4	INCOM 2018 - 16th IFAC Symposium on Information Control Problems in Manufacturing	Bergamo, Italy June 2018	International	Researchers and practitioners ~300	Paper Presentation	*Asynchronous Communication Platform Concept to Coordinate Large-scale Industrial Processes*	COCOP information system architecture	TAU
5	EURAM 2018 -Research in Action conference	Reykjavik, Iceland June 2018	European	Researchers ~50 in session ~200 in total	Paper Presentation	*The Sociotechnical Perspective on Workplace Innovation and Industry 4.0*	Social Innovation, Sociotechnical Systems, Workplace Innovation	TUDO

No.	Conference information				Presentation information			
	Conference Name	Where/When	Scope	Type & Size of audience	Presentation Type	Presentation Title	Presentation topics	Main partner
6	SETAC - Europe 24th LCA Symposium	Vienna, Austria Sep 2018	European	LCA practitioners from Univ., RTOs & consultancies ~50 in session ~350 in total	Abstract Presentation	*On-line LCA - Integrating LCA into distributed control system*	Online LCA, implementation and potential applications	VTT
7	KMIS 2018 - 10th International Conference on Knowledge Management and Information Sharing	Seville, Spain Sep 2018	International	Researchers ~200	Paper Presentation	*Information Models and Information Exchange in Plant-wide Monitoring and Control of Industrial Processes*	Information models, communication architecture	TAU
8	IECON 2018 - 44th Annual Conference of the IEEE Industrial Electronics Society	Washington USA Oct 2018	International	Academic, Industry ~1000	Paper Presentation	*Data-driven and Event-driven Integration Architecture for Plant-wide Industrial Process Monitoring and Control*	Industrial Informatics, Industrial applications of internet technologies, Process Control	TAU
9	POMS 2018- Production and Operations Management Society International Conference	Kandy, Sri Lanka Dec 2018	International	Production and operations management researchers and industry representatives ~150	Paper Presentation	*Business view on the development of industrial plant-wide optimization tool*	Optimization, Modelling, Business model, Business environment	VTT
10	IHSI 2019 - International Conference on Intelligent Human Systems Integration	San Diego, USA Feb 2019	International	Researchers and practitioners ~200	Paper Presentation	*Human Factors in Software Projects for Complex Industrial Processes*	Human factors, process industry, optimization	VTT

No.	Conference information				Presentation information			
	Conference Name	Where/When	Scope	Type & Size of audience	Presentation Type	Presentation Title	Presentation topics	Main partner
11	EMC 2019 - European Metallurgical Conference	Düsseldorf, Germany June 2019	European	Researchers and industry practitioners ~200	Paper Presentation	*Plant-wide optimization of a copper smelter: how to do it in practice?*	Optimization, Smelting, Copper	OUTOTEC
12	3rd IEEE Conference on Control Technology and Applications (CCTA)	Hong Kong, China July 2019	International	Control engineering researchers and practitioners ~300	Paper Presentation	*The Extended Kalman Filter for Nonlinear State Estimation in a U-loop Bioreactor*	Application of control engineering	2-control
13					Paper Presentation	*Economic Optimal Control of a U-loop Bioreactor using Simultaneous Collocation-based Approaches*	Application of control engineering	2-control
14	58th Annual Conference of Metallurgist (COM) + Copper 2019	Vancouver, Canada Aug 2019	International	Copper Metallurgy ~200	Paper Presentation	*Outotec Fully Automated Smelter - Vision, Status and Future*	Automation, process control, copper Smelter	OUTOTEC
15	ACODS 2020- Advances in Control & Optimization of Dynamical Systems Conference	Chennai, India Feb 2020	International	Process systems engineering researchers, scientists and practitioners ~500	Paper Presentation	*Nonlinear Model Predictive Control for an Exothermic Reaction in an Adiabatic CSTR*	Model Predictive Control, Nonlinear Systems and Control, Chemical Engineering	2-control

Table 6. COCOP presentations at events (workshops, exhibitions, ...)

No.	Event information				Action information			
	Event Name	Where / When	Scope	Type & Size of audience	Presentation type	Presentation Title	Presentation topics	Main partner
1	VTT Co-creation Day (Workshop)	Finland November 2016	National VTT Internal	VTT staff ~1500	Poster	*COCOP - Next Generation Plant-Wide Control*	COCOP project in general	VTT
2	Workshop for Process Industry: Tackling the Future of Plant Operation (Workshop)	Germany January 2017	European	Integrated automation & monitoring in industry ~100	Distribution of COCOP flyers		COCOP project in general	TAU
3	Automationsdagarna 2017 (Exhibition/workshop)	Sweden February 2017	Scandinavia	Automation, managers ~250	COCOP flyers and discussion in stand		COCOP project in general	OPT
4	Automaatiopäivät22 (Workshop)	Finland March 2017	National	Automation professionals from industry & academia >200	Distribution of COCOP flyers		COCOP project in general	VTT
5	cPPP Impact workshop (Workshop)	Brussels May 2017	European	cPPP consortiums & program coordinators (including SPIRE Community) ~200	Distribution of COCOP flyers		COCOP project in general	TAU
6	2017 EU Process Industry Conference: a look to the future (A.SPIRE) (Workshop)	Brussels September 2017	European	A. SPIRE members and SPIRE project members ~60	Presentation + Distribution of COCOP flyers	*Coordinating Optimisation of Complex Industrial Processes - COCOP*	COCOP project in general	TAU

No.	Event information				Action information			
	Event Name	Where / When	Scope	Type & Size of audience	Presentation type	Presentation Title	Presentation topics	Main partner
7	ESTEP WG People Meeting	Brussels October 2017	European	Human resources managers, CEO´s (steel companies, research & educ. institutions) ~16	Presentation	*COCOP Project Status*	Baseline Survey	TUDO
8	Steelmaster 2017 (Workshop)	Italy November 2017	National	Steel company employees (management, engineers) ~25	Presentation	*Human Resources in the Steel Industry*	Social Innovation	TUDO
9	ISPT (Institute for Sustainable Process Technology) Day 2017 (Workshop)	Netherlands November 2017	National	Dutch process technology community ~240	Video display	*"COCOP in a nutshell" video*	COCOP project in general + pilot cases	DSM
10	Tackle the Future of Plant Operation - Jointly towards a digital process industry (Workshop)	Spain December 2017	European	SPIRE project members, industry representatives ~140	Distribution of COCOP flyers		COCOP project in general and synergies with other projects	TAU
11	AI – Finnish Operations Research Society (Seminar)	Finland April 2018	National	Applied maths, decision making, AI specialists ~100	Distribution of COCOP flyers		COCOP project in general	VTT
12	SPRING Project (Workshop)	Switzerland April 2018	European	Academia, industry, industry associations ~20	Contribution to group work & discussion, statement of COCOP social innovation approach		Social Innovation, social KPIs, results of users perspective	TUDO

No.	Event information				Action information			
	Event Name	Where / When	Scope	Type & Size of audience	Presentation type	Presentation Title	Presentation topics	Main partner
13	Social Innovation Community (SIC): "Social & Technological Innovation: Antagonistic or Complementary Approaches?" (Workshop)	Germany June 2018	European	Social Science researchers ~12	Presentation	*Technological Development as a Social Innovation Process - The COCOP project*	Social innovation	TUDO
14	METAL 2018 - 22nd International Fair of Technologies for Foundry Metal (Exhibition)	Poland September 2018	International	Metal Industry, Metal Engineering and Metal Technology >500	COCOP flyers and discussion in stand		COCOP in general & steel pilot case	TECNALIA
15	SPIRE Thematic Workshop on Digital Technologies in Process Industries (Workshop)	Brussels October 2018	European	Research, administration ~80	Presentation + Distribution of COCOP flyers	*COCOP – Coordinating Optimisation of Complex Processes*	Advanced scheduling, architecture of plant-wide monitoring & control, new digital technologies	TAU
16	Digitized Operations for Sustainable process industries (SPIRE Sister projects Workshop)	Germany October 2018	European	SPIRE Project members + External entities. Researchers and Industry representatives ~ 125	3 presentations 5 posters COCOP flyers	See Organised events section	COCOP overview, architecture, pilot cases and social innovation	TAU
17	"Connected Industry" (Workshop)	Spain October 2018	International	Process Industry, IT providers and researchers ~150	COCOP flyers and discussion in stand		COCOP in general & steel pilot case	TECNALIA

No.	Event information				Action information			
	Event Name	Where / When	Scope	Type & Size of audience	Presentation type	Presentation Title	Presentation topics	Main partner
18	THTH (Association of Decentralised Information Management for Industry) Autumn Seminar	Finland October 2018	National	THTH members, research and industry representatives ~30	Distribution of COCOP flyers		COCOP in general	TAU
19	Steelmaster 2018 (Workshop)	Italy November 2018	National	Steel company employees (management, engineers, HR responsible, ...) ~100	Presentation	*Industry 4.0 needs Work 4.0: Combining Technological Innovation with Human Factor Requirements*	Industry 4.0, Work 4.0, Human Factor Requirements	TUDO
20	Automaatiopäivät 23 (Workshop)	Finland May 2019	National	Automation professionals from industry & academia >200	Presentation about a paper	*Plant-wide communication architecture enabling online life cycle assessment*	COCOP communication architecture, online LCA	TAU
21	OpenTech AI Workshop	Finland May 2019	European	Companies, researchers ~100	Poster	*Multi-step-ahead simulation of dynamic chemical processes using machine learning models*	Surrogate modelling, model simplification, machine learning	VTT
22	THTH Spring Seminar	Finland May 2019	National	Information management in process engineering ~50	Distribution of COCOP flyers		COCOP in general & architecture	TAU

No.	Event information				Action information			
	Event Name	Where / When	Scope	Type & Size of audience	Presentation type	Presentation Title	Presentation topics	Main partner
23	Apros User Group (Seminar)	Finland May 2019	International	Users of Apros simulation software for dynamic process simulation ~70	Presentation	*Combining Apros with AI and machine learning*	Mechanistic modelling, Surrogate modelling, Dynamic simulation	VTT
24	BEYOND 4.0 Summer School Work and Welfare in the Digital Age	Spain June 2019	European	Researchers, students, policymakers, companies, public authorities ~60	Presentation	*The Skills Debate in the Digital Age: Industry 4.0 needs Skills/Qualification 4.0*	Industry 4.0, Work 4.0, Qualification 4.0, digital transformation and scenarios	TUDO
25	Digitized Operations for sustainable process industries (MONSOON final workshop)	Italy September 2019	European	Research, companies, industry ~50	1 Presentation 3 posters COCOP Flyers	*COCOP – Coordinating Optimisation of Complex Processes*	Project Overview, Social innovation and Software Architecture & data processing	TAU
26	Steel Industry 2030 (Workshop)	Spain November 2019	National	Steel makers, metalforming companies, equipment suppliers ~55	Presentation + COCOP flyers	*Digitizing the Steel industry*	COCOP Steel use case: goals and tools	TECNALIA
27	AI Day 2019 (FCAI Workshop)	Finland November 2019	International	AI researchers & AI-interested industrials ~350	Poster	*AI-SURSPEED – AI for faster process simulation*	Surrogate modellling, dynamic simulation	VTT
28	Global Gallery- Presenting results from international Projects at TU Dortmund University (Workshop)	Germany January 2020	National	Researchers ~120	Poster	*Social innovation*	Social innovation in COCOP	TUDO

No.	Event information				Action information			
	Event Name	Where / When	Scope	Type & Size of audience	Presentation type	Presentation Title	Presentation topics	Main partner
29	Digitized Operations for sustainable process industries (FUDIPO & COCOP final workshop)	Virtual March 2020	International	Researcher, industrial companies ~75	5 presentations 6 posters	See Organised events section	COCOP overview, architecture, copper and steel pilot cases, social innovation and transferability	TAU TECNALIA

Table 7. List of accepted papers of the project for scientific journals and conferences

1. Warmelink, H., Koivisto, J., Mayer, I., Vesa, M., & Hamari, J. "*Gamification of the work floor: a literature review of gamifying production and logistics operations*". In Proceedings of the 51th Annual Hawaii International Conference on System Sciences (HICSS). 3-6 January 2018 in Hawaii (USA). doi:10.24251/HICSS.2018.139.
2. Jørgen K. H. Knudsen, John Bagterp Jørgensen."*Industrial implementation of nonlinear model predictive controllers*". In Proceedings of the NPCW21-21st Nordic Process Control Workshop. 18-19 January 2018 in Turku (Finland)
3. Kohlgrüber M. and Schröder A. "*The Sociotechnical Perspective on Workplace Innovation and Industry 4.0*". EURAM - Reykjavik 2018 Conference - Research in Action. 19-22 June 2018 in Reykjavik (Iceland).
4. Kannisto P. and Hästbacka D. "*Asynchronous Communication Platform Concept to Coordinate Large-scale Industrial Processes*". INCOM 2018 - 16th IFAC Symposium Information Control Problems in Manufacturing. 11-13 June 2018 in Bergamo (Italy). IFAC-PapersOnLine, Vol. 51, no. 11, pp. 1403-1408, 2018. Doi: 10.1016/j.ifacol.2018.08.325.
5. Warmelink H., Koivisto J., Mayer I., Vesa M. and Hamari J. "*Gamification of production and logistics operations: Status quo and future directions*". Journal of Business Research. September 2018. Doi: 10.1016/j.jbusres.2018.09.011
6. Hästbacka D., Kannisto P. and Vilkko M. "*Information Models and Information Exchange in Plant-wide Monitoring and Control of Industrial Processes*". KMIS 2018 - 10th International Conference on Knowledge Management and Information Sharing. 18-20 September 2018 in Seville (Spain). In Proceedings of the conference, volume 3, 2018, pp. 216-222. Doi: 10.5220/0006960602160222.
7. Hästbacka D., Kannisto P. and Vilkko M. "*Data-driven and Event-driven Integration Architecture for Plant-wide Industrial Process Monitoring and Control*". IECON 2018 - 44th Annual Conference of the IEEE Industrial Electronics Society. 21-23 October 2018 in Washington DC (USA). Doi: 10.1109/IECON.2018.8591323
8. Hemilä J. and Jansson J. "*Business view on the development of industrial plant-wide optimization tool*". In Proceedings of POMS 2018 - Production and Operations Management Society International Conference. 14-16 December 2018 in Sri Lanka. Doi:10.1109/POMS.2018.8629458
9. Liinasuo M., Lastusilta T., Savolainen J. and Kuula T. "*Human Factors in Software Projects for Complex Industrial Processes*". In Proceedings of the 2nd International Conference on Intelligent Human Systems Integration (IHSI 2019): Integrating People and Intelligent Systems. 7-10 February 2019 in San Diego (USA). Doi:10.1007/978-3-030-11051-2_78
10. Kohlgrüber M., Schröder A., Bayón F. and Arteaga A. "*A new innovation paradigm: combining technological and social Innovation*". Materials & Techniques Journal. Vol. 107, No. 1, March 2019. Doi:10.1051/mattech/2018065
11. Kopp R., Dhondt S., Hirsch-Kreinsen H., Kohlgrüber M. and Preenen P."*Sociotechnical perspectives on digitalisation and Industry 4.0*". International Journal of Technology Transfer and Commercilatisation. Vol. 16, No. 3, May 2019. Doi:10.1504/IJTTC.2019.099896
12. Korpi M., Jansson J., Pihlasalo J., Suominen O. and Vilkko M. "*Plant-wide optimization of a copper smelter: how to do it in practice?*". EMC 2019 conference. 23-26 June 2019 in Dusseldorf (Germany).
13. Ritschel, T.K.S., Boiroux, D., Nielsen, M.K., Huusom, J.K., Jørgensen, S.B. and Jørgensen, J.B. "*The Extended Kalman Filter for Nonlinear State Estimation in a U-loop Bioreactor*". 3rd IEEE Conference on Control Technology and Applications. 19-21 July 2019 in Hong Kong (China). Doi: 10.1109/CCTA.2019.8920643
14. Ritschel, T.K.S., Boiroux, D., Nielsen, M.K., Huusom, J.K., Jørgensen, S.B. and Jørgensen, J.B. "*Economic Optimal Control of a U-loop Bioreactor using Simultaneous Collocation-based Approaches*". 3rd IEEE Conference on Control Technology and Applications. 19-21 July 2019 in Hong Kong (China). Doi: 10.1109/CCTA.2019.8920479

15. Jansson J., Jåfs M., Keronen T. and Korpi M. "*Outotec´s fully automated smelter 2020- The vision, the status and the future*". COM 2019 hosting Copper 2019. 18-21 August 2019 in Vancouver (Canada).
16. Wahlgreen M.R., Schroll-Fleischer E., Boiroux D., Ritschel T.K.S., Wu H., Huusom J.K., Jørgensen, J.B. "*Nonlinear Model Predictive Control for an Exothermic Reaction in an Adiabatic CSTR*". ACODS 2020 - 6th Conference on Advances in Control and Optimization of Dynamical Systems. 16-19 February 2020 in Chennai (India).

4.10 Workshops organised by COCOP

Two events have been organised by the project in its final part. In order to promote the networking activities and join forces to get in touch with the largest audience of relevant stakeholders, the two events were organised in collaboration with other SPIRE projects.

4.10.1 Digitized Operations for Sustainable Process Industries Workshop

This workshop took place the 18th October 2018 in Frankfurt (Germany) and was co-organised by the four projects of the SPIRE-02-2016 call (MONSOON, FUDIPO, CoPro and COCOP), with the objective of presenting the EU perspective on digital operations in process industries, focusing on plant-wide monitoring and control of data-intensive processes, and introducing the four projects (see Figure 15. It was attended by about 125 people.

Figure 15. COCOP presentation and posters in the Digitized operations for sustainable process industries workshop

Figure 27 in annex V shows the programme of the workshop. First, the EU vision on digitization in sustainable process industries was presented by Angelica Marino (*EC DG RTD*), Dr. Martin Winter (chair of SPIRE Digital Working group - *A.SPIRE*) and Chris Decubber (Technical Director - *EFFRA*). Then the four projects introduced their vision and first outcomes, through technical presentations and a poster session. Finally, a panel with main experts in the field discussed about chances and challenges

of full digitalization of process operations. During the workshop, there were three talks related to the COCOP project: an introduction to the COCOP project by the Coordinator, a presentation of the communication architecture proposed for plant wide optimization and a presentation of the first outcomes in the pilot case. Five posters of the project were also presented (see Figure 15).

4.10.2 FUDIPO & COCOP final workshop

The COCOP final workshop to present the results obtained in the project took place the 11th March 2020 (see Figure 16). It was co-organised with the FUDIPO project and included the participation of other three related SPIRE projects (MONSOON, CoPro and MORSE). Announcement of the workshop was done through different channels (Web, Twitter, LinkedIn, ResearchGate, SPIRE web, SIG members, etc.) to reach the maximum audience as possible. Initially the workshop was going to be held in Dortmund (Germany) but, due to travel constraints by the COVID-19 sanitary crisis, five days before the event it was decided to replace it by a virtual workshop, using the *Zoom* video conferencing system.

Figure 16. FUDIPO and COCOP final workshop

Figure 28 in annex V shows the final programme of the workshop, that was quite similar to that initially planned but with some minor adjustments to adapt it to the new format. First, the vision on digitization in sustainable process industries for Horizon Europe was presented by Angels Orduña (A.SPIRE's Executive Director). Then, the COCOP and FUDIPO projects presented their vision, objectives, approach and the solutions implemented for different process industries, evaluating their impact on quality and resources/energy efficiency. Moreover, the other three SPIRE projects, MONSOON, CoPro and MORSE, all working in similar areas, provided insight on their projects. A poster session was also organized through several parallel Zoom meetings. During the workshop, there were five talks related to the COCOP project: an introduction to the COCOP project by the Coordinator, the presentation of the Co-Creation process implemented in the project and the results obtained, the presentation of the steel and copper pilot cases (goals, approach, implemented tools, evaluation results, etc.) and the description of the methodology used for the transferability assessment of the COCOP concept to other sectors. Six posters of the project were presented. The

workshop was also recorded using the Zoom system utilities. Both the posters and the videos of each COCOP talk are available at the project website.

There were 75 registered people from 15 different countries: Austria, Belgium, Denmark, Finland, Germany, Greece, Italy, Spain, Sweden, Switzerland, The Netherlands, Turkey, UK, Venezuela. About 50% of the attendees belonged to the industrial sector.

In order to evaluate the workshop, a Google form, with the evaluation questionnaire shown in Table 8, was created and sent to the participants, the answers were anonymous.

Table 8. FUDIPO & COCOO final workshop evaluation questionnaire

FUDIPO & COCOP final workshop Evaluation Questionnaire					
1. Organisation	Excellent	Good	Satisfactory	Poor	Very Poor
• Good program structure					
• Well organized presentations					
• Well organized poster session					
Any comment?					
2. Virtual workshop	Very good	Good	Medium	No	Not at all
• Was the Web conferencing system suitable for the workshop target					
• Are the virtual workshops a good alternative to classical physical workshops?					
How was the experience compared to a physical meeting? What is negative? What is positive?					
3. Contents	Very high	High	Medium	Low	Very Low
• Interest/Relevance of the topics of the workshop					
• Interest/Relevance of the knowledge gained during the workshop					
• Applicability of the knowledge gained					
• Would you recommend this workshop to other people?					
Which were the most interesting topics for you?					
4. Overall evaluation	Excellent	Good	Satisfactory	Poor	Very Poor
• Overall quality of the workshop					
• Overall satisfaction with the workshop					
Is there anything else you'd like to share about the workshop?					

36 responses were received, which correspond to about 50% of the participants. The Figure 17 summarises the results of the evaluation. It can be observed that all aspects were rated quite well:

- *Organisation*: it was well valued by the participants. The worst rated aspect was the posters session. For this session, as already mentioned, several parallel Zoom meetings were organised to present the different posters. Some of the participants commented that they were confused and did not know how to switch between posters.

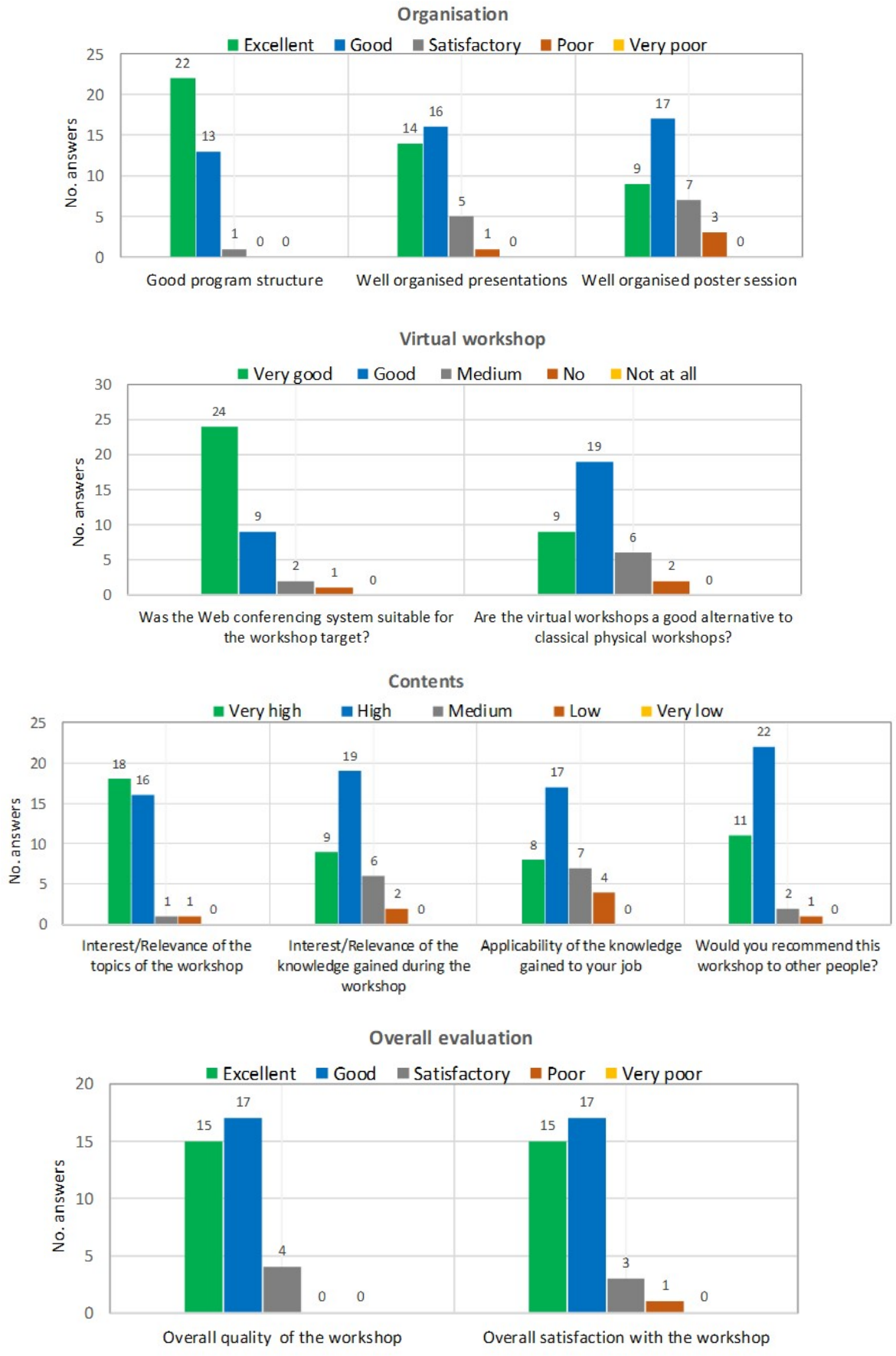


Figure 17. COCOP workshop evaluation results

- *Virtual workshop*: the web conferencing system was rated as "very good" by 67% of participants and as "good" by 25%, and most of them considered that the virtual workshops is a valid alternative to classical physical workshops (25% "very good" and 53% "good"). In the open question about the positive and negative aspects of the virtual workshops, the most commons answers were:
  - Positive aspects: no travelling, save time, save money, extreme CO2 footprint reduction, increase the possibility to attend more events
  - Negative aspects: It is more difficult to stay focused, no discussion in small groups and no F2F conversations during breaks
- *Contents*: the topics of the workshop were considered very relevant and the aspects more highlighted by the participants were: the exchange of information and experience ("*Seeing other projects working on similar problems and their solution suggestions*") and the examples of the application of the digitalisation technologies in industrial cases.

Finally, the overall satisfaction was very high: 42% of the participants responded "excellent" and 47% "good".

4.11 Other activities

Other dissemination activities have included the publication of project news in the local press and the publication of some related thesis works:

- Kannisto, Petri: "Distributed Industrial System Architectures : Exploiting Information and Knowledge to Increase Efficiency" (http://urn.fi/URN:ISBN:978-952-03-1221-3). TAU, Doctoral Thesis, October 2019. ISBN: 978-952-03-1221-3
- Savolainen, Jouni: "*Added value of extended dynamic simulation in process design and operational planning*" (https://aaltodoc.aalto.fi/handle/123456789/38147). VTT, Doctoral Thesis, June 2019. ISBN 978-952-60-8547-0
- Tahkola, Mikko: "*Developing dynamic machine learning surrogate models of physics-based industrial process simulation models*" (http://urn.fi/URN:NBN:fi:oulu-201906042313) (VTT) University of Oulu, Master's thesis, June 2019.

Finally, most of the partners have conducted internal presentations at their organisations to show the goals/progress of the project and have contributed to the project dissemination with communications in their day-to-day during visits with clients or meetings with other parties.

4.12 KPIs performance and evaluation

As it was explained in the previous section, some quantitative indicators were defined with the purpose of evaluating the COCOP dissemination activities.

Table 9 shows the comparative between the target and real values for each metric of the KPIs, for the whole period of the project. Although the proposed targets were ambitious, as it can be observed, most of them have been achieved and some of them exceeded (such as the number of visits to the website, where the actual value is more than twice the expected one). The main deviation corresponds to the number of papers published in scientific and trade journals, although it must be

considered that there are three more papers under the process review and other seven in progress (see next section). Because the final results are only obtainable at the end of the project, additional publications are also expected. It should also be noted that, if scientific journals/conferences papers are considered together, the number of scientific papers submitted and published amounts to 16.

Table 9. KPIs performance in the whole period: target vs real values

ID	Indicator	Metrics	Target Value (M1-M42)	Real Value (M1-M42)
KPI1	Awareness through the website and social media	Number of visits on the project website	160 visits per month	335 visits per month
		Number of posts on the blog of the website	1 post per month	1 post per month
		Number of members of the COCOP debate group in LinkedIn	100	58
		Number of contributions to LinkedIn/Twitter	125	140
		Number of presentations uploaded to the Website/SlideShare	5	6
		Number of videos uploaded to Website/YouTube	6	7
KPI2	Awareness of the Scientific Community interest	Number of papers in scientific journals	8	4 +3 under review +5 in progress +1 planned
		Number of presentations in scientific conferences/workshops	16	21 +3 planned
KPI3	Awareness of the industrial Community interest	Number of papers in trade journals	7	3 +2 in progress
		Number of participations at events with industry (fairs, exhibitions, workshops,…)	12	12 +3 planned
		Number of Interest expressions from industry to receive more information + industrial members of the Special Interest Group (SIG)	25	35 members in SIG, 23 industrial ones
KPI4	Coordination with other research projects	Number of participations in joint forums with other national/international projects	10	10 +1 in progress
KPI5	COCOP final workshop	Number of people attending the final COCOP workshop	70	75

5 Next COCOP dissemination activities

Although the project finishes the 31st March 2020, some dissemination activities will continue along the 2020 year in order to complete some ongoing activities and carry out some additional activities that have been planned to disseminate the last results obtained in the project. This section summarises these planned future activities, that will consist mainly of:

- Maintenance of the web page and social media with information about the new dissemination activities carried out (papers in journals, participation in conferences, etc.)
- Finish the papers for journals that are in progress and prepare the new planned ones (see the lists of Table 10)
- Presentation of the project in the planned events (see Table 11)

Table 10. In progress and planned COCOP publications in scientific and trade journals

Journal/Magazine information			Paper information				
Journal Name	Type	Journal topics	Paper title	Paper topics	Main partner	Status	Planned date
Journal of Cleaner Production	Scientific	Cleaner production and technical processes; Sustainable Consumption, Environmental and sustainability assessment	*The improvements to sustainability assessment enabled by online LCA*	Sustainability communication and eco-efficient use of resources	VTT	In progress	Q2-2020
SIDENEWS	Trade	Steelmaking	*Advisory tools to improve the steelmaking process*	General presentation of the tools developed for the steel pilot case	TECNALIA	In progress	Q2-2020
Empresa XXI	Trade	Manufacturing industry	*Challenges for the digitalization of the steel making process*	Big data, digital twins, traceability	SIDENOR	In progress	Q2-Q3 2020
Journal of Industrial Information Integration	Scientific	Industrial information integration engineering	*Plant-wide Systems Integration with Message Bus and Open Standards*	Communication protocols, architecture	TAU	In progress	Q2-Q3 2020
DYNA	Scientific	Industrial innovation, engineering & management	*On-line monitoring tool of the steel solidification process during the Continuous Casting*	Thermal model of the CC process, software sensors, on-line data	TECNALIA	In progress	Q3-2020
International Journal of Minerals, Metallurgy and Materials	Scientific	Minerals processing, physical metallurgy, process metallurgy, and materials science and processing	*Optimal Scheduling of Peirce-Smith Converter in Copper Smelting Process*	Optimization, advisory tools	TAU	In progress	Q3-2020
TBD	Scientific	Industrial innovation	*Scheduling of a copper production process*	Scheduling problem, optimization	TAU	In progress	Q3-Q4 2020
TBD	Scientific	Systems architecture, communication protocols	TBD	brownfield systems integration	TAU	Planned	Q3-Q4 2020

Table 11. In progress and planned COCOP presentations at events (conferences, workshops, exhibitions,..)

Event information				Action information			
Event Name	**Where/When**	**Scope**	**Event Topics**	**Presentation type**	**Presentation topics**	**Main partner**	**Status**
CoPro Final workshop	April 2020	European	Researchers, industrial companies of the SPIRE Community	Presentation / Poster	COCOP overview and results obtained in the project	TAU	In progress
IEEE International Conference on Emerging Technologies and Factory Automation (ETFA)	Austria September 2020	International	Industrial and factory automation	Paper	The implementation of OPC UA PubSub over AMQP	TAU	Planned
Scientific conference TBD	Q4 2020	European	Automation field	Paper	Orchestration vs. choreography in automation networks; an event-based approach requires more autonomy from network nodes	TAU	Planned
Scientific conference TBD	Q4 2020	European	Industrial information, integration engineering	Paper	COCOP software toolkit (generic libraries and applications...)	TAU	Planned
Steel Day 2020	Belgium June 2020	European	Developments in the Steel Industry	Presentation / Round Table	COCOP social innovation experience	TUDO	Planned
Iwater- Iwater - International Exhibition of the Integral Water Cycle	Spain October 2020	European	Professional Water industry	TBD: poster or presentation	Transfer of the COCOP project to the water treatment processing	MSI	Planned
Steelmaster	Italy November 2020	National	Skills needs for digital transformation	Presentation	Human Resources and Digital Transformation	TUDO	Planned

6 Conclusions

This report corresponds to the last deliverable related to the Dissemination and Communication task of the COCOP project, and describes:

- the key elements of the strategy that was defined and followed by the consortium to achieve proper project dissemination:
  - **the objectives** (*why*, mission & vision) → to spread the COCOP's results to the largest possible concerned audience (at the national, European and international level) in order to promote the implementation and use of the project results (exploitation).
  - **the subjects** (*what*) → the COCOP project itself and its results together with the all the techniques/methodologies used for the project technical development.
  - **the timing** (*when*) → with three main phases: 1) initial phase (*Awareness*) focused on increasing project visibility and mobilising stakeholders; 2) intermediate phase (*Interest/Desire*) focused on informing and engaging to the target stakeholders; 3) final phase (*Action)* focused on encouraging further exploitation of the COCOP outcomes (transfer and replicability).
  - **the target audience** (to *whom*) → industrial Community (Process industry & Process automation industry), scientific Community, "Internal" Community (COCOP partners), EU projects working to similar domain, standardisation bodies and Policy makers, Students and General public.
  - **the tools and channels** (*how*) → web page, social networks, channels offered by the EC and SPIRE, dissemination material distribution, COCOP Special Interest Group and mainly presentation of the COOCP results at scientific & trade journals, conferences, workshops, exhibitions and fairs.
  - **the responsibilities** (*who*) → all partners of the consortium have contributed to the COCOP dissemination during the whole project lifetime
  - **the rules** for performing the dissemination activities
  - **the way to evaluate and assess the impact** of the dissemination activities by means of KPIs
- the main results of the activities performed during the whole project:
  - COCOP Logo and visual identity designed and used in dissemination material and tools
  - COCOP Webpage implemented: www.cocop-spire.eu (with about 12900 visits and 9700 users) and 29 posts in the blog addressing project results and related technologies
  - COCOP at social networks: Twitter account (@CocopSpire), LinkedIn profile (COCOP), COCOP debate Group in LinkedIn ("COCOP: Process Industry Automation and Optimisation"), COCOP page in ResearchGate
  - Creation of the COCOP Special Interest Group with 35 members
  - Preparation of dissemination material that is also accessible from the website: three flyers (overview, steel pilot case and copper pilot case), several posters and presentations of the project and two main videos ("*COCOP in a nutshell*" and "*COCOP transfer to water treatment*").
  - Presentation of the COCOP project in scientific and trade journals, scientific conferences and different workshops and events. Some results of these activities: 16 scientific papers published/presented in scientific journals (three) and conferences (thirteen) and participation in other 29 workshops/events (ten of them corresponding to networking activities with other projects working in the same domain).

- Co-organisation of the "*Digitized Operations for Sustainable Process Industries Workshop*" and the "*FUDIPO & COCOP final workshop*" in collaboration with other SPIRE projects in order to show the results obtained in the project and give the opportunity to meet potential interested clients.

➢ the main activities planned along the 2020 year in order to complete some ongoing activities and carry out some additional activities planned to disseminate the last results obtained in the project.

7 Annex I: Technological platforms and Associations with involvement of COCOP partners

Acronym	SPIRE	
Name	**S**ustainable **P**rocess **I**ndustry through **R**esource and Energy **E**fficiency	
Web	https://www.spire2030.eu/	
Profile	PPP of HORIZON 2020	
Domain	Process Industry	
Scope	European	
Partners involved & Type of involvement	BFI	WG Process, Partnership Board
	SIDENOR	Industrial member
	TECNALIA	Participant of the Steering Committee and all the working Groups (Feed, Process, Application, Waste)
	VTT	Participant of the Steering Committee and the Working Groups: Feed, Application and Horizontal

Acronym	FoF / EFFRA	
Name	FoF - Factories of the Future EFFRA - European Factories of the Future Research Association	
Web	https://ec.europa.eu/research/industrial_technologies/factories-of-the-future_en.html www.effra.eu	
Profile	FoF - PPP of H2020 EFFRA - Association representing the FoF PPP Private Side	
Domain	Advanced manufacturing	
Scope	European	
Partners involved & Type of involvement	TECNALIA	Member of the Advisory Group
	VTT	Member

Acronym	MANUFUTURE	
Name	Future Manufacturing Technologies	
Web	http://www.manufuture.org/	
Profile	European Technological platform	
Domain	Process Industry, advanced manufacturing	
Scope	European	
Partners involved & Type of involvement	TECNALIA	Member of the Steering Committee
	VTT	Member

Acronym	IFAC	
Name	International Federation for Automatic Control	
Web	http://www.ifac-control.org/	
Profile		
Domain	Automation	
Scope	World	
Partners involved & Type of involvement	BFI	Technical Committee “Automation in Mining, Mineral and Metal Processing (MMM)”. Reviewer, Conference Organisation
	TAU	Technical Committee “Linear Control Systems”

Acronym	SAS	
Name	Suomen Automaatioseura ry Finnish Society of Automation	
Web	https://www.automaatioseura.fi/	
Profile	Industrial association for automation professionals	
Domain	Automation (process, manufacturing etc.)	
Scope	National	
Partners involved & Type of involvement	VTT	Individual employees as members
	TAU	Individual employees as members

Acronym	OPC Foundation	
Name	OPC Foundation	
Web	https://opcfoundation.org	
Profile	Technological platform, industrial association	
Domain	Industrial automation, information exchange	
Scope	World	
Partners involved & Type of involvement	TAU	Member (End-User Membership)
	VTT	Member (Corporate Membership)

Acronym	EUROSIM	
Name	Federation of European Simulation Societies	
Web	http://www.eurosim.info	
Profile	Forum for regional and national simulation societies to promote the advancement of modelling & simulation in industry, research & development	
Domain	Simulation in all domains	
Scope	European	
Partners involved & Type of involvement	VTT	Individual employees as members of national simulation society

Acronym	DIMECC	
Name	Digital, Internet, Materials & Engineering Co-Creation	
Web	https://www.dimecc.com/	
Profile	PPP co-creation platform for digital transformations	
Domain	Process, manufacturing, etc.	
Scope	National	
Partners involved & Type of involvement	VTT	Shareholder
	TAU	Shareholder

Acronym	EUROFER	
Name	The European Steel Association	
Web	www.eurofer.org	
Profile	Industrial Association	
Domain	Steel	
Scope	European	
Partners involved & Type of involvement	SIDENOR	Member

Acronym	ESTEP	
Name	European Steel Technological Platform	
Web	https://www.estep.eu	
Profile	Technological Platform	
Domain	Steel	
Scope	European	
Partners involved & Type of involvement	BFI	Support Group, WG Profit, WG Plant, WG I2m (Integrated Intelligent Manufacturing)
	SIDENOR	Associated member
	TECNALIA	Working groups (Automotive, Environment)
	TUDO	Working Group People (Vice-Chairman)
	VTT	Working group Construction

Acronym	CEFIC	
Name	The European Chemical Industry Council	
Web	http://www.cefic.org/	
Profile	It has 3 distinct groups of members: Corporate (ACOM) - Federation (AFEM) and Business (ABM) and 3 types of partnerships: Associated Companies, Affiliated Associations and partners.	
Domain	Chemical Industry	
Scope	European	
Partners involved & Type of involvement	DSM	Member of the Executive Committee and Member of ACOM

8 Annex II: Dissemination reports

This annex shows the templates and some examples of the Dissemination reports for the different types of activities.

Publications in magazines/journals		
Journal information	Name of the Magazine/Journal	*Automaatioväylä*
	Journal/Magazine type	*Trade journal*
	Indexed	*No*
	Impact factor (and quartile)	
	Web	*http://www.automaatiovayla.fi/in-english/*
Paper information	Paper title	*Working title: COCOP - Seuraavan sukupolven tehdasmittakaavan optimointia (In english: "COCOP – next generation plant-wide optmization")*
	Paper topics	*Overall introduction to the COCOP concept, partners and how the project will go forward*
	Partner coordinating the paper	*VTT (Jouni Savolainen)*
	Other partners involved	*TAU (Matti "Masa" Vilkko and David Hästbacka)*
	Planned date	*17/2/2017*
	Status	*Submitted 16/2/17*
	Comments	*Automaatioväylä is a Finnish trade journal for automation engineers. The magazine has a circulation of 3200. The targeted issue is 2/2017 which has an overarching theme of "process automation"*
To be filled after publishing the paper	Bibliographic Citation	
	DOI	
	ISBN/ISSN	
	Release date	*17/3/2017*
	Date to be in "open access"	
	Link to the paper in "open access"	*http://www.automaatiovayla.fi/lehti/verkkolehti/* *The web version of the magazine.*

National and International Conferences		
Event information	**Name of event**	*IECON 2018 - 44th Annual Conference of the IEEE Industrial Electronics Society*
	Web	*http://www.iecon2018.org*
	Organiser	*IEEE*
	When	*21-23 October 2018*
	Where	*Washington D.C., USA*
	Scope	*World*
	Audience Profile	*Academic, Industry*
	Target Audience Number	*1000+*
Presentation information	**Presentation title**	*Data-driven and Event-driven Integration Architecture for Plant-wide Industrial Process Monitoring and Control*
	Presentation topics	*Industrial Informatics, Industrial applications of internet technologies, Process Control*
	Presentation type	*Paper, oral presentation*
	Partner coordinating activity	*TAU (David Hästbacka)*
	Other partners involved	
	Status	*Completed*
	Comments	
To be filled after the conference	**Bibliographic Citation**	*Hästbacka, D., Kannisto, P. & Vilkko, M., "Data-driven and Event-driven Integration Architecture for Plant-wide Industrial Process Monitoring and Control",* in *44th Annual Conference of the IEEE Industrial Electronics Society*, 2018, pp. 2979-2985. *Doi: 10.1109/IECON.2018.8591323*
	DOI	*10.1109/IECON.2018.8591323*
	ISBN/ISSN	*978-1-5090-6684-1 (electronic) 978-1-5090-6685-8 (print)*
	Link to the paper/poster, if feasible	*https://ieeexplore.ieee.org/document/8591323*
	Number of attendees	*1000+*
	Picture of the event?	
	Any comment/feedback	

Event (Fairs, exhibitions, workshops, ..)		
Event information	**Name of event**	*2017 EU Process industry conference: a look to the future*
	Web	*https://www.spire2030.eu/news/new/2017-eu-process-industry-conference*
	Organiser	*A.SPIRE*
	When	*19th September 2017*
	Where	*Brussels*
	Scope	*European*
	Audience Profile	*A.SPIRE members and SPIRE project members*
	Target Audience Number	*60*
Presentation information	**Presentation type**	*Presentation of the project*
	Presentation title	*COCOP - Coordinating Optimisation of Complex Industrial Processes*
	Presentation topics	*COCOP project in general*
	Partner coordinating the activity	*TAU*
	Other partners involved	*DSM, VTT, Idener*
	Status	*Completed*
	Comments	
To be filled after the event	**Number of attendees**	*60*
	Picture of the event?	
	Any comment/feedback	*Networking with other projects related to COCOP*

Dissemination in the media (radio, newspaper, TV,..)	
Media type	*Press release*
Name of the media	
Scope	*National*
Audience Profile	*General public*
Date	*18.12.18*
Presentation title	*VTT kehittää ohjelmistotyökalua tuotantolaitoksen ympäristökuormituksen jatkuvaan seurantaan (English translation: VTT is developing a software tool for continuous environmental impact monitoring of production plants)*
Objective of the dissemination	*Promote online LCA*
Partner coordinating the activity	*VTT*
Other partners involved	*TAU*
Any comment/feedback	*In Finnish → Link: https://www.vtt.fi/medialle/uutiset/vtt-kehitt%C3%A4%C3%A4-ohjelmistoty%C3%B6kalua-tuotantolaitoksen-ymp%C3%A4rist%C3%B6kuormituksen-jatkuvaan-seurantaan*

Other Dissemination activity	
Type of activity	Doctoral Thesis
When	7.6.19
Where	Aalto University
Scope	World
Audience Profile	Process systems engineering community
Presentation title	Added value of extended dynamic simulation in process design and operational planning
Objective of the dissemination	Doctoral thesis
Partner coordinating the activity	VTT
Other partners involved	-
Comments	Link: https://aaltodoc.aalto.fi/handle/123456789/38147

9 Annex III: COCOP flyers

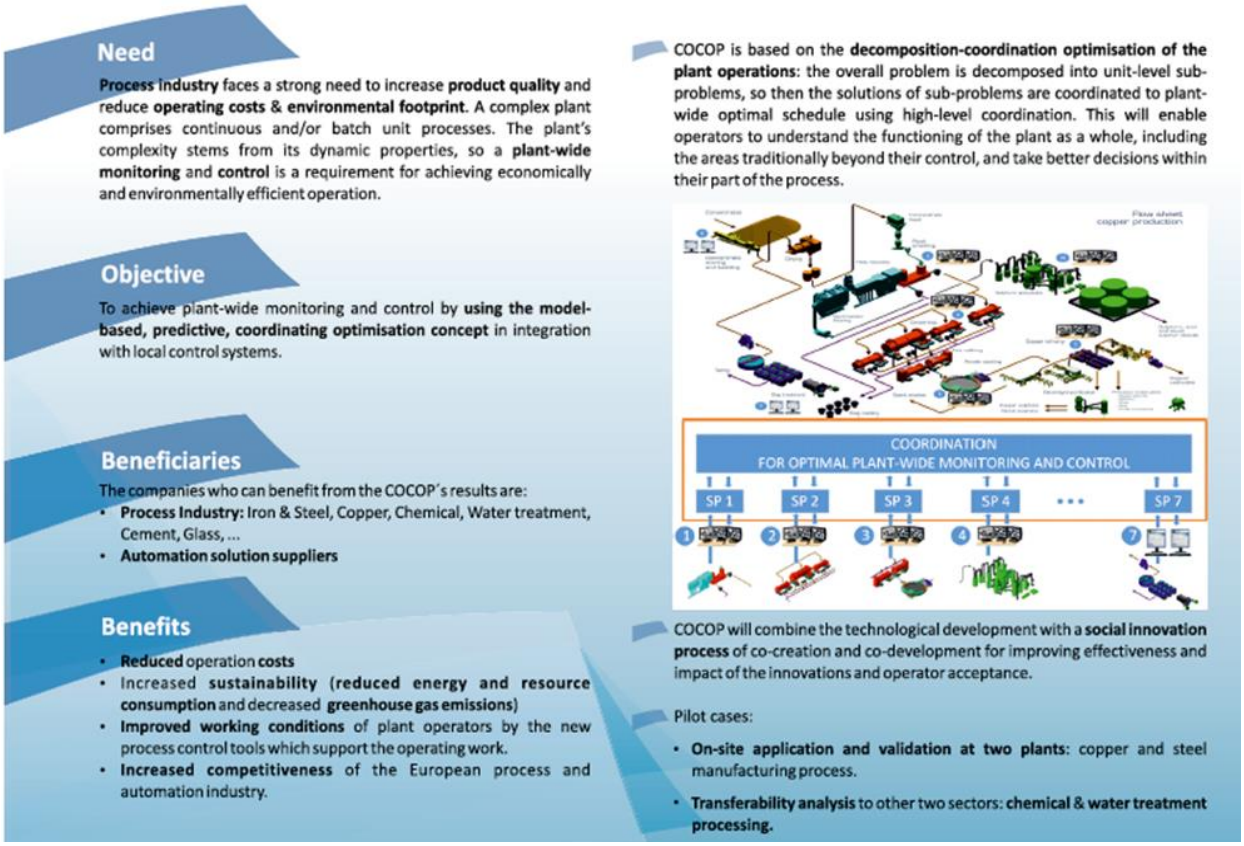


Figure 18. First COCOP flyer (external pages on the top and internal pages at the bottom)

Coordinating Optimisation of Complex Industrial Processes

12 partners from 6 European countries (Finland, Sweden, Denmark, Germany, The Netherlands and Spain) covering several sectors of the industry: **steel, nutritional** and **materials products, automation technology providers, consultancy** and **software.**

The vision:

Complex process industry plants will be optimally run by the operators with the guidance of a coordinating, real-time optimisation system

General details

Project Start Date: 1st October 2016
Project End Date: 31th March 2020
Project duration: 42 months
Grant Agreement n.: 723661
Subprogramme area: SPIRE-02-2016, H2020-IND-CE-2016-17
Web page: www.cocop-spire.eu
@CocopSpire

Contact Information

Prof. Matti VILKKO (matti.vilkko@tuni.fi)
Department of Automation
Science and Engineering
Tampere University
Finland

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723661

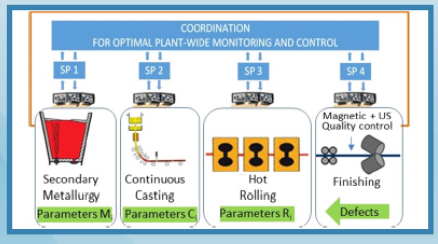
Need

Process industry faces a strong need to increase **product quality** and **reduce operating costs & environmental footprint**. A complex plant comprises continuous and/or batch unit processes, where the complexity stems from its dynamic properties, so a **plant-wide monitoring** and **control is needed.**

Objective

To achieve **plant-wide monitoring** & **control** by using the **model-based, predictive, coordinating optimisation** concept in integration with plant´s automation systems.

- COCOP is based on the **decomposition-coordination optimisation of the plant operations:** the overall problem is decomposed into unit-level sub-problems, and then, solutions of sub-problems are coordinated to plant-wide optimal operation using high-level coordination.



- COCOP combines the technological development with a **social innovation process** of co-creation and co-development for improving effectiveness and impact of the innovations and operator acceptance

Benefits

- Increased **product quality**
- Increased **productivity** and reduced operation **costs**
- Increased **sustainability** (reduced **energy and resource consumption** and decreased **greenhouse gas emissions)**
- Improved **working conditions** of plant operators
- Increased **competitiveness** of the European process industry

Steel pilot case

Goal: to develop a steel manufacturing **plant-wide monitoring and advisory tool to reduce the number of surface defects** at the final product for micro-alloyed steels, ensuring a good performance of the related sub-processes (secondary metallurgy (SM), continuous casting (CC) and hot rolling (HR)).

Models:

- SM model → predict the **castability index** of a heat.
- CC models → predict **thermal** and **shell thickness evolution** during the solidification process.
- HR model → predict **minimum/average temperature** of the billet before continuous rolling mill.
- Defects model → predict the **surface defects** generation in final product.

Advisory Tools:

- **Optimisation** tools → to define the optimal values for the parameters of the different sub-processes.
- **On-line monitoring and alarm** tools for SM and CC → to provide values of relevant parameters that are not measured and to warn in case of risks (alarms).
- **Off-line prediction** tools → to analyse the influence of the different parameters of the sub-process on its performance.
- **Quality** tool → to generate the quality report of a heat.

On-site application and testing:

Tools are easy to use and offer innovative data to support the production work and have a high potential the workers could benefit from.

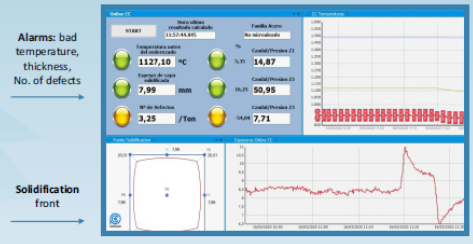


Figure 19. Final COCOP flyer for the steel case (external pages on the top & internal pages at the bottom)

Figure 20. Final COCOP flyer for the copper case (external pages on the top & internal pages at the bottom)

10 Annex IV: COCOP posters

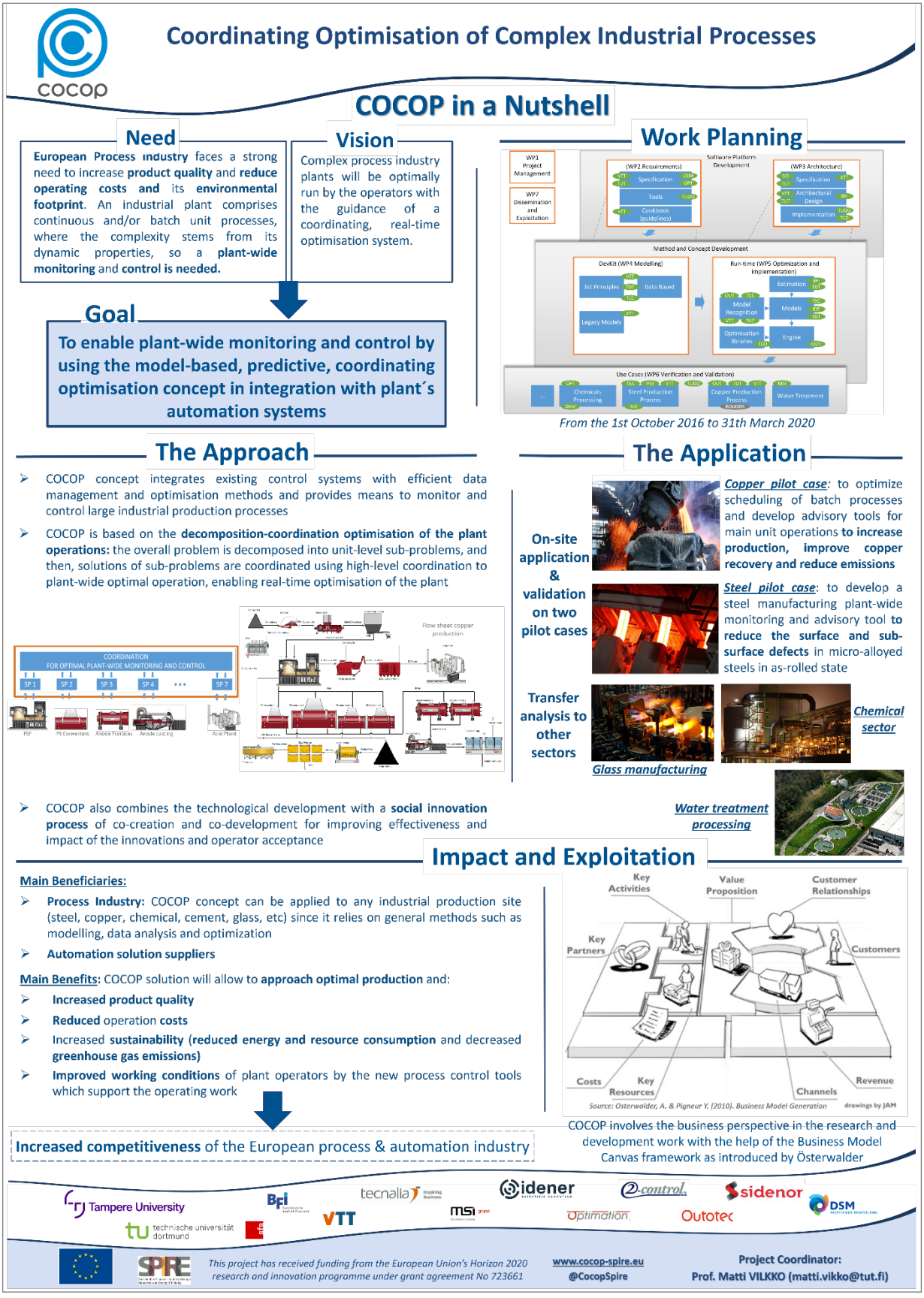


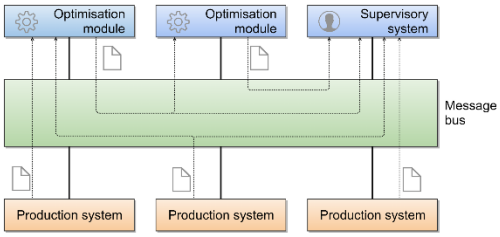
Figure 21. COCOP overview poster

Coordinating Optimisation of Complex Industrial Processes

Software Architecture

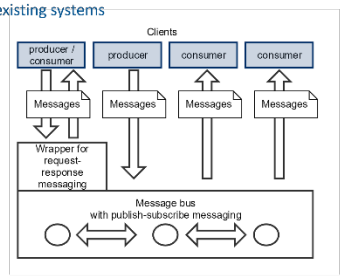
General Architecture

- Promote loose coupling of systems
- Communication based on
  1. a message bus
  2. commonly agreed message structures



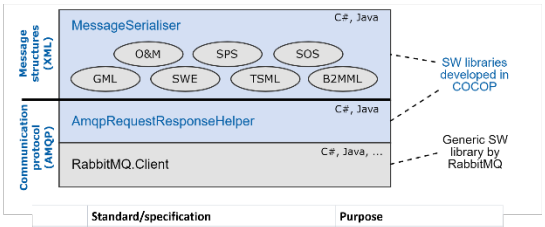
Supported communication patterns:

- publish-subscribe -> scalable for data streaming
- request-response -> enable integration to a variety of existing systems



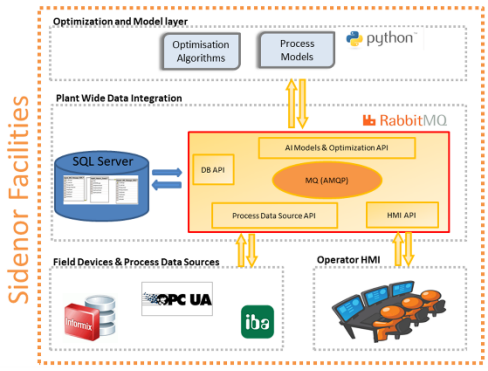
SDK

- Message structures and communication protocol are in separate layers
- The communication protocol is AMQP (v. 0-9-1)
- Messages structures are based on standards
  - O&M, SPS, SOS, GML, SWE, TSML: Open Geospatial Consortium (http://opengeospatial.org)
  - B2MML (implements ANSI/ISA-95): MESA International (http://www.mesa.org/en/B2MML.asp)
- SDK developed for .NET (C#) and Java
  - Still, messages are platform independent -> mixed platforms can exchange data

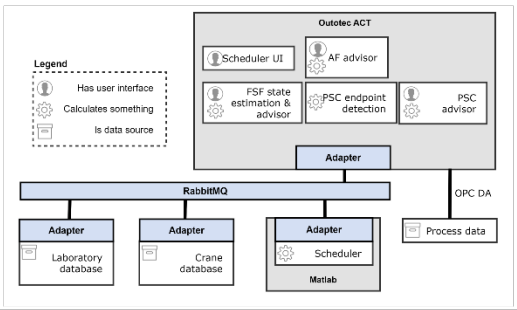


	Standard/specification	Purpose
AMQP	Advanced Message Queueing Protocol	Message bus
B2MML	Business to Manufacturing Markup Language	In COCOP: schedules
GML	Geography Markup Language (2016)	Measurement values
O&M	Observations and Measurements (2013)	Metadata of measurements
SOS	Sensor Observation Service (2012)	Request-response delivery of measurements
SPS	Sensor Planning Service (2011)	Remote control of tasks
SWE	SWE Common Data Model Encoding (2011)	Measurement values
TSML	TimeseriesML (2016)	Time series

Implementation: Steel



Implementation: Copper



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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723661

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@CocopSpire

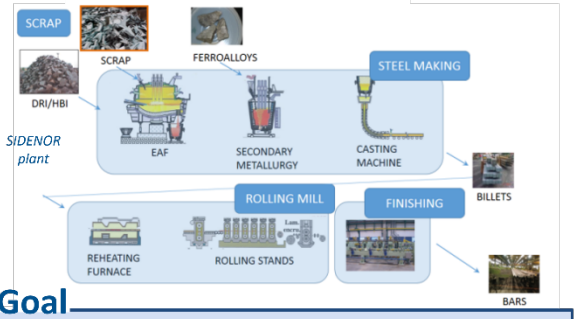
Project Coordinator:
Prof. Matti VILKKO (matti.vikko@tut.fi)

Figure 22. COCOP architecture poster

Coordinating Optimisation of Complex Industrial Processes

COCOP Steel Pilot case

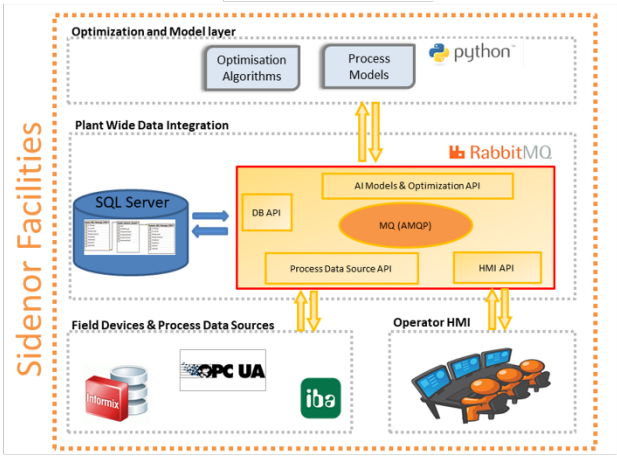
Steel making process



Goal

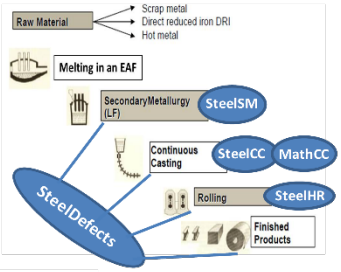
The aim is to develop a steel manufacturing plant-wide monitoring and advisory tool to reduce the number of surface defects at the final product for micro-alloyed steels, ensuring a good performance of the related sub-processes (secondary metallurgy (SM), continuous casting (CC) and hot rolling (HR))

Architecture



Models

- Model ***SteelSM***: data based model to **predict the castability index** of a heat after the SM process, a critical parameter regarding steel quality
- Model ***SteelCC***: data based model to **predict the temperature of the billet before the straightener** during the CC process
- Model ***MathCC***: mathematical model to **predict the thermal and shell thickness evolution** during the solidification process in the CC
- Model ***SteelHR***: data based model to **predict the minimum and average temperature of the billet** before the continuous rolling mill
- Model ***SteelDefects***: data based model to **predict the surface defects generation** in final product. It is defined by the parameters of the SM, CC and HR with the greatest influence on the occurrence of such defects



Coordinating Optimisation

To find the best combination of values for the key defect-related parameters of the three sub-processes (SM, CC, HR) that minimise the generation of surface defects in the final product assuring a good performance of each sub-process

Coordination Layer to assure a good global performance

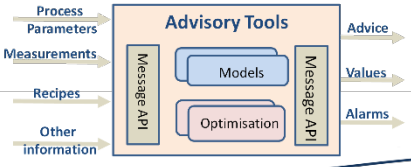
1. Use model *SteelDefect* to **get the optimal values of the key defect-related parameters** for each sub-process that **minimise the defects**
2. Optimize the parameters of each sub-process (using the models *SteelSM*, *SteelCC* and *SteelHR*) **to obtain a good performance**, considering as constraint the optimal values of the key defect-related parameters

Model *SteelSM* (data based model)	Model *SteelCC* (data based model)	Model *SteelHR* (data based model)
Optimisation: Maximise the **castability index**	**Optimisation**: Achieve the target **temperature of the billet before the straightener**	**Optimisation**: Achieve the target ***temperature*** *before the continuous rolling mill*

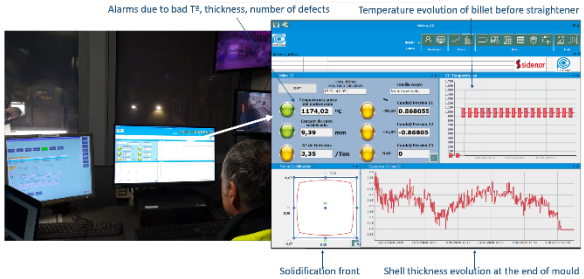
Model *SteelDefects* (data based model)
Optimisation: minimise the number of **surface defects**

Tools

- **Optimisation tools** → to define the optimal parameters for the different processes
- **On-line monitoring and alarm tools** → to provide values of relevant parameters of the process that are not measured and to warn in case of risks (alarms)
- **Off-line prediction tools** →to analyse the influence of the different parameters of the process on its performance
- **Quality report tool** →to generate a report of a heat with the analysis of the SM and CC process performance and the prediction of number of defects



On-line Testing



- It offers innovative data to support the production work and has a high potential the workers could benefit from. Additional functionalities are suggested
- It is user friendly, easy to use, not requiring additional workload

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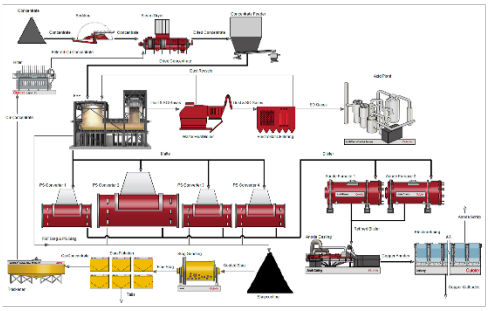
Project Coordinator:
Prof. Matti VILKKO (matti.vilkko@tut.fi)

Figure 23. COCOP steel pilot case poster

Coordinating Optimisation of Complex Industrial Processes

COCOP Copper Pilot Case Scheduling

Copper Production Process



Scope: From the flash smelting furnace to anode casting

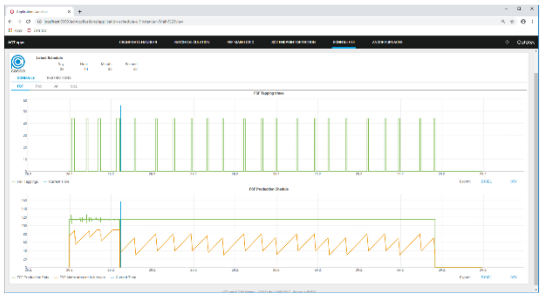
Optimised operation of the flash smelting furnace, Peirce-Smith converters and anode furnaces while considering the constraints imposed by the acid plant

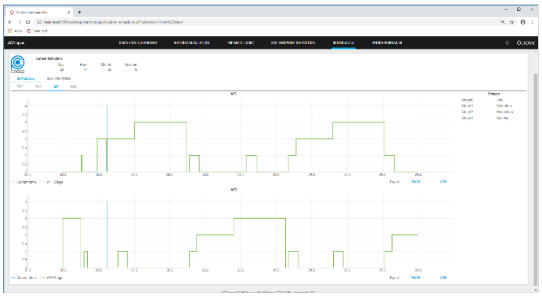
Overall objectives:

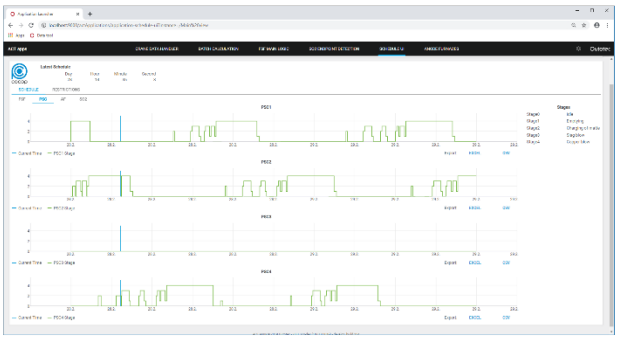
- Increase the production rates in situations where abnormal operating conditions may restrict capacity
- Provide advise to operators on current and upcoming operating stages
- Increase production stability through improved planning capabilities

Online Tests

- Tested in the real production environment with developers on-site for 2 weeks
- The current production state was incorporated by connecting the system to Outotec ACT software through the message bus
- Relevant scheduling situations occurred quite seldom. Improvements on the UI and usability are still needed







Continuous Time Solution

- **Mixed batch-continuous** scheduling problem
- The continuous time - MILP calculation can quickly provide **optimised schedules** when process conditions change
- 24 hour horizon with approximately 1000 variables, half integers – 3500 constraints – Solved in 10 seconds
- The result can be further improved by a single batch optimisation

Discrete Time Solution

- A single batch **discrete time** –MILP problem is formulated to provide an optimum schedule with **minimum copper losses.**
- The coordinator provides an optimum schedule considering the flash smelting furnace and Peirce-Smith converters only.
- The coordinator uses heuristics to solve the infeasibilities that exist among those units.
- The computational requirement is higher as compared to **continuous time approach.**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723661

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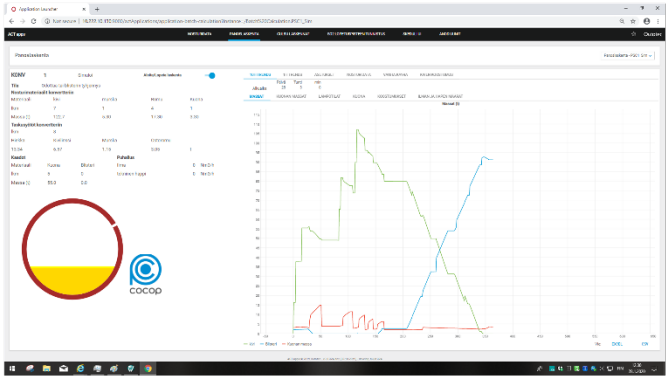
Figure 24. COCOP copper pilot case poster: schedulling

Coordinating Optimisation of Complex Industrial Processes

Peirce-Smith Converter Advisor

General

- The PSC Advisor simulates the batch process automatically
- The results are visualized in a web browser
- The process model is based on HSC Sim software
- Mass and energy conservation is solved transiently
- The model inputs are directly from automation data
- Simulates variables that are not measurable
- Enables improved process control with impact
  - *Brick lining life time, Increased revert melting, Cu recovery*



Matte Composition Calibration

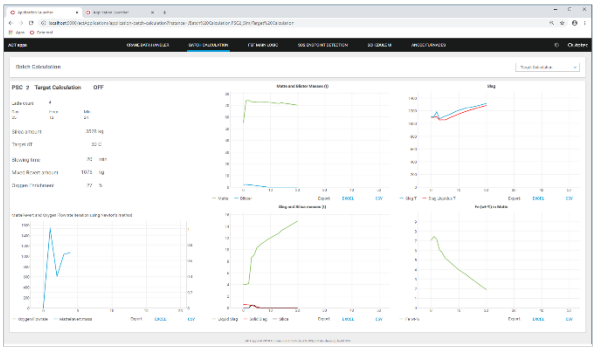
- The FSF composition history data is processed using Kalman filter
- Once new analysis of the FSF matte arrives, the PSC batch simulation is recalculated with updated matte composition of matte ladles
- Gives best possible simulation of current state

Slag Discharge Calibration

- When slag skimming is noticed the skimmed amount is estimated.
- When slag ladle measurement comes the batch simulation is repeated again and the discharged slag amount is corrected.

Advise for Slag Blow

- When a new matte ladle is measured, target calculation for coming slag blowing step is performed
- Proper amounts for silica and revert are searched
- Blowing time is set such that copper losses into the slag are minimized
- Silica amount is calculated using the mass balance over the slag blow
- The temperature target is determined by choosing a proper temperature difference for Slag and Slag liquidus temperatures
- Revert amount is computed iteratively by repeating the slag blow and updating the solution with Newton's method



Online Testing

- The simulated mass balance gave a reliable prediction of the state of the process
- Simulated temperatures were matching the manual dip rod measurements very well
- The PSC Advisor led to increased use of revert in slag blow during test period
- Especially young operators considered the PSC advisor as a useful tool
- Communication with the scheduling tool was working technically well

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723661ª

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Project Coordinator:
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Figure 25. COCOP copper pilot case poster: Peirce-Smith Converter (PSC) advisor

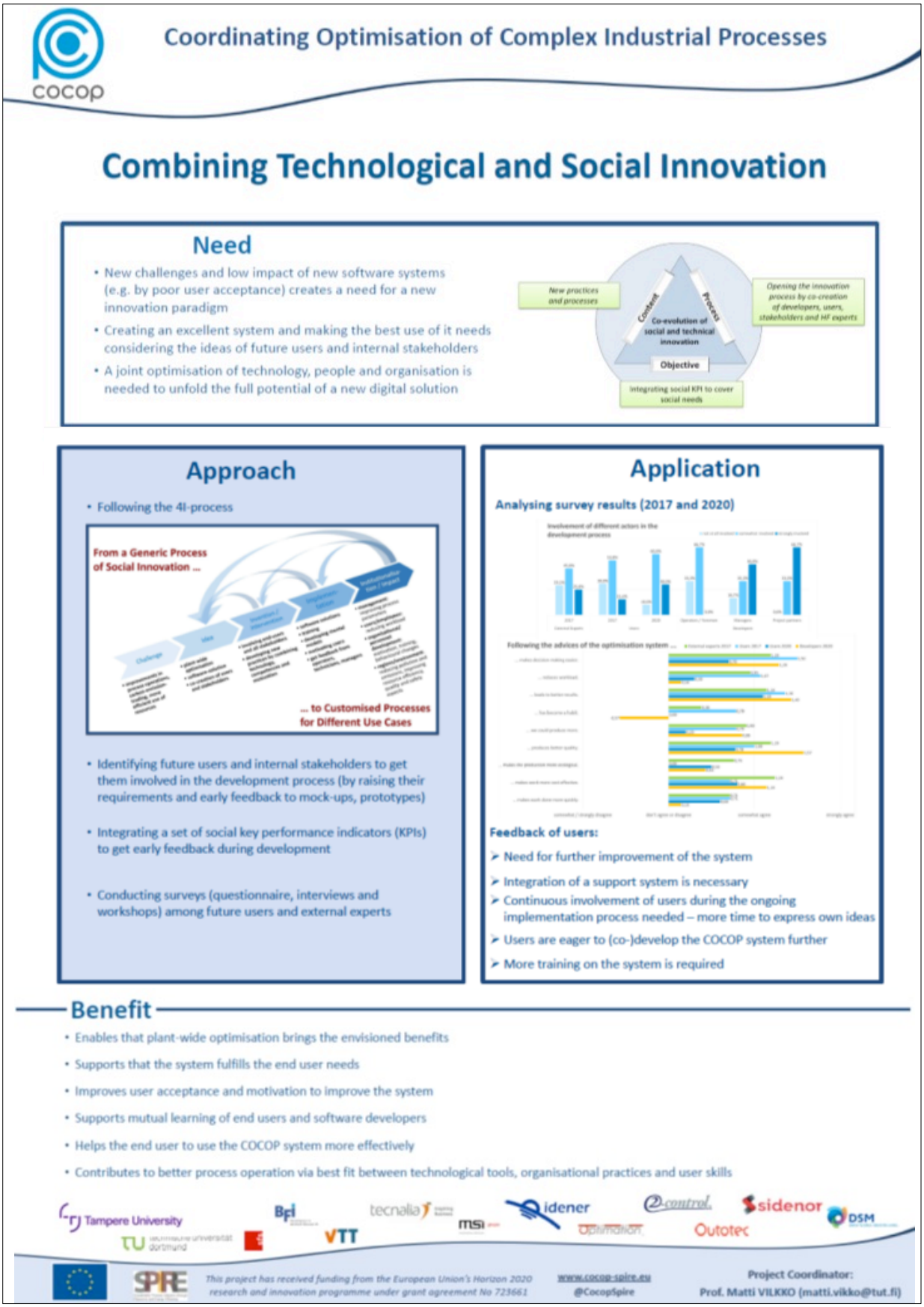

Figure 26. COCOP poster: combining technological and social innovation

11 Annex V: Programmes of the workshops organised by COCOP

DIGITIZED OPERATIONS for SUSTAINABLE PROCESS INDUSTRIES

Venue: DECHEMA, Frankfurt am Main, Germany

Date: 18 October 2018, 9:30 – 20:00

Programme of the Workshop

Time	Topic	Speaker
9:30	Registration	
10:15	Welcome by DECHEMA	Alexis Bazzanella (DECHEMA)
10:25	Overview of the workshop	Claudio Pastrone (ISMB)
10:30	EC Vision and recommendations	Angelica Marino (EC DG Research and Innovation)
10:50	SPIRE vision on digitization and data exploitation in sustainable process industries (title to be defined)	Martin Winter (chair of SPIRE Digital Working group, A.SPIRE)
11:10	EFFRA vision on digitization and possible synergies with SPIRE industries	Chris Decubber (Technical Director, EFFRA)
11:30	Coffee Break	
11:50	Introduction of the SPIRE-02 projects (vision and few initial results)	
12:00	MONSOON – MOdel-based coNtrol framework for Site-wide OptimizatiON of data-intensive processes	Claudio Pastrone (ISMB)
12:15	COCOP – Coordinating Optimisation of Complex Processes	Matti Vilkko (Tampere University of Technology)
12:30	FUDIPO – FUture DIrections of production Planning and Optimized energy- and process industries	Erik Dahlquist (Mälardalen University)
12:45	CoPro – Coordinated Production for Better Resource Efficiency	Sebastian Engell (TU Dortmund)
13:00	Lunch break	
	Technical Session: Plant-wide monitoring and control of data-intensive processes	
14:00	*Optimization and control of plant operations for improved efficiency* *(The session includes introduction and Q&A)*	Matti Vilkko (Tampere University of Technology)
	AI solutions for process and plant/site optimization in data intensive scenarios	Dimos Ioannidis (CERTH)
	Optimisation and scheduling in Copper plant	Mikko Korpi (Outotec)
	Large scale combined heat and power plants – production planning, performance monitoring and model based control with input from advanced sensors	Elena Tomas-Aparicio (Mälarenergi)
	Model-based operator support for improved energy efficiency in	Christian Jasch

DIGITIZED OPERATIONS for SUSTAINABLE PROCESS INDUSTRIES

MONSOON FUDIPO CoPro cocop

The objective of the workshop is to present the EU perspective on digital operations in process industries and to focus on plant-wide monitoring and control of data-intensive processes i.e., the scope of SPIRE-02-2016 projects.

First, the EU vision on digitization in sustainable process industries will be presented by Angelica Marino (*EC DG RTD*),, Dr. Martin Winter (chair of SPIRE Digital Working group - *A.SPIRE*) and Chris Decubber (Technical Director - *EFFRA*).

The four projects will then introduce their vision and first outcomes, through technical presentations and a poster session. Finally, a panel with main experts in the field will discuss about chances and challenges of full digitalization of process operations.

The event will end with the "Process Industry Aperitif" offering a pleasant workshop conclusion and an occasion for informal networking.

Attendance at the workshop is FREE, but the number of participants is limited. Please, register to the following link:

https://www.eventbrite.co.uk/e/digitized-operations-for-sustainable-process-industries-registration-50164721031

Venue:
DECHEMA
Frankfurt am Main, Germany

Date:
18 October 2018, 9:30 – 20:00

Workshop Organization Committee:

Rosaria Rossini (ISMB) - rossini@ismb.it
Marco Dias (GLN Plast) - marco.dias@famolde.pt
Claudio Pastrone (ISMB) - pastrone@ismb.it
Erik Dahlquist (Mälardalen University) - erik.dahlquist@mdh.se
Matti Vilkko (Tampere University of Technology) - matti.vilkko@tut.fi
Sebastian Engell (TU Dortmund) - sebastian.engell@tu-dortmund.de

SPIRE Sustainable Process Industry through Resource and Energy Efficiency

Figure 27. Programme of the Digitized Operations for Sustainable Process Industries Workshop (Oct. 2018)

Figure 28. Programme of the FUDIPO & COCOP final workshop (March 2020)