

Towards strategic action planning: using a collaboration maturity model to support international co-operation in research and innovation

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With the challenge to improve international co-operation in the area of raw materials research and innovation, especially between Europe and selected reference countries, the team of the INTRAW project came across several challenges. One of the challenges of the project consisted in the fact that action planning on collaboration could not sensibly be carried out without first categorizing the current state of collaboration as well as setting objectives on the state of collaboration envisioned. Existing approaches were not directly applicable in the context of international Cooperative & Support Action (CSA) planning addressing both company and policy level. Thus, considering the limitations of existing approaches and based on the capability maturity model integration (CMMI) approach, a generic and practical model was set-up to categorize the collaboration maturity already existing in companies, sectors and regions. This model allows categorization of the status as well as envisioned collaboration maturities related to single actions. The underlying methodology as well as the collaboration maturity model will both be described in more detail in this paper illustrated by reference to insights from the INTRAW project.

collaboration maturity model, research and Innovation, strategic action planning

I. INTRODUCTION

The aim of the European Commission funded INTRAW project was to work towards a sustainable future for the European Union in terms of access to raw materials, by establishing the European Union's International Observatory for Raw Materials. Although the project is now complete, the work is continuing through the Raw Materials Observatory, an association founded by the members of the INTRAW project consortium.

An important element of the work carried out in the context of the INTRAW project was the development of an action plan for a range of raw material stakeholders aimed at improved collaboration. Areas addressed in this strategic action plan were (1) research and innovation, (2) education and outreach, (3) industry and trade, and (4) substitution and recycling. For each of these areas, a benchmarking exercise between the European Union and selected reference countries was carried out as a basis

for strategic action planning and road mapping (For the report on research and innovation see e.g. [1]).

The target user group for strategic action planning in the context of the INTRAW project is decision makers at company and policy level to support their long-term planning concerning the access to raw materials, and principally focused on international collaboration.

II. BACKGROUND AND METHODOLOGY OF THE COLLABORATION MATURITY MODEL

A. The need to categorize collaboration maturity for strategic action planning

In the context of strategic action planning, the consortium of the INTRAW project faced a number of key challenges. One of these was the development of actions for development of international cooperation given a high level of uncertainty on future developments and scenarios. In order to anticipate multiple futures, three contrasting scenarios were developed to describe alternative worlds of raw materials in the year 2050 [2]. Based on these scenarios, the INTRAW team was able to analyze and evaluate the robustness of the current state and examine how each single action would affect potential future developments. Fig. 1 shows an overview of the framework used for the development of the strategic action plan for collaboration in raw materials developed in the context of the INTRAW project.

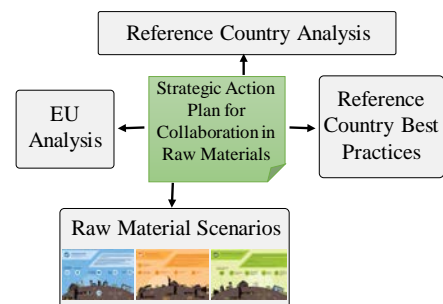


Fig. 1. Framework for strategic action planning in the context of the INTRAW project

A basic requirement for the identification of actions able to enhance collaboration is a deep understanding of the current state as a baseline or starting point for any progress or further development. Characterization of this baseline allows improved allocation of different actions and a more transparent communication of the underlying logic for decision makers. Being able to analyze different levels of collaboration between the systems of single companies and between the systems of entire economies or countries is one of the key requirements for developing a collaboration maturity¹ model in the context of the INTRAW project.

B. Existing approaches for the categorization of collaboration maturity

Collaboration in research and innovation is a topic that is researched upon since several decades [3]. It is assumed leading to improved quality, faster results and faster diffusion [4, p. 77]. The measurement of collaboration in research and innovation is in most cases carried out from an input and an output perspective: input is e.g. measured based on factors such as spending, human factors and equipment. Output is often measured in patents or publications as well as dissemination, training exploitation activities [5–7]. Existing research and innovation indicators in the reference countries were collected and analyzed in a benchmark exercise [1].

Maturity models are well accepted at different economic and policy levels to analyze and categorize the maturity of a variety of objects. Their key aim is to categorize the development of an object or a domain over time [8]. In the case of the required maturity model for the INTRAW project, “collaboration” is understood to be a joint effort towards a common objective. Collaboration in Research and Innovation are used for the realization of “broad” and “narrow” results, can happen top-down and bottom-up and create mutual benefit to mutual actors. The common objective of the INTRAW project is an improved access to raw materials including underlying processes of the raw material value chain. An early example of a maturity model is the Quality Management Maturity grid, describing the maturity of quality management in six categories [9, 10, 11, p.21f]. However, for a project focusing the objective of maturity models on the thematic area of collaboration, only a limited number of suitable models exist. An overview of existing collaboration maturity models is shown in TABLE I. These models are not generally applicable beyond team, project or company level and are often configured for more specific purposes such as knowledge sharing or interoperability in information and communication technologies. It can be observed that a significant influence and primary focus of development activities in this area has been software development and interoperability of information technology.

TABLE I. OVERVIEW ON EXISTING COLLABORATION MATURITY MODELS

Model	Description	Level of application
ECMM [12, 13]	Enterprise Collaboration Maturity Model for companies to adopt best collaboration and interoperability practices.	Corporate level
CollabMM [14]	Improve productivity and knowledge sharing in organizations.	Corporate level
Col-MM [15]	Quality assessment of team collaboration in organizations.	Team level
Collaboration 2.0 Maturity Model [16]	Support organizations in their introduction of enterprise social software or platforms.	Corporate level

A more extended list of existing models is provided by Alonso et al, especially in the context of software interoperability related to specific industries such as software development, defense or government services [12, p.431]. Other approaches are used to analyze performance on a project level [17]. Industry-Research typologies are generally meant to analyze single actors in specific collaboration systems e.g. related to their collaboration intensity [18, 19, 2f]

Overall, there was no maturity model found to be applicable in the context of the INTRAW project that addresses both company and policy level. Throughout the development process, various concepts for the analysis of collaborations were considered, e.g. for new strategic models of science industry collaboration [20], for a new collaboration-based approach for “opening up the innovation system towards new actors and institutions” [21], for policy driven collaboration networks between actors of the innovation system [22] or global R&D management and organization [23–26].

C. Development of a practical model to categorize collaboration maturity at company and policy level

The collaboration maturity model developed for the INTRAW project is based on the benchmarking results in the domains addressed and refined in interactive workshops of the INTRAW project consortium together with international representatives from the reference countries. Furthermore, it was tested and improved during the strategic action planning stage.

In order to derive actions based on the current state and the scenarios for the year 2050 [2, 27], current activities and the state of collaboration between Europe and the reference countries has to be considered as a basis. Thus, based on the CMMI framework², a collaboration maturity model [16] has been developed in the INTRAW project to evaluate the current state of collaboration between EU and the reference countries (Australia, Canada, Japan, South Africa and the United States of America) for each of the actions developed.

¹ The purpose of a collaboration maturity model is to help organizations understand the state of collaboration today, where it should go in the future and

the value of doing so, and how to get there.

² See for latest version of CMMI <http://cmmiinstitute.com/> (acc. Feb. 2017).

III. A COLLABORATION MATURITY MODEL FOR SUPPORTING STRATEGIC ACTION PLANNING FOR COMPANIES AND POLICY

For collaboration between the European Union and the reference countries selected, actions highly depend on the status of collaboration already existing. This is because the process of change arising from the actions will be evolutionary and not present an opportunity to leapfrog levels of collaboration. Thus, the improvement and especially the objective to attain higher levels of collaboration maturity has to be planned within a rather long and sustained time horizon. The objective of this model is to measure rather the management and thereby the maturity of collaboration than the collaboration itself, that is already covered with numerous RTD indicators in the reference countries [1, 7]. The five levels considered for collaboration maturity in the context of the INTRAW project are shown in Fig. 2.

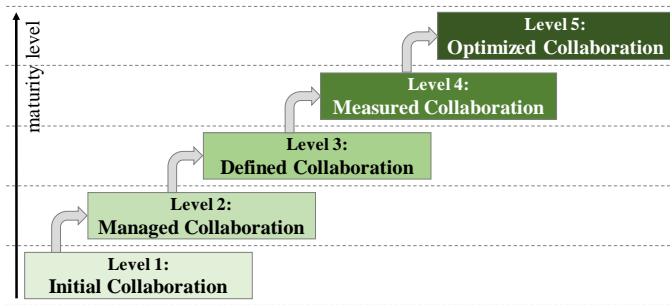


Fig. 2. INTRAW collaboration maturity model based on five categories of collaboration maturity.

In more detail, the maturity levels can be described as follows, starting from level 1 as a baseline for further improvement (see also [28]):

- **Level 1 – initial collaboration:** Unstructured collaboration, poorly controlled and reactive on an occasional and short-term basis. In this level, there are only unstructured activities for collaboration existing between the countries or companies. Overall planning of collaboration activities is not visible or existing.
- **Level 2 – managed collaboration:** Project-oriented collaboration is carried out most often in a reactive manner. In the managed collaboration, occasional programs for collaboration can be identified, but without any overarching objectives or standards. An overall collaboration strategy or plan is missing at this level.
- **Level 3 – defined collaboration:** Standardized, targeted and proactive collaboration. At this level, collaboration activities can be clearly related to underlying targets and objectives. Collaboration activities are based on common, pre-defined standards able to continuously support reaching defined goals and objectives.
- **Level 4 – measured collaboration:** Measured and controlled collaboration related to their efficiency and effectiveness. In addition to the 3rd collaboration maturity level, collaboration activities are not only targeted and based on common standards but also measured and controlled regularly from the input,

process and/or output perspective to evaluate their efficiency and effectiveness.

- **Level 5 – optimized collaboration:** Continuously improved collaboration supporting long-term objectives. This level combines all aspects of planned, measured and controlled collaboration in combination with the additional aspect of continuous improvement and the clear linkage of collaboration actions to short-, mid- and long-term objectives.

Indicators applied for the identification of collaboration maturity levels are shown in TABLE II.

TABLE II. INDICATORS FOR THE IDENTIFICATION OF COLLABORATION MATURITY LEVELS.

Indicator	Measurement				
	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
Collaboration planning	-	Reactive planning	Proactive planning	Proactive planning	Proactive planning
Collaboration Strategy	-	-	Targets & objectives defined	Targets & objectives defined	Targets & objectives defined
Collaboration measurement	-	-	-	Input, process, output	Input, process, output
Collaboration improvement	-	-	-	-	Continuous

Based on the complexity of the collaboration systems to be analyzed in the context of the INTRAW project, indicators for the collaboration maturity levels considered were analyzed in a qualitative and semi-quantitative approach categorizing the status of collaboration systems into two or three levels (e.g. no collaboration planning, reactive collaboration planning, proactive collaboration planning)

The five levels of collaboration maturity allow a common understanding of the current state of collaboration between the European Union and the reference countries related to each of the actions proposed on a company and on a policy level. It has to be considered that, despite providing a quantified scale, the collaboration maturity levels described are qualitative; reflecting the opinion of the INTRAW consortium members and representatives of the reference countries. Thus, there is scope for them to vary according to different perspectives on the collaborative situation - this feature is both a strength and a weakness of the model developed.

IV. APPLYING THE COLLABORATION MATURITY MODEL FOR STRATEGIC ACTION PLANNING IN THE INTRAW PROJECT

The design of an activity in the framework of an action plan is the result of upstream work, which allows the identification of a specific need for action or an opportunity for collaboration. Regardless of what is at the basis of decision making on the design of a specific action, the fact is, the proposed action always aims to contribute to improvement in an initial situation.

As pointed out in the description of the background and methodology of the collaboration maturity model developed for

INTRAW, the application of this model requires not only definition of the starting point in the collaboration within the scope of each proposed action, but also the expectation on the envisioned level of collaboration after successful conclusion of the action. For analyzing the collaboration maturity of collaboration systems defined in the INTRAW project, country representatives and field experts in raw material RTD were involved. Indicators and criteria were provided to the experts in the form of a checklist as an indicative tool for defining the collaboration maturity based on the levels described.

As an example of the application of the collaboration maturity model developed, specifications of two different actions with different collaboration maturity levels are shown in TABLE III and TABLE IV.

TABLE III. EXAMPLE 1 OF THE ACTION PLAN TO ENHANCE INTERNATIONAL RESEARCH AND INNOVATION ACTIVITIES ON RAW MATERIALS: PROMOTING REFERENCE COUNTRY'S PARTICIPATION IN H2020 [28].

ACTION	Promoting reference countries participation in Horizon 2020³ with emphasis on raw materials
TARGET GROUP	All stakeholders concerned by collaborative research and innovation activities.
GOAL	Promote existing collaboration frameworks. This can be done both, on a general level as well as on a targeted level to enhance benefits from selected R&I areas with specified reference countries.
TIME HORIZON	Mid- to long-term (>2 years).
INSTRUMENT	Further promoting the expansion of joint programs by marketing activities towards relevant stakeholders and through appropriate trade agreements and legal frameworks for R&I.
FACILITATOR	European Countries and its governments, Pan European Networks (like ERA- MIN), governments of reference countries.
SCENARIO	Scenario 1 and 2 (Sustainability Alliance and Unlimited Trade).
COLLABORATION MATURITY	Level 1: Partners from reference countries only participate in joint programs on an occasional basis.
INTERLINKAGE	Provide promotion in an integrated way, also for the areas of education and outreach and industry and trade.

For the particular case of example 1 shown in TABLE II, an extended participation of reference countries in activities and projects co-funded in the context of the Horizon 2020 program is proposed. The basis, in terms of collaboration maturity, is very low since partners from reference countries only participate in joint programs on an occasional basis. For this action, companies and policy makers can therefore start from a relatively green field without the need to coordinate action planning with existing activities or strategic objectives for collaboration. However, in the longer term, the success of this action will make it easier to reach other more structured and consolidated collaboration maturity levels.

TABLE IV. EXAMPLE 2 OF THE ACTION PLAN TO ENHANCE INTERNATIONAL RESEARCH AND INNOVATION ACTIVITIES ON RAW MATERIALS: CREATE MULTINATIONAL RESEARCH AND INNOVATION COOPERATION AGENDAS [28].

ACTION	Create multinational research and innovation cooperation agendas on a multilateral basis according to key priorities of RM research
TARGET GROUP	All stakeholders concerned by collaborative research and innovation activities, policy makers and officers of projects in European Union and reference countries.
GOAL	Collaborating with the reference countries should focus on activities with the highest benefit for all participating parties.
TIME HORIZON	Mid- to long-term (> 2 years).
INSTRUMENT	Further expansion of bilateral agreements such as FEAST, CSIRO or JSTCC.
FACILITATOR	European Countries and its governments, key players of already existing collaborations as FEAST, CSIRO or JSTCC.
SCENARIO	Scenario 1 and 2 (Sustainability Alliance and Unlimited Trade).
COLLABORATION MATURITY	Level 3: Collaboration is going on but has to be further expanded.
INTERLINKAGE	Bilateral agreements are crucial for the expansion of joint programs on a governmental level between the EU and the reference countries.

In example 2 shown in TABLE III, the topic addressed in the proposed action starts from a collaboration maturity level considerably higher than the action shown in TABLE II, and thus a more sophisticated baseline. Collaboration in the context of this action is already addressed in various activities. An extension of current collaboration activities thus requires a much higher coordination between existing actors and activities. Furthermore, an extension of collaboration maturity beyond level 3 must not only deal with actions and activities, but also the measurement of input and output of each action as well as its process efficiency.

V. OUTLOOK AND NEXT STEPS

The collaboration maturity model developed in the context of the INTRAW project allowed the categorization of the current state of collaboration maturity as well as the definition of objectives envisioned by each of the actions defined. This led to an improved prioritization of the actions defined and helped to estimate underlying cost and resource requirements.

Due to the fact that the analysis was carried out at a relatively high level, mostly relying on the judgement of experts and country representatives, it might be valuable to introduce sub-criteria that can be cumulated into the final maturity levels. This would increase transparency for decision makers and thus would potentially increase the level of adoption at a company and policy level. Among existing models, a strong baseline exists to derive criteria for the analysis and categorization at a company and policy level (see e.g. [15, p.310]). Whereas an additional, more detailed level of categorization adds value for decision makers, it has to be balanced against the additional amount of resources necessary for the analysis and the loss of general

³ Horizon 2020 is the biggest EU Research and Innovation program ever with

nearly €80 billion of funding available over 7 years (2014 to 2020).

applicability and should be elaborated for both, the methodology and the methods applied, in concrete case analyses.

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