ISEACAP : a gamified participative method for a better understanding of organisational routines related to the absorptive capacity

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ISEACAP: a gamified participative method for a better understanding of organisational routines related to the absorptive capacity

Abstract

SMEs (Small and Medium sized Enterprises) confront resource scarcity during innovative projects. Thereby they are increasingly taking part in collaborative networks to access the required complementary knowledge for conducting their projects. To achieve this, SMEs deploy their absorptive capacity (ACAP) which means their ability to acquire, assimilate, transform and apply external knowledge. ACAP can be integrated via diverse practices called routines when they are repeated and accepted collectively. However, organisation's actors often perform these routines unconsciously. Thus, enhancing knowledge absorption requires highlighting applied routines to acquire, assimilate, transform and exploit external knowledge.

This interdisciplinary thesis aims at: (i) Proposing a new participative method called ISEACAP (Identification, Simulation, Evaluation and Amelioration of Absorptive Capacity) based on gamification techniques. (ii) Providing a refine level of applied knowledge and ACAP's routines during innovative project by detailing related practices to each dimension of ACAP (acquisition, assimilation, transformation and application). (iii) Highlighting roles of ISEACAP's facilitators during experimental sessions to raise reflexivity among participants (organisations' actors). (iv) Describing role of ISEACAP's phases to facilitate learning on ACAP's routines for actors.

Applied methodology during this thesis relies on qualitative analysis of collected data through semi-structured interviews and experimental sessions via ISEACAP. Based on the conducted interviews and experimental sessions in France and UK with practitioners, in different activity sectors, two case studies had been developed in textile and food sectors. Collected data from these two cases were coded and analysed thematically. Considering the results, this thesis contributes in engineering science by proposing and formalising a new gamified participative method (ISEACAP), and in management science, the contribution relies on providing a better understanding of ACAP's routines.

Keywords: *Participative methods, Absorptive capacity, Organisational routines, Organisational learning, reflexivity*

ISEACAP : une méthode participative gamifiée pour mieux comprendre les routines organisationnelles liées à la capacité d'absorption

Résumé

Les PME (Petites et Moyennes Entreprises), dont les ressources sont limitées, prennent de plus en plus part à des réseaux collaboratifs. En effet, ces derniers leur permettent d'accéder à des connaissances complémentaires nécessaires pour mener à bien leurs projets innovants. Pour y parvenir, les PME doivent déployer leur capacité d'absorption (ACAP), c'est-à-dire leur capacité à acquérir, assimiler, transformer et appliquer la connaissance externe. Ces capacités, déployées de façon individuelle et collective, prennent la forme de différentes pratiques appelées routines lorsqu'elles sont répétées et acceptées collectivement. Or, les différentes dimensions de ces routines sont encore peu connues.

L'objet de cette thèse interdisciplinaire en sciences de gestion et en sciences informatique (ingénierie des méthodes) est de : (i) proposer la méthode participative ISEACAP (Identification, Simulation, Evaluation et Amélioration de la Capacité d'Absorption) intégrant des techniques de gamification (ii) modéliser et décrire finement les connaissances mobilisées ainsi que les routines d'absorption associées, en sein de projets innovants, en détaillant les pratiques de chacune des dimensions de l'ACAP (acquisition, assimilation, transformation, application) (iii) mettre en évidence le rôle des animateurs d'ISEACAP pour favoriser la réflexivité des acteurs sur leurs routines d'ACAP (iv) décrire les phases d'ISEACAP qui facilitent l'apprentissage des acteurs dans leurs routines d'ACAP.

La méthodologie suivie pendant cette thèse a consisté en une analyse qualitative des données collectées sous la forme d'entretiens semi-directifs et des expérimentations conduites par ISEACAP. A la suite des entretiens et des séances d'expérimentation réalisées en France et en Angleterre avec des praticiens, dans différents secteurs d'activité, deux études de cas ont été développées dans les secteurs du textile et de l'alimentaire. Les données collectées à l'issue des études de cas ont été codées sous la forme d'une analyse thématique. Les contributions en ingénierie des méthodes consistent dans la proposition et la formalisation de la méthode ISEACAP. En sciences de gestion, la thèse contribue à mieux comprendre les routines d'ACAP.

Mots clés : Méthodes participatives, Capacité d'absorption, Routines organisationnelles, Apprentissage organisationnel, Réflexivité

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Glossary of Acronyms

Acronym	Term
4EM	For Enterprise Modelling
ACAP	Absorptive capacity
ADR	Action Design Research
BPMN	Business Process Model and Notation
CDM	Critical Decision Making
DCs	Dynamic Capabilities
DSL	Domain Specific Language
DSML	Domain Specific Modelling Language
EKD-CMM	Enterprise Knowledge Development - Change Management Method
HRM	Human Resource Management
ISEA	Identification, Simulation, Evaluation, Amelioration
ISEACAP	Identification, Simulation, Evaluation, Amelioration of Absorptive Capacity
MDE	Model Driven Engineering
ME	Method Engineering
MOF	Meta Object Facility
OMG	Object Management Group
OPS	Open Source Software
PACAP	Potential Absorptive Capacity
PCEP	Pragmatic Constructivist Epistemological Paradigm
RUP	Rational Unified Process
SECI	Socialisation, Externalisation, Combination, Internalisation
SME	Small and Medium size Enterprise
UML	Unified Modelling Language
UX	User Experience
RACAP	Realised Absorptive Capacity
UCD	User Centred Design

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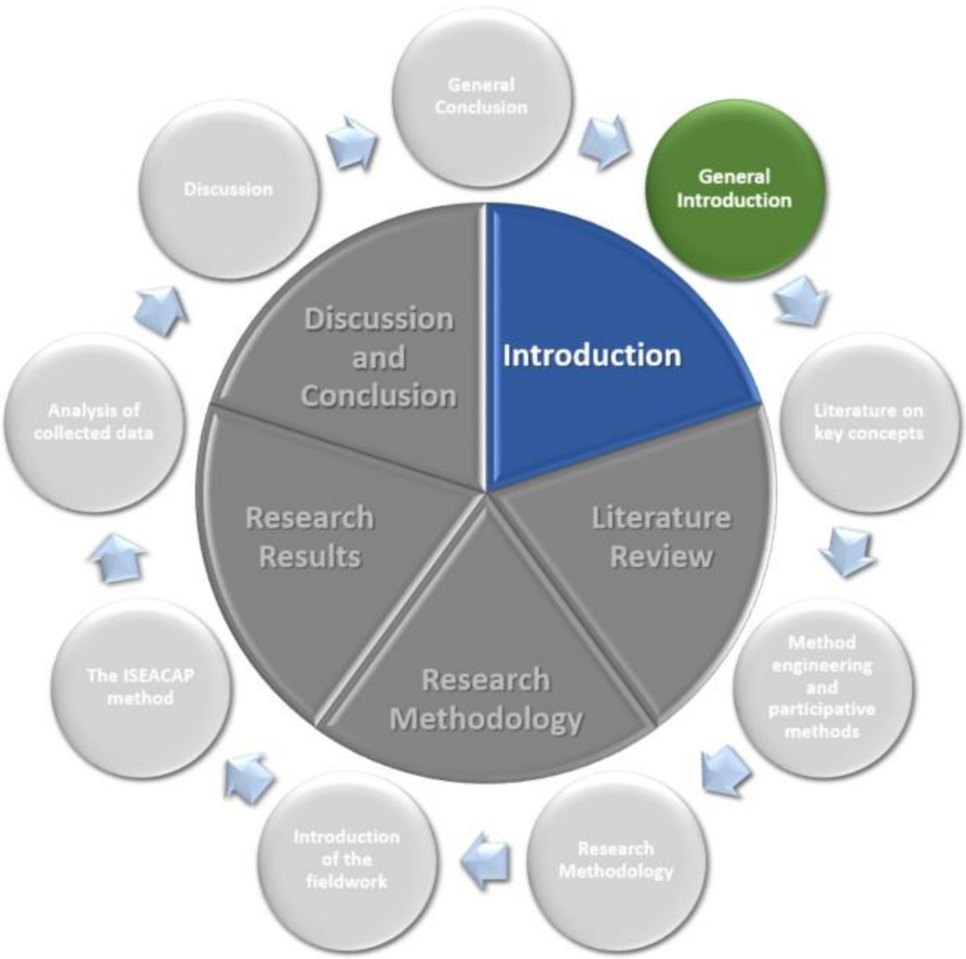
Chapter 1. General Introduction

RESEARCH CONTEXT AND PROBLEM
OBJECTIVES AND EXPECTED RESULTS
RESEARCH DESIGN
STRUCTURE OF THE DISSERTATION



1.1 Research context and problem

Innovative projects are vital for small and medium-size enterprises (SMEs) in order to achieve competitive advantages within the market. However, developing such projects necessitates a vast domain of knowledge which can create challenges for SMEs such as resources and competence's scarcity during project development. Thus, SMEs need to develop their innovative projects collaboratively in order to have access and use partners' knowledge. Hence, it has become widely accepted that organisations' abilities to create, retain, communicate and use knowledge are critical to their success (Duchek, 2013; Nonaka, Toyama & Nagata, 2000).

"A key factor to enhance the firm's ability to benefit from externally acquired knowledge is its absorptive capacity" (W. M. Cohen & Levinthal, 1989). To this end, Cohen & Levinthal defined the concept of absorptive capacity as "the ability of a firm to identify, assimilate, transform and exploit external knowledge for achieving organisational outcomes" (W. M. Cohen & Levinthal, 1989). Later in 2002, Zahra and George redefined absorptive capacity as "a set of organisational routines and processes by which firms acquire, assimilate, transform and exploit knowledge for producing dynamic organisational capabilities" (Zahra & George, 2002). Consequently, scholars argue that enhancing absorptive capacity necessitates the identification of organisational routines by which organisations acquire, communicate and assimilate external knowledge (Tu, Vonderembse, Ragu-Nathan, & Sharkey, 2006).

According to the literature, "organisational routines are perceived as activity patterns" (Becker, 2004) "that are repetitive and recognisable between interdependent actions and are carried out by multiple actors" (Feldman & Pentland, 2003). Many IS scholars treat the specific routines that constitute a firm's absorptive capacity as a "black box". In the same line, they argue that empirical analysis of absorption practices and routines poses a great challenge to the researchers as it is an attempt to comprehend complex, embedded and context-dependent patterns of knowing and acting (Duchek, 2013). Organisational practices and routines are typically dispersed over time and space (Pentland & Feldman, 2008) and identifying a particular routine necessitates complex qualitative methods (Pentland, Feldman, Becker, & Liu, 2012). Researchers must immerse themselves in the life of target organisation and conduct time consuming and costly longitudinal studies (Charreire Petit & Huault, 2008). Hence, there is a need to propose innovative methods that facilitate studying ACAP's routines and practices. In this study, we have considered routines as practices which can be performed systematically within the organisations and our general research question arises, "*How can we provide a better understanding of ACAP's routines?*" In other words, this question focuses on providing clear picture of ACAP's routines and practices for both researchers and organisations' actors. To this end, the first sub question arises, "*What kind of method can we propose to highlight ACAP's organisational routines?*"

Providing a better understanding of ACAP's routines can facilitate learning about ACAP's routines among the organisations' actors (Lane, et *al.*, 2006; Rezaei-Zadeh & Darwish, 2016). Scholars consider that organisations engage in learning at the collective level (Spicer & Eugene, 2006). To this end, collective reflexivity or reflective discussion is defined as a medium that allows people to generate meaning from an experience (Knipfer *et al.*, 2013, p. 5).

Reflexivity encompasses changes or problems that require the modification of existing working routines or invention of new ones (Knipfer *et al.*, 2013, p. 5). Therefore, reflexivity can be considered as a driving force to lead organisational learning besides making changes and improvements in the routines (Dittrich et *al.,* 2016). Collective reflexivity facilitates the integration of both individual and team learning into organisational best practices. However, inspiring the participants to participate in a collective way besides capturing and analysing reflective discussions is difficult for the researchers. A reflexivity based research often implicates building longitudinal and ethnographic case studies which can be prohibitively costly and time consuming (Howard-Grenville *et al*., 2016; Parmigiani & Howard-Grenville, 2011).

Based on the argued literature gap and our general research question, the two following sub-research questions arise here: (1) *"How to provide a reflexive space for organisations' actors to have reflection on their ACAP's routines?"* (2) *"How can organisational learning be enhanced via reflexivity?"*

1.2 Objectives and expected results

Our main research question has been developed through a literature review on the concepts of ACAP, organisational routines, reflexivity and organisational learning. As the result, we proposed a conceptual model to position our research.

In addition to addressing the first sub-question, we investigated on applied method for studying the ACAP's routines and practices and continued reviewing the fundamentals of method engineering and participative methods that allowed us constructing a participative method called ISEACAP (Identification, Simulation, Evaluation and Amelioration of Absorptive CAPacity). Based on the second sub-question, the ISEACAP provided a reflexive space on ACAP's routines through various techniques. Addressing the third sub-question, we applied the ISEACAP method in six different organisations in France and UK to study how the organisation learning can be enhanced via reflexivity on ACAP's routines.

ISEACAP consists of four phases: (i) model the process of the project (ii) map the knowledge mobilised during the project (iii) elicit organisational routines by which external knowledge is acquired and assimilated and (iv) enrich the elicited routines.

The construction of ISEACAP method relies on method engineering approaches in computer science. Applying the method in the organisations and analysing collected data rely on management science.

The application of four phases of the method provides a reflexive space where the participants are encouraged to get highly involved and discuss collectively on their ACAP's routines/practices through gamification and knowledge elicitation techniques. Their collective and guided reflexivity based on the protocol of ISEACAP allows the participants to better understand the ACAP's routines/practices, share their individual knowledge, reflect collectively on how to improve the ACAP's routines/practices for their future projects and finally create consensus results.

The method enables a common understanding among the researchers and organisations' actors in terms of ACAP's routines/practices. On the one hand, it helps the participants characterise and evaluate their identified routines/practices by providing an intense and guided collective discussion among them. On the other hand, these discussions allow researchers to collect valuable and in-depth data on ACAP's routines/practices and achieve a micro level of analysis.

1.3 Research Design

We applied a collaborative research by conducting about twenty brainstorming meetings among researchers from computer, management and industrial engineering sciences. During these meetings, we collected interesting ideas for developing the protocol of ISEACAP.

The method should be applied in-group sessions, also called experimental sessions, in computer science by having both organisations' actors and researchers around the table. To start, the researchers play the role of facilitators by following the protocol of ISEACAP and guiding the participants who should be the key actors of collaborative innovation projects of SMEs. However, in the long-term, the organisations' actors can play the role of the facilitator and reach to a continuous improvement in their ACAP's routines and practices.

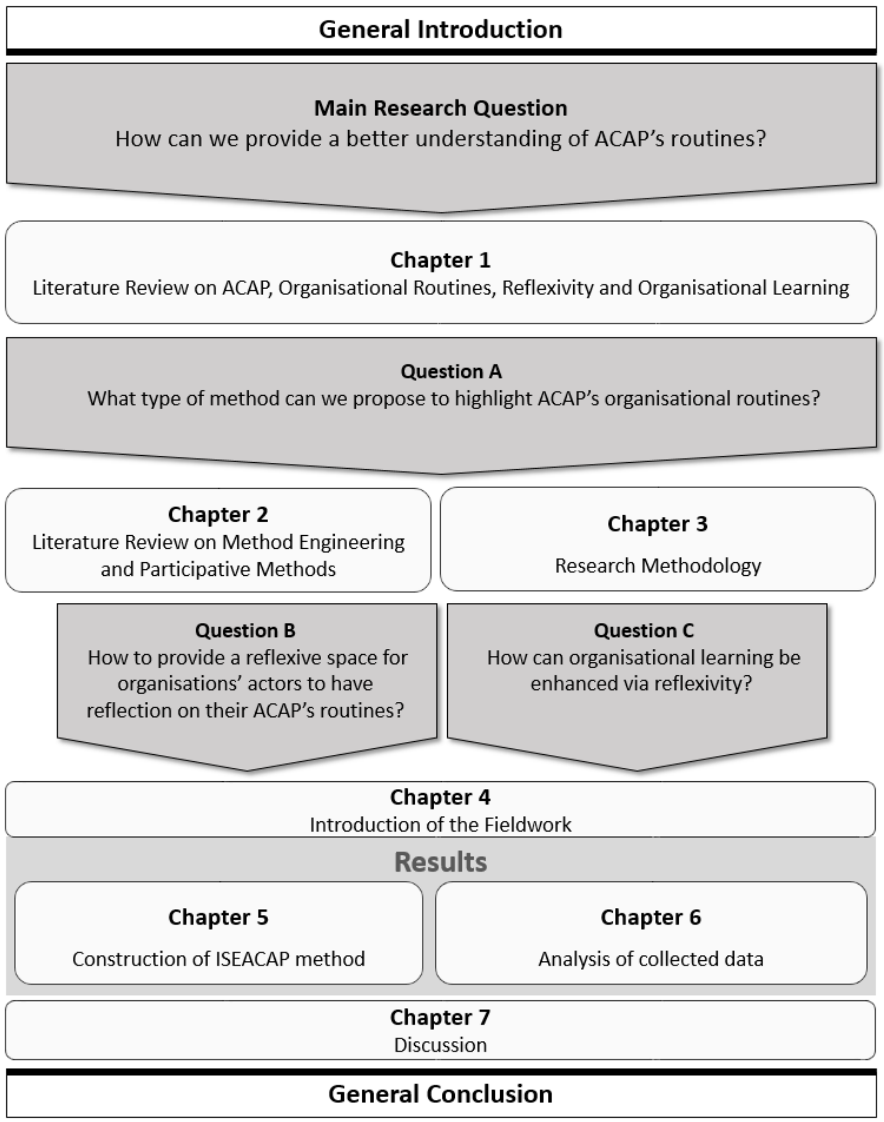
In addition, while conducting experimental sessions, we tape recorded the session (depending on the company's authorisation) which enabled us to analyse collected data after the session. Besides, we also had a validation form to collect participants' feedback about the method. This form allowed us to evaluate, improve and validate the method based on the end users' experiences.

For this study, we conducted six experimental sessions (group sessions) in four different companies in France and UK while only three sessions were authorised to be recorded. We also conducted semi-structured interviews with the companies to show the complementary role of the experimental sessions and interviews. The thematic analysis of the collected data highlights the role of reflexivity in learning about ACAP's routines.

1.4 Structure of the dissertation

Figure 1-1 sketches out a general view of the dissertation structure.

Figure 1-1: Dissertation structure



The dissertation includes seven chapters as the following to address all the research questions:

Chapter 1. Literature review on key concepts

This chapter reviews the existing literature on ACAP, routines, reflexivity along with associated existing theories about them. The presentation of each concept consists of synthetic table of definitions, related assumptions and the relations between the concepts. Based on the identified relations, we have proposed a conceptual model to formalise our research framework and highlight the research gaps and expected results.

Chapter 2. Method engineering and participative method

The second chapter deals with the revealed gaps through previous chapter and investigates an alternative to enable the reflexivity among the organisations' about their ACAP's routines. Thereby, chapter two refers to the computer science by presenting concepts of methods, methods engineering and participative methods. This presentation explains key factors of method construction and formalisation and compares existing participative methods that have close objectives to ISEACAP method.

Chapter 3. Research methodology

The third chapter is devoted to presenting the philosophical paradigm and applied research methodology of this study. The applied methodology emphasises on collaborative action research leading to presenting different types of action research.

In addition, the strategy of our research relies on case study, we consequently have an overview of case study definition and principles. This helps us clarify our research based on multiple case studies, define ACAP's routines as the units of analysis and focus on it at collective level. The chapter also explains applied data collection and analysis methods during this research.

Chapter 4. Introduction of the fieldwork

This short chapter presents all the companies in which we conducted experimental sessions via ISEACAP and lays special focus on the two companies that allowed us to record the sessions.

Chapter 5. Construction of ISEACAP

The fifth chapter is dedicated to present how ISEACAP was constructed. It explains the context and objectives of each phase of the method. The method relies on a general map that highlights two principal intentions: *As-is ACAP* and *As-if ACAP.* However, in this PhD research, we focus on As-is ACAP. In addition, the four phases of the method are illustrated by a virtuous cycle that contributes to continuous improvement in ACAP's routines.

In the continuation, this chapter presents applied user-centre design for ISEACAP development by detailing the evolved versions of the method in each stage of the design and the final protocol for each phase, thereby explaining the method formalisation through metamodeling, map formalism and graphical notations. Relying on the formalisation, the chapter is completed by introducing the support tool of the method called ISEAsy and the method validation.

Chapter 6. Analysis of collected data

The sixth chapter presents the analysis of collected data through the experimental sessions conducted via ISEACAP besides semi-structured interviews. The analysis consists of two stages: within the case study and cross-case analysis. Within the case studies, we will analyse all the collected data during the experimental sessions as well as interviews to identify ACAP's routines.

In cross-case analysis, we will initially provide a global vision of identified ACAP's routines and show the complementary role of identified routines via experimental sessions and interviews. Thereafter, we will focus on data collected through the experimental sessions to highlight the role of ISEACAP's protocol in different phases and the role of facilitators to raise the reflexivity among the participants to learn about their routines.

Chapter 7. Discussion

The last chapter confronts the conceptual model presented in first chapter based on the theoretical considerations with the results obtained in previous chapter. We have evolved the model to position our findings within existing works.

Finally, a general conclusion concludes the dissertation by highlighting the theoretical, methodological, managerial and engineering contributions of the work. In addition, confronted limitations during this research and the potential perspectives for future steps of this study will be presented in this chapter.

Chapter 2. Literature review on key concepts

1.1	INTRODUCTION
1.2	INNOVATION AND COLLABORATIVE NETWORKS
1.3	ABSORPTIVE CAPACITY (ACAP)
1.4	ORGANISATIONAL ROUTINES
1.5	REFLEXIVITY
1.6	CONCLUSION

1.1 Introduction

ACAP (Absorptive Capacity) is viewed as a dynamic capability embedded in a firm's routines and processes (Zahra & George, 2002, p. 186) and the benefits of dynamic capabilities depend on underlying learning processes, and it is difficult to observe dynamic capabilities unless it is put in to use (Helfat, 2007). Therefore, enhancing learning process can enable organisations to develop their capabilities to acquire, assimilate, transform and exploit external knowledge (Lane, et *al.*, 2006; Rezaei-Zadeh & Darwish, 2016).

Many studies in the field of organisational learning conceptualise learning as an established process (Song, 2015). This process consists of knowledge acquisition (development or creation of skills, insights and relationships), knowledge sharing (dissemination to others of what has been acquired by some) and knowledge exploitation (integration of learning so that it is assimilated, broadly available and can be applied to new situations) (*ibid*). Organisations engage in this process at the collective level (Spicer & Eugene, 2006) by focusing on how organisational knowledge assets may be created (Nonaka et *al*., 2000) and practical ways of managing those knowledge assets (Pedler & Aspinwall, 1999). To this end, reflexivity and reflective talk can be seen as a medium that allows people to generate meaning from an experience (Knipfer *et al.*, 2013, p. 5). Reflexivity includes changes or problems that require the modification of existing working routines or invention of new ones (*ibid*, p. 6). Therefore, collective reflexivity makes changes and improvement in routines (Dittrich et *al.,* 2016) where "opportunities to reflect with other participants might prompt routine change" Pentland & Feldman (2005; p. 799). In this regard, scholars argue that reflecting on a routine at the group level can facilitate routine change over time by fostering organisational learning and the articulation of knowledge (Edmondson et *al.,* 2001; Obstfeld, 2012; Dittrich et *al.,* 2016).

This study proposes ISEACAP method as a reflexive space for organisations' actors in which they can identify their ACAP's practices/routines. The method allows the actors to enhance their learning on their ACAP's routines by through collective reflexivity on their improvement. The method focuses on collaborative innovation projects, as external knowledge is more active through these types of projects. Thus, through this chapter we firstly overview the definition and types of innovation and collaboration. Then the literature review continues on absorptive capacity, organisational routines and reflexivity. Finally, we present a conceptual model based on the presented theories, to illustrate the relation between these concepts and position our method in the model.

1.2 Innovation and collaborative networks

1.2.1 Innovation

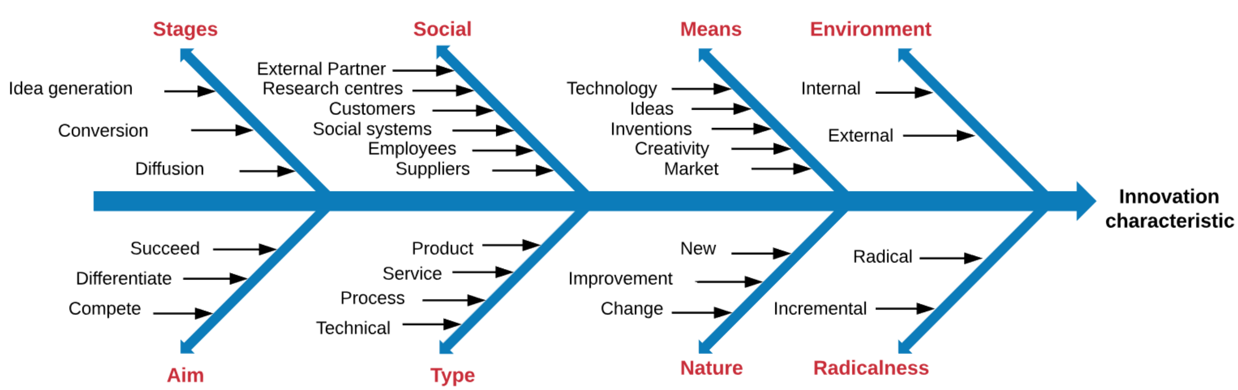
Innovation is defined in different fields including psychology, engineering, sociology, economy, and management and each views the process differently (Gopalakrishnan & Damanpour, 1997), (Damanpour & Wischnevsky, 2006). In management science, innovation is defined as an idea, practice, or material artefact perceived to be new by the relevant unit of adoption (Zaltman et *al.,* 1973; Dewar and Dutton, 1986) and it is widely considered as the life blood of corporate survival and growth (Zahra and Covin, 1994; p. 183). Innovation is recognised to play a central role in creating value and sustaining competitive advantage (Baregheh et *al.,* 2009, p. 1324) and represents the core renewal process in any organisation (Bessant *et al.*, 2005, p. 1366).

Innovation is tightly coupled to change, as organisations use innovation as a tool in order to influence an environment or due to their changing environments (internal and external) (Damanpour, 1996). However, innovation may involve a wide range of different types of change depending on the organisation's resources, capabilities, strategies, and requirements (Baregheh et *al*., 2009). Common types of innovation relate to new products, materials, new processes, new services, and new organisational forms (*ibid*).

1.2.1.1 Innovation characteristics

Innovations differ in terms of characteristics, in this term, we propose a fishbone diagram adapted from (Baregheh et *al*., 2009; Dewar & Dutton, 1986) and presented in Figure 2-1. This fishbone diagram is used in chapter four can to characterise the innovation of the cases.

Figure 2-1: A tool for innovation characterising



The first characteristic of innovation is the degree of newness presented by the notion of **Radicalness** (Dewar & Dutton, 1986, p. 1422). Radical and incremental describe different types of technological process innovations (*ibid*). Radical innovations are fundamental changes that represent revolutionary changes in technology and they represent clear departures from existing practice (Ettlie, 1983). In contrast, incremental innovations are minor improvements or simple adjustments in current technology (Dewar & Dutton, 1986, p.1423).

Another characteristic of innovation is its **nature**, which refers to the form of innovation as in something new, improved or changed. For instance a radical innovation can be either new or change, also an incremental innovation can be improvement or a minor change.

The **type** of innovation refers to the kind of innovation as in the type of output or the result of innovation, e.g. product, service, process and technical. Innovations can be developed in different **environments**, internally or intra-organisational, externally or inter-organisational i.e. in collaboration with external partners.

The **stages** of innovation refers to the "value chain of innovation" defined by (Hansen & Birkinshaw, 2007). We will explain it more in details through the next section

The **social** context is related to any social entity, system or group of people involved in the innovation process or environmental factors affecting it (Baregheh et al., 2009). External partner, supplier and customer could be distinguished according to the type of collaboration which is explained in the next section.

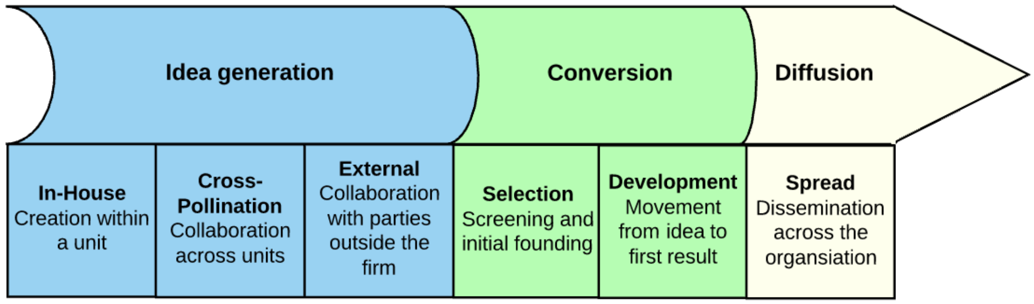
The **means** of innovation refers to the required resources (e.g. technical, creative, and financial) that needs to be in place for innovation (Baregheh et al., 2009, p. 1334). Many definitions have focused on the means of innovation, that is the ways in which ideas have been transformed into new, improved and changed entities, whether products or services, for example, for new markets (*ibid*).

The **aim** of innovation is the overall result that organisations want to achieve through innovation. The innovation aims on successful advancing, competing with competitors or differentiating from what exists in the market.

1.2.1.2 Innovation value chain

"To improve innovation, executives need to view the process of transforming ideas into commercial outputs as an integrated flow" (Hansen & Birkinshaw, 2007). According to Hansen and Birkinshaw, innovation consists of three phases presented in Figure 2-2.

Figure 2-2: Innovation value chain proposed by Hansen and Birkinshaw (2007)



Idea generation: Innovations start from an idea but where does the idea come from? Idea generation can happen inside a unit. However, the most important ideas can be created when fragments of ideas come together through brainstorming between different units or when companies tap external partners, experts, customers, universities or research centres and suppliers for ideas (Hansen & Birkinshaw, 2007, p. 122).

Conversion or more specifically, select ideas for funding and developing them into products or practices. Generating many good ideas is one thing; how you handle (or mishandle) them once you have them is another matter entirely (Hansen & Birkinshaw, 2007, p. 124). New concepts will not prosper without strong screening and funding mechanisms (*ibid*).

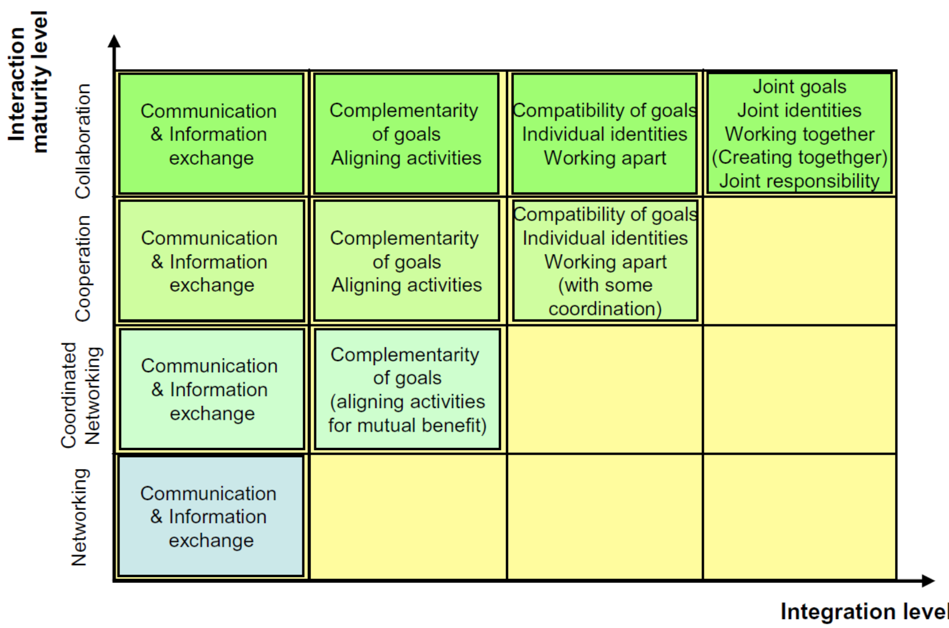
Diffusion: "Companies must get the relevant constituencies within the organisation to support and spread the new products, businesses, and practices across desirable geographic locations, channels, and customer groups" (Hansen & Birkinshaw, 2007, p. 121). In large companies with many subsidiaries and organisations, such diffusion is far from automatic (*ibid*).

Hansen and Birkinshaw (2007) argue that collaborating with external parties is an effective way for idea generation, but also it affects idea conversion and diffusion. In particular, for Small and Medium Enterprises (SMEs) developing innovation in collaboration has become a solution to overcome resource's scarcity and sustain their competitiveness (Schwalbe, 2009). In the next section, we present the definition and typology of collaboration and collaborative networks.

1.2.2 Collaboration and related concepts

Although there is a general intuitive notion of what collaboration is about, this concept is often confused with cooperation and for many people the two terms are indistinguishable (Camarinha-Matos & Afsarmanesh, 2006, p. 28). The ambiguities reach a higher level when other related terms are considered such as networking, communication, and coordination (Himmelman, 2001). Each concept brings a different value and can be considered as a component of collaboration. In an attempt to clarify these various concepts (Camarinha-Matos & Afsarmanesh, 2009, p. 47) propose the Figure 2-3.

Figure 2-3: Interaction levels *(Camarinha-Matos & Afsarmanesh, 2008)*



1.2.2.1 Networking

Networking involves communication and information exchange for mutual benefit (see Figure 2-3). A simple example of networking is the case in which a group of entities shares information about their experience with the use of a specific tool (Camarinha-Matos & Afsarmanesh, 2009, p. 47). They can all benefit from the information made available/shared, but there is not necessarily any common goal or structure influencing the form and timing of individual contributions, and therefore there is no common generation of value (*ibid*).

1.2.2.2 Coordination

In coordination or coordinated networking, in addition of communication and information exchange, it involves aligning/altering activities so that more efficient results are achieved (Camarinha-Matos & Afsarmanesh, 2009, p. 47). Coordination, that is the act of working harmoniously in a concerted way, is one of the basic building blocks of collaboration (*ibid*). For instance, coordinated activities happen when it is beneficial that a number of autonomous entities share some information and adjust the time of their activities for a new subject, in order to maximise their impact (*ibid*). Nevertheless, each entity might have a different goal and use its own resources and methods to create values individually.

1.2.2.3 Cooperation

Cooperation involves not only communication, information exchange, and adjustments of activities, but also resources sharing for achieving compatible goals (Camarinha-Matos & Afsarmanesh, 2009, p. 48). For instance, a traditional supply chain based on client-supplier relationships and pre-defined roles in the value chain is a cooperation towards complementary objectives. Each participant performs its part of the job, in an independent manner. There exists however, a common plan, which in most cases is not defined jointly but rather designed by a single entity, and that necessitates some low-level of co-working (*ibid*).

1.2.2.4 Collaboration

Collaboration is a more demanding process in which entities share information, resources and responsibilities to jointly plan, implement, and evaluate a program of activities in order to achieve a common goal and therefore jointly generating value (Camarinha-Matos & Afsarmanesh, 2009, p. 48). It implies sharing risks, resources, responsibilities, losses and rewards, and if the group desires, they can give the image of joint identity to an outside observer (*ibid*). Collaboration involves mutual engagement of participants to solve a problem together, which implies mutual trust and consequently takes time, effort, and dedication (Camarinha-Matos & Afsarmanesh, 2005, p. 443).

Therefore based on Figure 2-3 coordination extends networking; cooperation extends coordination; and collaboration extends cooperation and according to this perspective, collaboration contains everything that the other concepts have (Camarinha-Matos & Afsarmanesh, 2009, p. 48). As we move along from networking to collaboration, we increase the amounts of common goal-oriented risk taking, commitment, and resources that participants must invest into the joint endeavour (*ibid*).

1.2.3 Types of relationships

Beside presented concepts, three types of relationships, horizontal, vertical and diagonal are defined in the literature and play complementary role to the Camarinha-Matos & Afsarmanesh's (Camarinha-Matos & Afsarmanesh, 2005, 2006, 2008, 2009) works.

1.2.3.1 Horizontal relationship

Horizontal relationship is defined as a co-operation of direct competitors (Thoben & Jagdev, 2001, p. 17) (see Figure 2-4). For instance, two automobile manufacturers selectively co-operating in the development of a new engine (*ibid*). Other than this co-operation, they may very well be competitors in the same marketplace (*ibid*). Also, horizontal relationship encompasses initiatives, such as strategic alliances or joint ventures, and they are formed to profit from information exchange, social benefits and informal relationships (Foster-Fishman & Berkowitz, 2001).

Horizontal relationship is comparable with networking, coordinated networking and in some cases with cooperation, by considering that entities work together to have the similar benefits but not necessarily towards the same goal and sharing responsibilities. This type of relationship results in advantages such as competency leveraging, capacity transferring and knowledge flows.

1.2.3.2 Vertical relationship

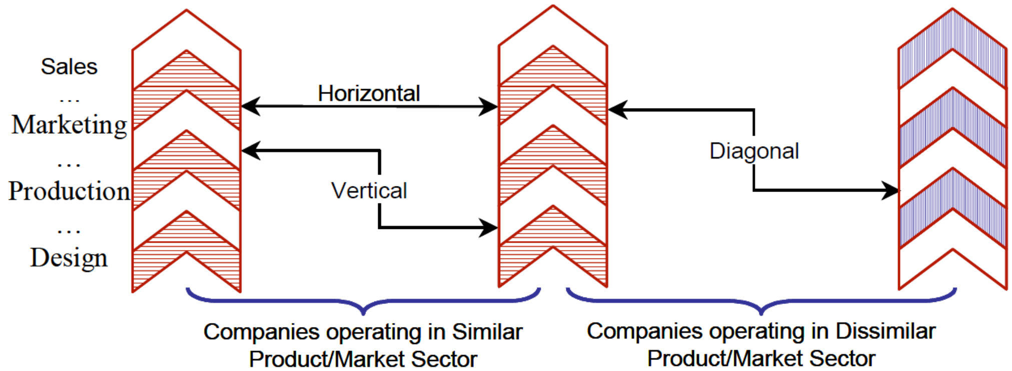
This type of relationship is characterised between non-competing forms, but belonging to the same sector, which intervene at different steps of the production. According to Thoben and Jagdev (2001, p. 16) Vertical relationship is between companies of the same branch along the value-chain (see Figure 2-4). The supply chains are examples of this type of relationship. From a single company's point of view a vertical relation might be forward (upstream) or backward (downstream) with the value chain (*ibid*). (Bahinipati & Deshmukh, 2012, p. 506)defined vertical collaboration as a relationship in which the buyer and the supplier work together for a common objective by sharing information and *resources* to solve problems, improve products, and streamline inventory-related processes. However, Vertical collaboration in buyer–supplier network requires that sensitive information and knowledge may be exchanged to other parties including competitors through common suppliers (Barratt, 2004).

Consequently, vertical relationship is comparable with cooperation and in certain cases with collaboration, because of the goals compatibilities and working apart with some coordination.

1.2.3.3 Diagonal relationship

Relationship between non-competing companies from different branches to develop a goal with similar needs and interests in certain areas (e.g. basic research, marketing) can be defined as Diagonal Thoben and Jagdev (2001, p. 17). By non-competing companies, we mean two companies operating in completely different Product/Market sectors (*ibid*). For instance, an automobile manufacturer and an aerospace firm decide to collaborate (and fund) the basic research on the application of new materials such as Carbon Fibre and the results of this research will be available to both partners (*ibid*).

Figure 2-4: Types of relationship (Thoben & Jagdev, 2001, p. 16)



Diagonal relationship can be considered as collaboration due to the joint goal and working jointly to achieve them. However, in a high level of integration it also could be cooperation with a high level of integration.

1.2.4 Relationship structures

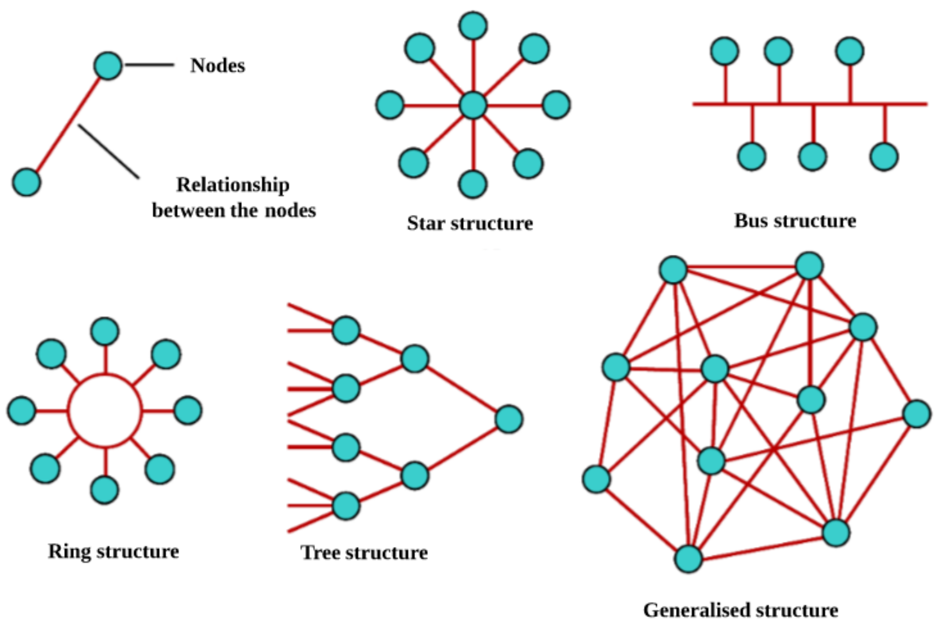
In general collaborative networks are defined by nodes and relationships, while a minimum amount of nodes in a network is two (Thoben & Jagdev, 2001, p. 7). By considering more than two nodes, various structures for enterprise collaborative networks are possible (*ibid*). Figure 2-5 shows different structures of relationships.

- **Star structure:** The communication between any two nodes should be always conducted through the central node. Therefore, the central node can be considered as a "controlling" node.
- **Bus structure:** There is a symmetric flow of information and goods between nodes.
- **Ring structure:** there is no unique direction for information or products flow. Hence, it can take any path. The difference between ring structure and star one is the absence of central "controlling" node. Therefore, in ring structure all the nodes are in the same hierarchically level and any two can communicate directly.
- **Tree structure:** This structure can be either converging or diverging (which will be a mirror of the converging type). In tree structure, the flow of information and goods is usually from left to right. The controlling node in a converging tree structure (which is shown in Figure 2-5) is often the one downstream to operations, with overall responsibility taken by the extreme right hand node. The diverging tree structure (mirror of what is shown in Figure

2-5) are often distribution type of networks and in this case controlling node is not often the extreme left-hand node.

- **Generalised structure:** It is a complex inter-relationship among several nodes. The connections between the nodes and the issues of controlling node cannot be generalised and pre-defined and they are situation and case dependent.

Figure 2-5: Relationship structures *(Thoben & Jagdev, 2001, p. 7)*



Inter-firm collaboration or collaborative networks can play imperative role in organisational learning (Tsai, 2009, p. 765). In particular, if the collaboration aims at innovation project. Thus, this study focuses on collaborative innovation projects and in the following we provide a definition for this type of the projects.

➢ *Defining collaborative innovation*

Scholars define collaborative Innovation as groups of self-motivated individuals from various parts of an organisation or from multiple organisations, who work together on a new idea, driven by a common vision (Gloor, Laubacher, Dynes, & Zhao, 2003). Collaborative innovation is also considered as an alternative to survive in an increasingly globalised and competitive marketplace, companies today must build, and rely upon, close relationships with customers and suppliers (Chapman, Corso, Di Milano, Chapmany, & Corsoz, 2005).

During this PhD, we worked collaboratively with a research team from operation and marketing department of Management school of Liverpool. To unifying our understanding about "collaborative innovation" concept and clarifying our targets, the following definition is proposed consensually:

Collaborative innovation can be described as a closed inter-organisational and reciprocal relationship between two or more independent companies/stakeholders (with diverse culture, competence, experience, and location). They actively work together through formal or informal mechanisms/agreements to develop a shared/clear vision, objectives and responsibility besides mutual understanding and trust among stakeholders, and joint decision-making and problem solving. They are committed in investing time, effort, and required resources (capital, knowledge, technology) to design, develop, design, test, and commercialise a new/improved product in terms of market, organisation, technology, and design enabling them to create more values and greater success that could not be achieved individually ultimately sustaining competitive advantage. This would allow them to share and minimise the costs and risks as well as expediting time to market.

This research is based on the concept of ACAP and thereby emphasises on knowledge sharing aspect and learning from partners during collaborative innovation projects. The following section reviews different definition of knowledge in the literature and highlights on which this study relies on.

1.2.5 Data, Information and Knowledge

There are different schools of thought for defining knowledge (Shin et *al.*, 2001). One of the basic definitions distinguishes knowledge from data and information (Rezaei Zadeh, 2013, p. 30). For instance, Hislop (2009) suggests that one way to define knowledge is to distinguish it from what it is not knowledge (Hislop, 2009).

Alavi and Leidner (2001) highlights the difference between data, information and knowledge by defining data as raw numbers and facts, information as processed data, and knowledge as authenticated information (Alavi & Leidner, 2001, p. 108). Knowledge can be considered as personalised information, possessed in the mind of individuals which "may or may not be new, unique, useful, or accurate related to facts, procedures, concepts, interpretations, ideas, observations, and judgments" (*ibid*).

Some scholars such as (Vance, 1997), assumes a hierarchical relation between data, information and knowledge. However, Alavi and Leidner (2001) argue that "knowledge is not radically different concept from information. Information is converted to knowledge once it is processed in the mind of individuals and knowledge becomes information/data once it is articulated and presented in the form of text, graphics, words, or other symbolic forms" (*ibid*). Considering the reverse order between these three concepts has more practical implications (Sharif, 2006; Tuomi, 1999). For instance Tuomi (1999) suggests that reverse direction between knowledge, information and data has better use for studying knowledge management and organisational memory phenomenon (Rezaei-Zadeh, 2013).

1.2.5.1 Different definitions on knowledge

Alavi and Leidner (2001) define knowledge from different perspectives (Alavi & Leidner, 2001, p. 110). (See Table 2-1)

- **A state of mind:** This perspective describes knowledge as "a state or fact of knowing" with knowing being a condition of "understanding gained through experience or study (Alavi & Leidner, 2001). Thus, it focuses on enabling individuals to expand their personal knowledge and apply it to the organisation's needs (Alavi & Leidner, 2001).
- **An object:** This perspective defines knowledge as an object (Zack, 1998) by considering that posits that it can be stored and manipulated (i.e., an object) (Alavi & Leidner, 2001).
- **A process:** Knowledge can be viewed as "a process of simultaneously knowing and acting" (Carlsson et *al.,* 1996; McQueen, 1998). This perspective focuses on the applying of expertise (Zack, 1998; Alavi & Leidner, 2001).
- **A condition of access to information:** Organisational knowledge must facilitate access to and retrieval of content (McQueen, 1998). This perspective completes knowledge as an object by emphasising on the accessibility aspect (Alavi & Leidner, 2001).
- **A capability:** through this perspective, knowledge is capability with the potential of influencing future action (Carlsson et al., 1996). In the same line, Watson (1999) defines knowledge as the capacity to use information; "learning and experience result in an ability to interpret information and apply in decision making" (Alavi & Leidner, 2001, p. 112).

Table 2-1: Different perspectives on knowledge (Alavi & Leidner, 2001, p. 111)

Perspectives	Description	Implications
Knowledge vis-à-vis data and information	– Data is facts, raw numbers. – Information is processed/interpreted data. – Knowledge is personalized information.	Exposing individuals to potentially useful information and facilitating assimilation of information.
State of mind	Knowledge is shaped based on knowing and understanding.	Concentrating on individual's understanding and learning.

Perspectives	Description	Implications
Object	Knowledge is considered as storable object	Constructing and managing knowledge stocks
Process	Knowledge is a process of expertise application	Focusing on the process of creation, sharing, and distributing knowledge
Access to information	Knowledge facilitates accessing to information	Organizing access to and retrieval of content
Capability	Knowledge provides required potential to influence action	Building core competencies and understanding strategic know-how

1.2.5.2 Types of Knowledge

Table 2-1 shows various ways of looking at knowledge, in the same line scholars propose various types.

- *Procedural knowledge vs. Conceptual knowledge*

Conceptual Knowledge

One of the traditional classification is based on two general types, namely "Conceptual" and "Procedural" knowledge. Conceptual knowledge is generally expressed as "I know that…" hence it is about the way in which things (which we call 'concepts') are related to one another and about their properties (Milton, 2007, p. 5). An important form of conceptual type concerns taxonomies, i.e. the classification of elements of a domain or a science.

Procedural knowledge

Procedural knowledge is in general about processes, tasks and activities and is generally expressed as "I know how …" For instance, to know how a machine should be adjusted is a procedural knowledge because it requires particular steps (Milton, 2007; p. 4). Hence, it is about processes, tasks and activities. It is about the conditions under which specific tasks are performed and the order in which tasks are performed. It is about the resources required to perform tasks and it is about the sub-tasks that are required (*ibid*).

- *Explicit vs. tacit knowledge*

Explicit Knowledge

Explicit knowledge, as the name suggests, is at the forefront of an expert's brain and is thought about in a deliberate and conscious way (Nonaka & Takeuchi, 1996). This type of knowledge is generally not too difficult to explain or express (Milton, 2007; p. 5). Alavi and Leinder (2001)defined explicit knowledge as articulated and generalised knowledge.

Tacit Knowledge

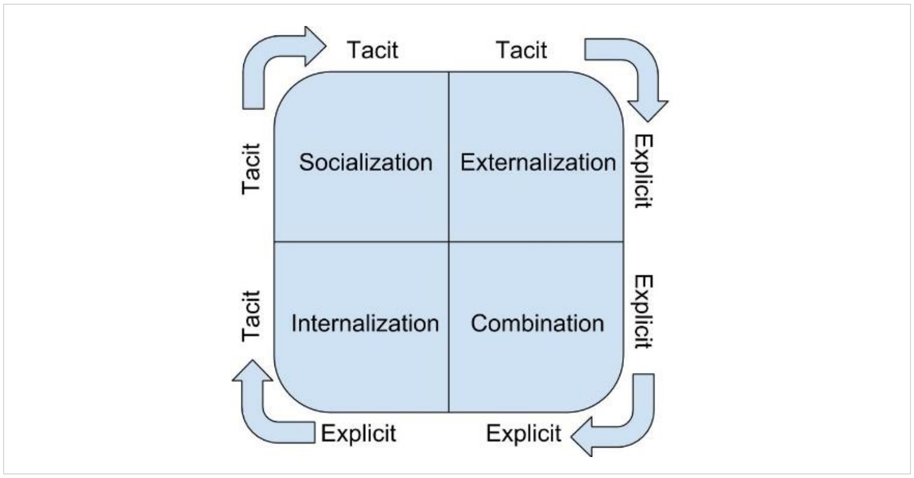
In contrast, tacit knowledge is at the back of one's brain, highly personal and hard to formalise (Polanyi, 1966). Subjective insights, intuitions and hunch fall into this class of knowledge. Tacit knowledge is deeply rooted in actions, procedures, routines, commitments, ideals, values and emotions (Schön, 1987). It is often built up from experiences rather than being taught (Milton, 2007) and it is the type of knowledge that someone gains when s/he practices something. Hence, tacit knowledge is difficult to communicate since it necessitates simultaneous processing to be elicited (Nonaka, 1994).

Based on the tacit vs. explicit knowledge typology, Nonaka (2000) proposes a model for knowledge creation cycle, which is presented in the following.

1.2.5.3 Knowledge creation process

In knowledge creation, individual and environment organisations interact with each other, and changes occur at both levels: an individual influences and is influenced by the organisation with which s/he interacts (I. Nonaka et *al.*, 2000; p. 8). To understand how organisations create knowledge dynamically, Nonaka et *al.* (2000) proposed a model of knowledge creation process called SECI (Socialisation, Externalisation, Combination, Internalisation). SECI considers the process of knowledge creation through conversion between tacit and explicit knowledge (see Figure 2-6).

***Figure 2-6 : SECI model** (Nonaka, et al. 2000)*



- *Socialisation*

From tacit to tacit: (knowledge transfer via shared experiences) (Nonaka, Toyama, & Konno, 2000)

- *Inter-firm social information collection*, in which managers engage in bodily experience through management by wandering about, and get ideas for corporate strategy from daily social life, interaction with external experts and informal meetings with competitors outside the firm (*ibid*)
- *Intra-firm social information collection*, in which managers find new strategies and market opportunities by wandering inside the firm (*ibid*).

Socialisation aims to recognise and assimilate knowledge from internal and external sources, which are embedded in the intuitions or experiences of individuals.

- *Externalisation*

From tacit to explicit: (articulation of experiences, ideas and thoughts) (Nonaka, Toyama, & Konno, 2000). Tacit knowledge is deeply rooted in actions, procedures, routines, commitments, ideals and often built up from experiences rather than being (Grant, 1958; Schön, 1983), based on the definition, it is not possible to communicate tacit knowledge and requires simulation and putting actors in the real situation (Nonaka & Toyama, 2005). To this end, externalisation needs a mechanism to lead actors share their knowledge, thinking and ideas in an explicit way. This part of model is the most critical as tacit knowledge should become explicit. Through the next chapters, we will explain knowledge elicitation techniques and highlight how our study contributes to the externalisation.

➢ *Combination*

From explicit to explicit: (synthesising the articulated knowledge into systematic sets) (Nonaka et *al.,* 2000).

- *Acquisition and integration*: managers are engaged in planning strategies and operations, assembling internal and external data by using published literature, computer simulation and forecasting (*ibid*).
- *Synthesis and processing*: managers build and create manuals, documents and databases on products and services and build up material by gathering management figures or technical information from all over the company (*ibid*).

Through externalisation, tacit knowledge becomes explicit by interpreting, and then through combination mechanism, the interpreted knowledge should be integrated in the knowledge base of the organisation.

➢ *Internalisation*

From explicit to tacit: (embodying the articulated knowledge; "learning by doing") (Nonaka et *al.*, 2000).

Internalisation is the process of embodying explicit knowledge into tacit knowledge (*ibid; p. 10*). Through internalisation, explicit knowledge created is shared throughout an organisation and converted into tacit knowledge by individuals. Internalisation is closely related to `learning by doing' (*ibid*). Explicit knowledge, such as the product concepts or the manufacturing procedures, has to be actualised through action and practice (*ibid*).

When knowledge is internalised to become part of individuals' tacit knowledge bases in the form of shared mental models or technical "know-how", it becomes a valuable asset (*ibid*). This tacit knowledge accumulated at the individual level can then set off a new spiral of knowledge creation when it is shared with others through socialisation (*ibid*).

The socialisation of SECI model becomes has the same vision as the concept of absorptive capacity. To this end, through the following part we overview the literature about ACAP.

1.3 Absorptive capacity (ACAP)

1.3.1 Definitions

Scholars define the absorptive capacity in different ways and each of them has a particular consideration on ACAP. For instance, Cohen and Levinthal define absorptive capacity through linking this construct to not only as a by-product of R&D activities (Cohen & Levinthal, 1989) , but also as the outcomes of organisational knowledge, experience, a shared language, cross-functional interface, the mental models, and the problem solving ability of organisational members (Camisón & Forés, 2010; Cohen & Levinthal, 1990)

The diversity of definition inhibits the evaluation and comparison of absorptive capacity studies together (Lane et *al.*, 2006), as illustrated in Table 2-2.

Table 2-2: Definitions of Absorptive Capacity

Study	Definition	Dimensions of ACAP	Theoretical lenses
Cohen and Levinthal (1989: 569)	The ability to learn from external knowledge providers	• Identifying • Assimilating • Exploiting	Organisational innovation
Cohen and Levinthal (1990: 128)	The ability to identify, assimilate, transform and apply external knowledge (requires a common knowledge base)	• Acquiring • Assimilating • Exploiting	Cognitive aspect of learning process
Cohen and Levinthal (1994: 227)	The ability to evaluate technological and commercial knowledge, assimilate it and apply it for commercial ends	• Evaluating • Assimilating • Applying	Technological changes and learning
Kim (1998: 510)	Individuals' knowledge and their efforts to solve problems.	• Learning • Solving problems	Organisational capabilities
Zahra and George (2002: 186)	Set of organisational routines and processes Potential ACAP Realised ACAP	• Acquiring • Assimilating • Transforming • Exploiting	Organisational routines and dynamic capabilities
Lane et *al.*, (2006: 833)	The organisational ability to implement external knowledge through learning processes	• Exploratory learning • Transformative learning • Exploitative learning	Processes-based organisational learning

Study	Definition	Dimensions of ACAP	Theoretical lenses
Todorova and Durisin (2007: 774)	The ability to value external knowledge	• Valuing • Acquiring • Assimilating/transforming • Exploiting	Dynamic capabilities and organisational learning
Lichtenthaler, (2009: 824)	The ability to explore external knowledge	• Exploration of external knowledge	Organisational ability
Roberts, et *al*. (2012: 628)	The ability to identify, assimilate, transform, and apply external knowledge. (Adoption of Cohen and Levinthal's definition)	• Identifying • Assimilating • Exploiting ACAP depends on 3 factors: • Prior related knowledge • ACAP of individuals • Path-dependent	Information systems researches and reviewed from different perspectives

As Table 2-2 shows, organisational scholars propose diverse definitions through different theoretical lenses. However, they have viewed absorptive capacity from two general perspectives: as a "stock" of prior related knowledge and as an "ability" to absorb knowledge (Roberts, et *a*l., 2012; p. 627). Absorptive capacity has been specifically conceptualised and measured as either (i) an asset, (ii) a substantive (or ordinary) capability, or (iii) a dynamic capability (Lane et *al*., 2006). A fundamental understanding of these views will give us insight into how absorptive capacity can be effectively leveraged in IS research (Roberts, et *al*., 2012; p. 628).

- *An asset* is anything tangible or intangible that a firm owns, controls, or has access to on a semi-permanent basis (Helfat & Peteraf, 2003). Through this vision, absorptive capacity can be conceptualised as the level of relevant prior knowledge possessed by the focal unit (Roberts, et *al*., 2012; p. 628). This static perspective of knowledge as an object equates absorptive capacity with the firm's knowledge base (i.e., the level of knowledge it possesses at any single point in time) (*ibid*). As such, absorptive capacity has been operationalised with variables that serve as proxies for the knowledge base, such as R&D intensity and patents (Tsai, 2001).
- *A substantive* (i.e., ordinary) organisational capability is a high-level routine (or set of routines) that confers a set of decision options on an organisation's management for producing significant outputs of a particular type (Winter, 2003). Absorptive capacity as a substantive organisational capability takes into account the routines and processes that firms use to identify, assimilate, transform, and apply external knowledge (Roberts, et al., 2012; p.

628). Measures that seek to capture a capability view of absorptive capacity include compensation policies, dominant logic, knowledge-sharing routines, and competencies (Lane et *al*., 2001).

- *Dynamic capability* refers to the capacity of an organisation to purposefully create, extend, or modify its resource base (Helfat et al., 2009; p.4). Dynamic capability is distinguished from substantive capability in that dynamic capability refers to the ability to change or reconfigure existing substantive capabilities (Roberts, et al., 2012; p. 629). Relying on dynamic capability, a firm's absorptive capacity affects its ability to reconfigure its existing substantive capabilities (*ibid*). Measures of absorptive capacity as dynamic capability are often survey-based (Lichtenthaler, 2009).

Our research aims to study ACAP's organisational routines acity as well as make change to the identified routines in order to enhance ACAP. Thus, this research refers to both substantive and dynamic aspects by relying on Zahra and George's definition of ACAP as "a set of organisational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge for producing a dynamic organisational capability". Table 2-3 presents four dimensions of ACAP proposed by Zahra and George (2002).

Table 2-3: Definitions of four dimensions of the absorptive capacity

Dimension of ACAP	Description
Acquisition	A firm's capability to identify and acquire externally generated knowledge that is critical to its operation
Assimilation	A firm's routines and processes that allow it to analyse, process, interpret, and understand the information obtained from external sources
Transformation	A firm's capability to develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge
Exploitation	A firm's capability based on the routines that allow firms to refine, extend, and leverage existing competencies or to create new ones by incorporating acquired and transformed knowledge into its operations

Source: (Zahra & George 2002)

Scholars have leveraged Cohen and Levinthal's original work on absorptive capacity in several ways (Roberts et *al*., 2012, p. 627). The application of absorptive capacity in such areas as innovation, organisational learning, mergers and acquisitions, and new product development signifies its substantial contribution to competitive advantage and firm performance (Lane et al., 2006; Roberts et al., 2012). In the following sections, we present assumptions underlying absorptive capacity and various visions on this important concept.

1.3.2 Characteristics of ACAP

1.3.2.1 Prior related knowledge

Absorptive capacity depends on prior related knowledge. Without some prior related knowledge, a firm will not be able to accurately determine the potential value of external knowledge (Roberts et al., 2012, p. 627). Regarding a firm's prior knowledge, multiple authors have distinguished the following two knowledge components: *technological knowledge* and *market knowledge* (Lichtenthaler, 2009).

➢ *Technological knowledge*

It is the knowledge that a firm actually explores, transforms, and exploits in its absorptive capacity processes (Cohen & Levinthal, 1990; Tsai, 2001). This implies that absorptive capacity is domain-specific (Roberts et al., 2012; p. 627).

➢ *Market knowledge*

By contrast, market knowledge refers to applications and commercialisation opportunities for technological knowledge(Teece, 2007). Thus, market knowledge provides a firm with insights into the functions that technological knowledge may fulfil. In addition, many inter-firm relationships are directed at accessing market knowledge (Lichtenthaler, 2009).

Therefore, industrial firms need both components of prior knowledge to successfully coordinate the absorptive capacity (Cohen & Levinthal, 1990). In other words, technological and market knowledge are complementary, and their integration in organisational learning likely enhances innovation and performance (Lane et al., 2006).

1.3.2.2 Accumulative capacity

Accumulating absorptive capacity in one period will permit its more efficient accumulation in the next (Roberts et al., 2012; p. 628). By having already developed some absorptive capacity in a particular area, a firm may more readily accumulate what additional knowledge it needs in the subsequent periods in order to exploit any critical external knowledge that may become available (Cohen & Levinthal, 1990, p. 136).

Likewise, the possession of related expertise will permit the firm to better comprehend and therefore evaluate the import of intermediate technological advances that provide signals as to the eventual merit of a new technological development (Cohen & Levinthal, 1990, p. 136). Thus, in an uncertain environment, absorptive capacity affects expectation formation, permitting the firm to predict more accurately the nature and commercial potential of technological advances (Roberts et *al*., 2012; p. 628).

Organisational scholars integrate absorptive capacity with other theoretical approaches, such as innovation, organisational learning and dynamic capability. Each of theoretical perspectives applies ACAP theory differently (Rezaei Zadeh, 2013; p. 32).

1.3.3 Absorptive Capacity and innovation

Organisational growth and survival depends on their capabilities to innovate products continually. Knowledge and innovation in general, and product innovation in particular, have a mutual effect upon each other. Innovation is achieved through application of new knowledge and, at the same time, implementing new knowledge motivates change and innovation (Murovec & Prodan, 2009; Rezaei Zadeh, 2013, p.19). To this end, organisations need to improve their absorptive capacity constantly. Improving ACAP and implementing new knowledge motivates change and innovation (Murovec & Prodan, 2009). ACAP enables organisations for achieving different outcomes, competitive advantages, strategic flexibility and innovation (Todorova & Durisin, 2007; Volberda et *al*., 2010; Zahra & George, 2002). However, new knowledge can be either created internally or acquired externally. Suggesting a direct link between knowledge and innovation may be problematic, when the importance of learning to organisational level, or so called “organisational learning” ignores (Rezaei Zadeh, 2013; p. 19). Organisational learning enables organisations to generate, acquire, and implement new knowledge for innovation (Weerawardena et *al*., 2006). Through the following section, we discuss how absorptive capacity relates to organisational learning.

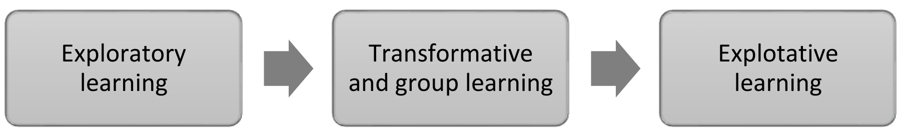
1.3.4 Absorptive capacity and organisational learning

Organisational learning is core to innovation performance (Brown & Duguid, 1991). It is defined as the development or acquisition of new knowledge or skills in response to internal or external stimuli that leads to a more or less permanent change in collective behaviour and that enhances organisational efficiency and/or effectiveness (Spicer & Eugene, 2006).

Absorptive capacity is clearly related to organisational learning (Lane et *al*., 2006) and organisational learning studies relate organisational ACAP to the experiences, routines, and histories of organisations to value, acquire, assimilate, and exploit external knowledge (Rezaei Zadeh, 2013; p. 32). Organisational learning theory is concerned with the development of insights, knowledge and associations between past actions, the effectiveness of those actions, and future actions (Huber, 1991).

Lane et al. (2006) position absorptive capacity within an expanded exploration/exploitation learning framework (Lane et al., 2006). Specifically, they relate three absorptive capacity processes (identify, assimilate, and apply external knowledge) to three learning processes (Figure 2-7 presents this process): exploratory, transformative, and exploitative learning (*ibid*). *Exploratory learning* is used to recognise and comprehend new external knowledge. *Transformative learning* combines new knowledge with existing knowledge, thereby allowing firms to effectively assimilate valuable external knowledge (*ibid*). Finally, *exploitative learning* is used to apply the assimilated external knowledge (*ibid*).

Figure 2-7: Learning process *(Lane et al., 2006)*



March (1991) emerges exploration and exploitation as twin pillars of organisational learning research (Roberts et al., 2012; p. 629). Exploration refers to learning gained through processes of concerted variation, organisational experimentation with new alternatives, and search for knowledge about unknown market opportunities (*ibid*). Exploitation refers to learning gained via local search, experiential refinement, and the use of existing knowledge, competencies, and technologies (*ibid*). Scholars engaged in organisational learning research recognise that "the long-term survival of an organisation depends on its ability to engage in enough exploitation to ensure the organisation's current viability and engage in enough exploration to ensure its future viability" (Levinthal & March, 1993; p. 105).

In addition to the relationship between absorptive capacity and exploration/exploitation in organisational learning, according to (Roberts et al., 2012) there are certain factors to distinguish absorptive capacity from organisational learning presented in Table 2-4.

Table 2-4: Differences between Absorptive Capacity and Organisational Learning

Difference	Absorptive Capacity	Organisational learning
Construct versus concept	A construct with well-defined assumptions and boundary conditions	A broad concept that encompasses a variety of processes and constructs
Active versus passive	Organisations must actively increase their absorptive capacity	Organizations can learn either actively or passively
External versus internal	Focuses on the role of external knowledge	Spans both internal and external knowledge

Source: (Roberts et al., 2012)

Absorptive capacity is a construct with well-defined assumption and boundary conditions, in contrary organisational learning is a broadly defined concept that encompasses a variety of processes. ACAP focuses on the role of external knowledge, while organisational learning includes both internal and external knowledge.

Another related concept to the ACAP is dynamic capability. As explained earlier, several scholars defined this capacity via dynamic capabilities. In the following we have an overview on the relation of these concepts.

1.3.5 Absorptive capacity and dynamic capabilities

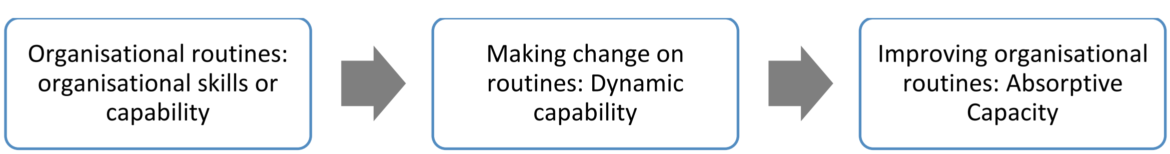
Dynamic capabilities (DCs) are defined as organisational processes which enable organisations to modify, change, delete, enhance, or reconfigure their resources (Ambrosini & Bowman, 2009). It is imperative to distinguish between capabilities and DCs. Winter (2000) views capability as "a high level routine that, together with its implementing input flows, confers upon an organisation's management a set of decision options for producing significant outputs of a particular type" (Winter, 2000; p. 983). Winter also notes that a capability is reflected in an activity that produces outputs that clearly matter to the organisation's survival and prosperity (Zahra & George, 2002; p. 189). Dynamic capabilities, however, are geared toward effecting organisational change; they are essentially strategic in nature (Teece et *al.*, 1997; p. 510) and, therefore, define the firm's path of evolution and development. Dynamic capability theory aims to establish a link between firms' resources and markets in order to explain how some organisations are successful over time and how they renew their capabilities through changes in markets (*ibid;* p. 509).

Moreover, DCs exhibit commonalities across firms, and scholars refer to them as “best practices” (Eisenhardt & Martin, 2000). Similarly, Teece et al. (1997) argue that DCs are heterogeneous across firms because of their unique positions, specific paths and processes (Teece et *al.*, 1997; p. 517). Zollo and Winter (2002, p. 340) define DCs "as a learned and stable patterns of collective activities through which firm systematically generates and modifies its operating routines in pursuit of improved effectiveness" (Breznik & Hisrich, 2014; p. 371).

The application of DCs to different business environments depends on firms' abilities to develop and use their capabilities (Wang & Ahmed, 2007). Research on the dynamic capabilities of the firm (Eisenhardt & Martin, 2000) offers new insights into the study of ACAP. Researchers argue that DCs are embedded in organisational processes and are directed toward enabling organisational change and evolution (Zott, 2003). These capabilities enable the firm to reconfigure its resource base and adapt to changing market conditions in order to achieve a competitive advantage.

ACAP is viewed as a dynamic capability embedded in firm's routines and processes, making it possible to analyse the stocks and flows of a firm's knowledge and relate these variables to the creation and sustainability of competitive advantage (Zahra & George, 2002; p. 186). Zahra and George (2002; p. 198) highlight that dynamic capabilities are "*geared toward strategic change and flexibility where firms create and exploit new knowledge by transforming acquired knowledge*". In addition, they define ACAP as a "*set of organisational routines and strategic processes by which firms acquire, assimilate, transform, and exploit knowledge for purpose of value creation*". As Figure 2-8 shows the relation between the concepts. Based on this relation, in order to enhance the absorptive capacity, it is required to make change on organisational routines associated to this capacity. Winter (2003) extends DCs on the broader concept of organisational routines and argues that an organisational capability is a high-level routine (or collection of routines) that together with its implementation input flows, confers upon an organisation's management a set of decision options for producing significant outputs of a particular type (Becker, 2004; Winter, 2003). Through the following section we provide a literature review on organisational routines.

Figure 2-8: Routines, dynamic capabilities and absorptive capacity



1.4 Organisational routines

1.4.1 Definitions

Table 2-5 presents existing definition for organisational routines which are considered as the basic components of organisational behaviour (Winter, 1967; p. 264). This study relies on the core definition presented by Feldman and Pentland (2003, p. 96) : "*repetitive, recognisable patterns of interdependent actions, carried out by multiple actors*". This definition provides a surface-level description of the characteristics that must be presented for something to be called an organisational routine (*ibid*).

Table 2-5: Examples of definitions for organisational routines

Authors	Organisational routines' definition	Nature
(Winter, 1967; p. 264)	Routines are the pattern of behaviour that is followed repeatedly, but is subject to change if conditions change.	Patterns of behaviour
(Koestler, 1967; p. 44)	Routines are flexible patterns offering a variety of alternative choices.	Flexible patterns
(Nelson & Winter, 1982)	Routines are the repository of organisational capability	Repository of organisational capability
(Cohen et *al.*, 1996; p. 25)	A routine is an executable capability for repeated performance in some context that been learned by an organization in response to selective pressures.	Capabilities
(Feldman, 2000; p. 611)	Routines are temporal structures that are often used as a way of accomplishing organizational work.	Temporal structures
(Zollo & Winter, 2002)	Routine represents a general way of doing things, that is, a stable pattern of behaviour that characterises organisational reaction to a specific internal or external stimulus.	Stable pattern of behaviour
(Feldman & Pentland, 2003; p. 96)	Routines are the repetitive, recognisable patterns of interdependent actions, involving multiple actors.	Patterns of actions
(Becker, 2004; p. 645)	Routines refer to recurrent interaction patterns, that is, collective recurrent activity patterns.	Recurrent interaction patterns
(Becker et *al.*, 2005; p. 777)	Routines act as organisational memory and repository of organisational capability. In this sense, while routines preserve knowledge (organisational memory), they also represent a source of endogenous change of the organisation.	Organisational memory

1.4.2 Routines' Characteristics

1.4.2.1 Patterns

The notion of "patterns" is central in the concept of routines. As presented in the Table 2-5 Winter (1967; p. 264) defines a routine as "*pattern of behaviour* that is followed repeatedly, but is subject to change if conditions change". In the same time, philosopher Koestler (1967; p. 44) defined routines as "*flexible patterns offering a variety of alternative choices*". The notion of routines as patterns also appears in the works of other scholars (e.g. Becker, 2004; Feldman & Pentland, 2003; Nelson & Winter, 1982; Zollo & Winter, 2002). The question then arises, "*If routines are patterns, then what these patterns consist of?*" To address this question Becker (2004)identifies four different terms that are used for denoting the "content" of the patterns: action, activity, behaviour and interaction (refer to the Table 2-5)

In the economics and business literature, the terms "action" and "activity" are usually considered as synonym. However, in the literature there is a difference between "action" and "behaviour". For instance, Becker (2004) indicates "behaviour" as a subset of "action" and distinguished them by the fact of observability. In the same way, "Interaction" is considered as a subset of "action", referring to such action that involves multiple actors(Becker, 2004; p. 645). This distinction refers both to the individual and collective levels.

Nevertheless, talking about individual and collective level refers back to the distinction between action (activity patterns) and behaviour (March & Simon, 1958). Collective level relies on "recurrent patterns of action" and individual level associated with the term "habit" (Becker, 2004; p. 645). Many empirical studies discuss on routines from collective level point of view and document them as patterns of interaction (e.g. Cohen & Bacdayan, 1994; Pentland & Rueter, 1994). In this research, we study organisation routines at the collective level.

1.4.2.2 Repetition (recurrence)

Recurrence is a key characteristic of routines (Cohen & Bacdayan, 1994; Cohen et al., 1996; Pentland & Rueter, 1994). In fact, one would be hard pressed to call something happening only once a routine (Becker, 2004; p. 646). Considering hiring routines, in each organisation hiring occurs more than once and for each position it should be customised. If we consider each customisation of hiring routine as an instance, we can conceptualise hiring as a category with several instances, Feldman and Pentland (2003) refer to these instances as performances.

1.4.2.3 Collective nature

Routines are collective phenomena (Nelson & Winter, 1982; p. 73). They involve the coordination of multiple organisational participants (Feldman & Pentland, 2003; p. 104). Thus, organisational routines are not just individual routines that are performed in the context of an organisation (*ibid*).

Recognising the collective nature of routines immediately improves our understanding of the concept of routines (Becker, 2004; p. 647). To involve multiple actors means that carrying out one routine might involve actors in different locations and organisational routines can therefore be distributed (Simon, 1982; Teece et *al.*,1994; Winter, 1994). Routines can be distributed across space, or across the organisation (Becker, 2004; p. 647). The multiple actors carrying out the routines belong to different organisational units, and are located in different places but they are linked by the interaction (*ibid*).

1.4.2.4 Interdependent actions

Becker (2004) considers routines as the unit of analysis and explains changes by emphasising on the processual nature of the routines (Becker, 2004; p. 649). Actors perform activities that are interdependent and each performance of a routine is a collective performance (Feldman & Pentland, 2003; p. 104). Interdependence is not limited to the immediate actions of the participants (*ibid*).

Because the actions within a routine are interdependent, individuals cannot just act as they please, because the actions of others can create or close off alternatives (Feldman & Pentland, 2003; p. 105). For instance, if nobody applies for a job, no hiring can take place (*ibid*). These kinds of constraints operate within the context of specific performances (*ibid*). The next time the routine is performed, each participant may face a different set of possibilities, based on the actions of others, while interdependence between actions can be viewed as part of structure (Pentland, 1995), it can also generate variety within specific performances (Feldman & Pentland, 2003; p. 105).

1.4.2.5 Path dependence

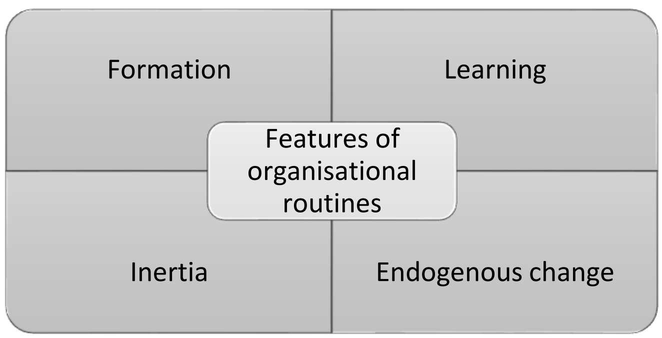
Path dependence means the process through which past actions influence the likelihood of future actions (Sydow et *al.*, 2009; p. 690). In organisational routines as elsewhere, path dependence is manifest in two ways: within performances, and between performances (Pentland et *al.*, 2012; p. 7). Within each performance or iteration of a pattern, each action is dependent on the prior actions (*ibid*). Thus, as each action is taken, it is more or less likely that other specific actions will follow (*ibid*). Path dependence *within a performance* makes the pattern recognisable (*ibid*). Path dependence *between performances* makes the pattern repetitive (*ibid*).

Routines build on the past and may adapt to experience incrementally in response to feedback about outcomes, but they do so based on their previous state (Cohen et *al*., 1996). Path dependent development of routines means that because one can be stuck on a path, along which the routine develops over time, the starting point matters (Becker, 2004; p. 653).

1.4.3 Routines' features

Any foundational theory of organisational routines should explain how routines change (or fail to change) over time (Helfat et *al*., 2009). Empirical research on routines has identified four dynamics presented in Figure 2-9 that are especially relevant to macro-level outcomes: formation, inertia (endogenous stability), endogenous change, and learning (Pentland et *al*., 2012).

Figure 2-9: Features of organisational routines



1.4.3.1 Formation

Evidence from laboratory experiments and field studies suggests that routines form through repetition (Cohen & Bacdayan, 1994; Rerup & Feldman, 2011; Pentland et *al*., 2012) and routines can form very quickly (Gersick & Hackman, 1990; Pentland et *al*., 2012).

1.4.3.2 Learning

Another widely documented feature of routines is the tendency to improve over time, at least in the early stages of formation (Pentland et *al*., 2012; Rerup & Feldman, 2011; Zollo & Winter, 2002) Routines have been theorised as a primary mechanism for organisational learning (Levitt & March, 1988).

1.4.3.3 Inertia

A hallmark of routinized behaviour is that patterns of action tend to stay stable even when external conditions change (Pentland et *al*., 2012; Howard-Grenville, 2005; Nelson & Winter, 1982). Such resistance to change contributes to the tendency of routines to exhibit sub-optimal results (Nelson &

Winter, 1982). Routines are dynamic systems, not physical objects, so it might be more appropriate to refer to this kind of dynamic equilibrium as endogenous stability (Pentland et *al*., 2012).

1.4.3.4 Endogenous change

Paradoxically, routines also have been observed to exhibit changing patterns of action even when external conditions are apparently stable (Pentland et *al*., 2012).

To make clear the difference between inertia and endogenous change, Pentland and Feldman (2005) argue that organisational routines tend to look different depending on one's point of view. When viewed from a distance, any particular organisational routine can exhibit a great deal of continuity over time, which leads some theorists to emphasise their role in organisational inertia and stability (Nelson & Winter, 1982). Closer observation of routines reveals that they can change continuously and endogenously, which leads other to emphasise their role in flexibility and change (Feldman, 2000; Pentland & Rueter, 1994).

Addressing these two features, theorists have argued that organisational routines are generative, dynamic systems, not static objects (Lazaric, 2000; Pentland & Feldman, 2005; Pentland & Rueter, 1994). Routines are continuously emerging systems with internal structures and dynamics (Pentland & Feldman, 2005, p. 794). The internal structure of a routine can produce a wide range of different outcomes on the continuum between 'very stable' and 'constantly changing', depending on circumstances (Pentland & Feldman, 2005, p. 795). We will explain changes in routines more in details through the section 1.4.6.

1.4.4 Routines and practices

Pentland and Feldman discuss different approaches of studying organisational routines: treating routines as black boxes, examining one aspect of a routine and considering interactions between various aspects of a routine (Becker et al., 2005; p. 786). Recent studies have started to open the "black box" of the routine and examine the situated actions through which routines are performed (Feldman, 2000). In this regard, Howard-Grenville (2005) explains that every performance of a routine requires effort as actors choose their actions in light of the specific situation and their experience of earlier iterations of the routine (Howard-Grenville, 2005).

Researchers such as Nelson and Winter (1982) see routines as socially constructed and collective recurrent programs of action that are the outcome of complex evolutionary processes (Nelson & Winter, 1982).

Practices and routines are very close (Duchek, 2013) and can be considered as the set of repetitive actions that are influenced by a number of contextual elements such as cognitive schema, norms, social beliefs and behavioural habits (Nicolini, 2009; Whittington, 2006).

In this study we distinguish between practices and routines through the repetitive characteristic of routines. Thus, a practices which is applied systematically can be considered as a routine.

Jones and Craven (2001) and Easterby-Smith et al. (2008) adopt a routine-based perspective on absorptive capacity and through interviews and participant observation, they illustrate knowledge absorption practices in specific organisational contexts (Duchek, 2013, p. 322). The definition of practice directs us towards the ostensive aspect of routines. In the following we overview the ostensive and performative aspects of routines.

1.4.5 Ontology of organisational routines

Scholars define two levels for organisational routines (parts, layers, or aspects) that are recursively associated: (i) a *concrete level* (performative aspect) that consists of the specific performances of the routine that may exhibit variations (Pentland et *al*., 2012; p. 8); and (ii) an *abstract level* (ostensive) that both shapes and is shaped by these specific concrete performances (Becker, 2004; D'Adderio, 2008; Feldman & Pentland, 2003; Parmigiani & Howard-Grenville, 2011; Pentland et *al*., 2012).

Latour (1986) uses the terms "ostensive" and "performative". An ostensive definition of a concept is one that exists in principle (Sevón, 1996). A performative definition is one that is created through practice: "Society is not the referent of an ostensive definition discovered by social scientists despite the ignorance of their informants. Rather it is performed through everyone's efforts to define it" (Latour, 1986; p. 273). Ostensive level may be devoid of active thinking, but routines enacted by people in organisations inevitably involve a range of actions, behaviours thinking, and feeling (Feldman, 2000; p. 622). The ostensive level is the abstract or generalised idea or schematic form of a routine (Feldman & Pentland, 2003; p. 101). In contrast, the performative level of the routine consists of specific actions, by specific people, in specific places and times (Pentland & Feldman, 2005, p. 795). Both of these levels are necessary for an organisational routine to exist (*ibid*).

1.4.5.1 The ostensive level

The ostensive level of a routine shapes our perception of "what the routine is" and Pentland et al. (2012, p. 6) refer to the abstract level simply as "history". Nelson and Winter (1982) compared ostensive level of routines with "organisational skills", such as hiring routine involves attracting, screening, and choosing applicants. If applicants were chosen, the routine would also include some form of extending an offer and joining up (*ibid*). This ostensive level may be codified as a standard operating procedure, or it may exist as a taken-for-granted norm (Feldman & Pentland, 2003; p. 101). The ostensive level may have a significant tacit component embedded in procedural knowledge (Cohen & Bacdayan, 1994). Artefacts of this level may exist in various forms. In the case of hiring routines, for instance, there may be written hiring procedures, application forms, or copies of past employment ads (Feldman & Pentland, 2003; p. 101).

The ostensive level cannot encompass specific performances because it is impossible to specify any routine in sufficient detail that it could actually be carried out (Becker, 2004; p. 648). There are always contextual details that remain open (that must remain open) for the routine to be carried out (Feldman & Pentland, 2003; p. 101). Rules are resources for action, but they do not fully determine action and they are not enough sufficient to specify a complete pattern of behaviour, because the interpretation of any rule, or any part of a rule, requires more details (J. Taylor, 1993). In this sense, the significance of a rule, or of the ostensive aspect of a routine, becomes apparent only in its performance (Feldman & Pentland, 2003; p. 101).

1.4.5.2 The performative level

The concrete level of routines has not been particularly controversial in the literature of organisational routines (Pentland et *al*., 2012; p. 7). Feldman and Pentland (2003) call the concrete level of routines as 'performative'. They define it as including specific actions taken at specific times and places. It has been more difficult to theorise rather than abstract level and there has been less consensus about what it contains (Pentland et *al*., 2012; p. 7).

Pentland and Rueter (1994) define the way in which participants construct routines from a repertoire of possibilities as "effortful accomplishments". Bourdieu (1990) argues that routines are inherently improvisational as they are carried out against a background of rules and expectations, but the particular courses of action we choose are always, to some extent, novel (Pentland & Rueter, 1994). Unreflective, habitual action is certainly possible, but even in highly constrained situations, participants engage in reflective self-monitoring in order to see what they are doing (Giddens, 1986). They interpret their actions in order to make sense of what they are doing and, though their choices of how to proceed appear automatic or mindless at times, there is always the possibility of resisting expectations and doing otherwise (Giddens, 1986; Orlikowski, 2010). Therefore, even routines that have been carried out by the same people many times, need to be adjusted based on the changes in the contexts (Feldman & Pentland, 2003; p. 102).

1.4.6 Changes in routines

1.4.1.1 Interactions between ostensive and performative aspects

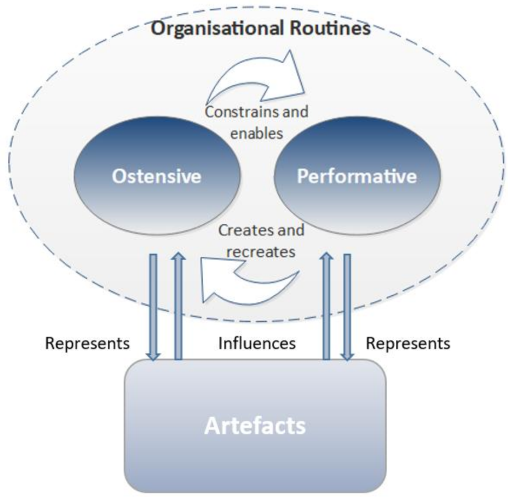
Routines have the potential to generate new patterns of action despite of their superficial stability as the ostensive aspect of routines remains stable, even though the performance are highly diverse (Pentland et *al*., 2012, p. 1380). In this respect, Howard-Grenville (2005) identifies two types of routine change:

- The first type consists of the flexible adaptation of individual performances that is to say, in temporary deviations from the abstract or general pattern;
- The second type concerns changes in that pattern across several performances.

The interplay between these two types of change can be theorised as part of an evolutionary process of variation and selective retention (Dittrich et *al*., 2016). Figure 2-10 illustrates in a simple way the interaction between ostensive and performative levels. It shows that ostensive level consists of abstract regularities and expectations that enable participants to guide and refer to specific performances of a routine (Feldman & Pentland, 2003; p. 100). The ostensive and performative levels are mutually constitutive and without them, the recognisable, repetitive patterns of action that characterise organisational routines cannot be produced or reproduced.

The influence of artefacts on organisational routines and interaction between ostensive and performative levels of routines represent generative systems. Ultimately, these generative systems can produce performances over a wide variety of time scales, from very fast (a few minutes or seconds) to rather long (weeks or months) (Pentland & Feldman, 2008; p. 241).

Figure 2-10- Interaction between ostensive and performative levels *(Pentland & Feldman, 2008; p. 241)*



1.4.1.2 Role of artefacts

Artefacts such as rules and written procedures are sometimes mistaken for the ostensive level of a routine (Pentland & Feldman, 2008; p. 242). Artefacts such as work logs and databases can also provide a convenient archival trace of the performative level (Pentland & Rueter, 1994). However, as shown in Figure 2-10, the ostensive and performative levels are recursively related while the artefacts are distinct from the routine as constituted through this recursive relationship (Pentland & Feldman, 2005; p.795).

Artefacts can represent either the ostensive levels of a routine (as in the case of a written procedure or a policy statement that describes the overall pattern of the routine) or the performative levels of a routine (as in the case of a transaction history or tracking database) (Pentland & Feldman, 2008; p. 242). In other words, artefacts influence both ostensive and performative levels , however, this is not a foregone conclusion and even artefacts that influence the specific actions taken do not necessarily change the overall pattern (Pentland & Feldman, 2008; p. 242). While artefacts may serve as a guide for action, the manner of use and interpretation leaves open a lot of possibilities such as rules, forms, diagrams and procedures, are more like the sign in that their meaning is open to a variety of interpretations (D'Adderio, 2008; p. 773). Artefacts with a strong symbolic dimension influence action to the extent that they are incorporated into the ostensive aspects of the routine (*ibid*). However, these artefacts should not be mistaken for the ostensive aspects of routines, as they do not capture the complexity of the embodied and cognitive understandings that guide actions taken in the enactment of routines (*ibid*).

From the same point of view, Pentland and Feldman (2008) argue that artefacts can influence either the ostensive aspects of a routine or the performative aspects (Pentland & Feldman, 2008; p. 242). Influence, however, is not a foregone conclusion and even artefacts that influence the specific actions taken do not necessarily change the overall pattern (*ibid*). While artefacts may serve as a guide for action, the manner of use and interpretation leaves open a lot of possibilities (D'Adderio, 2008; p. 776).

Still, we need to consider the role of artefacts in routines quite carefully, because they are at the centre of processes and they are implicated in at least two ways (Pentland & Feldman, 2008; p. 243):

- First, they are the immediate object of the activity;
- Second, artefacts are embedded throughout a typical work process. This is more about computer-based artefacts that are used to coordinate inter-dependent activities.

It is imperative to realise that managers design artefacts, not routines, and they hope that these artefacts will shape the ostensive aspect of a new routine, and also constrain the performances in some desirable way (Pentland & Feldman, 2008; p. 249). Nevertheless, when the participants actually start producing performances, it is not necessarily, what the designers had in mind, and some amount of improvisation is inherent in the execution of routines.

In this study we use artefacts (specifically documents of selected projects) to guide the participants towards a better understanding of their ACAP's routines. In the following we explain more about ACAP's routines.

1.4.7 The routines of ACAP

Absorptive capacity refers not only to the acquisition or to assimilation of information by an organisation but also to the organisation's ability to exploit it (Cohen & Levinthal, 1990; p. 131). Therefore ACAP does not simply depend on the organisation's direct interface with the external environment (*ibid*). It also depends on knowledge transfer across and within subunits that may be quite removed from the original point of entry (*ibid*). Thus, to comprehend the sources of a firm's absorptive capacity, the communication between external environment and the organisation is an imperative factor.

1.4.7.1 Gatekeepers or boundary spanners

According to Cohen and Levinthal (1990; p. 134) communication systems rely on specialised actors to transfer information from the environment or may involve less structured patterns. Actors who stand at the interface of either the firm and the or at the interface between subunits within the firm play crucial role in the firm's absorptive capacity (*ibid*). That interface function may be diffused across individuals or be quite centralised. In this respect, roles of "gatekeeper" or "boundary-spanner" are defined when the expertise of internal actors differs considerably from external actors who can provide useful information (Allen, 1984). For technical information that is difficult for internal staff to assimilate, a gatekeeper or boundary-spanner both monitors the environment and translates the technical information into an understandable form for the research group (Tushman, 1977). In contrast, if external information is closely associated to ongoing activity, then external information is readily assimilated and gatekeepers or boundary-spanners are not so necessary for translating information (Tushman, 1977). However, gatekeepers may emerge to the extent that such role specialisation relieves others from having to monitor the environment (Cohen & Levinthal, 1990; p. 132).

Even when a gatekeeper is important, his or her individual absorptive capacity does not constitute the absorptive capacity of his or her unit within the firm (Cohen & Levinthal, 1990; p. 132). The ease or difficulty of the internal communication process and, in turn, the level of organisational absorptive capacity are not only a function of the gatekeeper's capabilities but also of the capabilities of those individuals to whom the gatekeeper is transmitting the information and these capabilities are defined earlier as the "dynamic capabilities" (*ibid*).

1.4.7.2 Identifying ACAP's routines

As highlighted through the general introduction, Many scholars treat ACAP's routines as a "black box" (Duchek, 2013). This treatment becomes particularly obvious in empirical research, which is dominated by quantitative studies. The empirical analysis of absorption practices poses a great challenge for researchers, because it is an attempt to comprehend complex, embedded, and context-dependent patterns of knowing and acting while practices are usually distributed over time and space (Pentland & Feldman, 2008) (Duchek, 2013).

In this context, Pentland and Feldman highlight that identifying and capturing a particular routine are difficult and require complex qualitative methods (Pentland et al., 2012). Hence, researchers must participate in organisational life and therefore need to conduct longitudinal researches that are timely and costly (Charreire Petit & Huault, 2008). In the following, we have an overview on applied methods and strategies to study ACAP's routines and practices

1.4.8 Applied methods and strategies to study ACAP's routines and practices

1.4.8.1 An overview on existing works

In order to have a global vision about applied methods and strategies to provide a better understanding of ACAP, we consulted three databases (Ebsco, Science Direct and Cairn) which we had access via the University account. We limited our research by consulting the papers which contain "Absorptive Capacity" in their title and published during 2014-2016, thereby it resulted 81 papers. We consulted these papers in terms of applied methods and techniques, advantage and confronted limits during the research. The papers applied both quantitative and qualitative techniques. However, the majority of the papers applied quantitative techniques such as online survey. In addition, some of them applied mixed methods by applying different techniques such as semi-structured and survey. Two other identified techniques are literature review and statistics based on secondary data (Appendix 1 provides a short definition of research methods in social science). In Table 2-6 we illustrate the advantages and limits of identified methods and strategies of consulted papers.

According to the table, the case study strategy provides an in-depth study on ACAP while this could risk the generalisation aspect of the result; consequently, the multiple case studies can provide more generalised results.

Table 2-6: Advantages and limits of mobilised research methods for better understanding ACAP

Methods or strategy	Advantages	Limits
Case studies	– Provides an in-depth study on ACAP – Integrate mixed methods and quantitative data – Flexible in terms of semi-structured interviews (possibility to adapt the interview guide during the research)	– It is not easy to generalise the results to other cases – Confronting with the difficulty related to the comparison inter-cases
Mixed methods	– Complementary of the methods for refining the understanding of ACAP's practices	– Applying mixed methods takes more time to complete the research
Secondary data	– Possibility to have a wide sample – Time saving and optimising the costs of research – Possibility of running longitudinal research	– The collected data are not specifically associated to the ACAP and most of them are general – If the data is focused on a particular subject, it makes it

Methods or strategy	Advantages	Limits
		difficult to extend the data to another research problem
Survey (questionnaire)	– Finds the relation of ACAP with other factors such as project performance – Identifying	– It is difficult to measure the concept of ACAP
Literature review	– Refines the theory – The starting point is more accessible to generate new theories	– It necessitates to conclude the literature review based the empirical data

Through these different elements, we identified three types of contributions on ACAP for the developed researches within the consulted papers.

a) Researches highlighting the correlation between variables to propose a model (e.g. Buckley & Park, 2014) by:
   - Measuring ACAP in a specific context (e.g. Belderbos, Gilsing, & Suzuki, 2016; Moilanen, Ostbye, & Woll, 2014).
   - Highlighting the correlation between the level of developed ACAP and environmental factors and antecedents of concept (e.g. Behera, 2015; Kim, 2015).

b) Researches that mobilise different methodologies to refine the theory by:
   - Proposing a conceptual model for ACAP (e.g. Hopkins & Gross, 2015; Javalgi *et al.*, 2014).
   - Identifying antecedents of ACAP (e.g. Ebers & Maurer, 2014; Enkel & Heil, 2014).

c) Qualitative researches that provide description on the practices associated to the ACAP and identify which fosters ACAP (e.g. Gauch & Blind, 2015; Scaringella & Burtschell, 2015; Vicente-Oliva *et al.*, 2015). Among 81 papers, only 13 papers advocate this type of contribution which is close to our research objectives. Therefore, we consulted more in details these 13 papers to provide a summary of their research methods and their principal contributions (see Table 2-7).

Table 2-7: Examples of studies on ACAP's practices and routines

Authors	Applied methods	Principal contribution to ACAP
Bradford & Saad (2014)	Qualitative : case study includes of 43 companies	- The authors develop a method that allows evaluating firms' ACAP, however without evaluating the performances in terms of practices and routines.
Enkel & Heil (2014)	Mixed method : Survey with 268 responses 13 semi-structured interviews	- The authors identify the alternative coordinating schemas as the antecedents of PACAP (Potential Absorptive Capacity) through the collaborative between companies, which are embedded to the different activity sectors. These schemas allows to foster their PACAP by focusing on the exploitation dimension while in order to enhancing ACAP, it requires to improve exploitation dimension simultaneously. - The paper is based on organisational level of analysis that does not allow to explain how ACAP can be translated in terms of routines and practices.
Flatten *et al.* (2015)	Quantitative : Online survey with 608 responses	- The authors argue that transactional and transformational leadership practices have the positive effect on PACAP and RACAP (realised ACAP). These effects can be changes based on the different cultures. In addition, the leadership style based on the reward and penalty increase ACAP. Assimilation and transformation relies on individual behaviours while acquisition and exploitation develop through collective practices. - Nevertheless, the paper propose an approach for the action associated to the ACAP, the individual and collective routines and practices are not described clearly.
Gauch & Blind (2015)	Secondary data : International classification of patents	- The authors analyse the effect of technological development and standardisation practices on ACAP. According to this study, the level of technology and the practices related to the standardisation increase the level of ACAP within the organisations. However, these practices are not explained by details and they are presented in a general way.
Hernández-Perlines *et al.* (2016)	Mixed method: Case study includes of 6 company Survey with 112 responses	- The study propose a model that explain the role of ACAP on the transformation of training (formation) for actors to the organisational performance. ACAP plays the role of mediator in this model while authors did not precise how the phenomena is concretely applied in a micro level.

Authors	Applied methods	Principal contribution to ACAP
Limaj *et al*. (2016)	Quantitative: survey with 168 responses	- The authors analyse the mediator effect of ACAP between the “capacity of social information systems-SIS” and “innovation”. Using SIS influence positively the ACAP, in particular during acquisition and assimilation. Though the practices of the users of SIS are not expanded.
Martinkenaite & Breunig (2015)	Literature review	- The authors suggest to test ACAP through the dynamic interaction between the individual level and organisational level. This research open up the theoretical research on the micro-foundations between individual actions and organisational results.
Patterson & Ambrosini (2015)	Qualitative: 38 semi-structured interviews	- The proposed results in this study, suggests that the four dimension of ACAP intervene sequentially, the authors separate assimilation into two sub-dimensions: the knowledge assimilation before it is acquired, and knowledge assimilation after its acquisition. This conceptual abstract allows to better understand ACAP mechanism, while it is not identified how it can be translated to the individual practices.
Popaitoon & Siengthai (2014)	Quantitative: Survey (paper format), with 98 responses	- In this study, the authors argue that the practices of Human Resource Management (HRM) moderate the relation between project teams’ PACAP and long-term performance of a project while ACAP has effects on the short-term performance of the project. - The practices of HRM increase the knowledge absorption between two projects by facilitating the accumulation of prior knowledge via knowledge management programs.
Scaringella & Burtschell (2015)	Qualitative: 41 semi-structured interviews	- The authors claim that organisational learning shapes individual learning and plays an imperative role within inter-organisational learning. In dyads of learning with two direction, the complementary between teacher and students, the transfer from student to the teacher is less important and it relies on the asymmetric effect of knowledge transfer and ACAP. Knowledge transfer confront difficulties when there is complex knowledge to transfer because it depends on the capacity of students for learning and they may have very different knowledge bases. To this end, this study relies on the organisational practices related to the learning in a collective level and not individual.
Teigland *et al*. (2014)	Qualitative: 19 semi-structured interviews	- The ACAP’s practices of Open Source Software (OPS) communities are facilitated by an IT platform which manage the boundaries between users and their initial organisation

Authors	Applied methods	Principal contribution to ACAP
Vicente-Oliva *et al*. (2015)	Mixed method: 5 semi-structured interviews Online survey with 69 responses	- This study points out that the management of R&D projects is positively related to ACAP through diverse influences on the different dimensions of the concept. In addition, PACAP is strongly related to the prior experiences of project manager while RACAP is mostly associated to the practices of project management. In the same line, it is argued that projects start by relying on the internal knowledge and it will then transformed to the acquisition of external knowledge in order to avoid allocating more resources than what have been planned.
Vie *et al*. (2014)	Qualitative: 13 semi-structured interviews	- Through this study, authors present that PACAP of companies can be increased through the contact and collaboration with large-scales research centres. While RACAP depends on the choice of relevant persons in the company who are in contact with these centres.

Identified methods to study ACAP's practices, mainly look for three objectives: (i) identifying contextual antecedents that can foster ACAP in specific contexts; (ii) identifying potential barriers and challenges on the ACAP within specific contexts; (iii) evaluating contingency factors of project management, HRM and innovation that can influence ACAP.

Nevertheless, consulted papers applied different methods to identify ACAP's practices and routines, their results do not allow to describe precisely and in details these practices and routines. In this regard, Nicolini (2009, p. 1392) highlights that in order to study practices, generalising the results and have theoretical contributions, specific research methods should be mobilised. The methods that allows connecting "here-and-now" of a situated practice to other practices "elsewhere-and-the". To pursue this argument, in the following we overview the concept of "reflexivity" as a potential technique that could allow researchers to have more details on ACAP's routines and practices.

1.5 Reflexivity

1.5.1 Definitions

Table 2-8 presents definitions reflexivity based on the literature. Reflexivity is considered as a mean to change organisational settings and has been mainly studied by philosophers (e.g. Dewey, 1933), sociologists (e.g. Bourdieu, 1990; Giddens, 1994 and Archer, 2003) and psychologists (e.g. West, 1996, 2000). However, few researches in organisational studies have investigated this concept, even though it directly tackles organisational issues.

Table 2-8: Various definitions for reflexivity

Author(s)	Definition
(West, 1996; p. 559) (Schön, 1987)	Reflexivity can be defined as "the extent to which group members or individuals overtly reflect upon the group's objectives, strategies, and processes and adapt them to current or anticipated endogenous or environmental circumstances". This process is accomplished by means of discussion and conversations that may reflect the collective shared goals, task objectives, recent task mastery and performance and task-related social processes.
(Archer, 2003; Bourdieu, 1990; Dewey, 1933; Giddens, 1986; West, 2000)	Reflexivity is considered as a mean to change organisational settings.
(Knipfer *et al.*, 2013; p. 5)	Reflexivity has also been described as the intermediate that allows people to generate meaning from an experience. It includes changes or problems that requires the modification of existing working routines or invention of new ones.

In this study we adopt the definition proposed by Knipfer et *al.* (2013), while they use the term of "Reflection" in their paper and in different literature there is a various terminology such as: Reflection, Reflective thinking, Reflective talk, Reflexivity. We gather all these terms under the term of "Reflexivity".

Knipfer et *al.* (2013) recognise the reflexivity as the driving force that leads to organisational learning. The outcome of collective reflexivity facilitates the integration of individual and team learning into organisational best practices, envisage to imply in future situations that go beyond mere adaptation to a current situation (Knipfer et al., 2013, p. 10).

1.5.2 Modes of reflexivity

Archer (2003) distinguishes individual and collective reflexivity and proposed the concept of "internal conversation" to grasp actor's reflexivity. Internal conversations can be defined as "an internal dialogue is the practice through which we 'make up our mind's by questioning ourselves, clarifying our belief and inclinations, diagnosing our situations, deliberating about our concerns and defining our own project'" (*ibid*, p. 103). Table 2-9 proposes four modes of reflexivity based on Archer (2003) and Gurtner et al. (2007), however the "Meta-reflexivity" mode is not further taken into account in this research as relatively disconnected from organisational learning.

Table 2-9-Different modes of reflexivity (Dominguez-Péry, De Benedittis, & Movahedian, 2018)

Reflexivity mode	Description	Individual/ collective	Author
Communicative reflexivity	It consists of an open conversation carried within a group that shares strong ties. The outcome of these conversations is decisions that will mediate "existing social structures" and organisational routines.	Collective	Archer (2003)
Autonomous reflexivity	It consists of the lonely conversations carried out by actors within an organisation, with a performative aim.	Individual	Archer (2003)
Meta-reflexivity	It consists of lonely internal conversations dedicated to the lifelong projects, projections in professional career or personal life.	Individual	Archer (2003)
Guided reflexivity	It can be defined as the intervention of an external actor to the organisation to structure and guide conversations upon feedback reception	Collective	(Gurtner *et al.*, 2007)

Not all reflexivity modes have the same effect on organisational learning. Several research argue that a "guided reflexivity" is needed to reach the highest outcome of collective reflexivity (Gurtner *et al*., 2007; Gabelica *et al*., 2014). Guided reflexivity means "formal and structured intervention that provides teams with: (i) devoted time (time out from action), (ii) space and (iii) specific guidelines (or prompts) about how to collaboratively extract meaning from the provided feedback and set new goals and strategies for future performance" (Gabelica *et al*., 2014: 88).

Several reasons can explain that reflexivity intervention in groups is useful. Firstly, actors are generally reluctant to express organisational issues or failures; secondly, actors generally face the production paradox (Carroll & Rosson, 1987) meaning that under time pressure, actors want to get results (produce) and not necessarily learn. Finally, external actors can be efficient mediators to reformulate actors' conversation and help them revise their initial opinions, owing to their external and neutral position (Gurtner *et al*., 2007).

1.5.3 Organisational learning and reflexivity

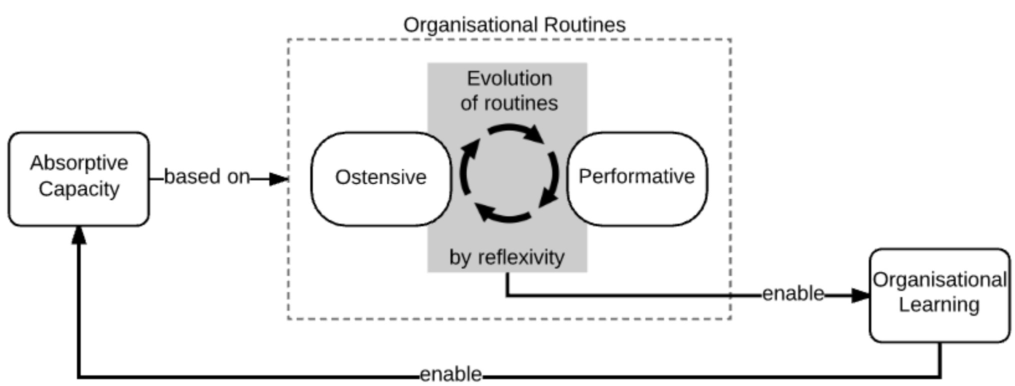
1.5.3.1 Enhancing learning through reflexivity

An organisation's potential to learn and develop over time is one of the most important assets to compete with other organisations including 'improvement', 'recording' and 'evolution of knowledge' and it has been operationalised in diverse ways (Knipfer *et al.*, 2013). Organisations engage in learning at the collective level (Spicer & Eugene, 2006).

Figure 2-11 summarises the relation between presented concepts, organisational routines, absorptive capacity and organisational learning. Routines are critical for organisational learning (Levitt & March, 1988) and they can also be at the root of a more structured and mastered organisational learning, while organisational learning enables organisations to develop routines for reusing external knowledge (Rezaei-Zadeh & Darwish, 2016). According to Pentland & Feldman (2005) and Dittrich *et al*. (2016), reflexivity and collective talk of actors is a powerful way to change routines' dynamics.

Figure 2-11-Relation between absorptive capacity, organisational routines and organisational learning

(Movahedian, Dominguez-Péry, Tassabehji, & De-Benedittis, 2017)



Routines change needs "performative struggles" and efforts (Feldman *et al.*, 2016), and it can be facilitated by providing "reflexive spaces" within organisations (Bucher & Langley, 2016). These spaces are defined by dedicated time and spaces to reflexive activities, which are disconnected from the original routines on which actors are reflecting upon. These spaces may bring new insights into intentional variations of routines.

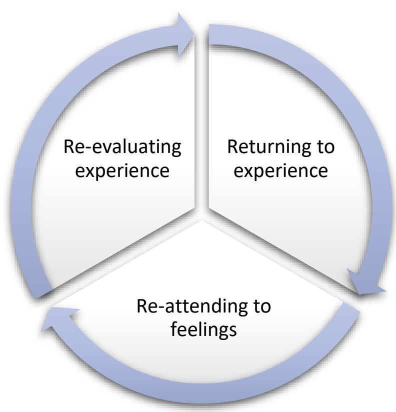
1.5.3.2 Process of reflexivity

Boud *et al*. (1985; p. 19) add the notion of learning to the reflexivity: "Reflection in the context of learning is a generic term for those intellectual and affective activities in which individuals engage to explore their experiences in order to lead to new understandings and appreciations". They also propose a reflexive cycle presented in Figure 2-12. The cycle combines three learning processes:

(i) Returning to experience (behaviour, ideas, feelings);
(ii) Re-attending to feelings (reflection hold by attend to feelings to re-evaluate experience)
(iii) Re-evaluating experience which can be considered as the outcome of the overall process.

The reflexive process ends with a concrete outcome which can be summarised as new organisational or individual perspectives, change in behaviours or individual and organisational learning (Movahedian et al., 2017).

Figure 2-12-Reflexive cycle *(Boud et al., 1985)*



Another relevant research is the three-stage process described by West (2000): (i) Teams reflect on how they have performed so far; (ii) then, they consider potential improvements, and (iii) they develop plans how the new strategies should be implemented. This last step refers to the implementation of the new strategies and implies actor's adaptation.

Consequently, organisational learning is based on individual and team learning at work and reflection is the driving force that leads to organisational learning (Knipfer et al., 2013; p. 30). In addition, the outcome of reflection facilitates integration of individual and team learning into organisational best practice (*ibid*).

1.5.4 Limitation of reflexivity based studies

Scholars consider reflexivity as one of the alternative to make changes on routines. Nevertheless, providing reflexive space and setting up reflexivity among actors is not easy. In one hand, stimulating enactment of participants in a collective way is always challenging (Howard-Grenville et al., 2016). Capturing and analysing reflexive discussion on the hand is difficult for researchers and it often necessitates building longitudinal and ethnographic cases studies (*ibid*). It is also difficult to perform conversation analysis outside the context of some ethnographic works (Fauré & Rouleau, 2011; p. 117). In addition, conventional approaches such as semi-structured interviews can collect some actors reflexivity, but they do not capture collective reflective talks (e.g. Fauré and Rouleau (2011) use interviews to identify general routines and highlight ostensive aspect of routines) and the result are not easily generalizable (Gurtner et al., 2007). In consequence, some questions raise: *"How to provide a reflexive space for organisations' actors to have reflection on their ACAP's routines?" And also "how can organisational learning about ACAP's routines can be enhanced via reflexivity?"*

1.6 Conclusion

Absorptive capacity is viewed as dynamic capabilities embedded in firm's routines and processes. Therefore, to enable the absorptive capacity it is required to make changes on organisational routines that applied to acquire, assimilate, transform and exploit external knowledge.

Researchers comprehend routines as complex social practices (Nicolini, Gherardi, & Yanow, 2003) or they can be considered as practices in specific context. The definition of practice direct us towards the ostensive level of routines that consists of abstract regularities and expectations to enable participants to guide and refer to specific performances of a routine, while the performative aspect of the routine consists of specific actions, by specific people, in specific places and times. Based on the presented theories, the artefacts are at the interface between ostensive visions of routines and their performance.

In addition, scholars consider reflexivity as an alternative to make change on routines. However, studies based on reflexivity are generally longitudinal and concentrate on specific area, which make the researches costly, time-consuming and limited in generalising the research results. To cope with these limitations and providing reflexivity on ACAP's routines we aim to propose a structured method and a protocol to conduct reflexivity within organisations to capture organisational routines associated to the absorptive capacity. In this perspective, the next chapter gives an overview on method, method-engineering concepts and shows how a method can be enriched by different techniques to improve actors' involvement and raise reflexivity among them.

Chapter 3. Method engineering and participative methods

2.1	INTRODUCTION
2.2	KEY CONCEPTS
2.3	METHOD
2.4	METHOD ENGINEERING
2.5	PARTICIPATIVE METHODS
2.6	CONCLUSION

2.1 Introduction

The previous chapter presented our literature review on the key concepts such as ACAP, organisational routines, learning and reflexivity. As highlighted, our main research objective is to provide SMEs a better understanding of ACAP's routines. To this end, this study proposes a participative method called ISEACAP (Identification, Simulation, Evaluation, and Amelioration of Absorptive Capacity) that provides both researchers and organisations' actors a clear vision on ACAP's routines.

The development of ISEACAP relies on method engineering approaches. Thus, this chapter firstly aims at presenting the fundamentals of these approaches and then overviewing existing definitions of models and metamodels, method and method engineering. In addition, we present applied techniques in ISEACAP construction such as gamification and knowledge elicitation. Finally, by using existing comparison criteria adapted from the literature, we compare existing participative methods which have close objectives to ISEACAP. This comparison highlights our starting point for method development.

2.2 Key concepts

2.2.1 Models

The IS community has a long culture in using and relying on models to represents methods. In this perspective, Model-driven engineering (MDE) is defined as a software development approach that focuses on creating and exploiting domain models, which are conceptual and associated to a specific problem (Schmidt, 2006).

Scholars provide various definitions for model as presented in Table 3-1 while they have consensus point to consider it as an abstraction of the system under study and partial or simplified view of the system. Rodrigues da Silva (2015) highlights the need of creating multiple partial models to better represent and understand the system under study (Rodrigues da Silva, 2015).

Table 3-1: Synthesis of Model definitions

Author(s)	Definition
(Seidewitz, 2003)	A model is a set of statements about the system under study.
(Kühne, 2006)	A model is an abstraction of a (real or language-based) system allowing predictions or inferences to be made.
(Selic, 2003)	A model is a reduced representation of some system that highlights the properties of interest from a given viewpoint.
(Bézivin & Gerbé, 2001)	A model is a simplification of a system built with an intended goal in mind so a model should be able to answer questions in place of the original system.
(Kleppe, Warmer, & Bast, 2003), (Rolland & Salinesi, 2005), (Dupuy-Chessa, 2011)	A model is a description of a part of a system that is sketch out through a formal language.
(Rodrigues da Silva, 2015)	A model represents a partial and simplified view of a system, so, the creation of multiple models is usually necessary to better represent and understand the system under study.

In the context of MDE, system is defined as a generic concept for designing a software application, platform or any other related artefact (Rodrigues da Silva, 2015, p. 140). Additionally, a system can be composed of other subsystems and has relations with other systems (e.g., a system may communicate with others).

A model can itself be considered as a system, with its own identity, complexity, elements, relations, etc. Thus, considering the model as a system helps define the system under study without considering it directly (Rodrigues da Silva, 2015, p. 140).

To distinguish a model from any other type of artefact, Ludewig proposes three criteria for model identification, mapping, reduction and pragmatism (Ludewig, 2003):

- **Mapping:** It must be possible to identify the object or original phenomenon (of the system) that is represented or mapped in the model.
- **Reduction:** The model must be a simplified version of the original, so not all aspects of the original must be depicted in the model.
- **Pragmatism***:* The model should be useful and be able to replace the original. In other words, they must serve same purpose.

In terms of characteristic of models, Booch et al. (1998) discuss that models help visualise a system, as *It-Is* or as we want it *To-Be* (Booch, Rumbaugh, & Jacobson, 1998). Models allow additionally to specify the structure and the behaviour of a system and give a template that help guide the development process (Booch et al., 1998).

Kleppe et al. (2003) define a model as a description of a part of a system that is sketch out through a formal language (Kleppe et al., 2003). In the following, we describe firstly metamodelling then modelling languages.

2.2.2 Metamodel

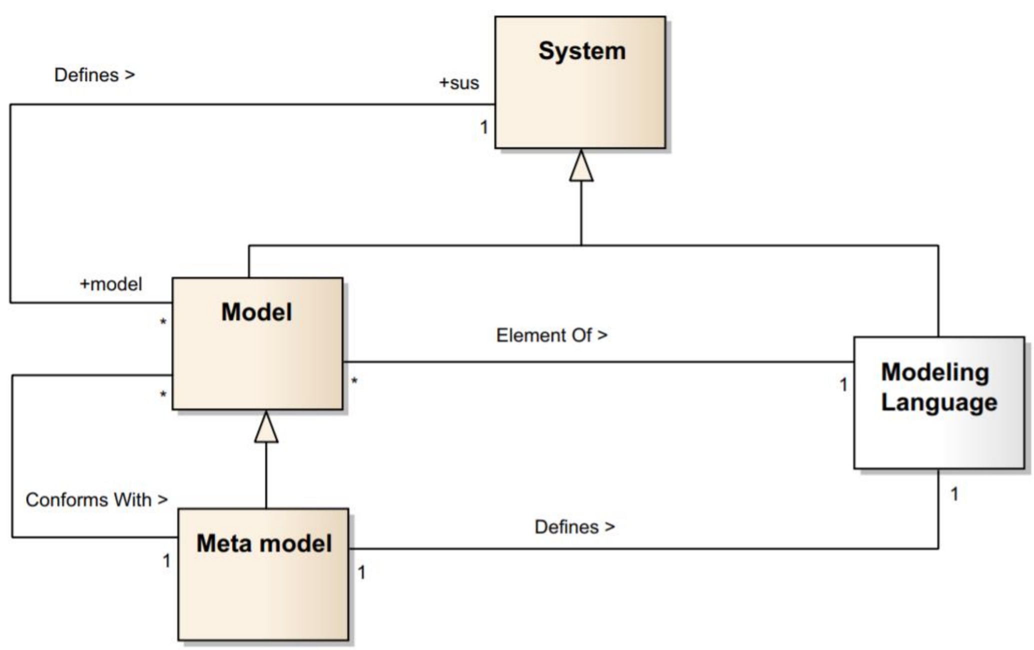
Table 3-2 highlights examples of important definitions provided by different authors. Scholars argue that MDE is based on the concepts of system, model, metamodel and modelling language (Favre, Estublier, & Blay-Fornarino, 2006). In this respect, Figure 3-1 proposed by Rodrigues da Silva (2015) , shows the relations between these concepts (Rodrigues da Silva, 2015).

Table 3-2: Synthesis of metamodel definition

Author(s)	Definition
(OMG, 2001)	A metamodel is a model of models.
(Seidewitz, 2003)	A metamodel is a specification model for which the systems under study being specified are models in certain modelling language.
(Favre, 2005; Favre et al., 2006)	A metamodel is a model of a language of models.
(Rodrigues da Silva, 2015)	A metamodel is a model that defines the language for expressing a model.

Figure 3-1 highlights at first, through the relationship "elements of" between model and modelling language, a modelling language allows to define several models (or a model is an element of a modelling language) (Rodrigues da Silva, 2015, p. 142). Second, through the relationship "defines" between metamodel and modelling language, a metamodel is a model of modelling language structure (or a modelling language is defined by a metamodel) (*ibid*). Third, a metamodel is a model of a set of models or is a model of models (*ibid*). Finally, a model "conforms with" a metamodel and it means that the model should accomplish the rules defined at its metamodel level (Kühne, 2006).

Figure 3-1: The metamodel definition: relationships between metamodel and model (Rodrigues da Silva, 2015)

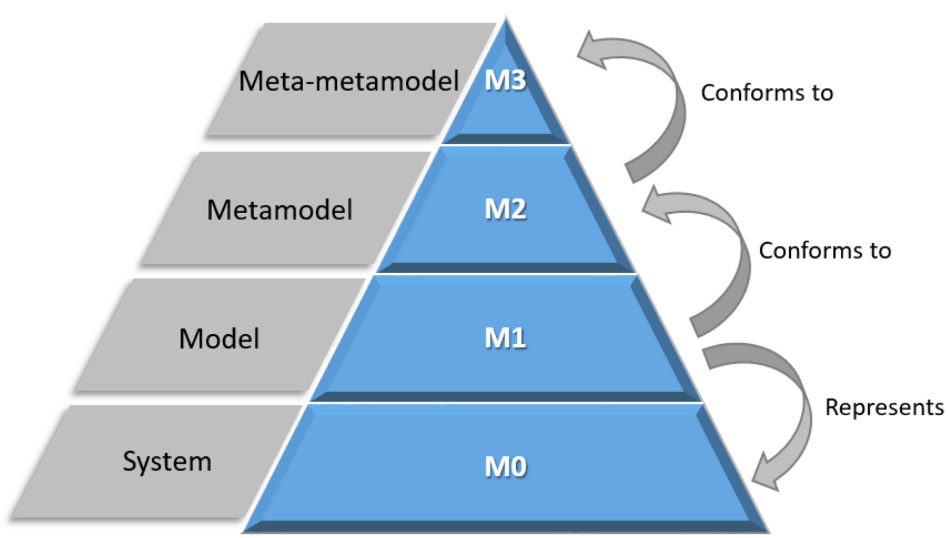


2.2.2.1 Level of modelling architecture

OMG (Object Management Group) defines four level of modelling architecture (see Figure 3-2):

- At the top of hierarchy, the meta-metamodelling layer (designated as M3) provides a language to specify metamodels. This level can be reflexive, that means it can define itself (OMG, 2001).
- At the second layer (M2), metamodels are defined as instances of meta-metamodel (OMG, 2001). This level defines a modelling language and represents the grammar of models in M1 through applying the vocabulary and grammars of M3 (e.g. a UML metamodel which is defined through the standards of UML and defines the internal structures of UML models) (OMG, 2001).
- At the third level (M1), the model of the real system that should conform to the metamodel and define information for M0. A model is valid if it conforms to the metamodel (Caron, 2007).
- Finally, the lowest level of the hierarchy (M0) contains real instances of elements defined in the model that actually exist in the context of a computational environment or even in the real world (Rodrigues da Silva, 2015, p. 143). This level contains all the real information of users and is an instance of a model.

Figure 3-2: Four layers of metamodelling (OMG, 2001)



2.2.3 Modelling language

Modelling language allows to define several models that conform with the modelling language's *abstract syntax* (metamodel), and *concrete syntax* (one or more graphical/textual notations) (Harel & Rumpe, 2000).

Abstract syntax captures vocabulary and concepts of the language (Dupuy-Chessa, 2011; Fondement & Baa, 2005) while concrete syntax describes the notation which can be the representation of language's elements. A clear separation between abstract and concrete syntaxes can be the used technique to manage the complexity of the modelling language definition. Abstract syntax defines the elements of the language (metamodel) independently of its representation (notations). The description of modelling language is completed by a semantic. Semantic communicates the interpretation of the language's elements to one or several entities (human or computers). It is a part of language and allows to a designer to communicate his/her understanding of the language. Kleppe (2007) defines language's semantic in four different way (Kleppe, 2007):

- *Denotational*: creating meaning for a model through the construction of mathematical objects.
- *Operational:* describing how a model can be interpreted as a sequence of calculation steps.
- *Translational:* translating the model in another language, which is widely perceived.
- *Pragmatic:* providing tools that execute the model. These tools are named reference implementation (Dupuy-Chessa, 2011).

According to the definition of syntax and semantic, Fraser et al. (1994) classify modelling language in three level (Fraser, Kumar, & Vaishnavi, 1994): (i) Informal: the syntax and semantic are not defined precisely; (ii) Semi-formal: the syntax is precisely defined, but semantic is described in natural language and in an informal way; (iii) Formal: both syntax and sematic are defined precisely. For instance, the syntax of a modelling language can be defined through a grammar or metamodel while the semantic is defined through denotational, operational or translational ways (Dupuy-Chessa, 2011). The programming language such as Z (Spivey, 1989) is an example of the formal languages.

Model Driven Engineering (MDE) provides the basic requirements (abstract and concrete syntax) to create new languages. These languages are called Domain Specific Languages (DSL) as they address specific problems in a limited domain. For instance, a general language such as UML can be used in various application domains. In this respect, a Domain Specific Modelling Language (DSML) is a language which is usually visual and used for modelling systems of a particular domain (Dupuy-

Chessa, 2011; Mohagheghi et al., 2013; Moody, 2005) and plays an imperative role in method development. Design and evaluation of methods require metamodelling techniques for describing their procedural and representational capabilities. The following defines a method and presents identified aspects of this concept.

2.3 Method

2.3.1 Definition

The term of method comes from a Greek word "Methodos" that means, "mean of investigation". Scholars provide various definitions within the literature for this term and Table 3-3 presents selected examples of them.

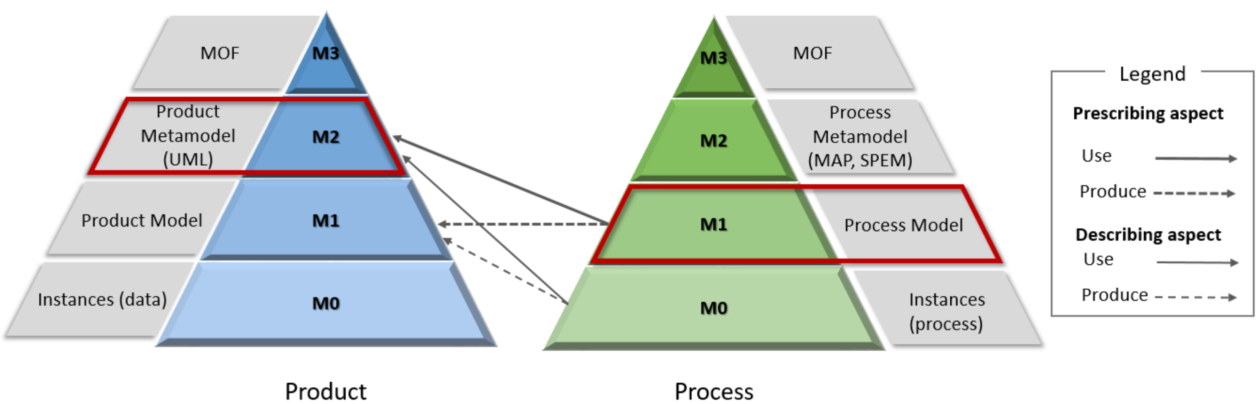
Table 3-3: Examples of method definition in IS literature

Author(s)	Definition
(Harmsen, 1997)	A method is a collection of procedures, techniques, product description and tools that aims to provide effective consistent support for the process of Information Systems engineering.
(Brinkkemper, 1996)	A method brings the concepts to describe the product and the methodological rules to shape a quality product with a reasonable efficiency.
(Booch et al., 1998)	A method is a rigorous process allowing to generate a set of models that describe divers aspects of an under construction software by using well defined notations.
(Brinkkemper, Saeki, & Harmsen, 1999)	A method is an approach to perform a systems development project, based on a specific way of thinking consisting of directions and rules, structured in a systematic way in development activities with corresponding development products.
(Rolland, 2005)	A method can be constructed based on two engineering aspects, the product and the process and consists of two elements: one or several product models and one or several process models.
(Hug, 2009)	A method is composed of a process model and one or several product metamodels.
(Céret et al. 2013, p. 796)	A method is a triplet made of a *process model*, a *product model* and a *collection of tools*.

This study relies on the both definitions provided by (Céret et al., 2013; and Rolland, 2005) a method can be defined as "*A combination of a product metamodel and a process model completed by a collection of tools".*

Figure 3-3 presents four level of modelling for product and process according to the definition of OMG (OMG, 2005). The **products** represents expected results and the **process** is the path to follow to achieve the results (Hug, 2009). In one side, process models 'prescribe' the use of product metamodel, for example UML to carry out product models (in bold on the figure), thereby process model represents the path to be followed. On the other side, a real process of IS engineering (instance), uses the product metamodel for producing associated models: this aspect of the process is 'describing', as we model only the trace of what is actually going on. In the following, we define the product and process more in details.

Figure 3-3: Four level of product and process modelling *(Hug, 2009)*



2.3.2 Product

A product model is the result of the application of a method (Rolland, Souveyet, & Ben Achour, 1998). In Figure 3-3 product side, the first level M0 represents the instances level which means representation of objects of real world within the system. M1 is the level of product models such as class diagrams. M2 is the metamodel level, usually UML used as the standard language for metamodelling. Finally M3 is the meta-metamodelling level, for instance MOF defined by OMG (OMG, 2007).

2.3.3 Process

The process is the path that is followed to accomplish the objectives of product construction. Therefore, the process can be considered as a set of activities to pursuing the objectives or describes a way of developing a methodological approach to accomplish the objectives. Thus the process can be defined within an abstract level and ideally illustrates the way of organising the production of product such as steps and activities and how they should be carried out.

In Figure 3-3, process side, M0 level represents the execution of real processes, for instance the process of IS engineering. M1 level represents the process model that should be used such as RUP[1] (Rational Unified Process) process model. M2 level represents the process metamodel, such as the metamodel of OMG, SPEM (OMG, 2008) or the metamodel of MAP (Rolland et al., 1998). Finally, M3 defines for instance, the meta-metamodel MOF (Meta Object Facility).

The first classification for process models was proposed by Dowson (1987) and includes three types (Dowson, 1987):

(i) *Activity-oriented* models focus on performed activities for producing a product and their organisation.
(ii) *Product-oriented* models couple the state of the product with the relevant activity to generate this state. This type of model visualises the process as a state transition diagram.
(iii) *Decision-oriented* models collect consecutive transformations of the product as the result of decisions. These types of models emphasise on decision-making and consulted context for making this decision (alternatives and arguments). Therefore, we can point out that activities are not anymore in heart of the model but will be highlighted as the result of decisions.

Following this classification, Rolland (2005) adds two more types: context-oriented and strategy-oriented models (Rolland, 2005). Context-oriented models can be defined as a combination of observable situations with certain number of specific intentions. In other words, the model describes the process as it depends to both situation and intention and generally it depends on the context of development (Rolland, 2005, p. 5).

The strategy-oriented models (Rolland, Prakash, & Benjamen, 1999) focus on several steps in the same process model. It is therefore multi-step and enables several possible paths to elaborate the product. It is based on notations and strategies to follow up to accomplish the intentions (Rolland, 2005, p. 5).

[1] The *Rational Unified Process* (RUP) is an iterative software development process framework created by the Rational Software Corporation, a division of IBM since 2003 (RUP, 2012). RUP is not a single concrete prescriptive process, but rather an adaptable process framework, intended to be tailored by the development organisations and software project teams that will select the elements of the process that are appropriate for their needs (RUP, 2012).

➢ Map formalism

In this study, we use a strategy oriented model called map (Rolland & Prakash, 2000, p. 181) to formalise the process model of ISEACAP.

Map is a goal-driven approach to represent a process model expressed in intentional terms and defined as a graph, with nodes as intentions and strategies as edges between intentions (Rolland, 2007, p. 143). An edge entering a node identifies a strategy that can be used for achieving the intention of the node (Rolland, 2007). Since there can be multiple edge entering a node, the map is capable of representing many strategies that can be used for achieving an intention (Rolland & Prakash, 2000).

An **Intention** is a goal that can be achieved by the performance of a process. Each map has two special intentions, *Start* and *Stop*, associated with the initial and final states respectively.

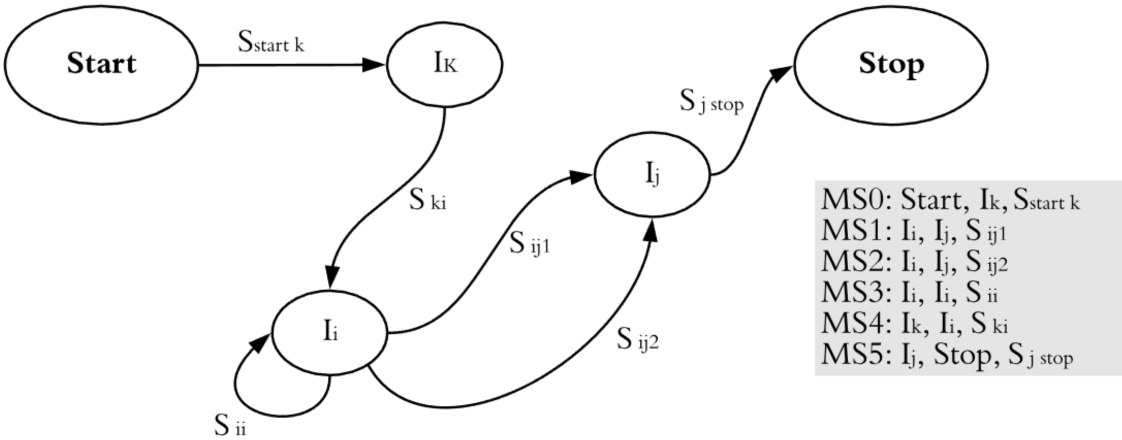
A **Strategy** is an approach, a manner or a means to achieve an intention. Strategies provide the means to capture variability in intention achievement. The strategy S_{ij} characterises the flow from the source intention I_i to the target intention I_j and the way I_j can be achieved once I_i has been achieved.

A **Section** is the key element of a map. It is a triplet $<I_i, I_j, S_{ji}>$ and represents a way to achieve the target intention I_j from the source intention I_i following the strategy S_{ij}. Each section of the map captures the condition to achieve an intention and the specific manner in which the associated with the target intention can be performed. Section of a map are connected to one another (Rolland & Prakash, 2000). This occurs:

a) When a given intention can be achieved using different strategies. This is represented in the map by several sections between a pair of intentions. Such a typology is called a *multi-thread*;
b) When several combinations of strategies can achieve an intention. This is represented in the map by a pair of intentions connected by several sequences of sections. Such a typology is called a *multi-path*.

In general, a map from its start to its stop intentions is a multi-path and map contain multi-threads. As an example, Figure 3-4 is a map that contains six section MS0 to MS5. It can be see that MS1 and MS2 together constitute a multi-thread whereas MS4, MS1 and MS4, MS3, MS2 are two paths between I_k and I_i constituting a multi-path.

Figure 3-4: An example of map (Rolland & Prakash, 2000, p. 182)



2.4 Method Engineering

2.4.1 Definition

Method engineering is defined as a set of engineering techniques that can be applied to develop a method (Rolland, 2005). Scholars define the method engineering variously. Table 3-4 presents examples of these definitions.

Table 3-4: Examples of definitions for method engineering

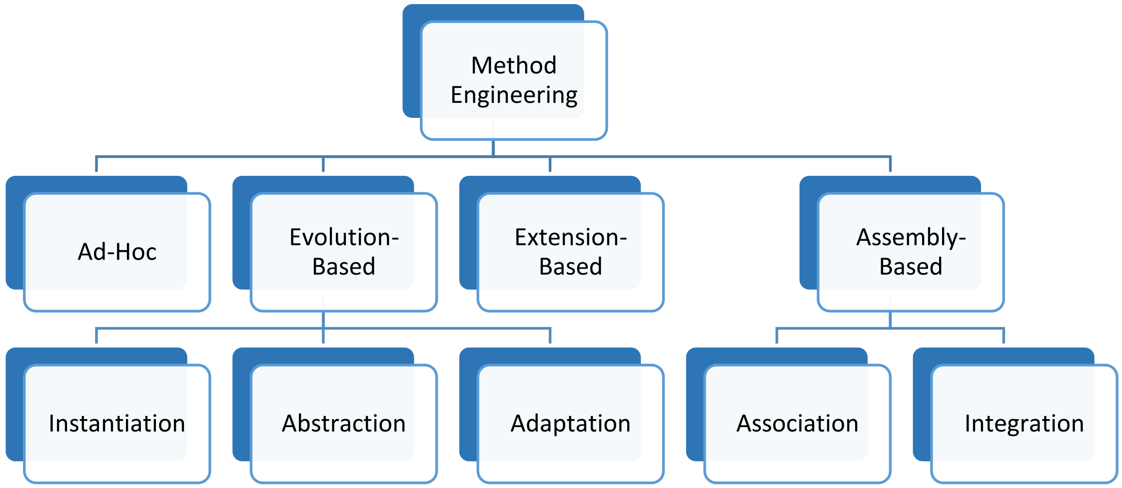
Author(s)	Definition
(Brinkkemper, 1996)	Method engineering is a conceptualisation discipline in order to construct and adapt methods, techniques and tools to develop information systems.
(Punter & Lemmen, 1996)	Method engineering is a method construction approach through combining different methods to develop an optimal solution by considering the raised problem.
(Fraser et al., 1994)	Method engineering is a proposition for designing and developing a meta-methodology targeted the method designs for information system development.
(Brinkkemper et al., 1999, p. 278)	Method engineering is a discipline to design, construct and adapt methods, techniques and tools for the development of information systems (Brinkkemper et al., 1999, p. 278). Similarly as software engineering is concerned with all aspects of software production, so method engineering is dealing with all engineering activities related to methods, techniques and tools (*ibid*). It must be obvious that the area of method engineering has links with many other research areas such as project management, software configuration management, software engineering environments, software process modelling etc.
(Rolland, 2005)	Method engineering discipline aims to adapt and construct a method for IS development by considering particular requirements of organisations within a situation. This discipline address a need of method construction that relies on a particular context of an organisation's project.

Relying on the definition provided by (Rolland, 2005) the method engineering can be defined as *"a discipline that proposes approaches and techniques, which allow to produce methods adapted to new requirements and technologies or new development paradigms for IS development".*

2.4.2 Typology of method engineering approaches

A large number of method engineering approaches has been proposed in the literature to provide a guidance for creating a new method (Prakash & Bhatia, 2002). Ralyté et al. propose a classification for existing method engineering approaches (see Figure 3-5) that consist of : Ad-Hoc, Evolution-based, Extension-Based and assembly-Based (Ralyte, Rolland, & Deneckere, 2004).

Figure 3-5: Typology of Method Engineering Approaches adapted from (Ralyte et al., 2004)



Ad-Hoc approaches deal with the construction of a new method from "scratch" (Ralyte et al., 2004). There are different reasons that can initiate a decision to construct a new method such as need of a new application domain that is not yet supported by a specific method or applying experience capitalisation as the starting point for a new method construction (*ibid*).

Extension-based approach proposes different kinds of extension that can be realised on an existing method. Their objective is to enhance a method with new concepts and properties (Ralyte et al., 2004).

Evolution-based approaches use some initial model or metamodel (As-Is) as the basis of evolution to result expected model (To-Be) by abstraction (Ralyte et al., 2004), instantiation or adaptation by considering objectives of the evolution or specific condition of related project (Rolland, 2005).

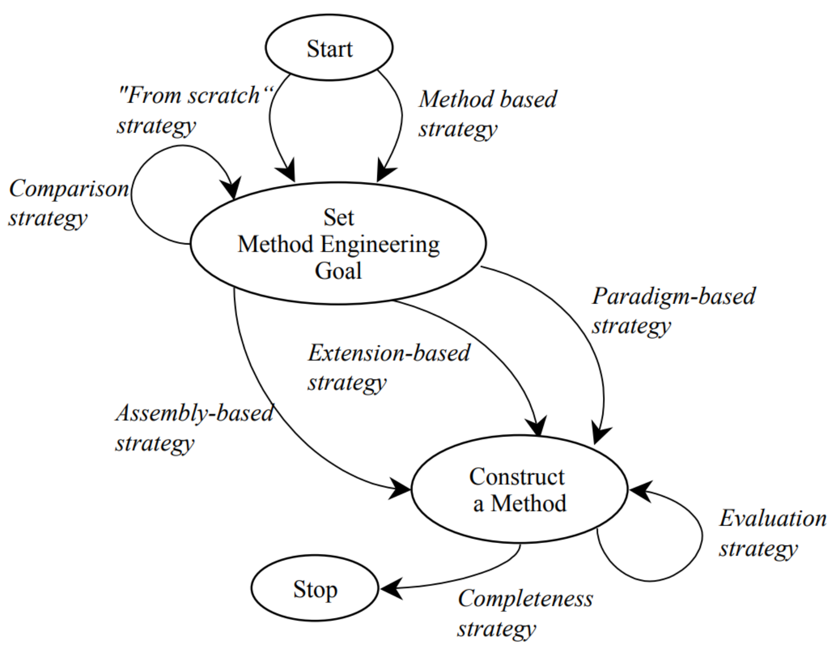
Assembly-based is defined two different sort of approach: by association and by integration. In assembly by association, the components from different methods (e.g. Me1 and Me2) are disjoined and generally complementary. This type of assembly aims to establish relations between Me1 and Me2 (Ralyté, Deneckère, & Rolland, 2003; Ralyte et al., 2004).

Through assembly by integration, the components should cover each other and the new method construction necessitates a more complex assembly that consists of integrating the concepts of Me1 to those of Me2 through appropriate operations (Ralyté & Rolland, 2001).

2.4.3 Method engineering process

The process of method engineering is defined in several ways. For instance Ralyté et *al*. (2003) propose a generic process model for situational method engineering through the Map formalism (see Figure 3-4). Situational method engineering aims to provide a better productivity of system engineering and better quality of products by adapting methods to the project situation at hand (Ralyté et al., 2003, p. 2). The situational method engineering has two principal intentions shown as two nodes in Figure 3-6: (i) set method engineering goal (ii) construct a method to achieve the goal. To accomplish these two intentions, different strategies are proposed. *Method based strategy* refers to method engineer's objective to enhance, extent or restrict an existing method. In the "*from scratch strategy*" the method engineer decides to develop a completely new method.

Figure 3-6: An example of method engineering process – Generic map of situational method engineering
(Ralyté et al., 2003)

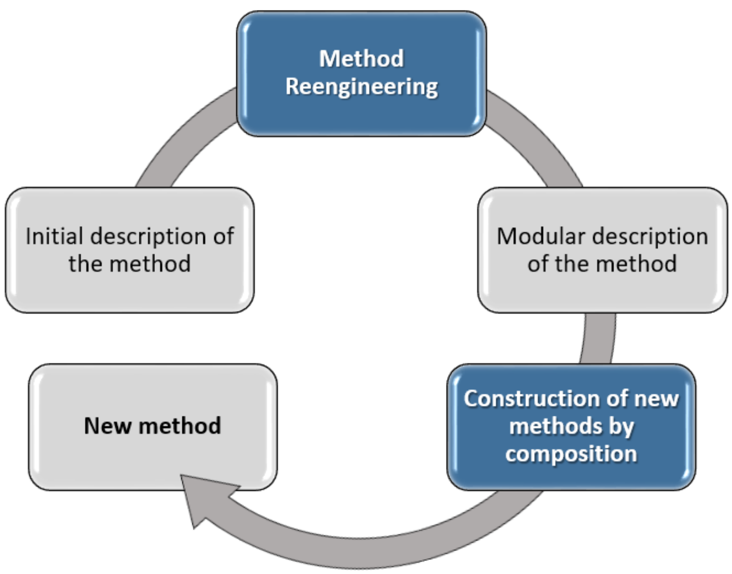


To "construct a method", the method engineer applies suitable techniques as the strategy to achieve this intention. "*By assembly-based strategy*" as explained earlier, the method engineer assembles different method components in order to construct a new method or to enrich an existing one. The second technique (referred to in the map by the "*Extension-based strategy*") is used for extending a method by applying extension patterns. Finally, the *paradigm-based strategy* is applicable, when a new fresh method must be constructed either by abstracting from a given model or by instantiating a meta-model. The strategy is called paradigm-based as the new method relies on its own paradigm.

According to Ralyté et al. (2003), these three strategies can be combined to construct a method that is the best fitting to the situation (Ralyté et al., 2003). At the end, the *evaluation strategy* is required to validate the method construction and can be applied via different evaluation techniques.

Another example of method engineering process proposed by (Rolland, 2005). Rolland argues that modular methods are easier to adapt, complete or configure. To this end she proposes a cycle for the situational method engineering by emphasising on composition. The cycle completes the proposition of (Ralyté et al., 2003) and consists of four steps (see Figure 3-7): (i) *initial description of the method* (ii) *reengineering the existing modular methods* by redefining the existing methods as the reusable modules or components (iii) *modular description of the method* by adapting the components of the existing methods (iv) *construction of new method by composition* and applying method construction techniques based on the adaption of reusable components of the existing methods (Rolland, 2005). The following section presents the motivational aspects for method engineering.

Figure 3-7: Method engineering cycle



2.4.4 Motivational aspects for Method Engineering

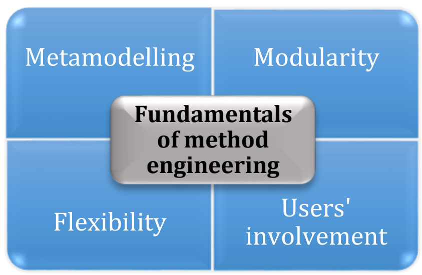
Rolland (Rolland, 2005) describes that classical methods do not sufficiently address IS problems as they are:

- often informal or not well defined,
- usually too general and not well adapted to the confronted problems,

- propose a global life cycle for steps and do not allow a detailed guiding of development activities,
- usually do not take in account the technical knowledge that is accumulated earlier by application engineers,
- not focalised on user involvement in both design and development of method

Thus, to tackle these obstacles, method engineering discipline allows developing a method based on four fundamentals (see Figure 3-8): metamodelling, modularity, flexibility and users' involvement. In the following, we explain these fundamentals in details.

Figure 3-8: Fundamentals of Method engineering adapted from (Rolland, 2005)



2.4.5 Fundamentals of method engineering

2.4.5.1 Metamodelling

Metamodelling refines the description of a method and represents the models that form a method (Rolland, 2005). Based on method definition, a method relies on a process model and a product metamodel. Each metamodel can be composed of one or several models. In our case, (we will see in the next chapter), we propose a product metamodel via UML and a process model via Map formalism.

In general, metamodelling can be applied not only for method construction but also for (i) formalising existing methods which are not well defined (Brinkkemper, 1996) (ii) standardising (iii) comparing methods (iv) and defining the relations between method engineering and programming languages.

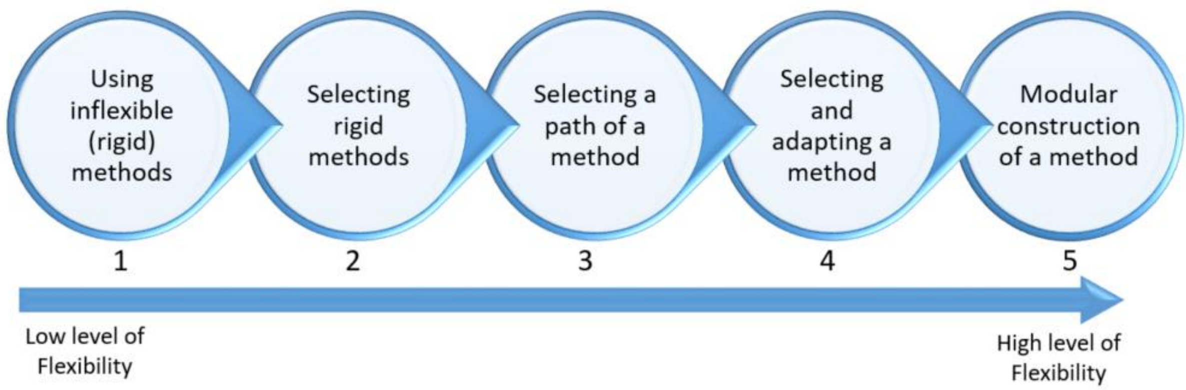
2.4.5.2 Modularity

The blocs and fragments of method's components (process and product) should be reusable for the construction of other methods (Rolland, 2005). Therefore, method engineering necessitates the method construction through reusable blocs and defines modularity as one the fundamentals of method development. Accordingly, a method can be seen as a collection of reusable components (*ibid*).

2.4.5.3 Flexibility

Harmsen et al. (Harmsen, Brinkkemper, & Oei, 1994) propose a spectrum as shown in Figure 3-9 to organise method engineering approaches based on their flexibility from "low" to "high" in terms of confronted situation.

Figure 3-9: Level of method flexibility



1. The lowest level of flexibility is dedicated to "using rigid methods" which means that the predefined methods provide low possibility of adaptability based on the confronted situation (Rolland, 2005).
2. The second level allows choosing the most adapted method to a project from a panel of predefined rigid methods.
3. The third level of flexibility consists of selecting appropriate path based on the situation.
4. The fourth level allows selecting and adapting a method based on the situation and apply it based on the project requirements.
5. Finally, the fifth level refers to the modular methods which are as much flexible and can be modified, improved and adapted based on the given situation.

2.4.5.4 Users' involvement

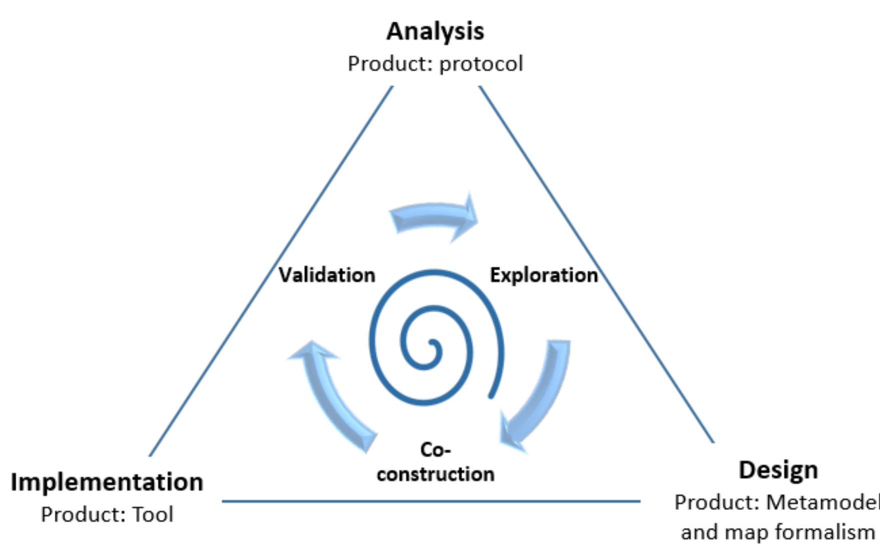
Users' involvement is about the level of user implication during the method construction. This fundamental relies on the user-centre design (UCD) and end-user validation cycle. The UCD is based upon identified needs of end-users, and end-users are involved throughout the design and development (Norman & Draper, 1986). The design is driven and refined by user-centred evaluation (Mandran et al., 2013). Scholars define the UCD in three stages: analysis, design and implementation.

The *analysis stage* should make it possible to identify users' practices, and to know their environment, theirs needs and expectations. The *design stage* is the one that leads to propose the necessary elements for developing a method. The *Implementation stage* is in particular associated to the tool development, evaluation and validation.

Each stage of UCD is made of a cycle called "evaluation cycle" with three steps involving end-users (Mandran et al., 2013): *Exploration*, *co-construction* and *validation* (so being user-centred). Figure 3-10 illustrates the UCD by considering the "evaluation cycle" that should be applied during each stage. *Exploration* relies on a state of the art, which is depending of the objective of the stage, but must also take into account specific needs of future users. *Co-construction* aims at making a collective proposal for problems emerged in the first step. *Validation* is a final step where end-users implement the proposal and evaluate it by responding to interviews or questionnaires (validation forms).

This approach is proposed for software development, Mandran, et *al.* (2013) conclude their paper with the intention to apply their approach to the development of a method (method as the product and output of a research). Therefore, we fulfil their intention by following their approach and adapting it for method development and proposing Figure 3-10.

Figure 3-10: User-centred evaluation cycle for method development



In each stage, the highest level of users' implication happens when they are involved during all the three phases of exploration, co-construction and validation. This implication could vary for each stage.

Our objective is construct a participative method that is based on the users' involvement. Therefore, the following section presents an overview on participative methods.

2.5 Participative methods

Participative methods are based on the users' involvement and participation during the method application. This PhD aims at developing a participative method to apply within the SMEs and generate consensus results collectively with the participants who are the organisations' actors.

2.5.1 Definition

One of the most important focal points of participative methods is process improvement. These methods are mainly based on quality tools such as flow charts, Ishikawa diagram, checklists, control charts, affinity and relational diagrams, etc. (Barjis, 2009). These tools provide means for self-reflection and analysis that help users solve problems and to propose creative solutions (Front, Rieu, Santorum, & Movahedian, 2015). In this respect, participative methods are defined as set of quality tools that tend to involve the users in the proposition of ideas to accomplish their objectives (Barjis, 2009; Front et al., 2015; Sandkuhl, Stirna, Persson, & Wißotzki, 2014).

Moreover, several participative methods rely on requirement and knowledge elicitation techniques like EKD proposed by Rolland et al. (1997), 4EM by Sandkuhl et al.(2014), while some of them such as ISEA method proposed by Front el. (2015) combine elicitation techniques with gamification to enhance the implication of the participants. Therefore, we define participative method as series of gamified elicitation techniques to apply at collective level and involve participants to yield consensus results (shown in Figure 3-11). Gamification or in other words gamifying the elicitation techniques makes the method playful and increases actors' involvement.

Figure 3-11: Foundations of participative method

2.5.2 Foundations of participative methods

2.5.2.1 Requirement and Knowledge elicitation techniques

Requirements elicitation is defined in computer science as the process of seeking, uncovering, acquiring, and elaborating requirements for computer based systems (Zowghi & Coulin, 2005, p. 34). It is generally perceived that requirements are elicited rather than just captured or collected (*ibid*). This implies there are discovery, emergence, and development elements in the elicitation process. Requirements elicitation is concerned with learning and understanding the needs of users and project sponsors with the ultimate aim of communicating these needs to the system developers (*ibid*). The requirements elicitation process involves a set of activities that must allow for communication, prioritisation, negotiation, and collaboration with all the relevant stakeholders (*ibid*).

Knowledge elicitation techniques are also defined in management science as the applicable techniques to elicit individual's knowledge (Tunnicliffe & Scrivener, 1991).

The use of these techniques is based on the type of knowledge that we want to elicit. Therefore, the initial step in knowledge elicitation is to identify knowledge type and then select appropriate tools or techniques to elicit it.

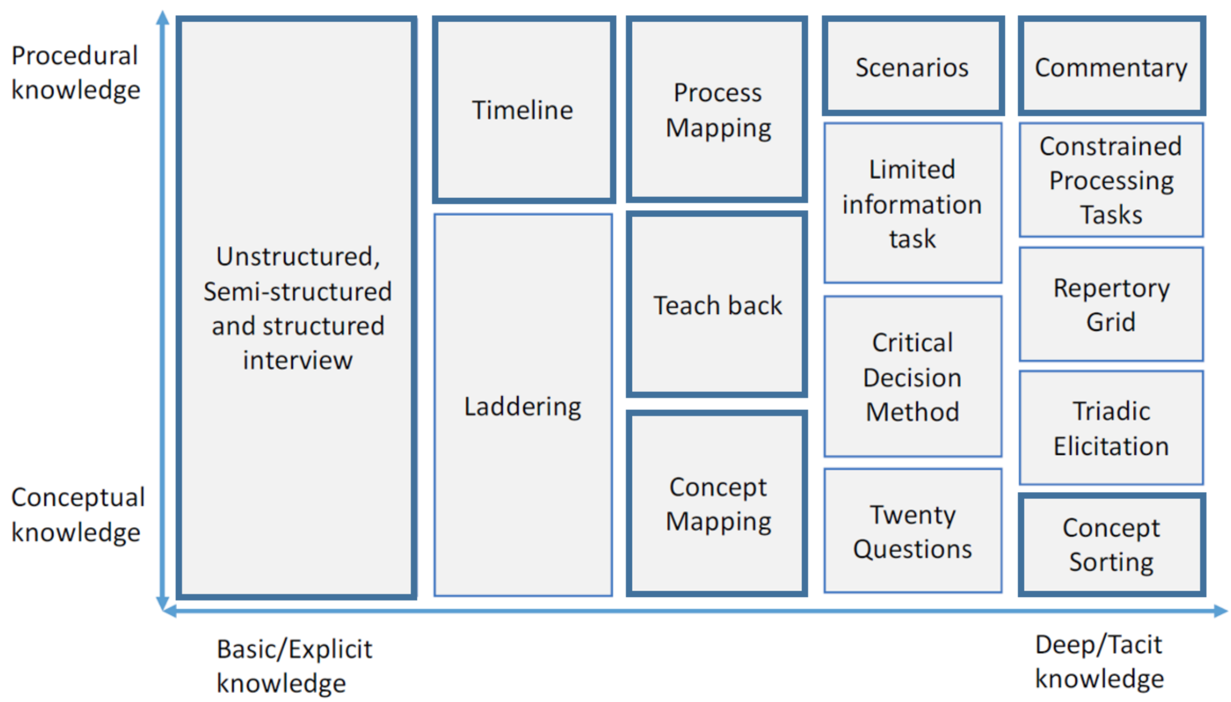
As presented through the first chapter, one of the usual knowledge classification is based on two general types "Conceptual" and "Procedural" knowledge. Conceptual knowledge is about the way in which things (called 'concepts') are related to one another and about their properties. Procedural knowledge is in general about processes, tasks and activities, which requires particular steps.

Another well-known way of characterising knowledge was proposed by Nonaka and Takeuchi in two general types: explicit knowledge and tacit knowledge (Nonaka & Takeuchi, 1995; Nonaka, Toyama, & Nagata, 2000). Explicit knowledge, as the name suggests, is at the forefront of an expert's brain and is thought about in a deliberate and conscious way. This type of knowledge is generally not too difficult to explain or express (K. Tsai, 2009). In contrast, tacit knowledge is at the back of one's brain, highly personal, unconscious, and hard to formalise (Polanyi, 1966). Subjective insights, intuitions and hunch fall into this class of knowledge. Tacit knowledge is deeply rooted in actions, procedures, routines, commitments, ideals, values and emotions (Schön, 1983). It is often built up from experiences rather than being taught and it is the type of knowledge that someone gains when s/he practices something.

According to these two classifications, Milton proposes a map of various knowledge elicitation tools and techniques (see Figure 3-12) (Milton, 2007). This ranges from interviews that capture explicit knowledge

In the following, we explain the imperative techniques for our method (shown in bold borders in Figure 3-12) and rest of the techniques are explained in Appendix 2.

Figure 3-12-Classification of knowledge elicitation technics adopted from Milton (2007)



- **Interviews**

Interviews are probably the most commonly used technique for requirements and knowledge elicitation (Goguen & Linde, 1993). Because interviews are essentially human based social activities, they are inherently informal and their effectiveness depends greatly on the quality of interaction between the participants (Zowghi & Coulin, 2005). Interviews provide an efficient way to collect large amounts of data quickly. The results of interviews, such as the usefulness of the gathered information, can vary significantly depending on the skill of the interviewer (Goguen & Linde, 1993). There are fundamentally three types of interviews being unstructured, structured, and semi-structured, the latter generally representing a combination of the former two. Table 3-5 compares the three different types of interview and highlights their positive and negative points. Depending on interviewer's objectives, each type can collect different data. Unstructured interviews are natural discussion to discover new areas and they do not follow an interview guide with predefine questions. Semi-structured interviews are based on series of questions while the interviewers can ask complementary questions during the interview. Structured interviews are usually conducted to collect specific information and following predefined questions.

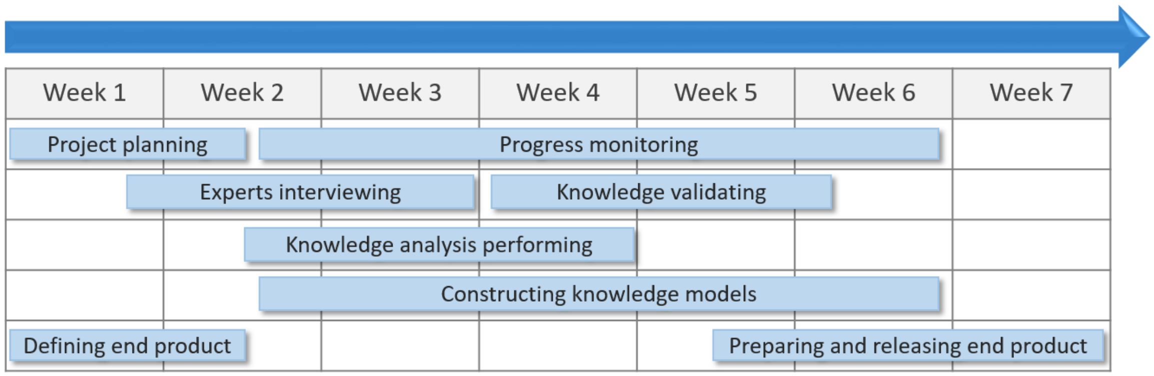
Table 3-5: Comparison of different interview types

Name	Description	Positive (+)/negative (-) aspects
Unstructured interviews	A natural conversation where the interviewer enforces only limited control over the direction of discussions (Zowghi & Coulin, 2005).	(+) The best technique to explore when there is a limited understanding of the domain, or as a precursor to more focused and detailed structured interviews (Zowghi & Coulin, 2005). (-) Do not follow a predetermined agenda or list of questions, there is the risk that some topics may be completely neglected. (-) Risk to focus too much detail on some areas, and not enough in others (McGraw & Harbison-Briggs, 1989).
Semi-structured interviews	A pre-defined set of questions and supplementary questions that can be asked during the interview (Milton, 2007).	(+) Useful to provide explicit knowledge. (+) It can cover several areas and flexible in the same time to focus on important one. (-) To elicit tacit knowledge, complementary techniques are required.
Structured interviews	A predetermined set of questions to gather specific information (Zowghi & Coulin, 2005).	(+) Depend on knowing what are the right questions to ask, when should they be asked, and who should answer them. (-) Tend to limit the investigation of new ideas; generally considered to be rigorous and effective

➢ Timeline

A timeline is a diagram that shows time along the horizontal axis and contains concepts as nodes. The width of each node shows when the concept starts and finishes. Timeline can be used to show the phases of a project or the order of events or tasks (example Figure 3-13).

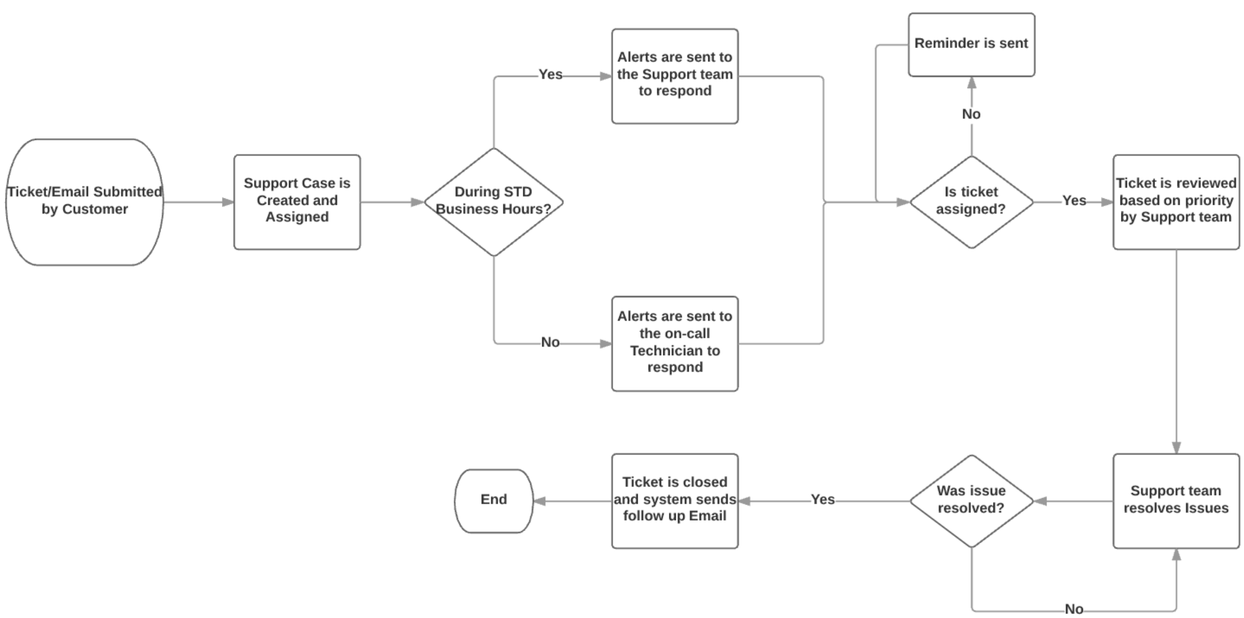
Figure 3-13: An example of a timeline- A knowledge management project



➢ Process mapping

A process map shows the way a task (process, activity) is performed. The main elements on a process map are the sub-tasks of the task that is being modelled (Milton, 2007). These sub-tasks are placed on the map in the order in which they are performed (see Figure 3-14).

Figure 3-14: An example of process mapping – A customer support process (Milton, 2007)



In requirement elicitation techniques, *task analysis* is very closed and complementary to process mapping. Task analysis employs a top-down approach where high-level tasks are decomposed into subtasks and eventually detailed sequences until all actions and events are described (Zowghi & Coulin, 2005). The primary objectives of this technique is to construct a hierarchy of the tasks performed by the users and the system, and determine the knowledge used or required to carry them out (*ibid*). Task analysis provides information on the interactions of both the user and the system with respect to the tasks as well as a contextual description of the activities (*ibid*). In most cases, considerable effort is required to perform through task analysis, and it is important to establish what level of detail is required and when components of the tasks need to be explore further (*ibid*).

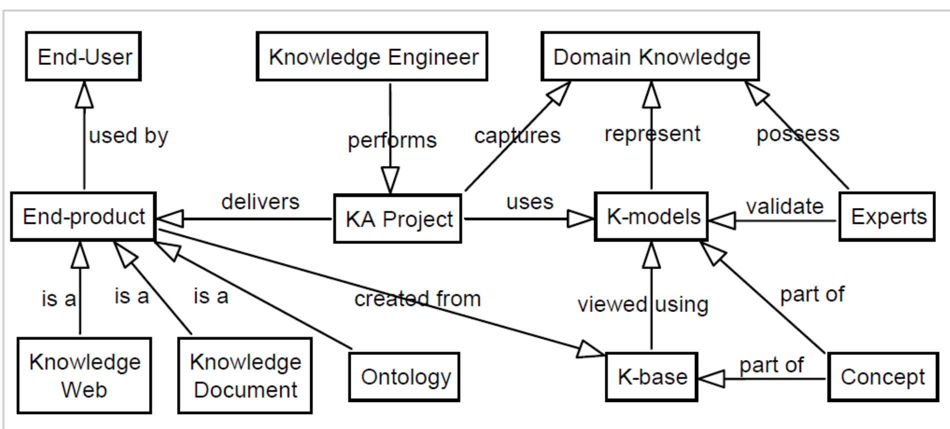
- **Teach back**

Teach back is a useful technique to provide a consensual understanding of knowledge among stakeholders and knowledge engineer (elicitor). The stakeholder explains something to the elicitor who explains in turn the same thing back to the stakeholder for verification and validation (Milton, 2007).

- **Concept mapping**

A concept map is a diagram that shows an arrangement of nodes linked by arrows. Each node represents a concept in the knowledge base and each link represents a relationship between a pair of concepts.

Figure 3-15: An example of concept mapping –Concept map of a knowledge management project (Milton, 2007)



- **Scenarios**

Scenarios are used to place the stakeholder in specific situations in which s/he performs a task or set of tasks that are of interest to the project. There are two types of scenarios: (i) Real situations that have occurred to the stakeholder or to other stakeholders; (ii) Realistic situations that could occur in the future.

- **Commentary**

This technique involves the stakeholder describing a task as it is performed. The basic technique here is the self-report, in which the stakeholder provides a running commentary of his/her thought-processes as a problem is solved or a task is performed.

- **Card (concept) Sorting**

Sorting techniques are an efficient method to capture the way an expert compares and orders concepts, and can lead to the revelation of knowledge about classes, properties and priorities. The simplest form is card sorting (Milton, 2007). Card sorting requires the stakeholders to sort a series of cards containing the names of domain entities into groups according to their own understanding (Zowghi & Coulin, 2005). Furthermore, the stakeholder should explain the rationale for the way in which the cards are sorted (*ibid*). It is important for effective card sorting that all entities are included in the process.

The presented techniques are defined to elicit individual's knowledge and some of them such as commentary or scenario necessitates cognitive effort of the experts to explain the rooted knowledge in their actions. The ISEACAP method aims to apply these techniques at the collective level to elicit collective knowledge along with individual knowledge. In addition, to stimulate the organisations' actors to elicit their knowledge we make elicitation techniques playful. Therefore, in the following we discuss about serious games and gamification techniques.

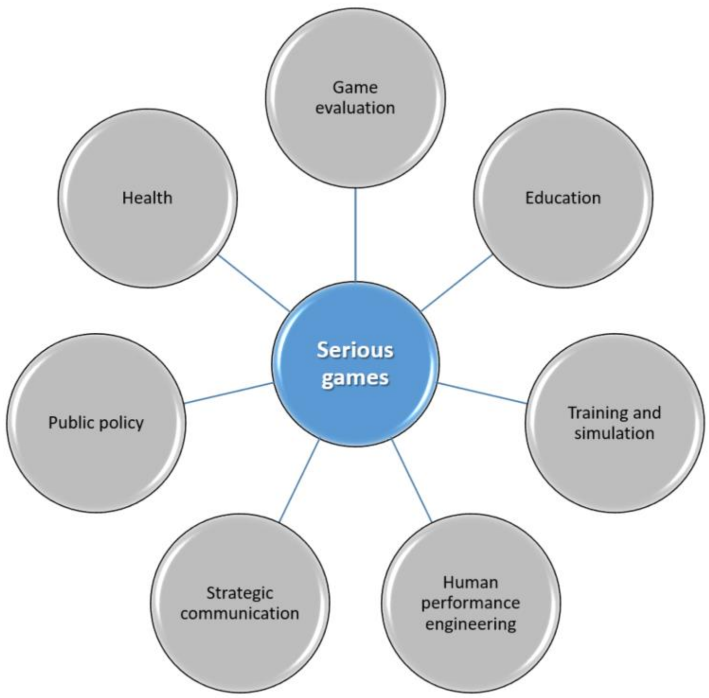
2.5.2.2 Serious games

A *game* is defined as a physical or mental contest, played according to specific rules, with the goal of amusing or rewarding the participants (Zyda, 2005, p. 25).

Applying games and simulations technology to non-entertainment domains results in serious games (Zyda, 2005). Serious games, unlike their entertainment, use pedagogy to infuse instruction into the game play experience. The formal definition might read as follows: "A mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives as shown in Figure 3-16" (Zyda, 2005, p. 28). Serious games have more than just story, art, and software, and they involve activities to educate or instruct knowledge or skill and it makes games serious. Michael and Chen argue that the serious games may be important to rethink the use of simplifying techniques and should respond to the conscious decisions made by players (Michael & Chen, 2006).

Wouters et al. (2013) investigate whether serious games are more effective in terms of learning and more motivating than conventional instruction methods (Wouters, van Nimwegen, van Oostendorp, & van der Spek, 2013, p. 1). Serious games are hypothesised to address both the cognitive and the affective dimensions of learning (O'Neil, Wainess, & Baker, 2005), to enable learners to adapt learning to their cognitive needs and interests, and to provide motivation for learning (Malone, 1981).

Figure 3-16: Application of serious game in various domains (Zyda, 2005)



- **An example of a serious game**

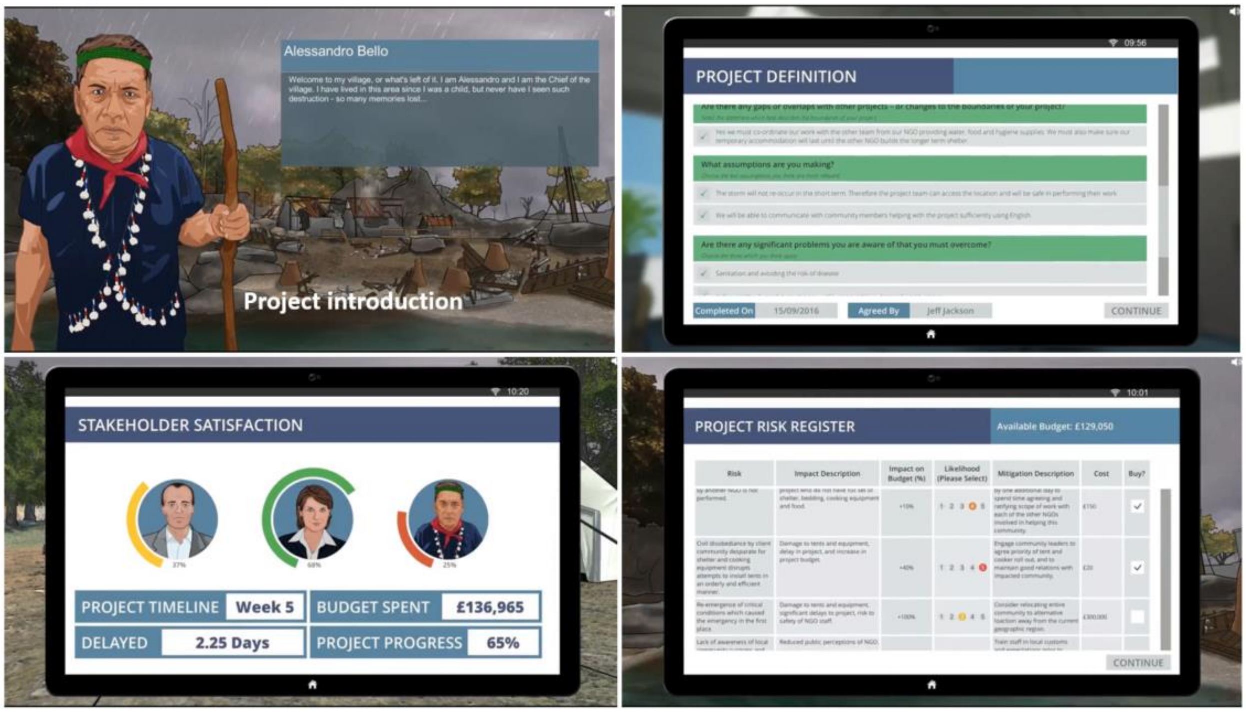
Totemlearning[2] Company has released an online serious game called: 'Unlock project management' in order to facilitate the learning of project management skills and techniques for students. This serious game is used for the project management module in management school of Liverpool for MBA students.

Unlock project management immerses players in a realistic project scenario to develop the skill to think like Project Managers (Totemlearning, 2016), covering project management tasks including

[2] http://www.totemlearning.com/

dealing with stakeholders, defining the project scope, planning, issue management, risk management, progress management, reporting and balancing conflicting needs (see Figure 3-17) .

Figure 3-17: Snapshots from different steps of the Unlock project management



The game uses a high-pressure project scenario (Totemlearning, 2016). A storm has devastated the island of Cataleyo and people need help, quickly! The player is tasked with providing quick-to-build, low cost shelter for the effected population (*ibid*). Players of this game will learn how to collect information, comprehend what is required and meet those needs by organising resources, assessing risks, staying in budget, prioritising tasks and satisfying stakeholders (*ibid*).

Applying the serious game within the module helps students better understand the concept through a real situation simulation and they are encouraged to involve actively during the course.

2.5.2.3 Gamification

Gamification can be described as the integration of game mechanisms into a non-game environment in order to give it a game-like feel (Deterding, Dixon, Khaled, & Nacke, 2011). The essential purpose behind designing and implementing gamification within different types of services or applications (e.g., customer-oriented applications and online services) is to increase the customer's engagement, enjoyment and loyalty (Matallaoui, Hanner, & Zarnekow, 2017, p. 5).

Deterding et al. (2011) defined gamification as an informal umbrella and an innovative approach for using game mechanisms in non-gaming systems to improve user experience (UX) and user engagement (Deterding et al., 2011).

- **Role of gamification**

Gamification is an interdisciplinary approach seeking to motivate users to achieve certain behavioural or psychological outcomes (e.g., learn faster, complete their personal profile, daily use of a specific platform) (Matallaoui et al., 2017, p. 3).

Gamification acts as a mediator that enables conveying game mechanics to users in order to motivate them to accomplish their tasks in a given context (*ibid,* p. 4). Studies have shown that game mechanics can have a significant effect on motivation and participation in non-playful contexts (*ibid,* p. 4).

- **An example of gamification**

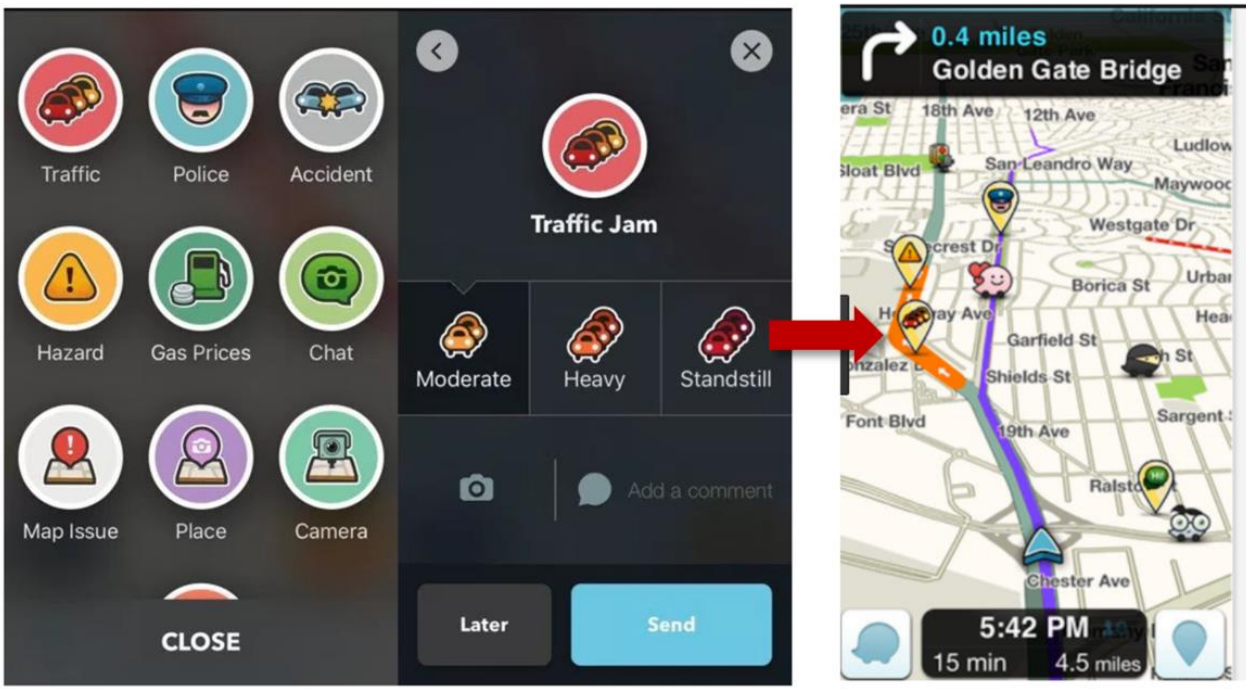
Waze[3] is an international community-based traffic and navigation mobile application. It is a social, crowdsourcing based application, which gets better with bigger communities, more interactions among community members and more contribution of users. Waze can be seen as an example of gamification techniques to encourage users to be active and make driving as a social and fun experience.

Waze users are identified through different values such as name, level, personality icon (that depends on our daily mood) and the car icon. To have a higher ranked profile, the most important value is their level, which depends on the scores and number of friends.

Pointing system: To increase the score and thereby the level, user can share traffic information, police, accident, hazard, gas prices etc. for instance for traffic information whenever users are stuck in heavy traffic, they can tap on the pink circle and choose relevant traffic situation (see Figure 3-18-left side) and gain points.

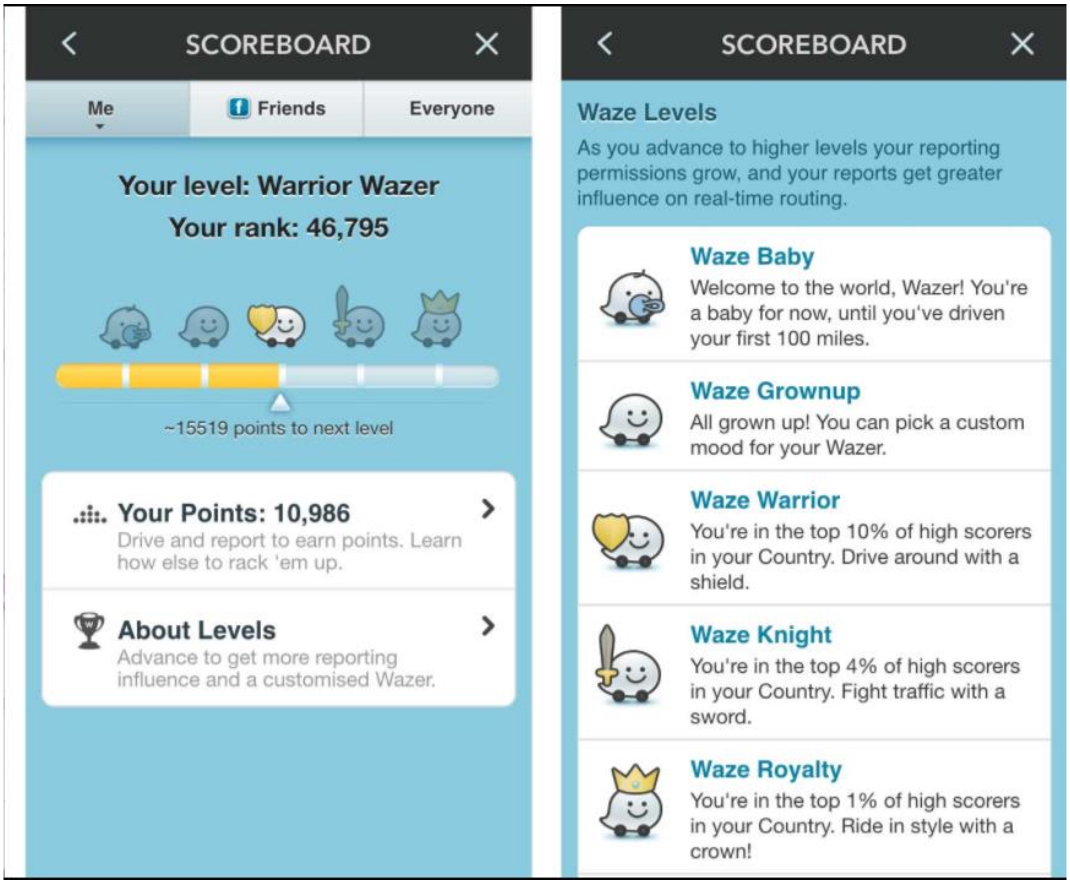
[3] http://www.waze.com

Figure 3-18: A snapshot of Waze application – A gamified traffic reporting system



Scoreboard and ranking system: To increase users' contributions, everyone receives points and gains ranks for each accomplished activity. A higher rank allows users to reach a higher level and thereby access to new options such as editing maps etc. (see Figure 3-19). However, to avoid disaster, Waze limits how far users can edit the map based on their levels (the higher level, the more can edit).

Figure 3-19: A snapshot of Waze application – scoreboard



2.5.2.4 Differences between serious games and gamification

There is often an attempt to bundle serious games and gamification, two distinct but interrelated concepts (Dyer, 2015). *Serious games* describe the design of full-fledged games for non-entertainment purposes, "gamified" application merely incorporate game elements (Deterding et al., 2011). Serious games are a reflection of games linked to particular learning objectives approaching a problem that cannot be satisfactorily solved with information systems allowing humans to solve them in game-like environments (Blohm & Leimeister, 2013). *Gamification* encompasses the design of gamified service bundles, i.e. a product, service, or information system in order to improve the following elements (Blohm & Leimeister, 2013; Dyer, 2015):

- *Usage objectives*: invoking users by activating particular motivations
- *Behavioural change*: introduce/reward new patterns of behaviour
- *Convey optimism*: enabling self-determination and the hope of experiencing success
- *Facilitation of social interaction*: allowing social exchange and/or competition

In general, gamification supports and enables the transformation of organisational value creation process mostly through improved customer loyalty and brand image (Dyer, 2015).

Applying elicitation techniques, gamification and serious games in a method, can enhance the level of users' involvement during method application. Participative method, as highlighted earlier, aim to involve users with the method application and result production. In the following, we present examples of participative methods to show the use of elicitation and gamification techniques in their structures.

2.5.3 Examples of participative methods

The chosen examples of the participative methods focus on process modelling and improvement, process reengineering or knowledge development.

CPI (Collaborative, Participative and Interactive modelling) is proposed by Barjis (2009) for collaborative business process modelling. This method focuses on collaborative and participative aspects as the fundaments of the method. The author emphasises on modelling sessions through an active collaboration and participation of the users (business process owners who can provide the relevant knowledge of the processes). The CPI modelling method consists of three aspects:

- Collaboration (expert aspect) between modelling experts as facilitators and business analysts towards a complete enterprise model through modelling session.
- Participation (end-users aspect) focuses on the contribution of business process actors such as managers, stakeholders who can provide input for modelling. This aspect aims to provide information to create and validate models.
- Interaction (tool aspect) relies on the tools for creating models and technologies to enable collaboration and participation. Interaction facilitates simulation and automates the process modelling.

PAWS (Towards a Participatory Approach to Business Process Reengineering) is a participative method to involve employees of an organisation in the business process reengineering (Borges & Pino, 1999). The method should be applied through six consecutive phases: learning, process elicitation, alternatives and solutions, option evaluation, workflow implementation and maintenance. The method aims to make employees more familiar with the objective of a project, identify problems of the current process, propose reengineering solutions, produce process model and finally validate the proposed model.

EKD-CMM (Enterprise Knowledge Development - Change Management Method) proposed by (Rolland et al., 1997) focuses on reasoning on change in organisations and tackles different aspects of organisations: who does what, how and why. It provides a systematic way to organise and to guide the change management (*ibid*). EKD is a method to document an enterprise, its objectives, business processes and support systems, help enterprises to consciously develop schemes for implementing changes (Nurcan & Rolland, 1999). The method refers to a set of conceptual models for describing various aspects of organisations including enterprise business processes (roles, actors, activities, objects...) and enterprise objectives by meeting two requirements: assisting enterprise knowledge modelling and guiding the process of change (Nurcan & Rolland, 1999).

The claim is that EKD engineers are repeatedly faced with situations that need them to make decisions. In fact, it is a repeatable process which is made of steps resulting from the application of a pattern for decision making (Rolland et al., 1997). The EKD approach provides various representations such as a matrix (columns of the matrix are intentions and rows are techniques). The EKD engineer performs and customises the representation by questioning practitioners (decision makers) within the organisation (Rolland, Nurcan, & Grosz, 2000).

4EM (For Enterprise Modelling Method) is an evolution of EKD (Sandkuhl et al., 2014). The advantages of this method are a defined procedure for the modelling, conducting of the modelling in the form of a project with defined roles, and a participative mode of practice (*ibid*). Through 4EM, elicitation techniques make it possible to obtain knowledge from different stakeholders about the aspects and parts of a crucial situation within the enterprise (Sandkuhl et al., 2014). 4EM should be applied during participative workshops where the elicited knowledge is immediately discussed and incorporated into an enterprise model (or discarded, if not relevant). The workshop should be conducted based on the predefined protocol by a knowledge engineer.

ISEA (Identification, Simulation, Evaluation and Amelioration) is a participative method which is dedicated to business process elicitation and improvement (Front et al., 2015). Through the ISEA method the participants identify their “activities” and make connections between them based on their chronological order. The process modelling via ISEA is gamified, fast and simple to produce a consensual process representation. In other words, thanks to ISEAsy, the support tool for ISEA, participants are autonomous and they highlight their tasks and make connections without needing a knowledge engineer (Front et al., 2015).

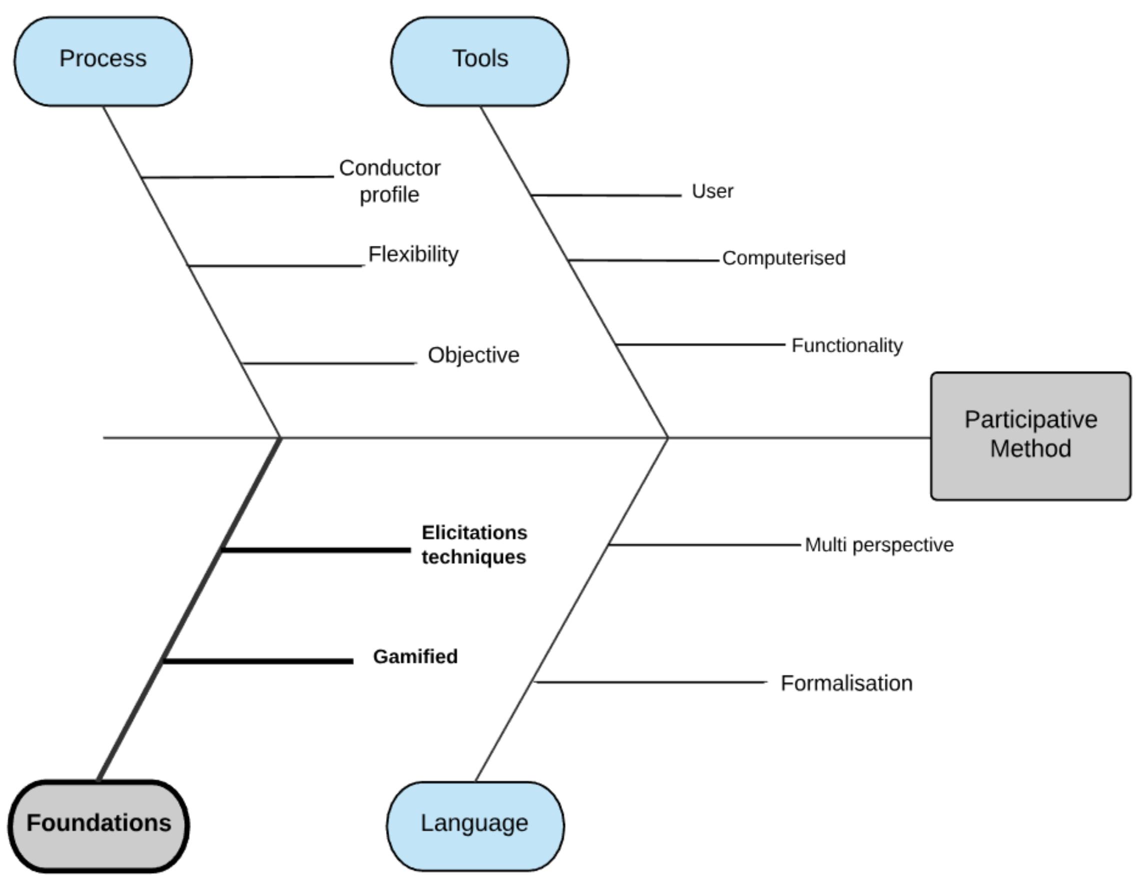
2.5.4 A comparison between the participative methods

Front et al. (2015) argue about participative method as "an active and end-user method" that should have a very simplified domain-specific language usable by end-users. Moreover, a participative method should cover multi-perspectives characteristics and be formalised with a well-defined process and language. Depending on these arguments, they propose three criteria that participative method should have: process, language and tool. In this research, we adapt these three criteria and add a new one called "Foundation". In the following, we describe the four criteria to compare the examples of the participative methods.

2.5.4.1 Comparing criteria

Front et al. (2015) define three criteria to compare participative methods: Process, Language and Tools. We add a new criterion called "foundation" bolded in Figure 3-20.

Figure 3-20: Participative methods comparison criteria (Front et al., 2015)



➢ *Process*

This criterion relies on the process that should be followed during method conduction and consists of three factors:

- *Conductor profile* that defines the profile of the process facilitator who can be an expert such as method engineer or an end-user. Most of the participative methods are conducted by experts and we consider as an advantage if the method could be conducted by a non-expert.
- *Flexibility* defines the adaptability of the method process to the project context (Céret et al., 2013).
- *Objective* relies of the principal goal of the method, for instance the ISEACAP method aims to identify ACAP's routines.

Table 3-6 presents the comparison between the participative methods based on the process criterion. As the table shows, expert or method engineer conducts the method. However, the ISEA enables end users to conduct the method without needing an expert to elicit and improve the business process.

Process of the participative methods such as EKD and ISEA are flexible to adapt in different context of the project, while the other methods are not flexible.

Table 3-6: Comparing the participative methods based on the process criterion

Method	Objective	Flexibility (Yes/No)	Conductor profile
CPI	Business process modelling	No	Expert
PAWS	Business process reengineering	No	Expert
EKD-CMM	Knowledge modelling and change management	Yes	Expert
4EM	Enterprise modelling	No	Expert
ISEA	Business process elicitation and improvement	Yes	End-users

➢ *Tools*

Another important criterion for method evaluation concerns the tools supporting the method. Front et al. (2015) defines this criterion based on three factors:

- *User:* the targeted users of participative methods' tools are generally the experts (method engineers). Thus, to rely on the participative aspect, it is imperative that tools are also usable by end-users.

- *Functionality:* relies on the tools' usage and if the tool can only create a model or could also transform it into executable models.
- *Computerised:* the support tool of the method is computerised or it is on paper format.

Table 3-7 presents the comparison between the examples of participative methods based on the tool criterion. Besides the presented factors by Front et al. (2015) for "tools" criterion, we add "computerised" factor as well. The table shows that except ISEA, the support tools for the methods are not end users oriented and need to be conducted by an expert during the sessions. The tool support for ISEA, called ISEAsy has end-users interfaces that allow end users to conduct the session and model the process with the tool. In addition, the outputs of the tools required to be analysed by an analyst and they are not transformable to executable models.

Table 3-7: Comparing the participative methods based on the tools criterion

Method	Computerised	User (Expert/End-users)	Functionality
CPI	Paper format	Expert	Modelling
PAWS	Paper format	Expert	Modelling
EKD-CMM	Application	Expert	Modelling
4EM	Paper format	Expert	Modelling
ISEA	Online application	Expert and End-users	Modelling and transforming to BPMN

- *Language*

This criterion is concerned with the language used during the modelling process (Front et al., 2015). This language should be characterised by its formalisation level and the multi-perspectives supported.

- *Formalisation* is one the important factors to evaluate a language and realise if it is formalised via a metamodel.
- *Multi-perspective* depends on the language of the method and if it supports several perspectives. Front et al. (2015) present the main following perspectives for process modelling oriented methods (Front et al., 2015):
    - Functional perspective: which process elements (activities) are performed.
    - Behavioural perspective: when and how activities are performed.
    - Operational perspective: where and by whom in the organisation activities are performed.

- Informational perspective: which information is manipulated by activities?
- Goal perspective: why the activities are performed.

Table 3-8 compares the methods based on the language criterion that relies on multi-perspectivity and formalisation. Based on the methods' objectives they meet part or all of the perspectives, for instance, EKD meets operational, informational and goal perspectives as it aims to provide solution for decision-making situations. 4EM focuses on functional, behavioural and operational as they are seeking to model the process and improve it. CPI and PAWS are related to the functional, behavioural and goal perspectives. ISEA supports functional, behavioural, operational and informational perspectives.

In terms of formalisation, CPI and PAWS are proposed through an informal process model and no modelling language supports them. EKD relies on a process map and a metamodel but so far, it is not supported by a concrete syntax. However, 4EM as the evolution of EKD is proposed through a concrete syntax (graphical notation). ISEA is supported by a process map and a formalised modelling language (concrete and abstract syntaxes).

Table 3-8: Comparing the participative methods based on the language criterion

Method	Multi-perspective	Formalisation
CPI	Functional, behavioural and goal	Informal
PAWS	Functional, behavioural and goal	Informal
EKD-CMM	Operational, informational	Process map and a metamodel
4EM	functional, behavioural and operational	Graphical notations
ISEA	functional, behavioural, operational and informational	Process model, metamodel and graphical notations

- *Foundations*

This criterion refers to the presented techniques in the previous section. We define two factors for the foundations:

- *Elicitation techniques* factor discusses about applied techniques in a method and if they are conducted in a collective way.
- *Gamified* relies on the gamification and serious games and to highlight if a method is gamified.

Table 3-9 presents the comparison between the participative methods based on the foundation criterion. As the table shows, elicitation techniques are not applied in a collective way in PAWS and EKD-CMM methods. For instance, in EKD-CMM, one of the integrated knowledge elicitation technique is “*Critical Decision Making-CDM*”. CDM focuses on a particular situation such as a problem or challenge in the organisation. Then the knowledge engineer uses this technique to elicit the details of the situation and the way that actors made decision to cope with it. CDM should be conducted through individual semi-structured interviews.

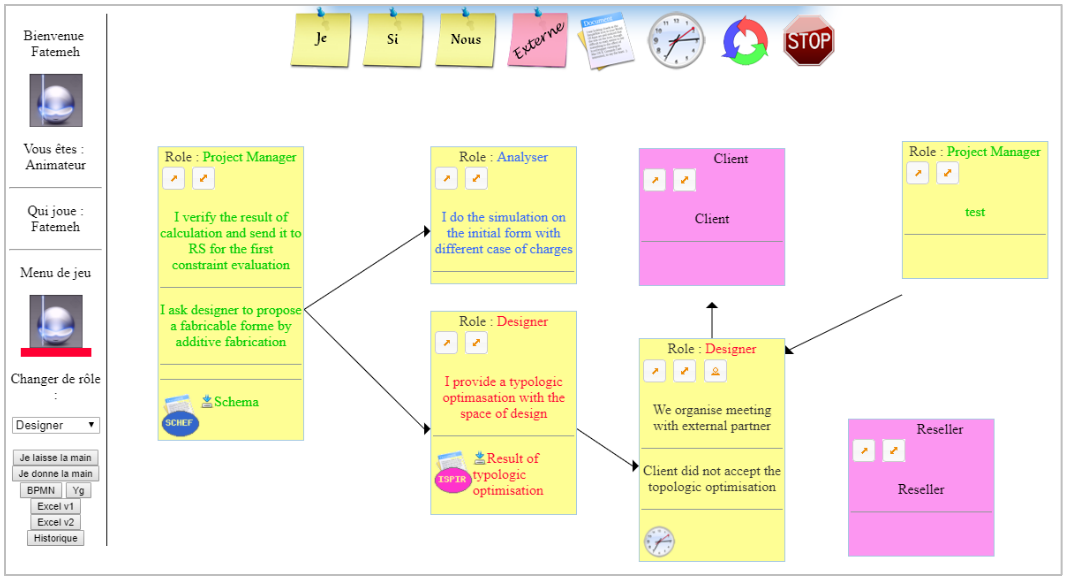
In CPI, 4EM and ISEA, most of the elicitation techniques are applied in a collective way. For instance, one of the steps in the 4EM’s protocol is “card questions” which is similar to the “repertory grid” to cluster the elicited concepts and participants to perform this step collectively. ISEA method is based on scenario techniques: at the beginning of the experimental sessions, the participants decide and replay the scenario collectively.

Table 3-9: Comparing the participative methods based on the foundations criterion

Method	Elicitation techniques	Collective elicitation (Yes/No)	Gamified (Yes/No)
CPI	Process mapping and commentary	Yes	No
PAWS	Constrained processing tasks	No	No
EKD-CMM	Critical Decision Making-CDM	No	No
4EM	Repertory grid	Yes	No
ISEA	Process mapping and scenario	Yes	Yes

As the Table 3-9 shows, all the presented methods apply elicitation techniques, while in terms of gamification and serious games; we argue that only ISEA applies gamification by proposing a playful interface in its tool (see Figure 3-21) in order to encourage participants to contribute in method application.

Figure 3-21: Playful interface of ISEAsy, the tool of ISEA



Considering our comparison study, we conclude that ISEA method meets so far most of the criteria. As we do not aim to start a method from scratch, we adapt ISEA as the starting point for our method development.

2.6 Conclusion

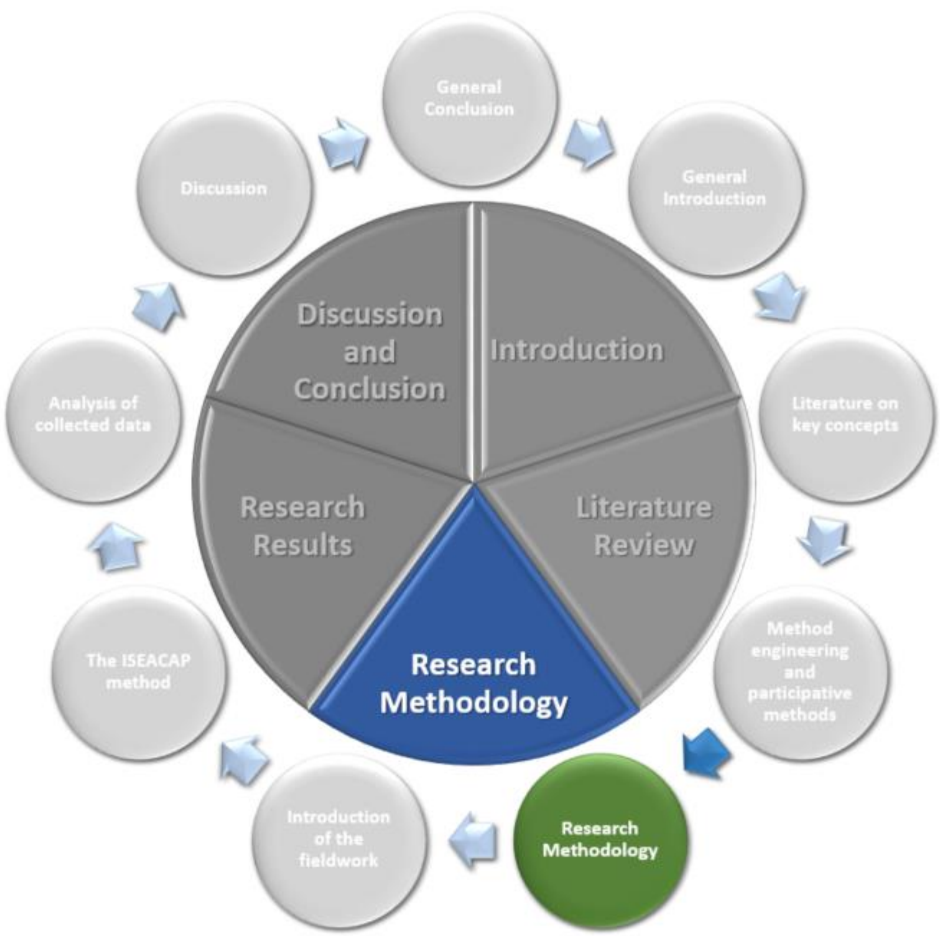
This chapter presented the key concepts in method engineering approaches and method development through UCD. In addition, we had an overview on participative methods by defining their foundations and comparing examples of existing participative methods via evaluation criteria.

The comparison allowed us to establish our starting point by adapting ISEA method. Thus, developing the ISEACAP does not start from scratch and we aim to evolve ISEA based on our research objectives. This evolution is an adaptation of ISEA's metamodel and develops it towards a new method for studying ACAP's organisational routines. Like ISEA that enables a high level of participants' involvement by applying gamification techniques, ISEACAP relies on gamification and elicitation techniques to raise collective reflexivity between the participants and reveal ACAP's routines.

Through the next chapter, we will present the methodology and epistemological stance of this study.

Chapter 4. Research Methodology

3.1	INTRODUCTION
3.2	PHILOSOPHICAL PARADIGM
3.3	REASONING APPROACHES
3.4	ACTION RESEARCH METHODOLOGIES
3.5	RESEARCH STRATEGY
3.6	DATA COLLECTION
3.7	UNIT AND LEVEL OF ANALYSIS
3.8	RESEARCH ENVIRONMENT
3.9	CONCLUSION



3.1 Introduction

Choosing a research type (qualitative versus quantitative) is influenced by the researcher's philosophical perspective about the nature of the phenomena under study and logical arguments about how knowledge can be developed (epistemology). In addition, selecting research method for collecting data also relies on the accepted philosophical paradigm of a study (Guba & Lincoln, 1994).

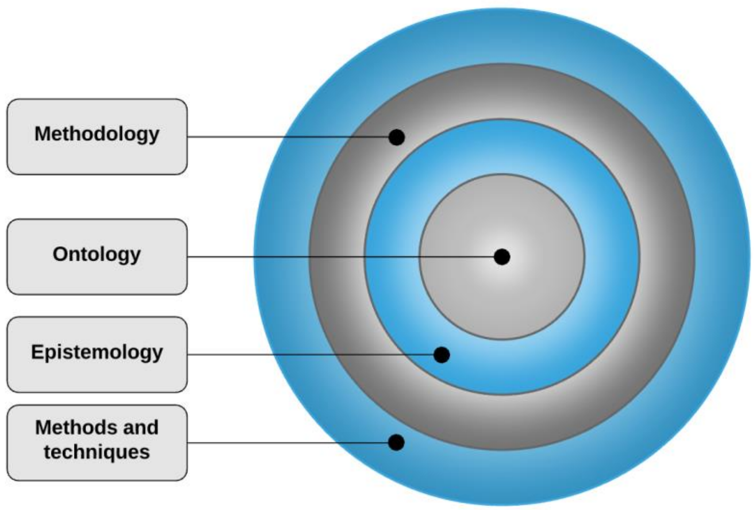
Moreover, Yin (2009) defines research design as "a logical plan for getting from here to there, where here may be defined as the initial set of questions to be answered, and there is some set of conclusions (answers) about these questions."

To this end, this chapter presents firstly the philosophical paradigm of this study and continues by describing the reasoning approach, research strategy and research parameters such as level and unit of analysis. The chapter explains also applied methods for data collection and analysis and it is concluded by detailing the research environments.

3.2 Philosophical paradigm

Most of central debates among philosophers concern matters of *ontology* and *epistemology* (Easterby-Smith, Thorpe, & Jackson, 2012, p. 17). Ontology is about the nature of reality and existence; while epistemology is about the best ways of enquiring into the nature of the world (*ibid*).

Figure 4-1: Research compositions (Easterby-Smith et al., 2012, p. 16)



Scientists and social scientists generally draw from different ontological and epistemological assumptions when developing their methodologies for conducting research. Easterby-Smith et al. (2012) illustrate the relationship between *ontology*, *epistemology*, *methodology* and *methods and techniques* (summarised in Table 4-1) by using the metaphor of a tree and research is a trunk that has four rings (see Figure 4-1). The outer ring, the bark, represents the methods and techniques adopted in a research project, such as interviews. These are the most obvious and visible features of a project, but they depend on decisions and assumptions about methodology, epistemology and ontology which lie behind scenes, and which are progressively less visible.

Table 4-1- Ontology, epistemology and methods and techniques (Easterby-Smith et al., 2012, p. 18)

Composition	Description
Ontology	Philosophical assumptions about the nature of reality
Epistemology	A general set of assumptions about ways of inquiring into the nature of the world
Methodology	A combination of techniques used to inquire into specific situation

Composition	Description
Methods and techniques	Individual techniques for data collection, analysis, etc.

We start with ontology represented by central core in Figure 4-1 or heartwood of the tree, and then we continue outwards.

3.2.1 Research ontology

Ontological aspects are categorised differently by scholars. Bell and Bryman (2007), for example, considered ontological perspectives as objectivism and constructionism. The former views social phenomena as facts that are external to a researcher and constructionism suggests that social phenomena and their meaning are constructed by social actors (Rezaei-Zadeh, 2013, p. 99). In consistence with Bell and Bryman (2007), Saunders et al. (2009) classified ontological views as objectivism and subjectivism. **Objectivism** regards social phenomena as external to actors and **subjectivism** considers the social realities as the action of social actors (Rezaei-Zadeh, 2013, p. 99). Easterby-Smith et al. (2012) divide ontological perspectives as those relate to natural science and as those use in social science. In this line of thought, they recognise four ontological views. In natural science, debates orient more towards *realism*, *relativism* and *internal realism*. Scholars in social science discuss, however, more on *internal realism*, *relativism* and *nominalism*. These four ontological visions are summarised in Table 4-2. In the following, we review these four visions to position our work.

Table 4-2: Four different ontologies adopted from (Easterby-Smith et al., 2012, p. 19)

Ontological view	Truth	Facts
Realism	Single truth	Facts exist and can be revealed
Internal Realism	Truth exists, but it is obscure	Facts are concrete, but cannot be accessed directly
Relativism	There are many “truths”	Facts depend on viewpoint of observer
Nominalism	There is no truth	Facts are all human creations

3.2.1.1 Realism

A traditional position emphasises that the world is concrete and external and thereby science can only progress through observations that have direct correspondence to the phenomena being investigated (Easterby-Smith et al., 2012, p. 19). Philosophers of natural science have modified this extreme position in recent decades and they point out the difference between the laws of physic and nature, and the knowledge or theories that scientists have about these laws (*ibid*).

3.2.1.2 Internal Realism

In internal realism, natural scientists assume that there is a single reality, but it is not possible for them to access that reality directly. Therefore, it requires to gather indirect evidence of what is going on in fundamental physical process (Putnam, 1987). Internal realism accepts, however, that scientific laws once discovered are absolute and independent of further observations (Easterby-Smith et al., 2012, p. 19). However, within social science we are interested in the behaviour of people (Blaikie, 2007). Therefore, choosing appropriate assumption and methods depends on the topic of enquiry and preferences of the individual researchers (Easterby-Smith et al., 2012, p. 20).

3.2.1.3 Nominalism

The position of nominalism suggests that the labels and names we attach to experiences and events are crucial (Easterby-Smith et al., 2012, p. 21). Scholars in nominalism position argue that social reality is no more than the creation of people through language and discourse (Cunliffe, 2001). From this position, there is no truth and the questions concern how people attempt to stablish different versions of truth (Easterby-Smith et al., 2012, p. 21).

3.2.1.4 Relativism

The position of relativism in natural science goes a stage further than internal realism, in suggesting that scientific laws are not simply out there to be discovered, but that they are created by people (Easterby-Smith et al., 2012, p. 19). Relativism was strongly influenced by the work of Latour and Woolgar (1979) who have studied the way scientific ideas evolve within research laboratories and raised debate and discussion about how to explain observed patterns and phenomena.

In social science, relativist ontology considers no single reality that can somehow be discovered, but many perspectives on the issue. In the same line of thought Guba and Lincoln (1989; p: 86) argue that there exist multiple socially constructed realities not governed by any natural laws or causals. These constructions are devised by individuals as they attempt to make sense of their experiences, which should be recalled, are always interactive in nature (Avenier, 2010, p. 1233). The relativist position assumes that different observers may have different viewpoint and what counts for the truth can vary from place to place and from time to time (Collins, 1983).

3.2.2 Epistemological stance

Ontological perspective illustrates the way how knowledge is constructed. Through epistemological posture researcher clarify the origin and nature of knowledge (epistemic assumptions), how it is elaborated (methodological assumptions), and how it is justified (Avenier & Thomas, 2015, p. 5).

Avenier and Thomas (2015) define an epistemological framework as a conception of knowledge relying on a set of mutually consistent founding assumptions relative to the subjects that epistemology addresses. The authors propose four epistemological framework "*post-positivism*", "*critical realism*", "*pragmatic constructivism*" and "*Interpretivism*". These frameworks fundamentally refer to the Piaget's (1967) definition of epistemology as "the study of valuable knowledge constitution" and thereby three questions are established, (i) what is the nature of the knowledge and its mode of investigation (ii) how is the knowledge established or generated (iii) its value and validity and how approve it (Le Moigne, 1995) (Avenier, 2011, p. 375).

Regarding the first question and based on research ontologies described earlier, Avenier and Thomas (2015) consider that a research briefly relies on three different assumptions, (i) the reality that exists (ii) what is perceived by the subject and the scientific knowledge that is based on a part of the reality or (iii) the perception of the reality (Avenier & Thomas, 2015). The connection between scientific knowledge is known therefore with reality or with the perception of the reality that allows researchers to generate new scientific knowledge. To this end, a researcher should choose the position according to the way of developing new knowledge and integrate the reality in the knowledge construction. This positioning correspond to the choice of epistemological paradigm. Two assumptions orient this choice:

- *Epistemic assumption*: substrates from which the knowledge is constructed, and necessitates to define the objective, the form and position of knowledge.
- *Ontological assumption:* concerns the situations that should be known "the world is directly knowable or it is knowable through the subject which has a knowledge of the reality". This assumption asks to define how the real situations are used to develop a knowledge.

The epistemic assumption is always presented while the ontological assumption is not always explicitly highlighted in research paradigms. In the following we present the four paradigms based on the works of (Avenier, 2010, 2011; Avenier & Thomas, 2015) and Table 4-3 summarises the four based on the knowledge's origin and nature, goal of knowledge generation process and status and shape of knowledge. Then in the following, we present each framework in details to position our research work.

Table 4-3: Four epistemological frameworks adopted from (Avenier & Thomas, 2015, p. 11)

Ontological view	Post-positivism (Boisot & McKelvey, 2010; Gephart, 2013)	Critical realism (Bhaskar, 2013; Mingers, 2004; Mingers, Mutch, & Willcocks, 2013; Smith, 2006)	Pragmatic Constructivism (Avenier, 2010, 2011, Glasersfeld, 1984, 1995, 2001, Le Moigne, 1995, 2002)	Interpretivism (Guba & Lincoln, 1989; Myers & Klein, 2011; Orlikowski & Baroudi, 1991; Sandberg, 2005)
Ontological founding assumptions	Ontological realism: Reality exists prior to and independently from human attention. There exists a unique immutable "real-as-is".	Ontological realism: Reality exists independently from human attention. Reality is both intransitive and stratified. Reality is constituted of three overlapping domains, those of the real, the actual, and the empirical. Generative mechanisms (GMs) reside in the real domain. Observable events occur in the actual domain. Experienced events lie in the empirical domain.	Humans experience resistance to their actions. Whatever resists human action possibly exists independently of human attention.	Ontological relativism: there exist multiple socially constructed realities not governed by any natural laws, causal or otherwise (Guba & Lincoln, 1989). The agreed meanings about a situation constitute the objective, intersubjective reality of this situation (Sandberg, 2005).
Epistemic founding assumptions	Epistemic realism: Real-as-is is knowable (with possible fallibility of measurement instruments).	Epistemic relativism, but not judgmental relativism. The real domain is not observable. Events (actual domain) are observable. Experienced events (empirical domain) are knowable.	Epistemic relativism in the following sense: human experience is knowable, and in the knowledge process, whatever stems from a situation is inseparably intertwined with whatever stems from the inquirer. The goal of inquiring influences the inquirer's experience of the situation.	Epistemic relativism: 'Facts' are produced as part and parcel of the social interaction of the researchers with the participants and knowledge is gained only through social constructions. Lived experience is knowable. Intentionality has a constitutive power on the meaning of reality that appears to us in our lived experience.
Goal of the knowledge generation process	Record constant conjunctions of observable events. Identify surface regularities and patterns.	Identify the GMs that are responsible for the events and patterns of events observed, as well as the manner by which GMs are contingently activated.	Build intelligible models of human active experience, which provide insights for organizing the world of experience.	Understand how human beings make individual and/or collective sense of their particular world and engage in situations.
Status and shape of knowledge	Correspondence conception of knowledge. Iconic representation of real-as-is.	Towards a correspondence conception of GMs, and a pragmatic conception of the manner they are activated. Field testable statements concerning GMs and activable propositions.	Plausible interpretations that fit experience and are viable for intentionally acting. Generic models and activable propositions.	Plausible interpretations that fit lived experience. Narratives supported by thick descriptions, and, in certain currents within interpretivism, generic statements.

3.2.2.1 Post-positivism

The post-positivism framework asks epistemic assumption and ontological assumptions as anchored in the reality: "the reality exists prior to and independently from human attention." (Avenier & Thomas, 2015). The reality is accessible and research can know it. However, the fault of instruments can impede the results. In this posture, the knowledge creation process identifies and validates the invariants and describes the reality in an objective way. In general, the goal of this posture is to validate ideas by controlling the factors on the field of the study via highly structured and large samples measurements (Saunders et al., 2009). The researches based on this posture are usually quantitative but can use qualitative as well (Rezaei-Zadeh, 2013, p. 88).

3.2.2.2 Critical realism

Critical realism defends a strong realist ontological assumption by considering that there exists a world independent of our knowledge (Avenier & Thomas, 2015, p. 8). At the same time, critical realism accepts the relativism of knowledge that is constructed socially and historically. Through this epistemological posture, the reality is the events that are observable and help knowledge construction (Mandran, 2017, p. 27). Thus, researchers aim to know what are the structures, the generative mechanisms and the contextual conditions responsible for the patterns of events observed (Avenier & Thomas, 2015, p. 8). The observable phenomena provides credible data and facts. Otherwise, insufficient data means inaccuracies in sensations (Saunders et al., 2009). Thereby, chosen methods must fit the subject matter and it could be quantitative or qualitative.

3.2.2.3 Interpretivism

Interpretive research attempts to comprehend phenomena through the meanings that people assign to them (Avenier & Thomas, 2015, p. 10; Orlikowski & Baroudi, 1991). In interpretivism paradigm, the two assumptions are relativist. The reality does not exist, it is constructed socially and is not influenced by natural laws and the individual who establishes it, confirms the situation. Researchers aim to develop an understanding of the social reality (intentions, motivations of individuals, languages and representations). Therefore, the facts are generated as a part of social interactions between researchers and participants and there is an interdependent between researchers and studies situation (Mandran, 2017, p. 27). Elaborated knowledge relies on consensus interpretation and that is based on real-life experiences. To achieve this objective, interpretivists conduct in-depth qualitative researches on small samples (Guba & Lincoln, 1994).

3.2.2.4 Constructivism and pragmatic constructivism

Individuals seek understanding of the world in which they live and work and they develop subjective meanings of their experiences, meanings directed toward certain objects or things (Creswell & Clark, 2003). These meanings are varied and multiple, leading the researcher to look for the complexity of views rather than narrowing meanings into a few categories or ideas (*ibid*). The goal of research, then, relies on the participants' views of the situation being studied and questions become broader and more general (*ibid*). This enable participants to construct the meaning of a situation, a meaning typically forged in discussions or interactions with other persons (Creswell, 2013). However, these subjective meanings are not often, negotiated socially and historically and they are not simply imprinted on individuals (*ibid*). Indeed, they are formed through interaction with others (hence constructivism) and through historical and cultural norms that operate in individuals' lives. Thus, constructivist researchers often address the *processes* of interaction among individuals (Creswell & Clark, 2003).

Scholars identify two different constructivist epistemological paradigms, namely Guba and Lincoln's (1989)constructivist epistemological paradigm and Von Glasersfeld's (1984, 1995) radical constructivism, which was further conceptualised by Le Moigne (1995, 2002) under the label of teleological constructivist epistemological paradigm (Avenier, 2010, p. 1231). Technological or radical constructivism are lately named by Avenier and Thomas (2015) as "Pragmatic Constructivism". The qualifying term "pragmatic" has been considered preferable to the other two labels because it highlights that, in this epistemological framework, knowledge claims justification and testing is performed in relation with intentional actions these claims are considered to illuminate (Avenier & Cajaiba, 2012). Consequently, pragmatic constructivism corresponds to the kind of pragmatism that Agerfalk (2010) suggests exploring for design science, and that Goldkuhl (2012) considers to constitute an appropriate philosophy for action research and design research.

Le Moigne distinguishes two components for the nature of the assumption: (i) nature of the knowledge and (ii) goal of knowledge hypotheses (Avenier, 2010, p. 1231). Table 4-4 shows that the two constructivist epistemological paradigms have major differences based on the assumption's components.

Table 4-4: Core founding assumptions of the two constructivist epistemological paradigms adapted from (Avenier, 2010, p. 1232)

Nature of assumption	Pragmatic/ Radical/ Technological Constructivism paradigm (Avenier, 2010; Avenier & Thomas, 2015; Glasersfeld, 1995; Le Moigne, 2002)	Constructivism paradigm (Guba & Lincoln, 1989, 1994)
Nature of knowledge	Phenomenological knowledge assumption. Human experience is knowable, but humans cannot rationally know such as a thing as an independent, objective world that stands apart from their experience of it. Consistent with the phenomenological knowledge assumption, no founding assumption on the possible nature of reality is made	Relativist ontology assumption. There exists multiple socially constructed realities not governed by any natural laws, causal or otherwise
Goal of knowledge	The elaboration of knowledge is portrayed as a process of intentional elaboration of symbolic constructions, called representations, based on experience. To know is to possess ways and means of acting and thinking that allow one to attain the goals on happens to have chosen. The goal of knowledge is finally to build functionally fitted and viable representations.	Truth is defined as the best-informed and most sophisticated constructions on which there is consensus. Theorisation is viewed as an act of generation. To know is to possess informed and sophisticated constructions on which there is consensus. The goal of knowledge is to build more and more informed and sophisticated constructions on which there is consensus.

A particularity of radical/pragmatic constructivism is that it refuses to posit any founding ontological assumptions (Avenier, 2010; Avenier & Thomas, 2015; Glasersfeld, 2001) and therefore it relies on a different epistemic assumption. In particular, this makes the pragmatic constructivist fundamentally different from Guba and Lincoln's (1989) "constructivist paradigm" (Avenier & Thomas, 2015). Based on these differences, Avenier (2010) brings together the design science and pragmatic constructivism and argues that the reality is constructed between researchers and study objects. The constructed knowledge is contextual, relative and goal oriented when the research outcome can be an artefact such as tools, methods or models.

Simon's (1996) conception of the sciences of the artificial is consistent with radical/pragmatic constructivism (Avenier, 2010, p. 1231). His conceptualisation relies on the development of appropriate means for modelling and understanding artefacts, i.e. phenomena in which human intentions are embodied (Avenier, 2010, p. 1236). These means can take the form of notions or principles as diverse as a system of symbols, representation, problem space, heuristic search, procedural and substantive rationality, planning without a final goal, and the principle of intelligent action (*ibid*). Then, using these means, scholars can develop knowledge relevant to understanding existing artefacts and/or for designing and implementing new artefacts having the intended properties (*ibid*).

3.2.3 Ontological and epistemological stances of this research

- **Ontological perspective**

In this research we study the ACAP's routines which are embedded into actors' actions. Considering the Saunders et al. (2009) argument on subjectivisms and objectivism, investigating on actors' actions and routines relies on subjectivisms ontology. In addition, based on the performative aspect of routines that can vary place to place and time to time, we can argue that the relativism ontology can be coherent with the routines based studies. Thus, by following Avenier's (2010) argument in which the scholars refuse to posit any ontological assumptions, this instability of perspective guides us towards the pragmatic constructivism stance.

- **Epistemological stance**

As mentioned before, routines are highly rooted in actors' actions which are not easily recognisable for the actors independently. Through this research we aim at providing a better understanding of ACAP's routines. To accomplish this objective we develop a participative method called ISEACAP that allows the participants to co-construct knowledge about their ACAP's routines. The method should be run in different case studies to explore their ACAP's routines. In addition, ISEACAP provides a reflexive space for the organisations' actors to think about their routines and how to improve them for their future projects.

During the development of ISEACAP it is crucial to consider the users and their needs as the heart of the design. This fact refers to the concept of design science presented by (Hevner, Ram, March, & Park, 2004; p: 75), that seeks to extend the boundaries of human and organisational capabilities by creating new and innovative artefacts (such as models, methods etc.) in order to be useful for solving the problems. In this regard, we present different reasoning approaches to highlight how the knowledge is generated.

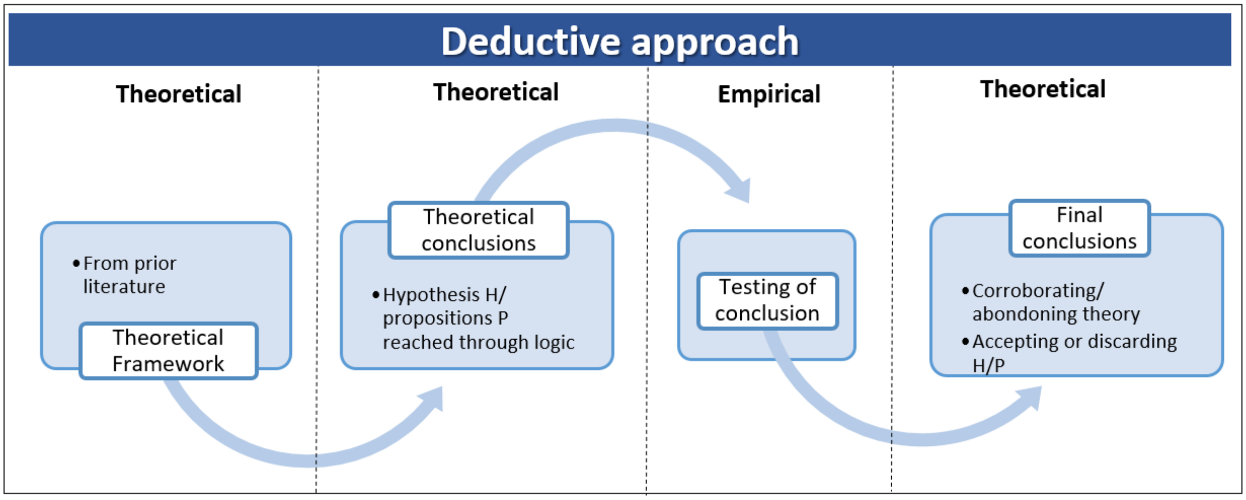
3.3 Reasoning approaches

Research reasoning strategy is used to demonstrate the relationship between theory and research (Bell & Bryman, 2007). Identifying a research reasoning strategy helps design the research and choose relevant methodology. To identify the reasoning strategy we question, "*How the knowledge is generated?*" *Deductive*, *inductive* and *abductive* are three strategies that are defined by the scholars to answer this question.

3.3.1 Deductive approach

Deductive reasoning approach is based on scientific principles which move from theory to data and allows to establish a hypothesis from the literature (Thiétart, 2014). Thus, data and information are collected to confirm or reject hypothesis and solve the problem (Mandran, 2017; Mohebbi, 2013). Researches that follow deductive approach therefore adopt positivism paradigm (Bell & Bryman, 2007; Rezaei-Zadeh, 2013). Management studies that use this approach aim to explain casual relationships between variables (Johnson & Duberley, 2000). Accordingly, the operationalisation of concepts, which refers to tangible indicators use to measure constructs, is a vital process to increase the validity of findings (Saunders et al., 2009). Figure 4-2 shows the process of the research based on deductive approach (Kovács & Spens, 2005, p. 137).

Figure 4-2: Reasoning approach – Deductive (Kovács & Spens, 2005, p. 137)



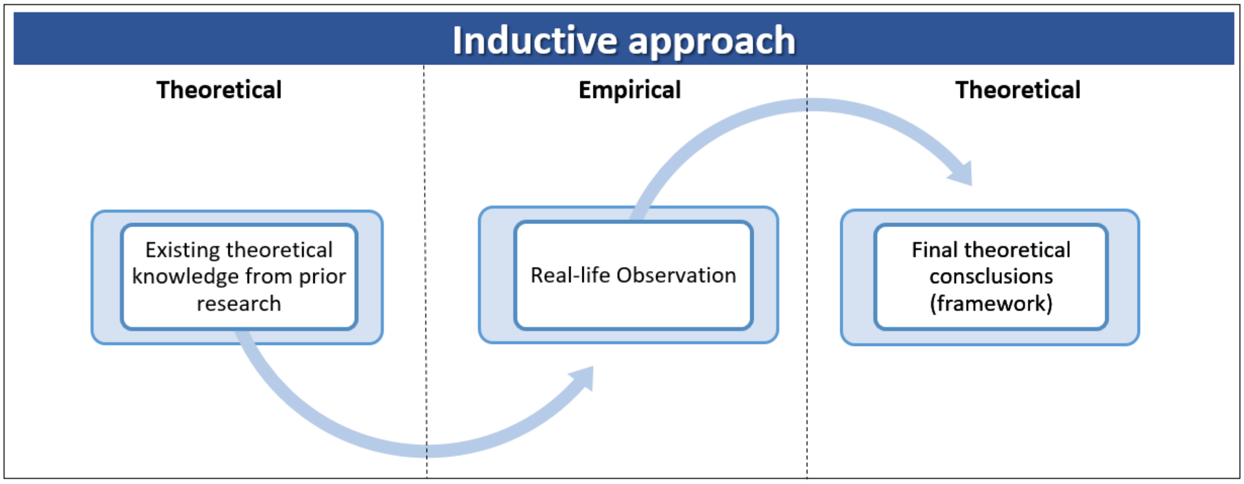
1) Firstly scan theory (e.g. in a literature review).
2) Derive logical conclusions from this theory and present them in the form of hypotheses (H) and propositions (P).
3) Test these in an empirical setting.
4) Finally present the general conclusions based on the corroboration or falsification of its self-generated hypothesis or proposition.

Concretely the logical sequence of the research with deductive approach starts from rule then to case and finally to result (Danermark, Ekstrom, & Jakobsen, 2001; Kovács & Spens, 2005).

3.3.2 Inductive approach

Inductive approach is totally reverse of deductive and aims to generate or improve a theory by observing and collecting data initially. Observation, pattern, tentative hypothesis and theory are important steps of the inductive approach (Mohebbi, 2013, p. 23). Inductive approach is a flexible approach as there is no need of predetermined theory to collect data. Researchers establish a hypothesis based on the collected data and observed facts and thereby define a theory as per the research problem (Gill & Johnson, 2010). Figure 4-3 presents the process of inductive approach.

Figure 4-3: Reasoning approach – Inductive (Kovács & Spens, 2005, p. 137)



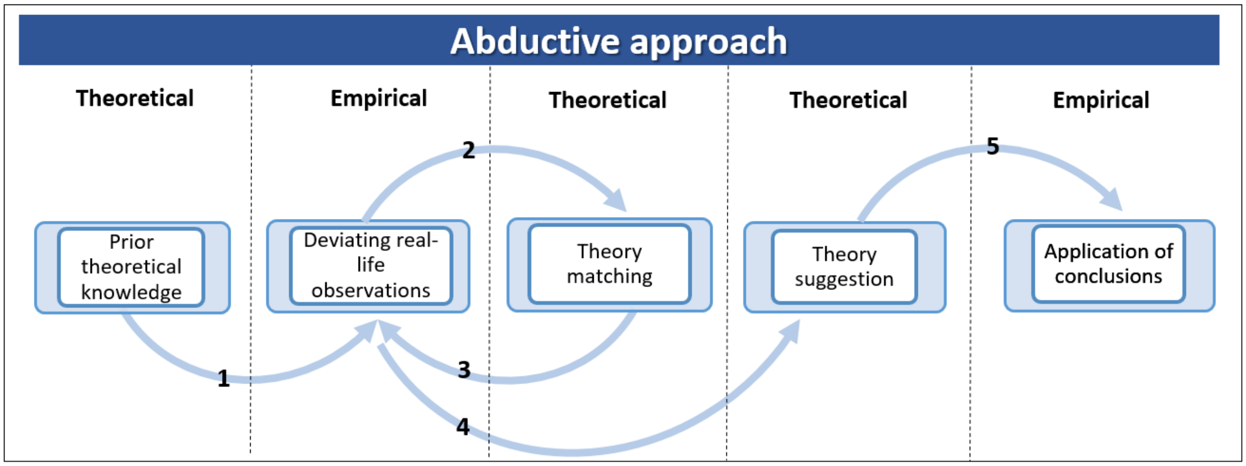
However, as it is shown, knowledge of a general frame or literature is necessary at the beginning (Andreewsky & Bourcier, 2000; Kovács & Spens, 2005). Instead, observations about the world will lead to emerging propositions and their generalisation in a theoretical frame (Kovács & Spens, 2005).

3.3.3 Abductive approach

Researchers see abduction approach as the systematised creativity or intuition in research to develop "new" knowledge (Andreewsky & Bourcier, 2000; Kovács & Spens, 2005; S. Taylor, Fisher, & Dufresne, 2002). Creativity is necessary to break out of the limitations of deduction and induction, which both are delimited to establish relations between already known constructs (Kovács & Spens, 2005). Instead of following a logical process, advances in science are often achieved through an intuitive leap that comes forth as a whole, and which can be called abductive reasoning (Kovács & Spens, 2005; S. Taylor et al., 2002). In introducing the concept of intuition into a scientific approach (*ibid*), abduction deviates from previous methods of scientific explanations (Danermark et al., 2001; Kovács & Spens, 2005). The abductive approach also differs from deduction and induction in its research process (Kovács & Spens, 2005, p. 136).

Like induction approach, the abductive approach starts with a real-life observation, however this does not hold for all abductive research and researchers would start out with some pre-perceptions and theoretical knowledge (Kovács & Spens, 2005, p. 139). A creative iterative process (see Figure 4-4) (S. Taylor et al., 2002) of "theory matching" or "systematic combining" starts (Dubois & Gadde, 2002) in an attempt to find a new matching framework or to extend the theory used prior to this observation (Andreewsky & Bourcier, 2000; Kovács & Spens, 2005).

Figure 4-4: The abductive research process (Kovács & Spens, 2005, p. 139)



This process aims to comprehend the new phenomenon and to suggest new theory in the form of new hypotheses or propositions (Andreewsky & Bourcier, 2000; Kovács & Spens, 2005). The abductive approach closes with the application of hypothesis and propositions in an empirical setting. However, this last step can already be characterised as a deductive part of the research (Kovács & Spens, 2005).

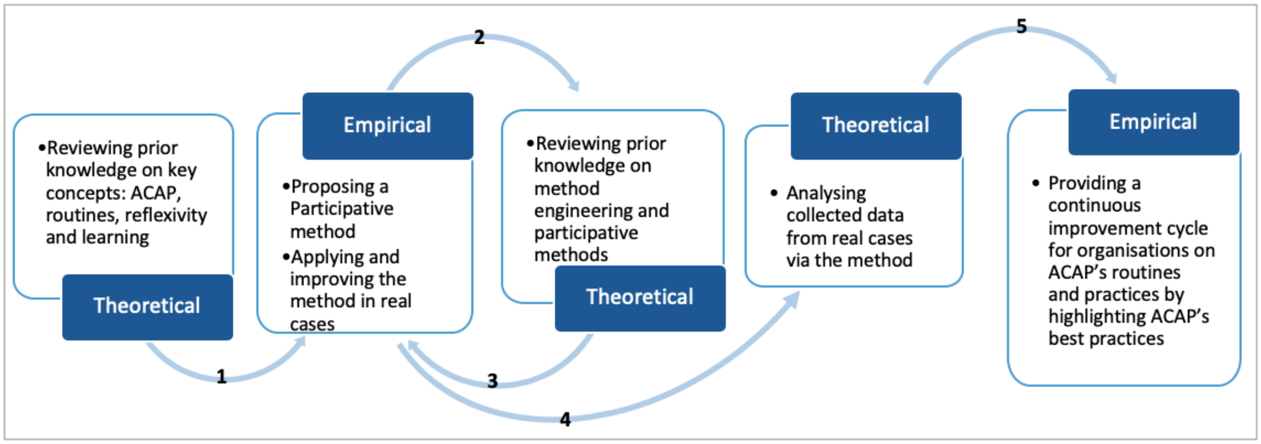
Dubois and Gadde (2002) claim that case studies and action research use abductive reasoning very commonly. This occurs due to simultaneous data collection and theory development, and the theory-building element in both methods (Dubois & Gadde, 2002).

3.3.4 Reasoning approach of this research

Figure 4-5 shows our research reasoning approach which is based on abductive approach. Through this study we firstly overview existing literature about the key concepts of the research: ACAP, organisational routines, reflexivity and organisational learning. This helps shape our conceptual structure and find out where we should focus more. Thereby, we propose a participative method which facilitates studying ACAP's routines in details. In addition, to develop the method based on method engineering discipline, we review associated concepts such as models, metamodels, and methods and compare existing participative methods which have close objectives to our method.

The ISEACAP method enables researchers to collect detailed data about ACAP's routines and reach to the theoretical objectives. In addition, the method provides the organisations' actors a clear vision on their ACAP's routines and practices which can help them improve these routines and practices continuously.

Figure 4-5: Positioning the reasoning approach: Abductive research



As argued earlier, identifying the reasoning approach helps researchers better choose the relevant research methodology. In the following section we present different types of action research methodologies.

3.4 Action research methodologies

Action research describes a global family of related approaches which integrate theory and action with the goal of addressing important organisational, community and social issues together with those who experience them (Coghlan & Brydon-Miller, 2014, p. 26). It focuses on creating collaborative learning and combining action and reflection, in an ongoing cycle of knowledge co-construction (*ibid*).

Most of the scholars concerned by action-research agree around Kurt Lewin's works (1951) as one of the leaders. For instance, in psychologic science, action research envisages an agreement between researchers and actors on specific area (Kastrup, 2015; Lewin, 1951). It therefore fosters the group organisation and collective participative spaces, which is included within the method (Kastrup, 2015). Towards the same path, various types of action research are defined by scholars such as participative action research, collaborative research, research engineering or intervention research. In the following we present them.

3.4.1 Intervention research

Intervention research is developed within different research communities such as anthropology (Bastide, 1971; Willigen, 2002), in social science (Lewin, 1951) or in operation research such as designing and modelling (David, 2000). In operation studies, intervention research aims to design, implement and evaluate artefacts or management tools within the organisations by knowledge co-construction in two dimensions: technical and usage (Béjean & Moisdon, 2017). However, the knowledge co-construction with actors is more about usage dimension and there is a collective research in this term only in actors' side. Therefore as Kastrup (2015) argued, in this research, the implication of researcher in knowledge production (usage dimension) is more or less eliminated and emphasises on the neutrality of research (Kastrup, 2015).

In management science, as (David, 1999, p. 13) argues, intervention research can be presented as a project that represents the interventions of actors within organisations. Research project identifies cognitive processes of design by which the organisational action strategies are developed, then formalise and share these process as the research result (David, 1999, p. 13; Martinet, 1990).

3.4.2 Engineering research

Engineering research is in the same line as intervention research while researchers have direct interventions in the construction of the reality (David, 1999, p. 19). Chanal et al. (1997) discuss that engineering research aims to (i) provide a better understanding of modelling of complex phenomena (ii) producing a useful research for the researchers in terms of scientific knowledge and be also useful for the participants (iii) and it is based on constructivism epistemological paradigm.

This methodology relies on action research by investigating about process of organisational changes and involving actors who are affected by the change, in the research process. Through this kind of research the researchers have "research engineers" status (Chanal et al., 1997, p. 214).

In addition, the outcome of engineering research can be the construction of an artefact (Chanal et al., 1997, p. 214) and that will be *designed*, *developed*, *implemented* and *tested* by researchers in partnership with actors (*ibid*, p. 219).

We can compare engineering research with user-centred design as both methods are based on the users' needs. As defined in chapter two, the UCD is based upon identified needs of end-users, and end-users are involved throughout the design and development (Norman & Draper, 1986). The engineering research is developed in IS management science while the user-centred design is usually applied in IS engineering or computer science.

In addition, in management science, engineering research and Action Design Research (ADR) defined by (Sein, Henfridsson, Purao, Rossi, & Lindgren, 2011) are in the same line while they are slightly different in the role of actors through the research.

3.4.3 Action Design Research (ADR)

In Action Design Research, IT artefacts are shaped by the organisational context during development and use (Sein et al., 2011, p. 37). This research method can be considered for generating prescriptive design knowledge through building and evaluating ensemble IT artefacts in an organisational setting (Sein et al., 2011, p. 40). It deals with two challenges: (i) addressing a problem situation encountered in a specific organisational setting by intervening and evaluating; and (ii) constructing and evaluating an IT artefact that addresses the class of problems typified by the encountered situation (*ibid*). The responses demanded by these two challenges result in a method that focuses on the building, intervention, and evaluation of an artefact that reflects not only the theoretical precursors and intent of the researchers but also the influence of users and ongoing use in context (*ibid*). In other words, ADR supports knowledge creation through the design and appreciation of artefacts (*ibid*, p. 51).

3.4.4 Participative action research

Several authors converge to indicate there are various terms to describe the researches that researchers and actors interact to co-create the knowledge (Gonzalez-Laporte, 2014, p. 14). However, action research federates several authors to define a general approach in which researchers and actors interact through a combination of action and reflection (Coghlan & Brydon-Miller, 2014; Gonzalez-Laporte, 2014).

In social sciences, the participative action research is defined as a long-term approach that aims to solve the problem of social groups such as inequality or social injustice. It is conducted by questioning the practices or the oppressive structures, then by making changes on them and thereby improving the condition of society (Anadón & Savoie-Zajc, 2007; Michaud & Bourgault, 2010). This type of action research is considered as an intellectual tool to help population and helps actors take their position within a public place (Anadón & Savoie-Zajc, 2007). Ideally, researchers take part in the group and all the actors of the group (co-researchers) in equal position and without hierarchy (Michaud & Bourgault, 2010). Actors must accept to play an active role during the process of change (*ibid*).

According to Larivière et al. (2014), participative action research allows to produce three types of knowledge: (i) academic transferable knowledge (ii) knowledge of practices (iii) experiences (Larivière et al., 2014). The latter comes from the reflections between researchers and actors to identify how the research group developed and implemented its ability of problem solving and collaboration (Guillemette & Paré, 2011).

3.4.5 Collaborative action research

In education science, the collaborative action research is defined as an approach for knowledge co-construction between researchers and actors (Desgagné, 2007), while the research object is the actors' knowledge of action (Larivière et al., 2014). This research is composed of two parts (i) a formal research activity that aims to conceptualise knowledge comes out of practices (ii) reflexive activities for actors that could be useful for their professional development (Morrissette, Lopez, & Tessaro, 2012). Through this type of study researchers involve organisations' actors to explore their practices and deliver their contextual understanding to their team (Desgagné & Bednarz, 2005). This exploration could be performed through reflexive activities that lead to the reconstruction of practices that could be useful for the future (Desgagné, 2007). Therefore, the research objective is about thinking and reflecting on the practices and highlighting the significant experiences (Desgagné, 2007; Morrissette et al., 2012).

Pasmore et al. (2007), argue that collaborative research concerns the dual and intermingled processes that are going on as an organisation is undergoing development by adopting new structures and processes, while researchers attempt to provide knowledge, which is not readily accessible in the organisation, from scientific sources or by gathering and analysing observations (Pasmore et al., 2007, p. 13). In this type of action research, different degrees of collaboration are possible (*ibid*).

Through the Table 4-5 we provide a summary of presented types of action research, based on the general objectives, role of actors and researchers.

Table 4-5: Summary of the different types of Action Research

Research type	Objectives	Role of actors	Role of researchers
Intervention research	– Produce knowledge – Set up neutrality of the research	Play an active role through participation on knowledge production	Play a less active role than actors to preserve the neutrality aspect of the research
Engineering research	– Produce knowledge – Modelling complex phenomena	Actors who are affected by the change are involved actively to produce knowledge	Play an active role through a direct intervention in the construction of reality
Action Design Research	– Produce knowledge – Provide an artefact based on organisational needs	Two different actors: Practitioners and end-users – Practitioners: Contribute to the specific ensemble being designed – End-users: evaluate the utility for the users	Play an active role in problem formulation, building, evaluation, reflecting, learning and formalising the learning
Participative action research	– Produce knowledge to make social changes – Improve the social life.	– Paly an equal role with researchers (as co-researchers). – They must play an active role during process of change.	Play an active role and take part in a same group with actors

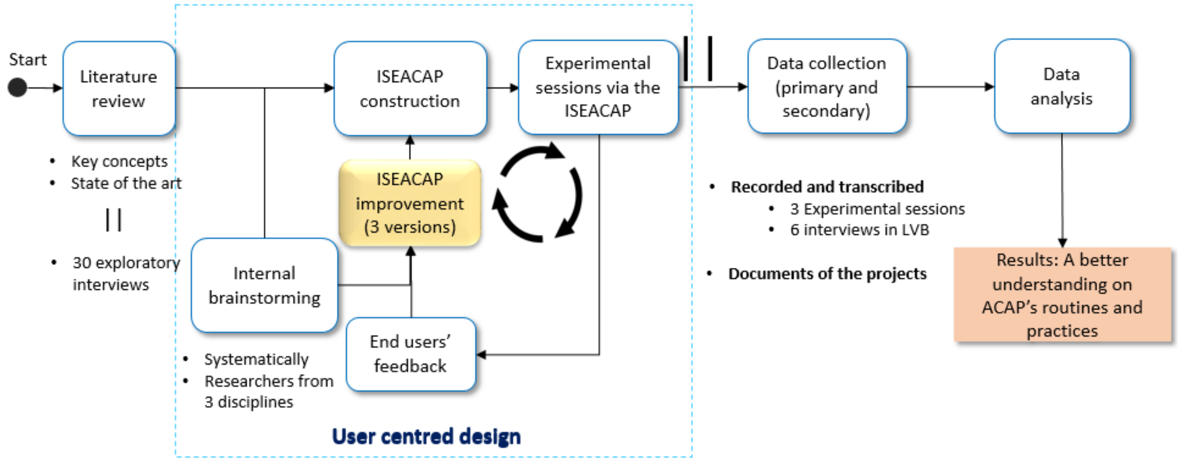
Collaborative action research	– Knowledge co-construction between researchers and actors. – Highlight knowledge of practices via a formal research activity. – Provide reflexive activities to the researchers and actors.	– Actors plays not only the role of informant, but they are also involved to explore their activities and deliver it to the team.	– Researchers play role in the same time in research and training. – Researchers should formalise clearly the objectives

Based on the provided comparison, we can argue that our research methodology emphasises on the "collaborative action research" and "engineering research". The development of ISEACAP relies on engineering research (user-centred design in computer science) the participants are highly involved and each phase of the method must be validated finally by the end users and by highly involve actors in method construction (as an artefact) besides providing reflexive space for them to reflect collectively about their past experiences and activities in order to reveal their ACAP's routines. In the following we expand our research methodology framework.

3.4.6 Research methodology framework

This study is based on knowledge co-construction between researchers and actors, thereby, as Figure 4-6 represents, our research framework relies in general on collaborative action research. Considering "engineering research" approach as a subset of collaborative action research, the construction of ISEACAP method is based on this approach which is in computer science called user-centred design.

Figure 4-6: Research methodology framework



Our research framework starts from the literature review on existing literature on ACAP, routines, learning and reflexivity besides existing participative methods. This literature review provides required bases for developing the very first version of the ISEACAP method. In addition, several brainstorming meetings are organised among six researchers (including PhD student) from three different fields (computer science, management and industrial engineering). Each meeting starts with a short PowerPoint presentation on the summary of previous session, highlights ideas and confronted challenges. After the presentation, the researchers discuss and take note of new ideas and results of the discussion. These meetings should be held systematically (at least once per month).

As the results of the meetings we collect the researchers' ideas to enhance the method construction. Via constructed method we conduct experimental sessions to collect end user's feedback and also collect data through tape recording.

An experimental session, is a meeting between researchers (at least two members of brainstorming meetings), and organisation's actors (two to five participants) around a table. The researchers conduct the session by following the ISEACAP's protocol (we will explain the ISEACAP's protocol in chapter five). If the hosted organisation allows us, the session should be tape recorded. At the end of the session, the participants fill out the validation form which asks their opinion about the method application and helps improve the method.

We organise again brainstorming meetings between the researchers to discuss about collected users' feedback regarding the method and raise ideas to improve it.

Beside of the experimental sessions we conduct also semi-structured interviews with organisations' actors (key actors of selected projects) to identify their ACAP's routines and practices. By analysing the collected data through the interviews and recordings of the experimental sessions we can meet our theoretical objectives by providing a detailed and clear vision on ACAP's routines and practices.

Our research is based on case study and thereby in the following we explain the strategy of our research.

3.5 Research strategy

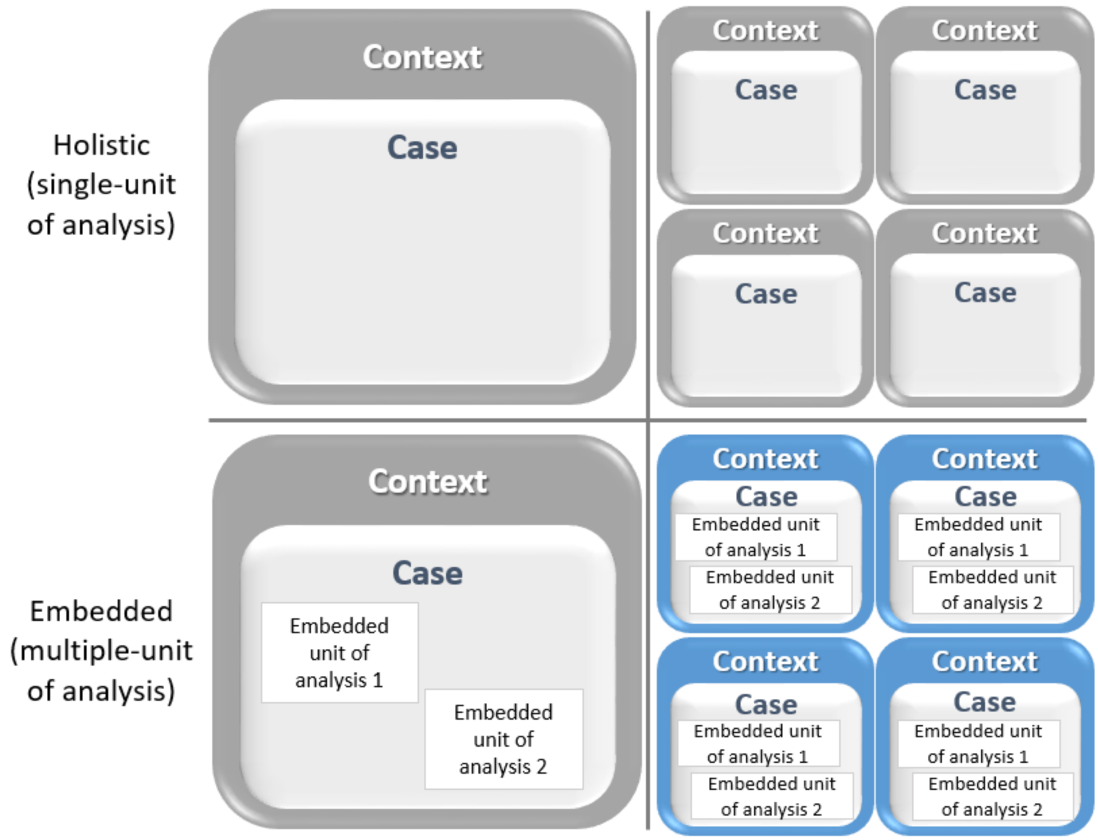
3.5.1 Case study

Among research strategies in management science, case study is linked to action research and classified between exploratory qualitative researches (Hlady-Rispal, 2015, p. 251). Eisenhardt (1989) and Yin (1994) consider case studies as the most appropriate tool in the critical, early phases of a new management theory, when key variables and their relations are being explored. In addition, case studies are typically carried out in close interaction with practitioners, deal with real management situations, create managerially relevant knowledge and principally recognised by the strong internal validity of the results (Gibbert, Ruigrok, & Wicki, 2008, p. 1466) (Amabile et al., 2001; Leonard-Barton, 1990) (Ayerbe & Missonier, 2007, p. 38).

Case studies play imperative roles for knowledge generation (Avenier & Gavard-Perret, 2012; De Benedittis, 2016, p. 170; Mucchielli, 2005). They are defined as "in-depth approach of research on one or several examples of actual social phenomena, by using various data sources (Avenier & Gavard-Perret, 2012; De Benedittis, 2016)". Case studies relies on qualitative, can be considered as a complete empirical method for organisational studies and play the role of a tool in the first phase of theory development through actualising the variables and their relations with a phenomena (Gibbert et al., 2008, p. 1465).

According to the dictionary of social science, a "case" can be an individual, an event or a social activity, a group, an organisation or an institute (Jupp, 2006, p. 20). Furthermore, case studies can be conducted through a unique case or multiple case, and can be designed based on a holistic or embedded models (Hlady Rispal, 2009, p. 182; Yin, 2009). The Yin's definition (2009, p. 18) for case study emphasises on two fundamental elements, the first one, the scope of investigation by focusing on a contemporary phenomenon (Yin, 2009, p. 18). Secondly, strong interrelation of this phenomenon with its context, although he argues that boundaries between the case and its context are not likely to be sharp. Yin (2009, p. 46) proposes four different research design for case study researches (see Figure 4-7). Figure 4-7 points out that single and multiple case studies reflect different design situations and that, within these two variants, there also can be unitary or multiple units of analysis (Yin, 2009, p. 46). The resulting four types of designs for case studies are single-case (holistic) designs, single-case (embedded), designs, multiple-case (holistic) designs, and multiple-case (embedded) designs.

Figure 4-7: Basic types of design for case studies (Yin, 2009, p. 46)



In this study, we apply the multiple case study strategy by applying the method in different cases. In "Analysis of results" chapter we will explain the results obtained from our case study.

3.5.2 Case selection

This study focuses on collaborative innovation projects developed by SMEs. Thus, to find relevant case studies, we conducted series of exploratory interviews with several SMEs which are located in particular in France and UK as we had logistics facilities for these two countries. Our exploratory interviews were semi-structured and allowed the interviewees describe their projects. Table 4-6 summarises conducted interviews by: phone, skype, face-to-face in France and UK, and also during a B2B (Business to Business) event between French and British companies at Grenoble. As conducting our research in a company required at least two sessions of two hours with the presence of projects' key actors, most of the interviewed companies did not accept to continue with us and the table shows the acceptance rate which is very low and highlights one of the limitation of this research.

Table 4-6: Exploratory unstructured interviews-Case study selection

Country	Total number of interviews*	Result
France	– Face to face: 7 (three of them are transcribed, the rest are recorded and summarised) – Telephone: 7 (not recorded) – B2B: 6 (not recorded)	3 companies from foods and textiles sectors accepted. 2 of them are embedded in the same network (textile).
UK	– Face to face: 4 (all of them are recorded and transcribed) – Skype: 2 (not recorded) – B2B: 4 (not recorded)	2 companies embedded in different networks accepted. However, each company allocated only one actor for experimental sessions.
Total	30 interviews	5 acceptances

**These numbers represents only the interviews in which the PhD student was one of the interviewers*

Based on the collected acceptance from five companies, we conducted our semi-structured interviews along with experimental sessions with the projects' key actors. In the next section we present applied data collection techniques.

3.6 Data collection

During this study collected data during experimental sessions and interviews are considered as primary data and documents of the projects are considered as the secondary data.

2.6.1 Primary data

2.6.1.1 Interviews

Interviews are defined as a research method where respondents are asked to explain what they do, think, or feel (Collis & Hussey, 2013). The effectiveness of interviews depends greatly on the quality of interaction between the interviewer(s) and interviewee(s) (Zowghi & Coulin, 2005). Interviews provide an efficient way to collect large amounts of data quickly. The results of interviews, such as the usefulness of the information gathered, can vary significantly depending on the skill of the interviewer (Goguen & Linde, 1993). There are fundamentally three types of interviews being unstructured, structured, and semi-structured, the latter generally representing a combination of the former two.

- *Unstructured interviews* are conversational in nature where the interviewer enforces only limited control over the direction of discussions (Grawitz, 1972). Because they do not follow a predetermined agenda or list of questions, there is the risk that some topics may be completely neglected. It is also a common problem with unstructured interviews to focus in too much detail on some areas, and not enough on others (McGraw & Harbison-Briggs, 1989). This type of interview is best technique to explore when there is a limited understanding of the domain (Zowghi & Coulin, 2005).
- *Semi-structured interviews* use a pre-defined set of questions and supplementary questions that can be asked during the interview (Grawitz, 1972; Milton, 2007). This type of interviews is used commonly and enables explicit knowledge and thereby to elicit tacit knowledge, complementary techniques are required.
- *Structured interviews* use a predetermined set of questions to gather specific information (Zowghi & Coulin, 2005). The success of structured interviews depends on knowing what are the right questions to ask, when should they be asked, and who should answer them (*ibid*). Although structured interviews tend to limit the investigation of new ideas, they are generally considered to be rigorous and effective (*ibid*).

After collecting the acceptance from the five companies, three in France and two in UK, we used semi-structured interviews to collect more details about the project, actors and ideally have a clear vision on the process of the project and where we can focus during the experimental sessions. At the second stage which is only developed with one of the cases in France (AGY), we conducted semi-structured interviews to identify their ACAP's routines and practices applied during their project. Collected data from these interviews is used in chapter six to compare with experimental sessions and highlight the complementary role between these two methods (interviews and experimental sessions). The reason why we conducted semi-structured interviews about ACAP's routines with only AGY is the limited time that the companies could dedicate to our research besides what they had accepted for experimental sessions. Table 4-7 presents the list of conducted interviews with the companies which accepted to participate in our study.

Table 4-7: List of conducted interviews with selected cases

Date	Country and name	Modality and duration	Interviewee's role in project	Recording and transcription	Output
April 2016	France (LVB and AGY)	Telephone 35'	Project manager	Recorded and transcribed	- Identifying the process, documents and actors of the project - Agreeing an appointment for the first experimental session
May 2016	France (Alpha)	Telephone 20'	R&D engineer	Not recorded	- Identifying the process, documents and actors of the project - Agreeing an appointment for the first experimental session
June 2016	France (Beta)	Telephone 20'	Project manager	Not recorded	- Identifying the process, documents and actors of the project - Agreeing an appointment for the first experimental session
July 2016	UK Liverpool (PRG)	Face to face 40'	Project manager	Recorded and summarised	- Identifying the project, process, documents and actors of the project - Agreeing an appointment for the first experimental session

Date	Country and name	Modality and duration	Interviewee's role in project	Recording and transcription	Output
August 2016	UK Liverpool (CSL)	Face to face 35'	Project manager and Application manager	Recorded and transcribed	- Identifying the process, actors and documents of the project - Agreeing an appointment for the first experimental session
July 2017	France Toulouse (LVB and AGY)	Face to face 59'	Project manager (general director)	Recorded, transcribed and coded	- Identifying key information about the company's structure, project and actors - Identifying ACAP's routine/practice
July 2017	France Toulouse (LVB)	Face to face 50'	Economic planning expert	Recorded, transcribed and coded	- Identifying key information about the company's structure, project and actors - Identifying ACAP's routine/practice
July 2017	France (AGY)	Telephone 80'	Technical manager	Recorded, transcribed and coded	- Identifying internal key actors, external partners of the project. - Identifying created or reused documents during the project. - Identifying ACAP's practices through the interviews
July 2017	France Toulouse (AGY)	Face to face 90'	General director of the project holder	Recorded, transcribed and coded	- Identifying internal key actors, external partners of the project. - Identifying ACAP's practices through the interviews
July 2017	France Toulouse (AGY)	Face to face 59'	Marketing officer of the project holder	Recorded, transcribed and coded	- Identifying key information about the company's structure - Identifying ACAP's practices through the interviews
July 2017	France Toulouse (LVB)	Face to face 32'	Communication officer	Recorded, transcribed and coded	- Identifying key information about the company's structure - Identifying ACAP's practices through the interviews
Sept 2017	France (AGY)	Telephone 37'	Research Director	Recorded, transcribed and coded	- Identifying key information about the company's structure - Identifying ACAP's practices through the interviews

The semi-structured interviews are conducted based on the interview guide presented in Table 4-8. The guide consists of six parts as following:

- *General information* collects general data about the interviewee profile, interview details and company.
- *Process and documents* collects required information for experimental sessions about the process of the project development, created and reused documents during the project.
- *Collaboration* gathers interviewee's information about the structure of the collaboration, interaction with other project stakeholders and used IT facilities.
- *Preparation of the project* focuses on before the project development and aims to bring out how external knowledge mobilised and helped develop the idea.
- *Project development (ACAP routines)* collects information about applied practices and routines during the project development to acquire, assimilate, transform and apply external knowledge.
- *Learning from the project* highlights the strengths, weaknesses or confronted blocking points during the project. This part brings out the learned lessons from the project which could be taken into consideration for the next projects of the company.

In chapter 6 "Analysis of the results" we explain more in detail the structure of the guide and compare obtained results via the semi-structured interviews and the experimental sessions, in order to illustrate their complementary roles.

Table 4-8: Semi-structured interview guide

Objectives	Questions
General information	□ Contacted person: □ Interviewee's name: □ Position in the company: □ Contact information: □ Date of interview: □ Interviewers: □ Anonymising of the interview? Yes / No □ Recording is authorised? Yes / No □ Experience in the company… □ Prior experience… □ How many employees in the company? □ Other collaborative projects?

Objectives	Questions
Process and documents	□ Could you please tell us the history of the project? □ Do you remember an important moment of the project in terms of knowledge exchange between the partners? □ During this project that step seems to you crucial in terms of innovation. □ Could you tell us about exchanged or mobilised knowledge from external partners? By which partner? □ Which document of the project seems important to you? Why?
Collaboration	□ How do you qualify your collaboration with the partners of the project? □ Does your company develop collaborative projects frequently? □ How does the collaboration can help the strategy of your company? (an example please) □ Does your company use IT/IS systems to conduct the collaboration?
Preparation of the project	□ How did you explore useful knowledge for the innovation before the project? (e.g. Strategic Monitoring) □ Did you analyse the related risks before this collaboration? □ During which part of the project did the partners engaged? □ How did you defined the functioning modality of this collaboration? (coordinating and task assignment, deliverable, resource allocation) □ Did you define before the project expected results and objectives? □ How did you do to share the responsibility?

Objectives	Questions
Project development (ACAP routines)	**General** ☐ Do you define the process of the project at the beginning of your project? (For this particular project, could you describe us the process, phases of the project, deliverables, actors etc.) ☐ Are the processes are shared and used by all the partners? **Acquisition** ☐ Did you involve external actors during all the stage of the project? If yes, did they mobilised knowledge in the project? Which knowledge? ☐ Did you attend to the conferences etc.? If yes, did they have any input in terms of knowledge and innovation for this project? **Assimilation** ☐ How did the partners communicate during the project? ☐ Did you employ the informatics supports to enhance the communication between actors? **Transformation** ☐ Did you document your contributions throughout the project? ☐ How did you manage your documents? Did you share them with your partners? **Application** ☐ Did you prototype the product and test that with end-users? How did you conduct the test?
Learning from the project	☐ What are the strength/weaknesses/ blocking points during this project and you plan to improve them for their future projects? (In terms of internal or external, collaboration, etc.) ☐ Did you have regular intermediate meetings with the partners to collect their experiences, ideas or feedback? ☐ Do you think that regular meetings and engaging actively the partners are required during collaborative projects? Could you explain the reason of your response? ☐ How did you organise internal learning or exchanging captured knowledge during the project (within the organisation) ☐ In your organisation, do you have the facilities for reflexivity on your routines and practices performed during the projects

2.6.1.2 Experimental sessions

The experimental sessions hold within the companies and the key actors of the project were the participants of the sessions. The sessions are conducted by the researchers who play the role of facilitators and follow the ISEACAP's protocol. Table 4-9 summarises the conducted sessions with selected cases. Through the next chapter explain the details of the cases.

Table 4-9: List of conducted experimental sessions via ISEACAP

Date	Country and name	Duratio n	Participants	Recording state	Output
July 2016	France Isere (Alpha)	160’	Chief Executive Officer R&D Manager Research Engineer Operator	Recorded, transcribed and coded	Map of mobilised knowledge during the project
July 2016	France Isere (Beta)	120’	Project Manager Project Associate Technician Commercial Officer	Not allowed to record	Map of mobilised knowledge during the project
August 2016	UK Liverpool (PRG)	118’	Project manager	Recorded and summarised	Map of mobilised knowledge during the project
August 2016	UK Liverpool (CSL)	120’	Application manager	Recorded and summarised	Map of mobilised knowledge during the project
July 2017	France Haute-Garonne (LVB and AGY)	130’	General Director LVB Technical Manager AGY Research Director LSP	Recorded, transcribed and coded	Map of mobilised knowledge during the project
July 2017	France Haute-Garonne (LVB and AGY)	82’	General Director LVB Technical Manager AGY Research Director LSP	Recorded, transcribed and coded	ACAP’s practices and routines flow

These experimental sessions provides us with three types of data:

a) Sessions’ recordings which highlight the details of discussion and reflection between the participants and will be analysed in chapter six.

b) Sessions’ output documents which are produced collectively by the participants and the facilitators (the researchers). These outputs are: the process model of the project (shown in Appendix 3), the map of mobilised knowledge (shown in Appendix 4) and the flows of ACAP’s routines/practices (shown in Appendix 13).

i. The process model shows internal and external actors of the project, carried out activities by them and created or reused documents.

ii. The knowledge map helps the participants and researchers have a clear vision about the applied knowledge by the external partners as well as internal actors. In addition, this map allows them to have a global vision on the required knowledge to develop the project.

iii. The ACAP's routines flow provides a common understandings for both researchers and participants about performed ACAP's routines/practices and helps the participants reflect on their routines to improve them for their future projects.

c) The evaluation forms (Appendix 11 and Appendix 12) filled out at the end of each session to collect the participants' feedback about the conduct of the method. In chapter five we will explain the role of this collected data to develop and improve the ISEACAP.

3.6.1 Secondary data

(Given, 2008, p. 232) defines secondary data as "collected and archived or published by others" and in other words existing data which can be imperative to describe the context (Thiétart, 2014) Secondary data is defined in two types: (i) collected data by the organisations based on their needs and (ii) the external secondary data which is reachable via databases, websites, collected data by other researchers, public or private studies, press etc. The later type should be refined and filtered to be more appropriate for the research purposes (Given, 2008).

This research relies on the first type of the secondary data, by using the companies' documents as the starting point of the first part of the experimental sessions. The documents are created or reused during the project development by the organisation's actors and at the beginning of the experimental sessions help recall their experiences. These documents include of (but not limited to) minutes of the meetings, progress reports, PowerPoints, technical forms, emails etc. Before starting the first part of the experimental sessions, during the semi-structured interviews, the researchers identify the most important documents to the project in terms of innovation and containing external knowledge. Thereafter, at the end of interviews, the researcher requests the company to prepare a hard copy of the identified documents for the first experimental session.

Consequently, the method employs secondary data as lever to stimulate the participants to generate primary data mentioned in previous sections. Collected primary data needs to be analysed in appropriate level based on the research objectives and questions. The following section presents applied data analysis techniques on collected primary data during experimental sessions and semi-structured interviews.

3.7 Unit and level of analysis

3.7.1 Level of analysis

IS scholars analyse the absorptive capacity in diverse levels (Roberts et al., 2012, p. 625) and it is recognised as a multilevel construct. In this perspective, Robert et al. (2012), examine different ACAP's studies at individual and collective levels (Roberts et al., 2012; p: 632). According to their investigation, majority of IS researches study ACAP at collective level, while only a few studies focus on ACAP at individual level (Roberts et al., 2012, p. 633). Moreover, Lane et al. (2006) argue that scholars tend to omit the absorptive capacity of individual organisational members (Lane et al., 2006) and the emergence of absorptive capacity from the actions and interactions of individual, organisational, and inter-organisational remains unclear (Volberda, Foss, Lyles, Volberda, & Foss, 2010, p. 931).

Cohen and Levinthal (1990) show that organisation's absorptive capacity depends on the absorptive capacities of its individual members. To this extent, the development of an organisation's absorptive capacity will build on prior investment in the development of its constituent, individual absorptive capacities, and, like individuals' absorptive capacities, organisational absorptive capacity will tend to develop cumulatively (Cohen & Levinthal, 1990; p: 132). However, a firm's absorptive capacity is not simply the sum of the absorptive capacities of its employees, and it is therefore useful to consider what aspects of absorptive capacity are distinctly organisational (*ibid*: 133). Considering the collective aspect of ACAP which composes of individuals, we can refer to Klein et al. (1994) who argue that "the level of some theories is neither the individual, nor the group, but the individual within the group (Klein et al., 1994, p. 201)".

This research aims at studying ACAP by providing a better understanding on ACAP's routines. Scholars define routines as "Repetitive, recognisable pattern of interdependent actions, involving multiple actors (Feldman & Pentland, 2003; p. 96)" and thereby routines are considered as "collective recurrent activity patterns (Becker, 2004; p. 645)". This objective directs us to study both individual and organisational actions and co-construct knowledge on ACAP's practices/routines with organisations' actors. In other words, we start from individual level within the group to achieve to the collective level. This collective level describes "any interdependent and goal-directed combination of individuals, groups, departments, organisations, or institutions (Morgeson & Hofmann, 1999; p: 251)".

3.7.2 Unit of analysis

This research is based on multiple case studies strategy with multiple units of analysis. According to Yin (2009) the unit of analysis relies on the research questions. As introduced in the first chapter our main question is ""how can we provide a better understanding of ACAP's routines?" and accordingly we consider ACAP's routines as one of our units of analysis.

Organisational routines are a crucial part of any account of how organisations accomplish their tasks in society (Becker et al., 2005; p: 775). They also hold one of the keys to understand change in the economy, and to understand how organisational capabilities are accumulated, transferred and applied (Cohen et al., 1996; Winter, 2000).

Additionally, routines are fundamental to understand change partly because they provide a basic definition of what change really is at collective level(Becker et al., 2005; p: 776). Thus, they can be considered as the units of analysis that can capture a significant level of granularity to highlight organisational changes (*ibid*). To this end, in chapter six we analyse collected data from experimental sessions as well as semi-structured interviews, to highlight revealed ACAP's routines/practices. This analysis is based on ACAP's dimensions (acquisition, assimilation, transformation and exploitation) and provides both researchers and actors a clear vision and common understanding on ACAP's routines.

Other research questions that we investigate in this study are "**A.** what kind of method can be propose to highlight ACAP's organisational routines? **B.** how to provide a reflexive space for organisations' actors to have reflection on their ACAP's routines? And **C.** how can organisational learning be enhanced via reflexivity?" The first question has been answered through the literature review in the first and second chapters. The second question has been partially answered through the second chapter where the method engineering is presented and to complete the answer of this question, we will explain in chapter five how to the method is developed. In addition in chapter six we will highlight how the method enables the reflexivity. Thus, another unit of analysis is required to address the second and the third questions (see Table 4-10). We consider the second unit of analysis as the "reflexivity passage" and define it as "uninterrupted discussion among two or more participants during the experimental sessions". The "reflexivity passages" is investigated on collected data during experimental sessions to find out the role of the ISEACAP's protocol as well as facilitators (a researcher who conducts the session) to raise and guide the reflexivity. In chapter six we will present how far the result of this investigation addresses the questions B and C.

Table 4-10: Unit of analysis based on research questions

Research Question	Unit of analysis	Applied cases
How can we provide a better understanding of ACAP's routines?	ACAP's organisational routines	Semi-structured interviews about ACAP's routines with AGY/LVB Experimental sessions with Alpha and AGY/LVB
How to provide a reflexive space for organisations' actors to have reflection on their ACAP's routines?	Reflexivity passages	Recorded experimental sessions with AGY/LVB
How can organisational learning be enhanced via reflexivity?	Reflexivity passages	Recorded experimental sessions with AGY/LVB

3.7.3 Data analysis: thematic analysis

Qualitative thematic analysis is one of the numerous research methods used to analyse text data (Tesch, 1990). It can be applied for identifying, analysing and reporting themes or patterns within data (Braun & Clarke, 2006, p. 79). Thematic analysis provides also knowledge and understanding of the phenomenon under study (Tesch, 1990).

Thematic analysis relies on the importance of the data in relation to the research question, and represents some level of patterned response or meaning within the data set (Braun & Clarke, 2006, p. 82).

To apply the thematic analysis, we firstly collect data by recording experimental sessions and semi-structured interviews, then transcribe collected data, define important themes (ACAP's routines/practices, reflexivity and organisational learning) and finally codify the data.

Codifying means gathering different parts of the text which contain relevant information to the seeking themes (Downe-Wamboldt, 1992, p. 314). An imperative question to address in terms of coding is: what 'size' does a theme need to be? Ideally, there will be a number of instances of the theme across the data set, but more instances do not necessarily mean the theme itself is more crucial and needs to display evidence of the theme's importance (Braun & Clarke, 2006, p. 82). A theme might be given considerable space in some data items, and little or none in others, or it might appear in relatively little of the data set. Researcher judgement is necessary to determine what a theme is. According to the research questions and units of analysis we defined three main themes in Table 4-11.

The first theme is ACAP's routines which relies on the definition of routine provided by Feldman and Pentland (2003, p. 96): "*repetitive, recognisable patterns of interdependent actions, carried out by multiple actors*" and consists of four sub-codes based on the four dimensions of ACAP (acquisition, assimilation, transformation and application).

The second theme is reflexivity which is based on Knipfer et al.'s (2013) definition: "Reflexivity is an intermediate that allows people to generate meaning from an experience" in a collective way. Reflexivity consists of two sub-themes: (i) Reflexivity passage which is defined as a continuous discussion among more than two participants (i.e. collective aspect). (ii) Role of facilitator that relies on the guidance of researcher(s) to raise a reflexivity passage.

The third theme relies on organisational learning about ACAP's routines. Reflexivity recognised by scholars as the driving force that leads to organisational learning (Knipfer et al., 2013, p. 10) and according to this definition we consider another theme as "organisational learning". To highlight the theme, we refer to the participants' discussion and if they argue explicitly about "what they applied (or what should have been applied) practices/routines and if it could be useful for their future projects", that can be considered as learning about ACAP's routines. Highlighted ACAP's routine/practices should be discussed and agreed by the participants to be considered as learning in organisational level.

Table 4-11: Coding guidelines for main themes

Theme	Description
ACAP's routines	When a participant describes a practices (could be a practice which is not applied during the project) which should be performed by multiple actors to acquire, assimilate, transform or exploit knowledge. The practice should be performed repeatedly previously (a routine) or evaluated as important to be repeated in the future projects (to be routinized). • ACAP-Acquisition: Practice/routines that are applied to identify and acquire external generated knowledge (e.g. mobilizing external partners and experts during projects, using different techniques for sharing information, etc.) • ACAP-Assimilation: the practices/routines that allow that allow to analyse, process, interpret, and understand the acquired external knowledge (e.g. discussing and reflecting about acquired knowledge, formalizing acquired knowledge via visual representations, etc.) • ACAP-Transformation: the practices/routines that can be applied for refining and combining existing knowledge and assimilated knowledge (e.g. synthesising assimilated knowledge, planning to integrate in operation, evaluating current actions based on the assimilated knowledge, etc.) • ACAP-Application: the practices/routines that can be applied to incorporate the transformed knowledge into the operations and enhance existing competencies or develop new ones (e.g. creating new designs, improving existing results based on the transformed knowledge, etc.)
Reflexivity	Reflexivity is an intermediate that allows people to generate meaning from an experience in a collective way. • Reflexivity-Passage: a reflexivity passage is a continuous collective discussion among participants without any interruption (by the facilitator). • Facilitator's role: facilitator is a researcher who guides the session based on the ISEACAP protocol. Facilitator's role is the part of the facilitator's speech in the transcripts which is just before the reflexivity passage.

Learning	Learning about ACAP's routines/practices happened when the participants argue explicitly about that, its importance and take it into consideration in their future projects.

Based on the identified themes, through the chapter six, we provide a global vision on ACAP's routines. Table 4-12 presents the number of identified routines from the transcription of three experimental sessions (two of them conducted in AGY&LVB and one of them in Alpha) and number of reflexivity passages. These routines will be presented in details in chapter six.

Table 4-12: Number of coded routines – Experimental sessions in Alpha and AGY&LVB

Cases	Number of codified "ACAP's routines"	Total number of codified "Reflexivity"	Total number of pages (transcription)
AGY&LVB	44	90	144
Alpha	24	69	77
Total	68	159	221

In addition, the reflexivity theme allows us to show the frequency of reflexivity during different parts of the ISEACAP's protocol besides highlighting different roles that a facilitator plays during a session and how each role influence the reflexivity.

Finally, we discuss how ISEACAP provides a reflexive space which facilitates the organisation to have learning about their ACAP's routines/practices and enhance them for their future projects.

The following section is dedicated to present the research environment of this study. As highlighted earlier, this research is conducted in multidisciplinary environment in collaboration with different research centres.

3.8 Research environment

This research is developed in both academic and industrial environment. In the following, we present the academic environment and the next chapter is dedicated to explain the industrial side which consists of research case studies.

This PhD takes part of a national research project called ACIC (Absorptive Capacity for Innovation in Companies), funded by French National research Agency (ANR). The ACIC project started in January 2015 to end September 2019 and includes three work packages:

- Work package 1: Characterisation of ACAP
- Work package 2: Proposing a maturity grid to evaluate ACAP within the Companies
- Work package 3: Proposing a participative method to identify the practices and routines associated to the ACAP

The PhD started in February 2015 and embedded in work package three in order to propose the participative method that is called ISEACAP. The third work package of ACIC project was in collaboration between three research laboratories: management, computer and industrial sciences while the PhD student is attached basically to the management and computer science research centres.

- **CERAG: Management science research laboratory**

The principal research environment of this study is the management science laboratory of the University of Grenoble called CERAG ("Centre d'Etudes et de Recherches Appliquées à la Gestion"). CERAG is composed of five scientific axes: human resources, finance, marketing, strategic management and information systems management and this PhD is considered in the information systems management axe.

- **LIG : Computer science research laboratory**

The second research environment is the computer science laboratory of the University of Grenoble called LIG ("Laboratoire d'Informatique de Grenoble"). This research centre composes of five axes: data and knowledge processing, distributed systems, parallel computing and networks, formal methods, models, and languages, interactive and cognitive systems, software and information system engineering. On the same topic, this PhD is defined within the software and information systems engineering, called SIGMA team.

- **GSCOP: Industrial science research laboratory**

The third academic partner of the project is GSCOP ("Sciences pour la conception, l'Optimisation et la Production") located in Grenoble is a multidisciplinary laboratory which has been created to meet the scientific challenges imposed by the ongoing changes within the industrial world. The scope of the laboratory goes from the products conception to the production systems management and is based on strong skills in optimisation.

- **Scientific visit at the University of Liverpool**

In addition of having the chance of working in a collaborative project environment, the author of this manuscript had three months (Since June 2016 to September 2016) of scientific stay at Liverpool and working with the University of Liverpool, Management School, Marketing and Operation Department. During this stay she was gladly supervised by Doctor Hossein Sharifi who had been studying the concept of absorptive capacity during several researches and within various concepts. Thus, thanks to his guidance, she could reinforce the literature reviews and took part to a survey developed collaboratively with their team and which is still under development.

This visit gave her the opportunity to be introduced and discuss with other PhD students (current and previous), senior lecturers and professors. Through these discussions, she was introduced to Doctor Ronald Dyer, who is working on the serious games and gamification concepts. This introduction helped enrich her knowledge in terms of serious games and apply it through the next steps of her research.

In addition, during this visit, she could conduct five exploratory interviews with five SMEs which are developing collaborative innovation projects. As result of these interviews, two companies agreed to participate in experimental sessions (CSL and PRG cases). Participants of these sessions provided constructive feedbacks to improve the method and develop the next steps.

3.9 Conclusion

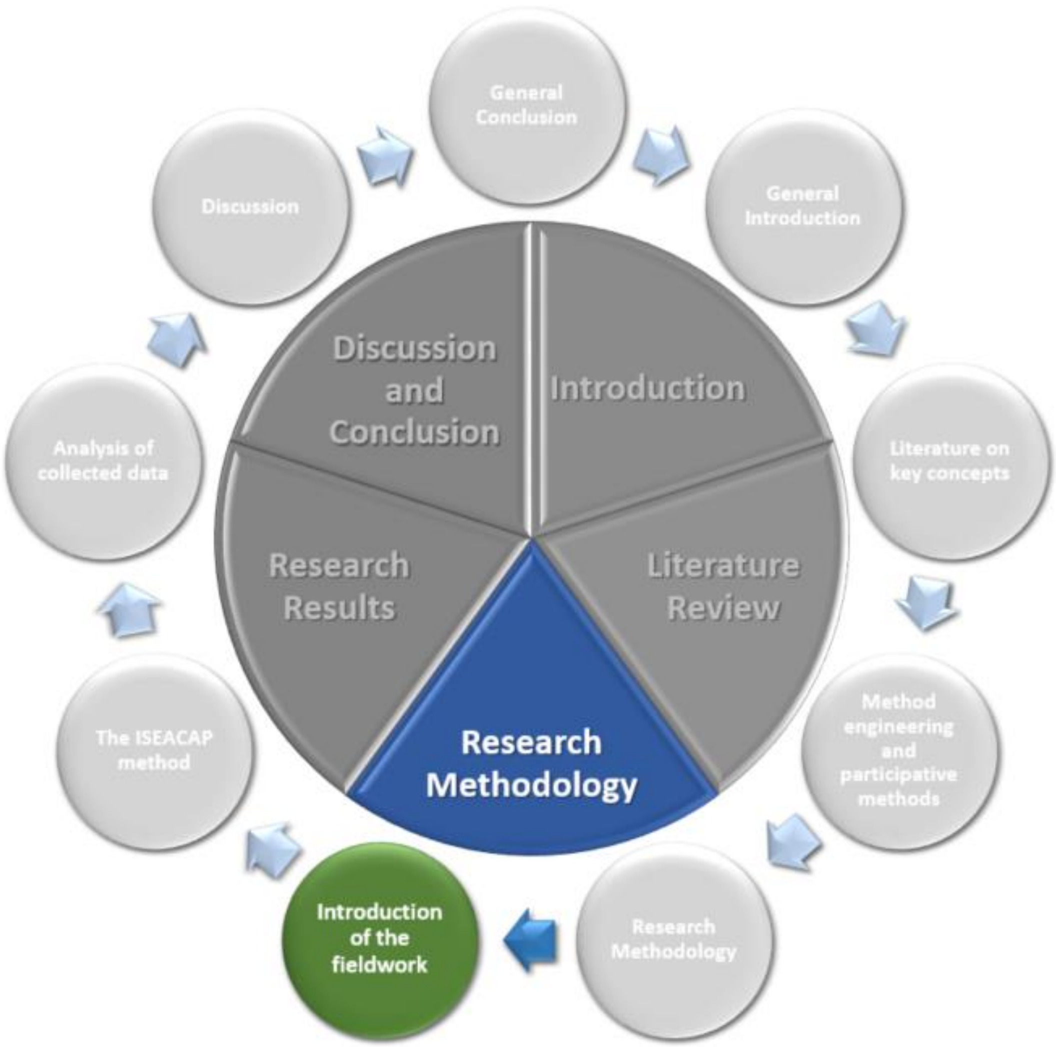
Through this chapter we explain the philosophical paradigm that consists of ontological and epistemological frameworks. This study relies on the pragmatic constructivist epistemological framework by providing a participative method that allows both researchers and actors to co-construct knowledge about actors' practices and routines. In addition the chapter posits the research methodology on collaborative action research as it enables the participants (companies' actors) to construct the meaning of their ACAP's practices and routines through discussion, interaction and reflection with other participants.

The chapter discusses also about three types of collected data via experimental sessions and semi-structured interviews. The first type of the collected data is the participants' feedback through the evaluation form and we will describe in chapter five how this could help develop and improve the method. The second type of data allows to produce visual outputs of the experimental sessions which play an imperative role for the companies' actors to have the consensus understanding of their ACAP's routines and practices. Finally the third type of data is collected via recording the experimental sessions and semi-structured interviews and allows the researchers to apply thematic analysis and co-construct detailed knowledge about ACAP's routines and practices. The analysis of the third type will be presented in chapter six.

In the next chapter we present the cases which accepted to participate in our research project.

Chapter 5. Introduction of the fieldwork

4.1	INTRODUCTION
4.2	TEST CASE STUDY
4.3	BETA AND ALPHA COMPANIES
4.4	CSL COMPANY
4.5	PRG COMPANY
4.6	AGY-LVB COMPANY
4.7	CONCLUSION



4.1 Introduction

The previous chapter explained about conducted exploratory interviews to find SMEs which develop collaborative innovation projects in France or UK. As the result of these interviews only five companies accepted to participate in our research work. Thus, this chapter is dedicated to the presentation these five companies.

The companies' participation allowed us to conduct experimental sessions and semi-structured interviews. Beside collected data via recordings, the experimental sessions helped develop and improve ISEACAP based on the participants' feedbacks.

Due to the companies' authorisation among five conducted session we have recording of three experimental sessions which is a rich dataset to be analysed in terms of ACAP's routines, reflexivity and organisational learning.

In the following, we present these SMEs and explain briefly the contexts of their collaborative innovation projects.

4.2 Test case study

4.2.1 Project description

Test case study was a collaborative project between a French aerospace group and a research laboratory. The project called "Additive Manufacturing" was a collaborative innovation projects between the research laboratory and the manufacturer as the customer. Additive Manufacturing refers to a method of manufacturing of pieces by adding material and successive layers through a computer-based process.

The project aimed to make changes in the arm of airplanes seats through Additive Fabrication and make them lighter and more resistant. The manufacturer in this project was considered as the client and the research laboratory was in charge of the study. We conducted three experimental sessions with the key actors of the project from the research laboratory.

4.2.2 Innovation and relationship characteristics

Table 5-1 presents the innovation characteristics of the Test case study project. These characteristics relies on presented literature in chapter one *section 1.2.1.1*. The table shows that the project is about the improvement of an existing piece of airplane seats and reinforce it via the new technologies and engineering ideas. The project had been developed in the research centre for an external partner as the client and completed successfully (Diffusion stage).

Table 5-1: Innovation characteristics - Test case study

Stage	Social	Means	Environment	Radicalness	Nature	Type	Aim
Diffusion	Research centre and customer	Technology and ideas	External	Incremental	Improvement	Technical	succeed

Table 5-2 presents the relationship characteristics of the project partners. Based on the chapter one *section 1.2.2* the interaction level between the partners is collaboration: the research centre and the manufacturer had communication and information exchange, complementary goals and through their individual identities they were working separately to develop different parts of the project while at the beginning of the project they had worked together through several meetings to develop the initial idea.

Table 5-2: Relationship characteristics-Test case study

Interaction level	Type of relationship	Structure of relationship
Collaboration	Vertical	Ring structure

4.2.3 Conducted sessions

Overall, the test case study was involved during the method development. The actors of the project considered the project highly confidential and did not authorise to record the sessions. Through the first experimental session, the participants (project actors) modelled the process of their project via ISEA and ISEAsy tool. Indeed, the ISEA method was initially developed for recurrent business processes and the purpose of this session was testing the ISEA method and its tool for non-recurrent processes such as an innovation project. Additionally, we explored ideas for the general structure of the method and what can be defined as the main phases of the method. Through the two other experimental sessions, we followed the same steps, (i) validating or improving the current phase and (ii) exploring ideas for the next phases. Table 5-3 summarises our interactions with the test case study.

Table 5-3: Agenda of interactions with Test case study

Date	Type of interaction	Participants	Goals
May 2015	Experimental session	– Project Manager – Responsible of form analysis – Responsible of proposition analysis	– Validating ISEA method for process modelling of innovative project. – Exploring ideas for the general structure of the method.
June 2015	Experimental session	– Project Manager – Responsible of form analysis	– Collecting ideas to improve knowledge mapping.
Mars 2016	Experimental session	– Project Manager – Responsible of form analysis	– Validating the knowledge mapping and collecting ideas for routines eliciting phase.

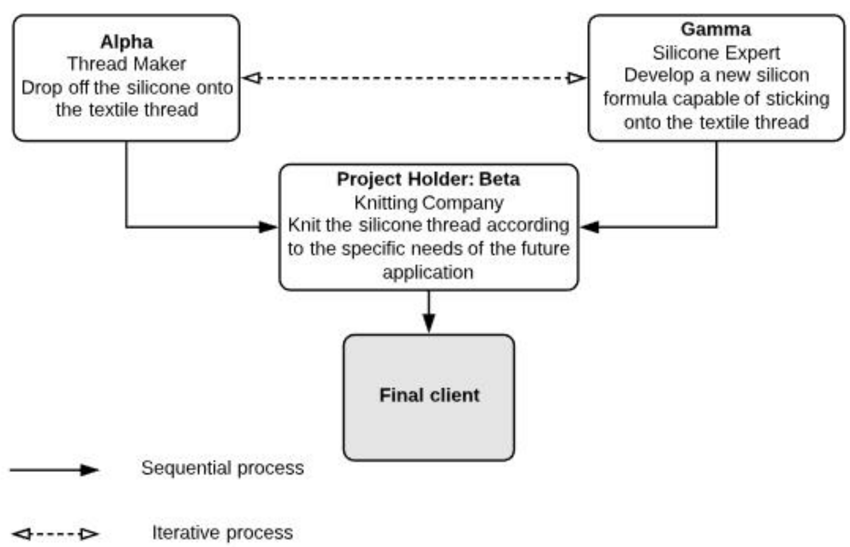
4.3 Beta and Alpha companies

4.3.1 Project description

Alpha and Beta companies developed collaboratively an innovative project, which aimed at coating polyester yarns with silicon and knitting silicon textile. Both companies identified the coating and winding of the silicone textile thread as the most important part of the project in terms of innovation. In the identified part three companies were involved called Gamma, Alpha and Beta for confidentiality reasons. Alpha is a small French manufacturer of textile thread and joined the project in 2008, with Beta (specialised in textile knitting activities) and Gamma (a silicon expert).

Beta was the project holder and in direct collaboration with Alpha and Gamma (Figure 5-1). Beta worked also directly with the client while two other partners did not communicate with the client during the project. Alpha and Gamma had an iterative relation during the project as Gamma provided raw materials of the yarns for Alpha. Planning and development phases covered 2008-2011 thereafter, the execution and production phase were launched successfully and the product has been commercialised in 2015.

Figure 5-1: Structure of the collaboration between the three partners



4.3.2 Innovation and relationship characteristics

Table 5-4 shows the characteristics of the project. The project aimed at producing a new product with external partners for a final customer. The project has been successfully completed (Diffusion stage) and commercialised: Beta Company got a patent for this innovation. The aim of the project was producing a different product with better functionalities for specific needs in medical and sport markets.

Table 5-4: Innovation characteristics – Beta and Alpha companies

Stage	Social	Means	Environment	Radicalness	Nature	Type	Aim
Diffusion	External partner, customer	Ideas, market and invention	External	Radical	New	Product	Differentiate

Table 5-5 illustrates the characteristics of the relationship between the partners. The interaction level is cooperation as they had communication and information exchange while they worked and accomplished their responsibilities separately with some coordination.

Table 5-5: Relationship characteristics- Beta and Alpha companies

Interaction level	Type of relationship	Structure of relationship
Cooperation	Vertical	Tree structure

4.3.3 Conducted sessions

We started our communication with the actors of the project via a first telephonic interview with the project manager of **Beta** Company who explained the project and confirmed the current process model which had been modelled via ISEAsy during another research project before starting this PhD. The telephonic interview resulted the identification of an important part of the project (industrialisation: coating and winding of the silicone textile thread) as the core of innovation and we could take an appointment to have an experimental session with the key actors of the project in Beta company: Project Manager (PM), Technician (Tech), Project Associate (PA) and Commercial Officer (CO). The session lasted 120 minutes. However, the company did not allow us to record the session. At the end of the session, we provided the company with their knowledge map as the result of knowledge mapping session which cannot be presented in this manuscript for the same confidentially limitations.

After the experimental session with Beta, we had also a telephonic interview with the research engineer of **Alpha** Company. This interview aimed to validate the identified process model with Beta, identify created or reused documents during the project and take an appointment for conducting an experimental session. As identified with Beta, the research engineer of company Beta confirms also the "industrialisation" as the most important part of the project (Appendix 3) and we could organise an experimental session with the key actors of Alpha, Chief Executive Officer (CEO), R&D Manager (RM), Research Engineer (RE) and Operator (OP). The session lasted "160 minutes" and we (researchers) follow the protocol of the ISEACAP method (knowledge mapping). The produced knowledge map during this session is shown in Appendix 4. The entire session was allowed to be videotaped and transcribed.

Table 5-6 presents the summary of conducted interviews and experimental sessions in Alpha and Beta companies. In general, the conducted individual interviews aimed to understand the project context, recognise the process, identify created or reused documents and find a common availability with the actors. Therefore, we asked these questions in a general way without following a particular interview guide.

Table 5-6: Agenda of interactions with Beta and Alpha companies

Company	Date	Interaction	Participants	Goals
Alpha Company	**May 2016**	Individual and unstructured interview (phone) 20’	− Project Manager	− Validating the process model of the project. − Identifying the most important part in terms of innovation. − Identify available project’s key actors in Beta Company.
	July 2016	Experimental session 120’	− Project Manager − Project Associate − Technician − Commercial Officer	− Validating knowledge mapping phase and collecting potential ideas to improve the knowledge mapping phase.

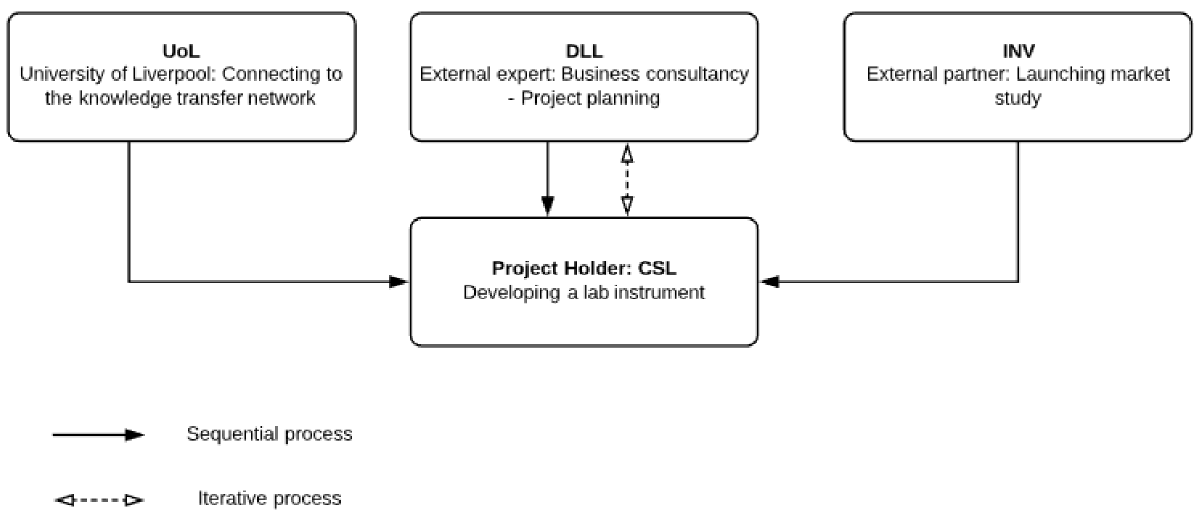
Company	Date	Interaction	Participants	Goals
				– Exploring potential ideas for routines eliciting and enriching phases. – Providing the map of mobilised knowledge during the project.
Beta Company	**June 2016**	Individual and unstructured interview (phone) 20’	– Research Engineer	– Identifying performed activities during the project. – Identifying project’s key actors in company Alpha. – Identifying important created or reused documents during the project. – Validating the process model of the project.
	July 2016	Experimental session 160’	– Chief Executive Officer – R&D Manager – Research Engineer – Operator	– Validating knowledge mapping phase and collecting potential ideas to improve the knowledge mapping phase. – Exploring potential ideas for routine eliciting and enriching phases. – Providing the map of mobilised knowledge during the project. – Collecting data via recordings

4.4 CSL Company

4.4.1 Project description

CSL is a SME located in Cheshire, UK and develops laboratory software solutions to improve analytical performance and ensure quality lab results. The company started a collaborative innovation project to create a web-based application with a dashboard-featured appearance. The web-based application is in connection with an external device that can be attached to the lab's instruments and allows to monitor and report constantly the instrument data output. To develop the project, CSL collaborated with the University of Liverpool and two other companies. For the targeted project, CSL played the role of the holder and focused on the software, Figure 5-2 presents identified partners of the project and proposes the network structure. INV is an external partner (a small company) who launched the market study for the instrument and communicated the results to CSL. UoL is the University of Liverpool that provided knowledge transfer network for CSL. An expert from DLL provided the planning of the project and had an iterative communication with CSL to validate the project plan.

Figure 5-2: Structure of the collaboration between CSL and project partners



4.4.2 Innovation and relationship characteristics

Table 5-7 characterises the innovation of CSL Company. CSL aimed at creating a new product (device and the web-based application), which can be considered a radical innovation to the company. When we interviewed the actors of the project in 2016, the project was in primary phases of the development (conversion stage). The company collaborated with external partners and research centres to develop the project while the intellectual property of the new product belongs to CSL. The innovation was an improved version of existing products in the market by an additional function of instant analytical reporting.

Table 5-7: Innovation characteristics – CSL company

Stage	Social	Means	Environment	Radicalness	Nature	Type	Aim
conversion	Research centres, external partners	Technology, Idea and Invention	External	Radical	Improvement	Product and service	Compete

Table 5-8 characterises the relationship between the partners of the project. The interactions between CSL, DLL and INV can be identified as collaboration since they worked together to achieve a mutual goal. Between CSL and UoL, the interaction is networking as they had only communication and information exchange.

Table 5-8: Relationship characteristics- CSL company

Interaction level	Type of relationship	Structure of relationship
Collaboration Networking	Horizontal Diagonal	Star structure

4.4.3 Conducted sessions

We had been introduced to CSL by Dr Ronald Dyer researcher at the University of Liverpool and we could arrange face-to-face interview with the two key actors of the project: Project Manager and Application Manager. The collective interview lasted 45 minutes and helped understand the project context, interviewees' profiles, identify the partners of the project and make an appointment for experimental session. Appendix 5 presents the process model of the planning phase of the innovation project in CSL Company. Based on the process model and identified documents, we conducted the knowledge mapping session with the Application manager.

For the experimental session, the project manager was not available to participate and we had to the session should be conducted with only one participant "Application Manager". As the method should principally be conducted between at least two participants, the application manager tried to play two roles (project manager and application manager). Thus, this session provided us the opportunity to evaluate the method for an individual participation.

Table 5-9 presents the agenda of interactions with CSL Company. We had an experimental session for knowledge mapping where beside of identifying and mapping mobilised knowledge, we could explore potential ideas for routines elicitation.

Table 5-9: Agenda of interactions with CSL company

Date	Interaction	Participants	Goals
August 2016	Unstructured collective interview (face to face) 45’	– Project Manager – Application Manager	– Understanding the context. – Identifying the process of the project. – Identifying internal key actors, external partners of the project. – Providing the process model of the project.
September 2016	Experimental session 120’	– Application Manager	– Identifying and mapping mobilised knowledge during the project.

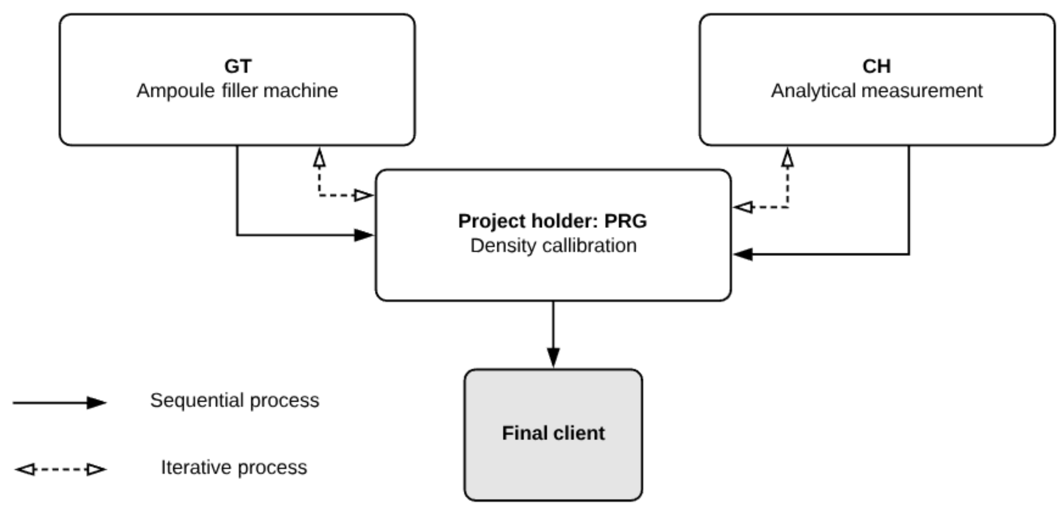
4.5 PRG Company

4.5.1 Project description

PRG is a SME in chemical manufacturer field located in UK and specialised in the production of reference materials. One of their innovative project was the density measurement of a particular material. During this project, PRG owned the Intellectual Property and provided the calibration part while another small company CH provided analytical measurement and equipment.

CH is also small company based in UK. They are specialist in measuring instruments. For the project, PRG brought knowledge and expertise in stability and homogeneity besides providing raw materials, while CH provided required equipment with the low level of uncertainty. For packaging part of the project, PRG involved another company GT which is specialised in filling (via ampule filler machine) and packaging. Figure 5-3 shows the structure of this collaboration.

Figure 5-3: Structure of the collaboration between PRG and project partners



4.5.2 Innovation and relationship characteristics

Table 5-10 characterises the innovation project of PRG Company which has been successfully ended (Diffusion stage). Their project was an incremental innovation that improved their existing products in terms of packaging. PRG Company collaborated with external partners to accomplish their customer demand. They could reduce transportation and packaging costs notably and have adopted this technique for their future projects as well.

Table 5-10: Innovation characteristics – PRG company

Stage	Social	Means	Environment	Radicalness	Nature	Type	Aim
Diffusion	External partners and customer	Market and ideas	External	Incremental	Improvement	Product	Succeed

The relationship between the partners is characterised in Table 5-11. The PRG was the project holder and coordinator. The partners were working apart with complementary goals and communicating regularly. This relationship is vertical as they created a value chain for density measurement, analysing and packaging. The PRG Company was the core of the relationship by communicating with both partners and creating the star relationship structure.

Table 5-11: Relationship characteristics- PRG company

Interaction level	Type of relationship	Structure of relationship
Cooperation	Vertical	Star structure

4.5.3 Conducted sessions

We had been introduced the PRG company by the University of Liverpool. Table 5-12 presents our interactions with this company. We had an initial interview with the Company's Director (SB) in July 2015 to understand their work context and present our research project. As the result of this interview, the project manager (SB) confirmed to participate in our experimental session. In July 2016, we had one more interview with the same person, to identify one of their collaborative innovation projects, partners and documents.

Table 5-12: Agenda of interactions with PRG company

Date	Type of interaction	Participants	Goals
July 2015	Unstructured individual interview (face to face) 160’	– Company Director	– Understanding the context of the company. – Identifying company’s partners. – Explaining the research project and get their confirmation for the experimental session.
July 2016	Unstructured individual interview (face to face) 40’	– Company Director	– Choosing a collaborative innovation project. – Identifying internal key actors, external partners of the project. – Identifying created or reused documents during the project.
September 2016	Experimental session 118’	– Project Manager – Technical manager*	– Identifying and mapping mobilised knowledge during the project. – Validating knowledge mapping phase. – Exploring ideas for routines elicitation phase. – Providing the map of mobilised knowledge during the project

** As technical manager could not participate in the session, the project manager played two roles (technical and project managers) during the session.*

For the experimental session, the Technical Manager couldn’t finally attend and thereby the Project Manager played respectively his real role and then the role of the technical manager. As the result of this session we provided the map of mobilised knowledge during the project and collect ideas for the third step of the method.

4.6 AGY-LVB Company

The companies AGY and LVB are our main case studies as we conducted the experimental sessions for all the phases of the method and the companies authorised sessions' recordings.

4.6.1 Project description

The PR consortium is about a collaborative innovation project that aims to propose a small domestic appliance for growing a specific food plant. Two small companies are the holders of this project (AGY-LVB) and they collaborate with a large company (S) that is a specialist in designing and producing small domestic appliances. We consider these two companies as one company, since they are located in the same place, with same principal stakeholders. Another partner is a small company that is a specialist to grow the specific food plant (PRY). Two research centres collaborate in this project to provide required technical and scientific supports (IFR and LSB). In addition, four sub-contractors work with the project holders for prototyping (Fablab, DRSC) and market study (GLN, RST). However, these four sub-contractors are not engaged in the consortium.

Figure 5-4: Collaboration structure – PR Project

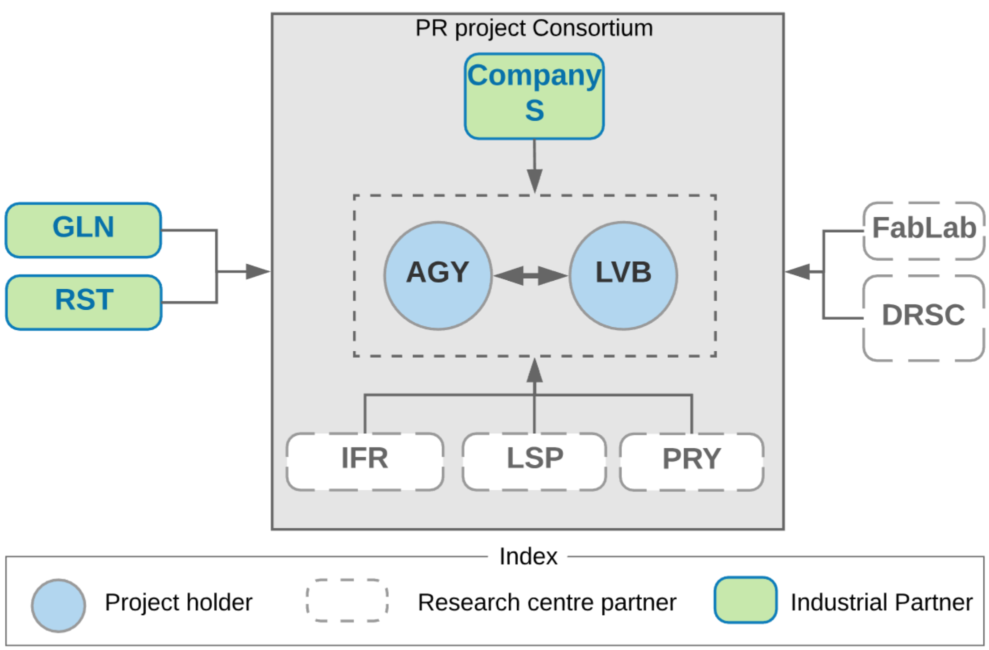


Figure 5-4 shows the structure of the collaboration. Company S brought their commercialisation experiences in terms of the analysis of market behaviour in domestic appliances domain. LSP, LVB-AGY provided a transversal vision on the technical aspect of the project. In particular, LSP had transversal vision on the programming, modelling and simulation and AGY on chemical aspects. PRY and IFR provided cultural and nutritional aspect.

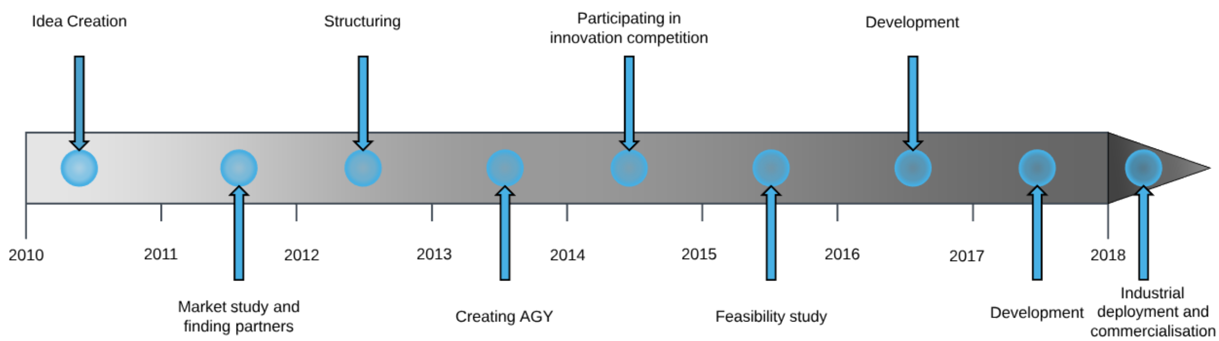
The innovative product did not exist previously in the market and they had to create both the usage culture and the market need. During one of our interviews, the marketing officer argued, "*When we have a copy of the product in the market, it means we succeed and can increase the production (Int, YZ, p. 17)*". Therefore, their project could be considered as a push radical innovation.

The project has been run through three phases (i) feasibility study during 12 months (ii) development, industrialisation of the innovation during two years (iii) and commercialisation, which is currently in progress.

Semi-structured interviews helped us to define the following timeline for the project:

- In 2010, the idea of the project had been created within the company LVB and they started to collaborate with a research centre (IFR) to develop it.
- Following this collaboration in 2011, another research centre (PRY) and a large production company (S) joined to the project. In this stage, GLN and RST collaborated to prepare the financial chart of the project and market study, these two small companies are outside of the consortium (see Figure 5-4).
- During 2011 to 2013, they had applied for a public fund but it was not accepted as their application missed a clear structure for the project and as well as the collaboration.
- Therefore, in 2014 they established a start-up called AGY in order to be the project holder and works specifically on this project.
- With this new structure, in 2015, their application had been selected in a national innovation competition and awarded a public fund.
- Due to the competition, they should accomplish three consequences phases:
    - 2015 to 2016, feasibility study of the project, declaring partners and structure of the consortium PR.
    - 2016 to 2018, development phase including technical design and prototyping, punctual exchanges with partners, marketing etc.
    - After 2018, industrial deployment and commercialisation phase

Figure 5-5: Timeline of PR project



Between 2012 and 2015, technological part was developed progressively through the collaboration with the research centre (LSP). From the beginning of the project (ideation stage), two research centres participated in the project development informally and they had been considered outside of the consortium (see Figure 5-4). One of them (FabLab) collaborated in designing and prototyping. The other (DRSC) provided information in terms of analysing nutritional results and standardisation.

4.6.2 Innovation and relationship characteristics

Table 5-13 summarises the characteristics of the collaborative innovation project of LVB-AGY. The project is the creation of a new product that consider radical innovation to the company and new to the market. Up to now, the project is in conversion stage and moving from idea to the first result. The product aims succeeding to enter to market at a moment there is no competitor or similar appliance in the market. The project holders have used various means like collecting external partners' ideas, creativity, technology and invention to accomplish this innovation.

Table 5-13: Innovation characteristics – LVB-AGY

Stage	Social	Means	Environment	Radicalness	Nature	Type	Aim
Conversion	Research centres, external partners	Technology, idea, invention, creativity	External	Radical	Improvement	Product and service	Compete

Table 5-14 characterises the relationship between the project partners. The interaction level between the partners can be identified as collaboration since they worked together through brainstorming meetings to develop the initial ideas. Additionally, they worked apart to accomplish their individual responsibilities defined in the project consortium. The relationship structure relies on generalised type as the project stakeholders communicated through different types of meeting (technical, strategic or steering committees) to accomplish their responsibilities.

Table 5-14: Relationship characteristics LVB-AGY

Interaction level	Type of relationship	Structure of relationship
Collaboration	Diagonal	Generalised

4.6.3 Conducted sessions

Key actors of LVB-AGY were motivated to advance the project and open to the university researches. From the beginning, they had worked in collaboration with different researchers. Technical manager from AGY, General Director from LVB and Research Director from LSP research centres accepted to participate in our experimental sessions.

Table 5-15 presents the summary of our interactions with PR actors, in particular LVB-AGY's actors. Due to the actors' acceptance and availability we had also the opportunity to conduct semi-structured interviews to identify ACAP's practices during the PR project (the interview guide has been described in previous chapter). The objective is to compare collected data through the interviews and experimental session and through the sixth chapter, we will discuss about the result of this comparison.

Table 5-15: Agenda of interactions with PR project actors

Date	Type of interaction	Participants	Goals
April 2016	Individual interview (phone) 35’	– General Director LVB (Project Manager)	– Understanding the context. – Identifying company’s partners. – Explaining the research project and get their confirmation to participate in the project.
July 2017	Individual interviews (phone and face to face) Total of 384’	– General Director LVB – Economic planning expert LVB – Technical Manager AGY – General Director AGY – Marketing officer AGY – Communication officer AGY – Research Director LSP	– Identifying the process of the project. – Identifying internal key actors, external partners of the project. – Identifying created or reused documents during the project. – Identifying *ACAP’s* routines and practices. – Providing the process model of the project.
July 2017	Experimental session 1 130’	– General Director LVB – Technical Manager AGY – Research Director LSP	– Identifying and mapping mobilised knowledge during the project. – Validating knowledge mapping phase by users. – Providing the map of mobilised knowledge during the project.
July 2017	Experimental session 2 82’	– General Director LVB – Technical Manager AGY – Research Director LSP	– Eliciting ACAP’s organisational routines – Enriching identified routines – Validating routines elicitation and enrichment phase by users. – Providing the flow of applied ACAP’s routines during the project. – Highlighting the important ACAP’s routines for their future projects.

4.7 Conclusion

This chapter introduced our case studies by describing the context of their projects and summarising our interactions with the companies. Overall, we had nine experimental sessions conducted on five cases. However, we could analyse the recording of only three experimental sessions conducted in two case studies of Alpha and LVB-AGY:

- Knowledge mapping session in Alpha company
- Knowledge mapping session in PR project
- Routines elicitation and enrichment session in PR project

This limitation was created due to the recording authorisation from companies or the number of participants:

- "Test case study" and "Beta" company did not authorised recording of the sessions.
- In the case of "CSL" and "PRG" companies, we had only one participant, which does not meet ACAP at collective level.

Recordings of the three validated sessions and conducted semi-structured interviews in PR project were transcribed in order to be analysed through the sixth chapter. Moreover, all the conducted experimental sessions (recorded or not recorded) played imperative roles for developing and improving the ISEACAP method. Thus, next chapter presents the detail of ISEACAP development and explain the role of each experimental session in the progress of the method.

Chapter 6. The ISEACAP Method

5.1	INTRODUCTION
5.2	CONTEXT AND OBJECTIVES
5.3	METHOD CONSTRUCTION APPROACH
5.4	PROTOCOL OF ISEACAP
5.5	METHOD FORMALISATION
5.6	SUPPORT TOOL FOR ISEACAP
5.7	VALIDATION OF ISEACAP BY USERS
5.8	CONCLUSION

5.1 Introduction

This chapter focuses on our second sub research question "how to provide a reflexive space for organisations' actors about their ACAP's routines?" Relying on the provided literature review in first and second chapters, we propose to address this question through a participative method called ISEACAP (Identification, Simulation, Evaluation, and Amelioration of absorptive CAPacity).

This chapter presents the context and four main objectives of the method which are structured as four phases of a virtuous cycle. Thereafter, it describes the development of the ISEACAP method through user-centre design during different experimental sessions and illustrates the users' involvement from the early stages of the method construction. It also describes the protocol of each phase in order to facilitate the method replication by other researchers and actors.

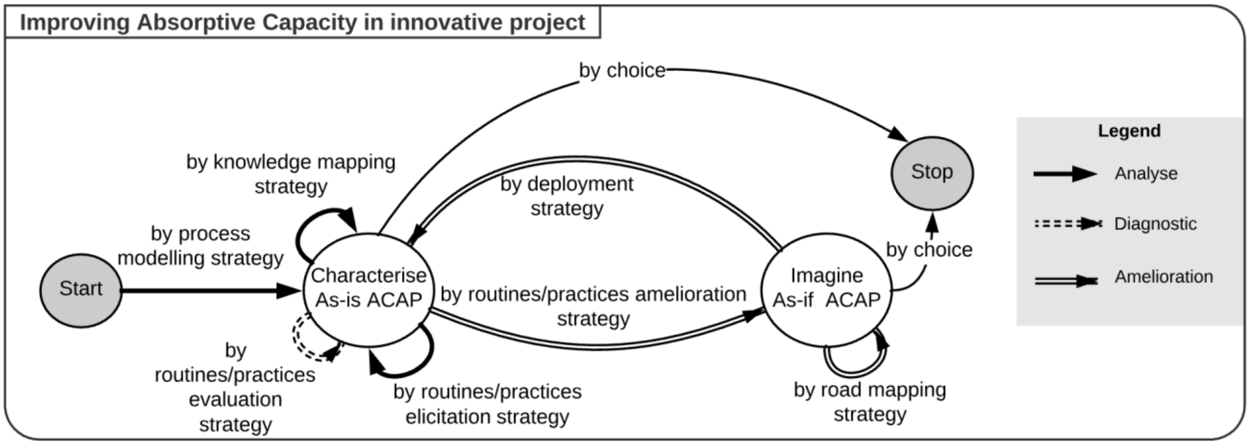
The chapter also sketches out the metamodel, intentional maps and graphical notations of each phase of the method. Finally, through the last section, we present the support tool of ISEACAP called ISEAsy and illustrates the method validation.

5.2 Context and objectives

Scholars view continuous improvement as an approach to enhance creativity and achieve competitive excellence in today's market (Oakland, 1999) and define it as a culture of sustained improvement and involves everyone working together to make improvements without necessarily making huge capital (Bhuiyan & Baghel, 2005, p. 761). Organisations achieve improvement via dedicated tools and techniques. However, organisations run improvements throughout longitudinal procedures and should integrate these procedures within their organisational culture (Bhuiyan & Baghel, 2005, p. 765).

In this perspective, the ISEACAP enables practitioners to apply the method within their organisation autonomously, achieve consensual results and enhance their ACAP's routines continuously. Figure 6-1 shows the general Map of ISEACAP that highlights two principal intentions: *Characterise As-Is ACAP system* and *Imagine As-If ACAP system*. The traditional approach *As-Is / To-Be* (van Lamsweerde & Letier, 2000) is transformed into a continuous improvement approach by iterative cycles *As-Is / As-If* based on *analysis*, *diagnostics* and *amelioration* strategies (Cortes-Cornax, Front, Rieu, Verdier, & Forest, 2016). The general process of ISEACAP is a particular case of *As-Is/As-If* framework proposed by the SIGMA team applied in ACAP concept (Front, Rieu, Cela, & Movahedian, 2017).

Figure 6-1: General map of ISEACAP



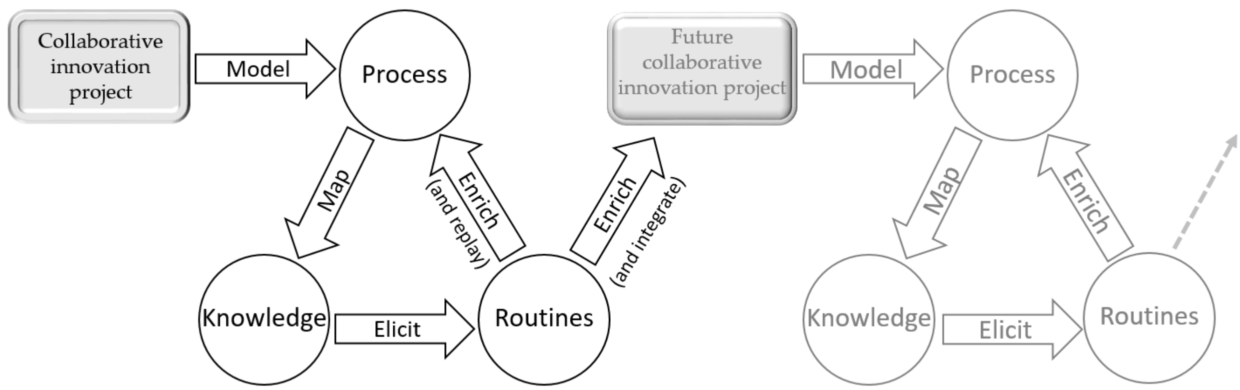
In the general map, we analyse the absorptive capacity (ACAP) through modelling of an innovation project, knowledge mapping and routines/practices elicitation. ACAP diagnostic is based on the evaluation of routines/practices. Amelioration of absorptive capacity is about specifying how and when appropriated routines and practices should be integrated (road mapping) and apply them in future projects (deployment).

This dissertation focuses on *analyse* and *diagnostic* of *As-Is ACAP* with the perspective of *amelioration* of ACAP's routines/practices. To this end, we propose in Figure 6-2 a virtuous cycle, which plays a complementary role to the general map and fulfils the four objectives of ISEACAP through four phases as below:

i. *Modelling collaborative innovation project process* that helps identify actors of the project, individual and collective activities performed during the project as well as created or reused documents.
ii. *Mapping and characterising mobilised knowledge during collaborative innovation projects* through series of gamified elicitation techniques that highlights where external knowledge is mobilised.
iii. *Eliciting ACAP's organisational routines* via gamified elicitation techniques that allows to identify and characterise organisational routines which are performed to acquire and transform an external knowledge.

iv. *Enriching organisational routines by evaluating and comparing them with best routines/practices of knowledge absorption* that aims at integrating them in their future innovation projects or to replay the same projects with these enriched routines.

Figure 6-2: Virtuous cycle for enriching ACAP's routines



Through the next section, we explain the construction of the method and follow with the method presentation and formalisation.

5.3 Method construction approach

The ISEACAP method has four main phases that allow to yield the final objective "continuous enhancement of ACAP's routines":

i. **Process modelling** of a collaborative innovation project is considered as the starting point of the method as it allows to:
   a. have a clear vision on the performed activities during the project
   b. illustrate the intervention and contribution of external partners
   c. highlight crucial parts of the project in terms of innovation.

ii. **Knowledge mapping:** provides a map of mobilised knowledge during identified parts of the project and highlights where external knowledge entered and transformed.

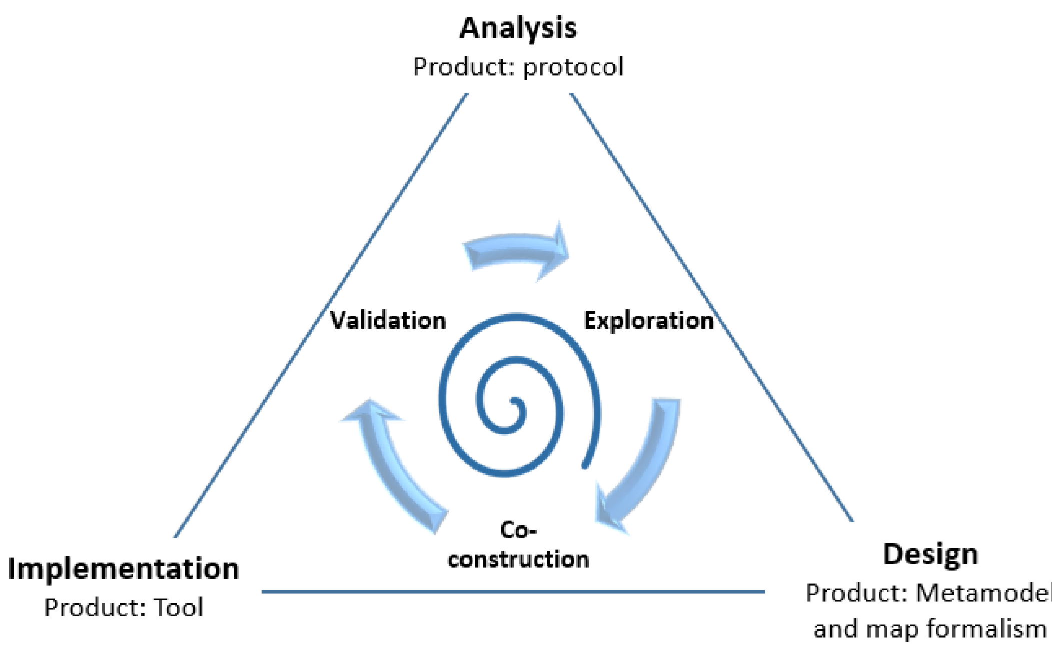
iii. **Elicit organisational routines**: highlights how the knowledge is acquired, assimilated and transformed during the project.

iv. **Enrich elicited routines**: evaluates and enriches elicited routines through collective reflection among the actors in order to be ideally improved and integrated in future projects.

5.3.1 User-centre design and validation cycle

ISEACAP is built on user-centred design (UCD), and in particular the user-oriented validation cycle, which is adapted for method development (see Figure 6-3). The UCD is based upon identified end-users' needs, who are involved during the design and development (Norman & Draper, 1986). The design is driven and refined by user-centred evaluation (Mandran, Dupuy-Chessa, Front, & Rieu, 2013). Scholars define the UCD in three stages: analysis, design and implementation.

Figure 6-3-User-centred evaluation cycle for the development of a method



The *analysis stage* enables identification of users' practices, and to know their environment, their needs and expectations. For instance, testing ISEA for the first time on an innovative project can be considered as the *analysis* stage and results the first version of the method and thereby we could draft the protocol of the method.

The *design stage* leads the proposition of required elements to develop a method. For instance, to develop the ISEACAP method we organised several focus groups between interdisciplinary researchers besides running experimental session with the end-users. We provided a first experimental session with end-users to collect their feedback and formalise the method with meta-models. Through analysis of collected feedback and ideas, the protocol could be validated and completed and the first version of the method formalisation via map formalism, metamodels and graphical notations was proposed.

The *Implementation stage* is in particular associated to the tool development, evaluation and validation. In the case of ISEACAP, after the validation of the method through the *design* stage, the tool development and validation were accomplished during *implementation* stage. The product of this stage is the ISEAsy supporting tool of ISEACAP method.

Each stage of UCD is an iterative cycle called "evaluation cycle" with three steps to involve end-users: *Exploration*, *co-construction* and *validation*. Figure 6-3 illustrates the "evaluation cycle" for method development. *Exploration* relies on a state of the art in the considered field and depends on stage's objectives, but also must take into account future end-users' needs. *Co-construction* consists of a collective proposal in coping with problems emerged through the first step. *Validation* is a final step where end-users implement the proposal and evaluate it by responding to interviews or questionnaires (validation forms, e.g. Appendix 11 and Appendix 12).

The end-user validation cycle is basically proposed for Domain Specific Language Development by Mandran, et *al.* (2013). The authors conclude their paper with the intention to apply their approach to the development of a method (method as the product and output of a research). Therefore, we fulfil their intention by following their approach and adapt it for developing the ISEACAP method. An important remark has to be highlighted: during each stage of our method development, experimental sessions with end users are led with the purpose of *validation*, but also *exploration* and *co-construction* with the future users as proposed by (Front et al., 2015).

5.3.2 ISEACAP construction

Following the UCD and end-user validation cycle, we evolved the ISEACAP through several experimental sessions within the various companies presented in previous chapter. As Figure 6-4 shows, we have developed the method through three versions to achieve to the latest one.

Figure 6-4: General view of ISEACAP construction

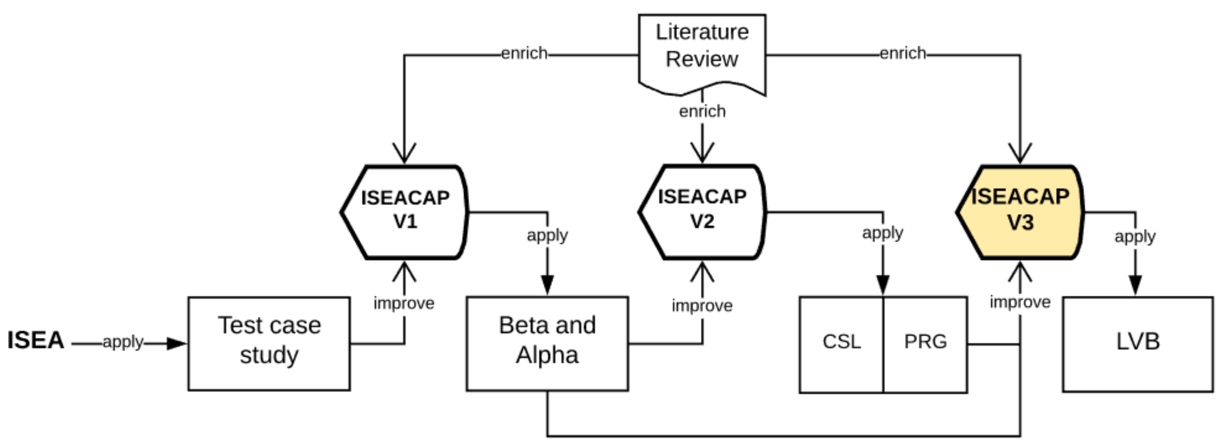


Table 6-1 presents the development of the four phases of ISEACAP during each version. The first version was dedicated to validate the process modelling phase and collecting end users' feedback for improving the first version of the knowledge mapping protocol. The second version focused on the validation of knowledge mapping phase and collecting end users' ideas to co-construct routines eliciting phase. Finally, through the third/current version, the knowledge mapping and routines eliciting phases were validated and ideas have been collected to co-construct routines enriching phase. In the following, we explain the details of each version based on the UCD stages.

Table 6-1: ISEACAP development through end-user validation cycle

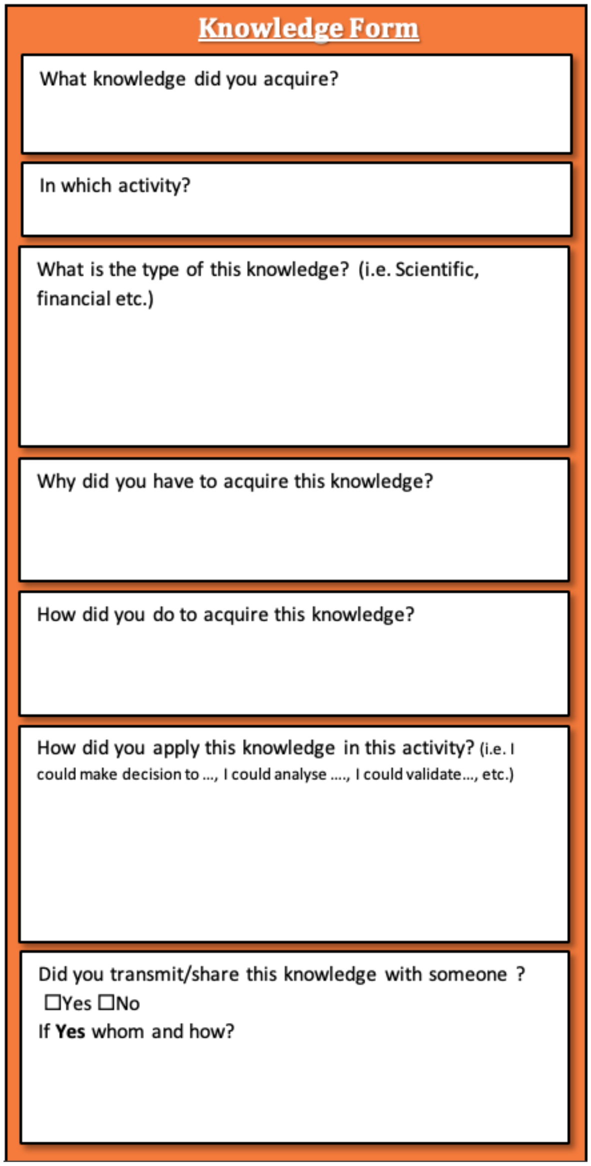
ISEACAP	V1	V2	V3
Process modelling	– Validation of the protocol, tool and language for innovation project processes		
Knowledge mapping	– Co-construction of protocol – Exploration of language – Exploration of tool	– Validation of the protocol – Co-construction of the language – Co-construction of the tool	– Validation of the language – Validation of the tool
Routines eliciting	– Exploration of protocol – Exploration of language	– Co-construction of the protocol – Co-construction of the language – Exploration of tool	– Validation of the protocol – Validation of the language – Co-construction of the tool
Routines enriching		– Exploration of protocol – Exploration of language	– Co-construction of the protocol – Co-construction of the language – Exploration of tool

5.3.2.1 ISEACAP V1: Process modelling validation and knowledge mapping co-construction

As the starting point we applied the ISEA method and its tool to model the process of the Test Case study. The *test case study* is used alongside the construction and development of ISEACAP (two researchers of the project contribute in test case study and provide all the supports and required information).

Besides of the process modelling validation (an example of process model is shown in Figure 6-10), we explored potential alternatives for knowledge mapping phase and one of them was a knowledge form shown in Figure 6-5 to ask the participants about applied knowledge during each of their activities.

Figure 6-5: Knowledge Form- ISEACAP version 1



Knowledge Form

What knowledge did you acquire?

In which activity?

What is the type of this knowledge? (i.e. Scientific, financial etc.)

Why did you have to acquire this knowledge?

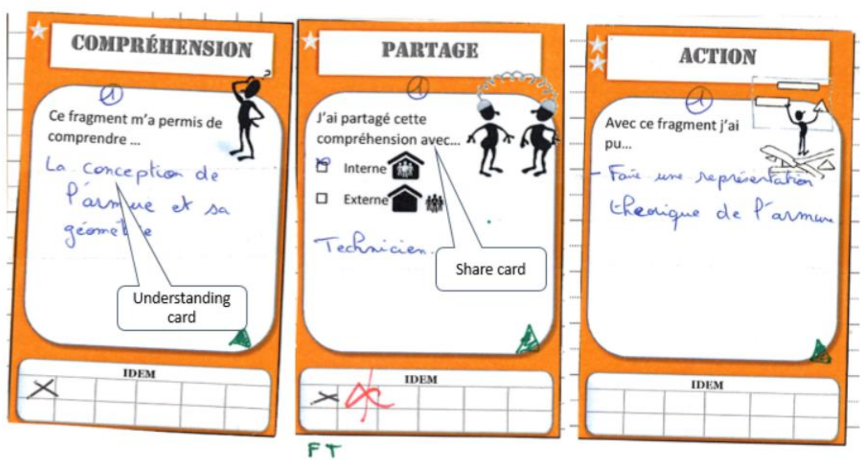
How did you do to acquire this knowledge?

How did you apply this knowledge in this activity? (i.e. I could make decision to ..., I could analyse ...., I could validate..., etc.)

Did you transmit/share this knowledge with someone ?
☐Yes ☐No
If **Yes** whom and how?

These forms did not work very well as they contained direct and general questions about knowledge which is basically tacit and difficult to access and thereby not easy for the participants to answer. Moreover, the form seemed boring for the participants comparing with the playful role playing used in the process modelling phase. Therefore, we changed the protocol of knowledge mapping and focused on the project's documents as the starting point. These documents had been identified during the process modelling (example is shown in Figure 6-12). The participants selected and cut off the most important parts of the document, which are called document's *fragments*. In addition, instead of the forms, we used gamification and elicitation techniques by defining **three cards** (see Figure 6-6): Understanding, Action and Share.

Figure 6-6: ISEACAP V1-Three cards- Example of test case study



- **Understanding card**: Participants explain what they have understood from the fragment of the document.
- **Action card**: Participants explain what they performed based on the fragment.
- **Share card**: Participants highlight with whom they have shared their understanding from the fragment.

Participants should use these three cards to explain their understanding from each fragment of the documents, then, collectively group the fragments and name the groups.

This version is initially tested with the participants of the *Test case study* and they validated the understandability and ease of use of the instruction.

The process modelling phase had been validated for an innovative project. Additionally, the knowledge mapping phase had been analysed through the knowledge form and thereby the protocol was evolved by adding the three cards. We contacted two companies Alpha and Beta to conduct experimental sessions in order to apply the method regarding their project and collect validation and feedback for the new protocol of knowledge mapping.

- **Gathered feedback from experimental sessions**

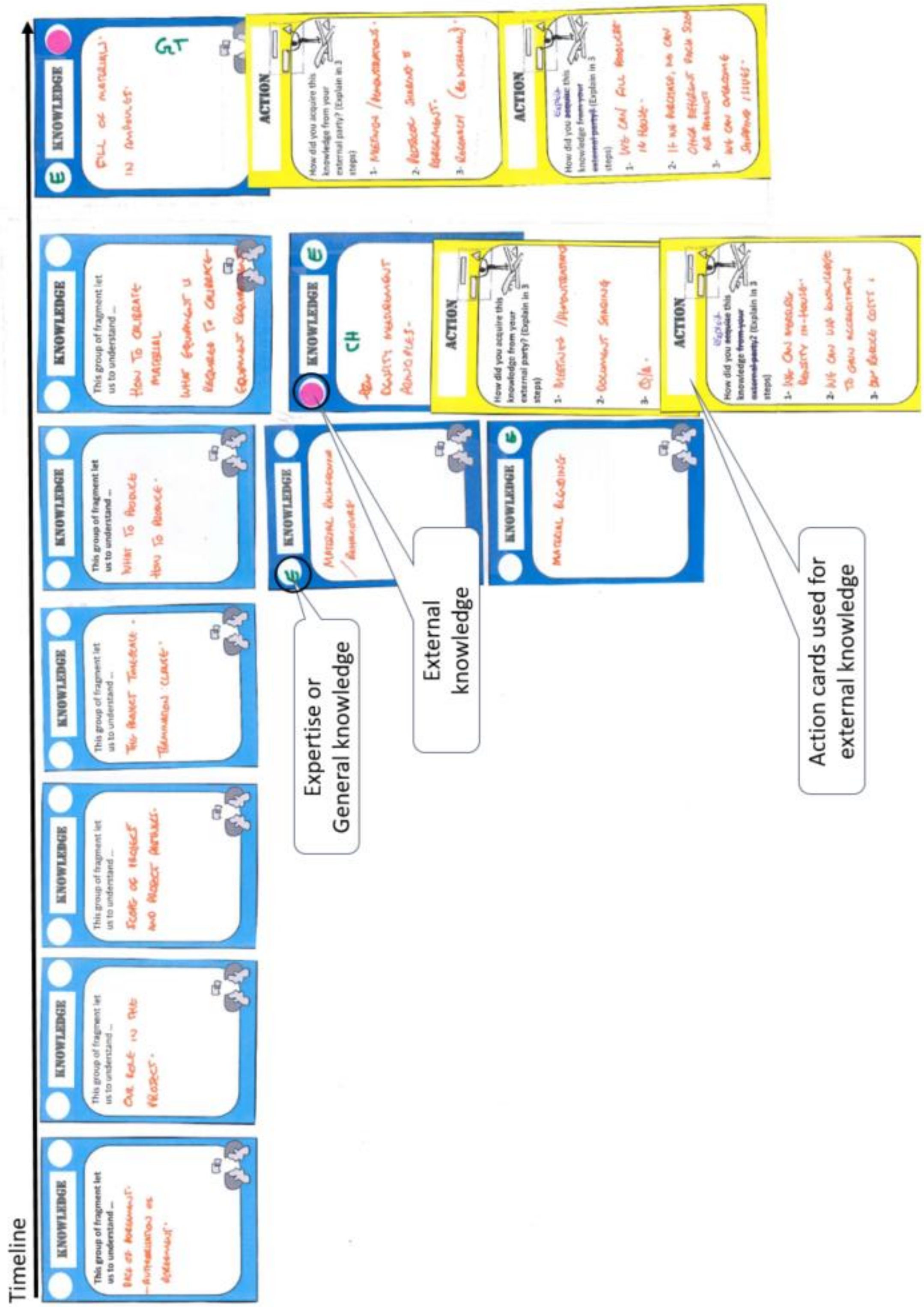
Based on the participants' feedback (Companies Alpha and Beta, in total 7 actors) the fragmentation part was easy to apply by following the instructions and hints. However, grouping and naming the fragments was not very easy for them neither naming the groups: because of cards variation, each participant tended to group based on different type of card (action, understanding or share) while the main objective was grouping based on the Understanding card. Therefore, we could improve the protocol of knowledge mapping by reducing the types of cards and propose the second version of the ISEACAP.

5.3.2.2 ISEACAP V2: Knowledge mapping validation, routines eliciting exploration and co-construction

In order to facilitate the "fragment grouping and naming" steps, we reduced the three cards "Understanding", "Share" and "Action" to only one orange card called "Information". In addition, we provided a blue card called "Knowledge" for naming the groups.

We applied the second version of ISEACAP in two SMEs CSL and PRG located in UK. During these two experimental sessions, we applied principally the second phase of the method (knowledge mapping) and explored and tested potential ideas for the third and fourth phases of ISEACAP. We used the previous "Action" card at the end of the session to ask the participants to explain what action/activity they had performed to acquire, assimilate, transform and exploit external knowledge (as shown in Figure 6-7).

Figure 6-7: ISEACAP V2 - Knowledge map and action cards - PRG case study



The new version of the protocol for knowledge mapping was also validated through these two sessions. The sessions were conducted through the paper format and previewed design (metamodel, graphical notations and map formalism) are validated. We also explored potential ideas during the sessions to develop the tool.

We also collected the participants' ideas and feedbacks for developing the routines eliciting protocol (refers to the use of action cards at the end of the session).

➢ **Gathered feedback from experimental sessions**

The participants of the two companies filled out the validation form presented in Appendix 11. They shared their ideas about the protocol of the method and validated the ease of use of "Information" and "knowledge cards".

However, the action cards used at the end of the session to co-construct ideas for routines eliciting and enriching phases, were not very easy for the participants to fill out. These cards faced the same challenge as "Knowledge form" in the V1, direct and general question about actions which are highly tacit.

Therefore, in the third and the last version of ISEACAP, we removed these cards and applied appropriate techniques to make the phase of routines eliciting more gamified. To this end, we proposed the third/latest version of the ISEACAP method.

5.3.2.3 ISEACAP V3: routines eliciting validation, routines enriching co-construction

Between the second and third versions of ISEACAP, we conducted several brainstorming meetings with researchers involved in other work packages of the ANR-ACIC project. Resulting from these meetings, we developed the routines eliciting and enriching phases and tested them internally among researchers.

Besides, all the phases of the ISEACAP method were also applied in LVB-AGY and at the end of each session the participants' feedback were collected. The knowledge mapping session was validated in terms of protocol and we collected the participants' ideas for improving the online tool. In addition, the protocol of the routines eliciting phase was validated and routines enriching protocol was enriched via observations and collected ideas.

➢ **Gathered feedback from experimental sessions**

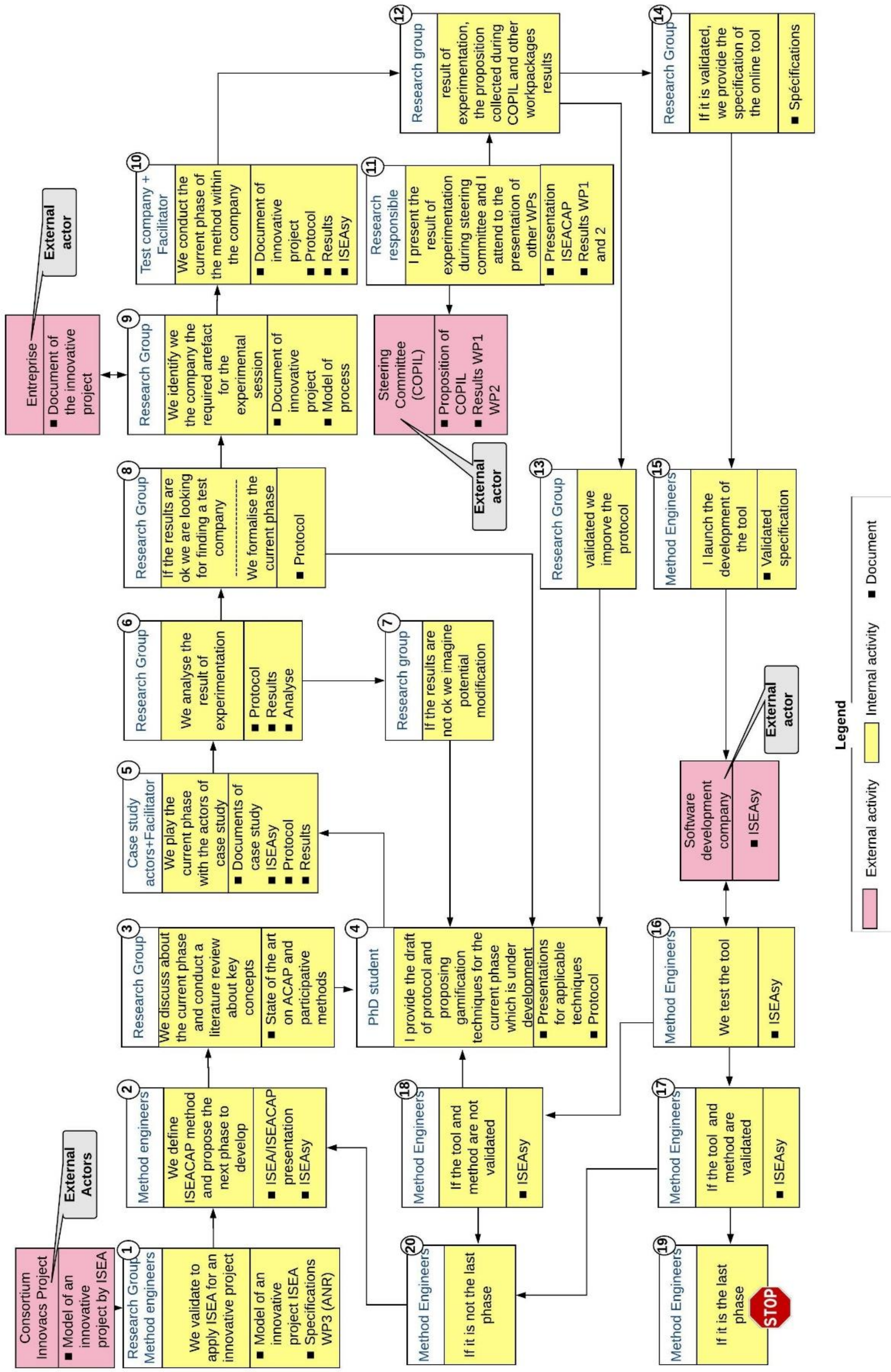
The first experimental sessions in LVB-AGY was dedicated to knowledge mapping and the second for session to routines eliciting and enriching validation. Based on the participants' feedback (3 actors for both sessions), provided instructions via the protocol of routines eliciting were easy to comprehend and follow. However, routines enriching phases required more explanation to be clear for the participants. As one of the participants, discussed that "*it is a very interesting activity and values to be more developed*". The improvement of "routines enriching" is in the perspectives of this PhD.

5.3.2.4 Process of ISEACAP construction at a glance

In Figure 6-8 we provide the process model of the method construction by using the protocol of ISEACAP. In other words, we applied ISEACAP itself to see how it is constructed. We identified all the activities, actors, documents and created knowledge during our research project.

As explained earlier, the method was developed through several brainstorming meetings among researchers from various fields. Thus, we defined two levels of actors in the model, internal and external.

Figure 6-8: Process of ISEACAP construction at a glance



External actors

- Innovacs consortium: The research federation called "Innovacs" had investigated on applying ISEA in the context of innovative projects. As the result of this investigation, ISEA was considered as the starting point of our research project.
- Enterprise: External companies (SMEs) which had been contacted for conducting the experimental sessions in their organisation and developed innovative projects in collaboration with their partners.
- Steering Committee: The meeting including all the partners of the ANR-ACIC where the participants reported on their ongoing work, and we had feedback and knowledge exchange about the project and how it could be run better.
- Software Development Company: The sub-contractor company that developed ISEAsy the online support tool of ISEACAP.

Internal actors

- Research Group (RG) are all the researchers who participated in brainstorming to develop the ISEACAP method including the PhD student. These researchers are from three fields of computer science, management and industrial engineering.
- Method engineer is one of the researchers from computer science or the PhD student.
- The research responsible is the PhD co-director who is the responsible of the work package in the project ACIC project as well.
- Test Company is a sample of a collaborative innovation project in which the researchers from industrial engineering filed collaborated and knew very well the project. For the first test the real actors of the company had participated in the experimental session while for all other tests the two researchers played the role of the actors and accomplished the tests.
- Facilitator is one of the researchers from the research group who conducted the experimental sessions based on the protocol.
- PhD student is a member of research group, who provided propositions based on literature for method evolution, protocol formalisation and improvement.

Process of ISEACAP development

Following the process model, as the starting point, in *activity 1* the ISEA method (which had been developed in LIG laboratory in 2011 for business process modelling and improvement) was applied by an external partner (Innovacs) to model a sample of collaborative innovation project. Based on the results of this application, we decided to launch a new research project.

In *activity 2*, the method engineer defined a new part of the method about enhancing absorptive capacity in innovative projects. The research group presented the general steps of the method and considered process modelling by ISEA as the first step. Based on the formulated steps, the PhD student prepared a protocol for each step of the method (*activity 4*).

To enhance the research, the research group conducted a literature review on absorptive capacity key concepts, participative methods and techniques (*activity 3*).

A case study (named Delta) was presented by the industrial engineering researchers to conduct ISEACAP for modelling the process of their innovative project and having their feedback for improving the method (*activity 5*). Throughout the method development, we used this case study to explore and co-construct it. Afterwards, if the results had been satisfying (*activity 6)* the research group should find an external case study (SMEs embedded in collaborative projects to develop an innovative project) (*activity 9*). If the results from internal case study had not been satisfying, the research group should revise the protocol to improve it (*activity 7*).

The research group had conducted experimental sessions though the method with the identified companies (*activity 10*) and the research responsible presented obtained results to the steering committee (*activity 11 and 12*). Through the feedback analysis from steering committee, the research group could improve the method (*activity 13*). Then the method engineer discussed and provided specification of the support tool for the method (*activity 14*). The specification should be transferred to the external partner (company of software development) to launch the tool development (*activity 15*). The tool was tested by the method engineer (*activity 16*). As the result of the test, if it worked as expected, the method engineer should validate the tool and this part of the method (*activity 17*), and thereby if it was the last phase of the method, the process should be stopped (*activity 19*). However, if the tool or the method had not been validated through the test, thus, the activity 4 should be performed again to improve them.

In addition, if it is not the last phase of the method, the research group must define the next one and the process needs to be applied from the beginning. In the other terms, the process should be iteratively applied until all the phases of the method are developed, tested and validated.

5.4 Protocol of ISEACAP

The ISEACAP method proposes to draw a map of knowledge for highlighting how it was mobilised during the project by focusing on external knowledge. To provide the map we firstly model the process of the innovative project during which the knowledge was mobilised. In order to accomplish these objectives, we defined four phases for the method: (i) process modelling (ii) knowledge mapping (iii) routine eliciting (iv) routine enriching. In the following, we explain the protocol of each phase through the example of our case study LVB-AGY.

5.4.1 Process modelling

For investigating on ACAP during collaborative innovation project, we need firstly to have clear vision on the performed activities and highlight the intervention and contribution of external partners. To this end, the process modelling is defined as the starting point of the ISEACAP method. Avoiding to start from scratch we adapted an existing participative method called ISEA (Front et al., 2015), which had been dedicated to business process elicitation and improvement. We adapted the protocol of ISEA method to conduct the process modelling session.

The process modelling session aims at replaying the process of an innovative project in a participative way while all the key actors of collaborative innovation project play their real role during the project. This modelling session allows participants (actors of the project) to replay and recall their common story along the project.

We modelled the process of LVB-AGY's project by using collected information from the interviews and via ISEAsy tool as shown in Figure 6-10. The model was validated by the named actors in the following.

To model the process, the facilitator must follow the adapted protocol of ISEA method presented in Table 6-2. The actors of the project who explained and validated the process model are the four key internal actors of AGY: The *Innovator*, the *Project manager* from LVB, the *Technical manager* from AGY and the *Cooking expert* from LVB. This session can last around two hours and should be led by one or more facilitator(s) as following:

1. During the **introduction,** the facilitator describes the objectives and the general context through a PowerPoint presentation.

2. The session must be conducted as a round table and **role assignment** since participants play their real role during the project. Each role has a specific colour to facilitate tracing the activities.
3. At the beginning of the session, participants agree on a **scenario** to play and it is enough precised and limited to be simulated during two hours. To this end, facilitator(s) asks participants to identify the most crucial part of the project in terms of innovation.
4. Then through **role playing** each participant assumes his own role in the project. Figure 6-9 is an example of a role playing during a process modelling session via ISEAsy tool. Each participant describes his/her performed activities. Participants take their turn, one after the other, depending on the situation, as occurred during the project. Via yellow post-it, participants highlight their internal actions while via pink post-it external partners can be highlighted.

Figure 6-9: The role-playing game for process modelling - using the ISEAsy tool

The facilitator can be a researcher, a method engineer or a participant (who played beforehand and knows the instruction of the session). The facilitator conducts the session by following the protocol shown in Table 6-2.

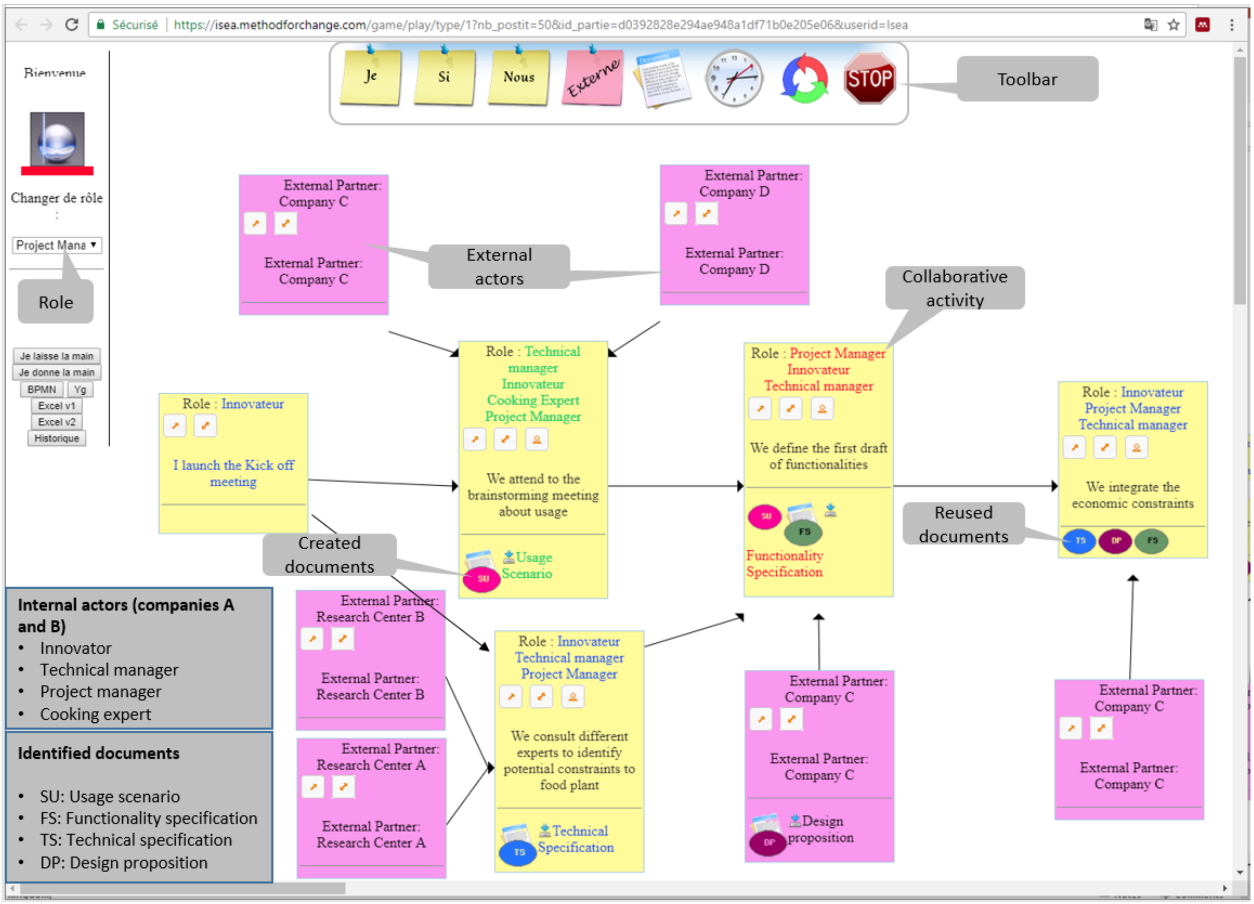
Figure 6-10 shows the model of the innovative project process in LVB-AGY through ISEAsy tool. Six activities are identified from the most important part of the project in terms of innovation. The interactions of the LVB-AGY with their external partners, as well as their internal collaborative activities are highlighted in the model. In addition, the documents created or reused during the process are identified. These documents are the starting point for the knowledge mapping session.

Table 6-2: Process modelling protocol

Activity and Description	C/ I*	Materials and Duration
1. **Introduction:** facilitator (researcher or method engineer) describes the general context of the session through a PowerPoint presentation.	**C**	**PowerPoint** **15 min**
2. **Roundtable and role assignment:** facilitator presents identified roles in the process and assigns each role to the related participant. Generally, each participant plays the same role as in the real life. In the support tool ISEAsy, a role is depicted by a colour. Moreover, the facilitator represents the external actors.	**C**	**ISEAsy tool** **10 min**
3. **Scenario proposal:** scenario is collectively discussed and selected. It must be precised and limited enough to be simulated in less than two hours.	**C**	**Collective discussion** **20 min**
4. **Role-playing:** each participant plays a role and acts out a real-life situation and describes his/her performed activities during the innovative project. Participants take their turn, one after the other, depending on the situation. – A participant places a yellow post-it to represent an activity. Then s/he adds used documents to accomplish this activity. Other participants can further reuse these documents in their activities. If the intervention of an external actor is necessary, a pink post-it is added by the facilitator, where no action is noted on and only documents may be added on.	**C**	**ISEAsy tool** **40 min**

**Collective/Individual*

Figure 6-10: Process modelling via ISEAsy (LVB-AGY process)



Results. Figure 6-10 shows an example of the process modelling result via the ISEAsy tool. Participants identified their performed activities during the most crucial part of the project in terms of innovation. The project starts with the kick-off meeting launched by the innovator. Interactions with external partners are highlighted (e.g. *TS: Technical specification*) as well as created or reused documents (e.g. FS: functionality specification and TS). In addition, two types of activities are distinguished in the model:

- Individual activity: describes what an internal actor performed and starts with "I…" (E.g. *Innovator: I launch the kick-off meeting*).
- Collaborative activity: describes what several actors performed collaboratively and starts with "We…" (E.g. *Technical manager, project manager and Innovator: We consult different experts to identify potential constraints for food plant*)

This starting point allows participants to review their common history of the project and collect important documents. The second experimental session is dedicated to mapping mobilised knowledge throughout the process.

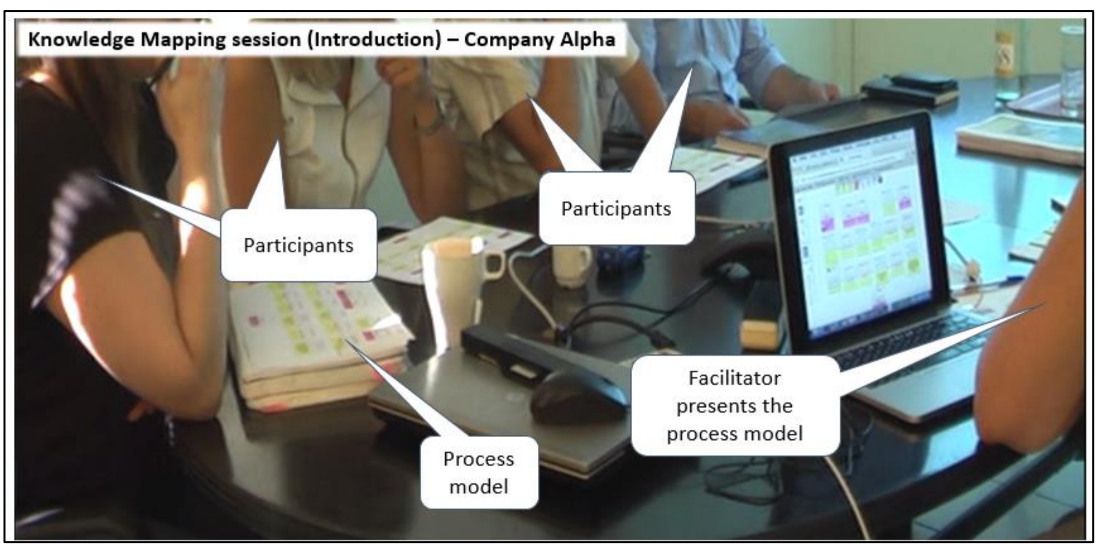
5.4.2 Knowledge mapping

The second phase of ISEACAP aims at (i) mapping mobilised knowledge through the process of the innovative project, (ii) identifying when and where external knowledge is acquired and transformed.

This phase must also be held through a participative session with key actors of project as participants of session around the table. A facilitator who can be a researcher, knowledge engineer or a participant (who knows beforehand the instruction) conducts the session by following the protocol presented in Table 6-3. Participants play the same role as in process modelling session, i.e. their real role in the project.

1. Through the **introduction** as displayed in Figure 6-11, facilitator provides a copy of process model for participants and overviews it with them to (i) recall what they have performed during previous session (ii) collect their validation for the proposed model (iii) choose the most important documents.

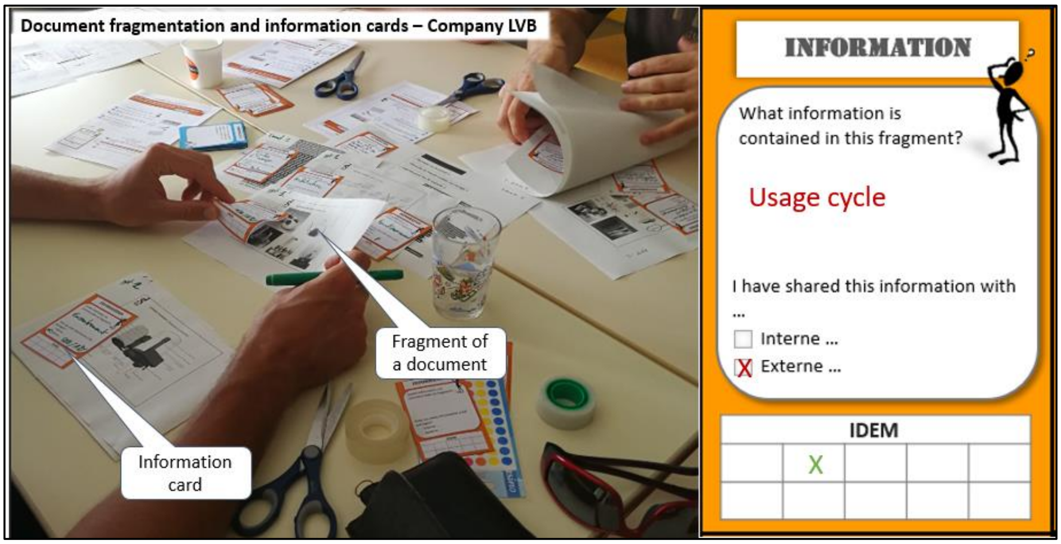
Figure 6-11: Introduction of knowledge mapping session



2. After choosing documents, through the **fragmentation** step, participants start to cut off their important parts called “fragments” and write down contained information of the

fragment on **information cards**. They can add one or several cards to a document fragment. Both steps must be performed individually. Figure 6-12 shows the document fragmentation and information cards. Use of "information cards" is comparable with the "Limited Information tasks" elicitation technique.

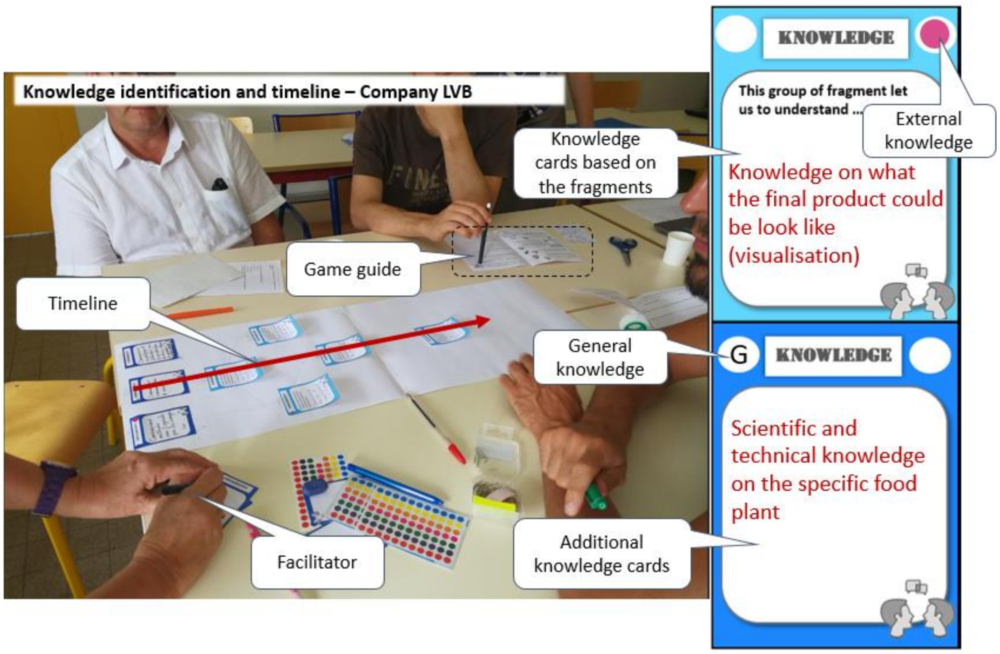
Figure 6-12: Knowledge mapping session - Fragmentation and information card



1. A **collective discussion** allows each participant to describe his/her information cards. Other participants can check the "IDEM" box if they capture the same information from the fragment. The "collective discussion" activity is close to the "commentary" elicitation technique.
2. After collective discussion, participants **group the fragments** based on the proximity of written information on the cards. This step must be performed through a silent brainstorming that means the participants cannot talk together. The fragment grouping relies on "concept sorting" elicitation technique.
3. Through the **knowledge identification**, with the help of facilitator(s) and via "knowledge cards", the participants collectively name each group of fragments to explain what they have understood from the group. The chosen name for the groups are considered as knowledge. For this step, we applied "teach back" technique, as participants discuss what they have perceived from each group of fragments, then facilitator(s) helps them by proposing a relevant name for the group and the participants agree or modify it consensually (see Figure 6-13). Using knowledge cards to insert the selected names for the groups is comparable with the "repertory grid" elicitation technique.

4. When all the fragments are grouped and named, participants must arrange the knowledge cards on a **timeline** based on the chronological order (see Figure 6-13). In this step, participants may remember mobilised knowledge, which is not mentioned in the documents. Thereby, they can add new knowledge with dark blue cards as shown in Figure 6-13.

Figure 6-13: Knowledge mapping phase- Knowledge identification, characterisation and timeline steps



5. After arranging all the knowledge cards on the time line, participants **characterise** their knowledge to highlight external with pink stickers and general that can be applied in other projects with 'G'. For instance as shown in Figure 6-13, "*Scientific and technical knowledge on the specific food plant*" is not identified from the documents and represents general knowledge of internal actors. In the contrary, the "*knowledge on what the final product could be look like*" is identified from documents and mobilised by an external actor to the project.
6. The last step is **transformation identification** where facilitator(s) helps participants make connections between knowledge cards with arrows. Two different arrows are used to show knowledge mobilisation or transformation (dotted arrows for knowledge mobilisation and simple arrows for knowledge transformation). Specific knowledge can be transformed via the mobilisation of the general-internal/ general-external/specific-external knowledge.

Based on the identified transformation, we focus on the conjunctions where there is a branch of external knowledge. Table 6-3 summarises the protocol of knowledge mapping session.

Table 6-3: Knowledge mapping protocol

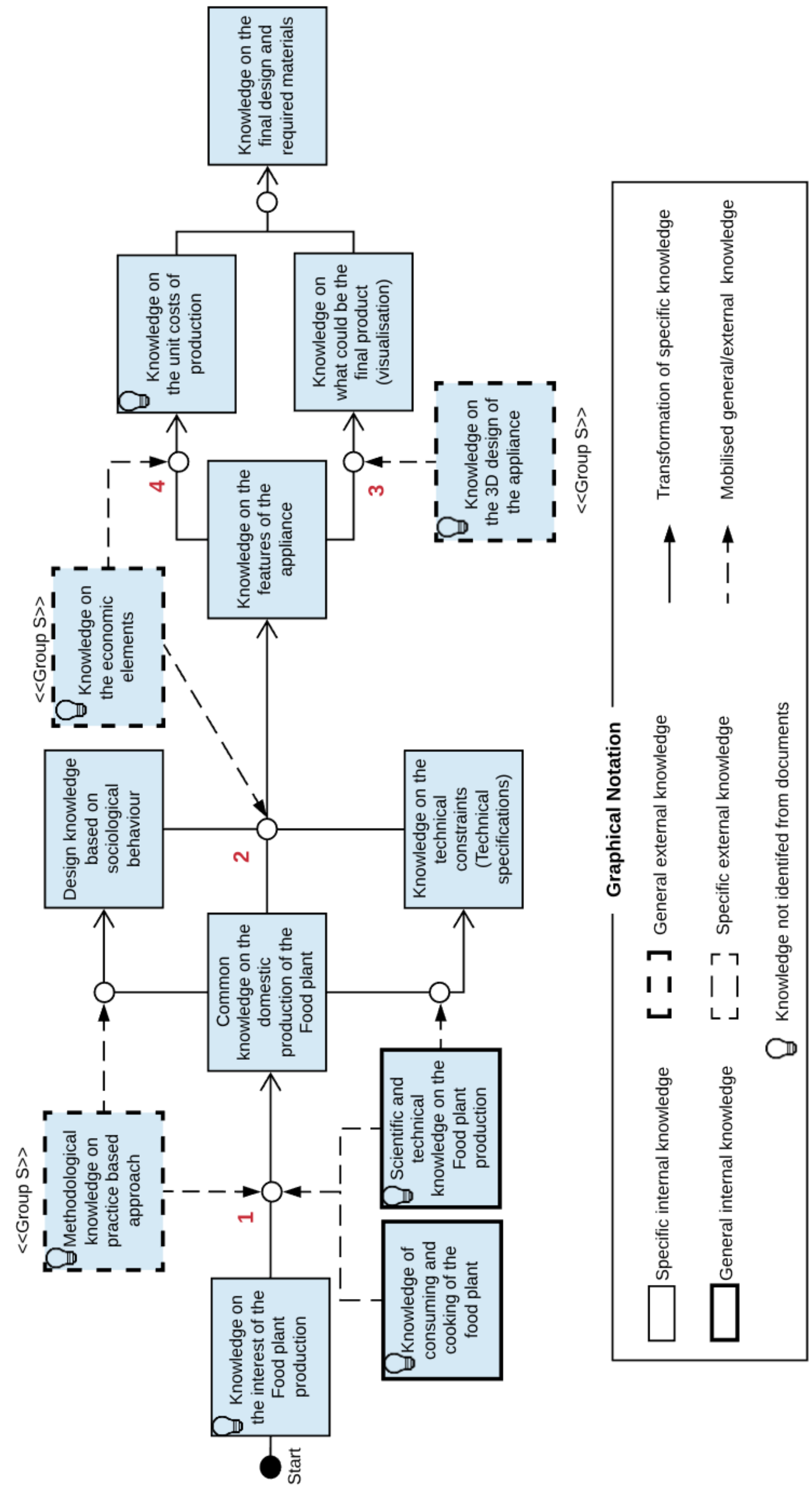
Activity and Description	C/ I*	Materials and Duration
Introduction: facilitator(s) begins the session with an overview of the process model provided in the process modelling phase. All participants re-enact the same role as real situation.	C	Process model 15 min
Document fragmentation: each actor selects the documents that seem important for enhancing innovation along the project. – The participant must cut off at least five pieces (fragments) from the selected documents by answering to following question: "*what are the most valuable parts of the document for innovation and progress of the project?*"	I	Hard copy of documents Scissors 10 min
Information elicitation by information cards: participants describe "*what information is contained in the fragment?*" and associate it with the fragment. – The participant must fill out at least one "information card" for each fragment	I	Information cards Colour pens 15 min
Collective discussion: each participant describes what s/he has written on his/her cards. – Other participants can add new information cards to explain if the fragment contains other information for them.	C	15 min
Fragment grouping: participants group all the fragments based on the proximity of the contained information by answering the following question: "*which fragments are close in terms of contained information?*" – This activity must be done through a silent brainstorming.	C	Silent brainstorming Fragments 5 min
Knowledge identification by knowledge cards: during a collective discussion with the help of facilitator(s), participants fill out "knowledge cards" by answering the following question: "*what did you understand from that group of fragments*?" – The knowledge card must be filled out with a short phrase	C	Knowledge cards 15 min
Identification of knowledge chronology (timeline): participants arrange their knowledge cards based on chronological order.	C	A3 paper 5 min

Activity and Description	C/ I*	Materials and Duration
– Participants can add new knowledge cards (dark blue) by answering this question: "*Is there other knowledge or expertise that you used or acquired during the project which is not mentioned on these knowledge cards?*"		
Knowledge characterisation: participants characterise knowledge collectively. – External knowledge should be highlighted by "pink" stickers – General knowledge by "G" – Specific knowledge to the project should be arranged on the main axe of timeline and general/external knowledge outside of the time line based on the chronological order.	C	Colour stickers 10 min
Transformation identification: participants with the help of facilitator make connection between knowledge. – General and external knowledge mobilised in the project are highlighted with dotted arrows. – Specific knowledge transformed during the project is highlighted with simple arrows.	C	Colour pen 10 min

**Collective/Individual*

Results. Figure 6-14 shows the output of knowledge mapping session in AGY-LVB. As the map shows, sources and application of knowledge are identified based on internal/external and general/specific to the project. For instance "*Methodological knowledge on practices based approaches*" is mobilised during the project via external partners is considered as a general one. The identified external knowledge is the starting point for the next phase where the method helps the participants in highlighting their performed routines/practices to acquire, assimilate, transform and exploit it.

Figure 6-14: Output of knowledge mapping session in LVB-AGY

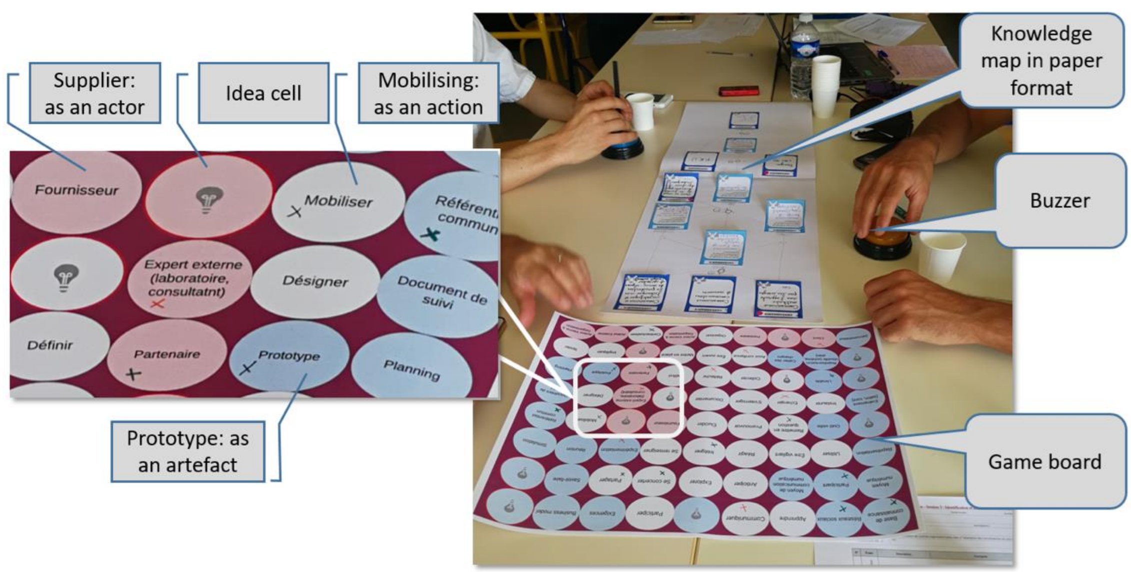


5.4.3 Routines eliciting

The third phase of ISEACAP focuses on applied practices/routines to acquire and transform the knowledge during the collaborative innovation project. As routines are highly rooted in actors' actions, we integrated elicitation and gamification techniques to develop the steps of this phase. Facilitator(s) follows the protocol shown in Table 6-4 and conducts the session based on the following activities:

1. **Introduction**: to start the session, facilitator brings the map of knowledge produced in previous phase and participants focus on the transformation nodes. For instance, in the knowledge map shown in Figure 6-14, four transformation nodes are highlighted. All these nodes have at least a branch of external knowledge.
2. **Storytelling**: the participants explain what was happened on the highlighted nodes in the knowledge map through the storytelling. To facilitate this activity, we provided a "game board" shown in Figure 6-15. The "game board" is based on four different cells: Verbs, Artefacts, Actors and Idea. These cells are proposed to inspire the participants and help them in remembering what they have performed for acquiring, assimilating, and exploiting the external knowledge. However, "Idea" provides free cells for participants to add their own word. When a participant finishes the story, s/he should mark the used cell on the game board.

Figure 6-15: Routines eliciting session - Game board and storytelling



Participants can use the buzzer to take the turn and complete others' stories, and put a cross mark on the used cell of the game board. At the end the participant summarises the story in a short phrase and in parallel, facilitator inserts that in an Excel table (see Figure 6-16). This table will be used for practices characterisation. In addition, facilitator counts the scores of the participants as following:

- 3 points: The participant chooses an existing cell on the game board that it is not yet used
- 2 points: The participant adds a new word
- 1 point: The participant chooses an already used word

The scoring does not aim to launch a competition between the actors of the same company, but on the contrary, it is the team's score. Facilitator adds the score of all the participants and at the end of session gives them their ranking comparing to other organisations.

Figure 6-16: Routines eliciting session - Snapshot from Excel table filled out by facilitator

8	Node Number	Actor's initial	Organisation's Practices	Done/not done	Satisifaction/ insatisfaction	Individually/ collectively	Sytematic/ emerging	Shared/not shared
9	1	AB	Valuing the knowledge base of different partners in a Mind Map	Done	Satisfaction	Collectively	Emerging	Shared
10	1	PG	An external expert from Company C guide us to work on "usage scenario"- Common vision on usage and functionality.	Done	Satisfaction	Collectively	Emerging	Shared
11	1	GG	Sharing and adapting knowledge among partners	Done	Satisfaction	Collectively	Systematic	Shared
12	1	PG	Visualised representation enhanced the reflexivity and raised the ideas	Done	Satisfaction	Collectively	Emerging	Shared
13	2	AB	The common referential common allowed partners to work in parallel to develop the project.	Done	Satisfaction	Collectively	Systematic	Shared

3. **Characterisation**: after storytelling, facilitator reads for participants the collected phrases in the Excel table to have their validation. Each phrase represents a routine or practices. Then, participants characterise each phrase by answering the following questions:
   - Is the practice carried out during the project or should it have been carried out?
   - Are you satisfied with the performed practices?
   - Was the practice performed collectively or individually?
   - Is the practice shared with other actors?
   - Is the practice performed systematically or emerging within the organisation? Here if the answer is systematically, the practice is already routinized and can be considered as a *routine*.

In this phase, we applied gamification techniques to highlight practices and routines that are hardly explicable in normal situation. To this end and to encourage participants, we used the game board, role playing, scoring techniques and buzzers to stimulate actors to complete the story and explain their practices and routines in details. Table 6-4 summarises the protocol of the routines eliciting phase.

Table 6-4: Routines eliciting protocol

Activity and Description	C/ I*	Materials and Duration
Introduction: Facilitator brings the knowledge map resulted from previous session and explains that participants should focus on the transformation circles where the external knowledge is applied, to illustrate what was performed to acquire, transform and exploit external knowledge.	C	Knowledge map 15 min

Storytelling: Participants tell concrete stories of what happened or should have happened in the transformation points and how external knowledge was acquired, transformed and exploited.
– First participant chooses a cell from the game board:
    o Verbs: represent the actions
    o Artefacts: represent tools, documents etc.
    o Actors: represent internal or external actors or experts.
    o Idea cells: when participants cannot find words to use on the game board, they can propose new cells.
– Tells a story in one minute and synthesises it in a phrase: "Tell a story of what happened or should have happened in this node?"
– After each phrase, the participant marks the used cells on the game board.
Facilitator inserts the phrase in an Excel table and counts the scores
    o 3 points: new cell
    o 2 points: idea cell
    o 1 point: used cell
– If one of the participants wants to continue the story but it is not his/her turn, s/he can push the buzzer (game rule: a participant cannot push the buzzer more than twice on a same story).
	C	Buzzer
		Game board
		Excel table
		Colour pen
		40 minutes

Practice characterisation: participants are invited to characterise their identified practices/routines during the storytelling.
– Participants precise for each practice/routine if it is:
    o Applied/not applied
    o Satisfactory/unsatisfactory
    o Individual/collective
    o Systematic/emergent: means if the practice is performed regularly or only once during the project.
    o Shared/not shared: means if the practice and its result are shared with other actors of the project and organisation
	C	Excel table
		10 minutes

**Collective/Individual*

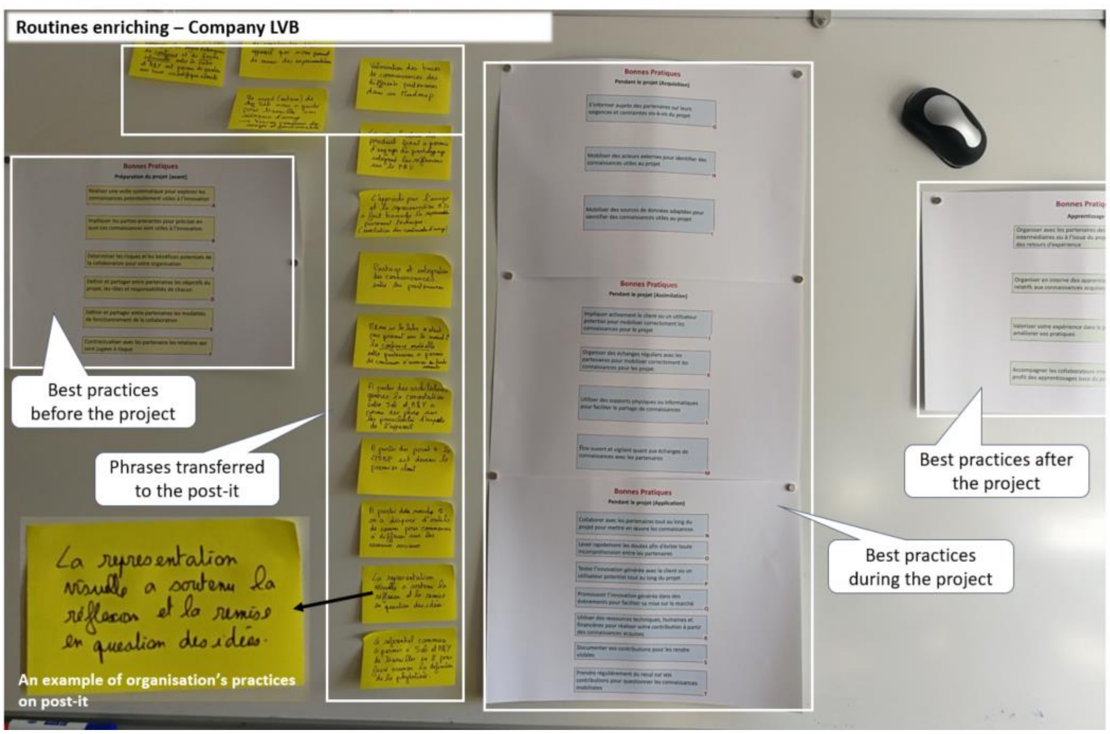
Results. This phase results a list of elicited routines/practices with their characteristics as shown in Figure 6-16. This list plays the role of starting point for routines enriching phase.

5.4.4 Routines enriching

Routine enriching phase aims to enrich elicited routines by comparing them with best practices of knowledge absorption and provides a reflexive space for participants to think about how they can improve them. Routines eliciting and enriching phases can be conducted in the same session with the same participants and facilitators through the following activities:

1. **Introduction:** the starting point of this phase is the list of elicited routines and practices filled out during the routines enriching phase. In the paper format, all the phrases are transferred on yellow post-its and stuck on a board as shown in Figure 6-17.

Figure 6-17: Routines enriching - Introduction



2. **Clustering**: three packages of the best practices are extracted from literature by (Banhayoun Sadafiyine, Le Dain, Prudhomme, & Dominguez-Péry, 2017). The authors are the research team of one of the ANR-ACIC work packages (Work package 2). The WP2 researchers identified about 120 best practices of knowledge absorption resulting from their literature review and an empirical study. We conducted three brainstorming with

them to adapt and summarise these 120 best practices into 26 practices and organise them in three packages as presented in Table 6-5:

- Package 1: Preparation practices applied *before the project*.
- Package 2: this package contains three sub-packages:
  - Acquisition practices: practices applied *during the project to acquire* external knowledge.
  - Assimilation practices: practices applied *during the project to assimilate* acquired knowledge.
  - Application practices: practices applied *during the project to apply* external assimilated knowledge.
- Package 3: practices that actors have learned from this project and can apply *after the project* in their future projects.

Table 6-5: Best practices packages

Package	Practices
Preparation (before the project)	▪ Carrying out a systematic monitoring ahead of the project ▪ Determining relevant and important acquired knowledge with participating organisations. (including client) ▪ Determining potential benefits and risks for the organisation ▪ Defining the goals of the project, partners' roles and responsibilities and share them with partners ▪ Defining and sharing the collaboration modality (tasks coordination, deliverables and resources allocation) ▪ Introducing contractual relations between participating organisations

Package	Practices
During the project	**Acquisition** ▪ Consulting via partners about their requirements and constraints regarding to the project ▪ Consulting via external actors (clients, experts) to obtain external knowledge related to the project ▪ Mobilising the external knowledge resources such as conferences, databases, social networks etc. to the project **Assimilation** ▪ Involving actively the clients or potential users to integrate relevant knowledge to the project ▪ Organising the exchanges with partners to integrate relevant knowledge to the project ▪ Facilitating knowledge sharing during the project, through intermediate objects and computer resources ▪ Be open and vigilant during knowledge exchange with participating organisations **Application** ▪ Cooperating with participating organisations if it is required ▪ Testing innovation with client or potential users during the project ▪ Promoting innovation that is generated during events ▪ Using adapted resources to the contribution (technical, human, financial) ▪ Formalising contributions ▪ Raising doubts to avoid any misunderstanding among partners ▪ Stepping back from the details of contribution to improve the performance
Learning (After the project)	▪ Organising steering meetings to collect return of experiences ▪ Set up continuous learning during the project ▪ Exchanging internally about relevant acquired knowledge during the project ▪ Enhancing gained experiences during the project for improving your practices ▪ Encouraging active involvement of internal actors to leverage learning from the project ▪ Encouraging the openness on the environment among internal actors

Facilitator(s) explains these packages and allows participants to read them by themselves as well. Then participants place their identified practices collectively on a relevant package. This step must be performed through a silent brainstorming as shown in Figure 6-18.

Figure 6-18: Routines enriching - Clustering through silent brainstorming

3. **Associating**: After participants clustered their practices, facilitator starts to read the best practices (extracted from literature) and identified practices to make associations between them by asking the participants (Figure 6-19). If one of the identified practices is not related to any of the best practices, the facilitator makes a new group for this practice. Throughout the associating activity, participants might remember new practices/routines that they applied and did not identified during the storytelling. They can add these practices/routines via pink-post its. During this step, facilitator(s) plays an imperative role to encourage participants to get a consensual result.
4. **Evaluating**: after associating identified practices/routines to the best practices, facilitator asks participants about best practices which have not been applied during the current project and if they can be evaluated as important for future projects. This activity aims to raise the reflexivity among the participants and stimulate them to think about the potential practices to be enriched and routinized in their organisation.

The routine enriching phase lasts one hour. Table 6-6 presents the protocol of ISEACAP for *Routine Enriching* phase.

Figure 6-19: Routines enriching - Practice association

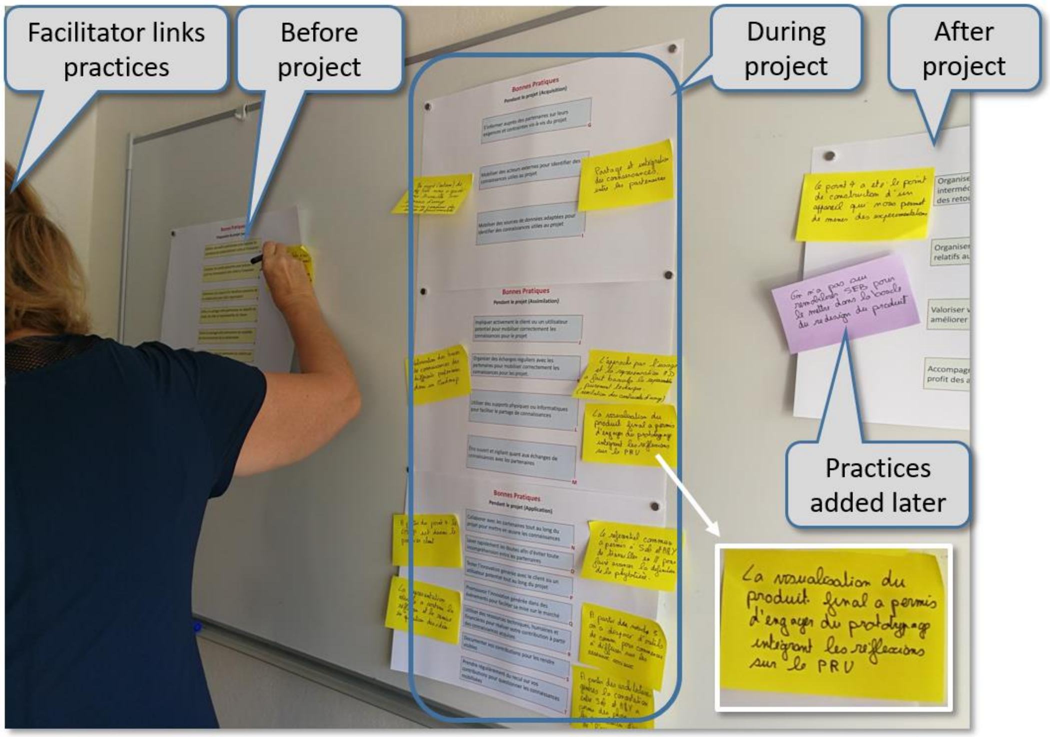


Table 6-6: Routines enriching protocol

Activity and Description	C/ I*	Materials and Duration
Introduction: the facilitator insert the identified practices (phrases from the Excel table) to the post-it and stick them on a board beside the three packages of best practices. Then explain the packages for the participants.	C	Yellow post-it 5 min
Clustering: Participants read the packages and place their post-its through a silent brainstorming in the relevant package. – Participants put the yellow post-its in the relevant package without talking. – Participants can replace others' post-its.	I	Three packages of best practices 10 min
Associating: facilitator reviews each package with participants and replaces post-its if required and then asks participants for each post-it "To which best practice, your identified practice is associated to?" facilitator links the identified practice and the chosen best practice. – If participants remember practices that they did not mentioned during the storytelling, they can add it on pink post-it.	C	Pink post-it Colour pen 10 minutes

Activity and Description	C/ I*	Materials and Duration
Evaluating: Participant evaluate the importance of identified practices and best practices which are not applied by considering their application in their future projects. – Facilitator asks for all the identified practices and best practices "Is this practice crucial and applicable in the future projects – The facilitator raises the collective discussion between the participants by "how it could be integrated in the future projects?"	C	Colour stickers 10 minutes

**Collective/Individual*

Results. The output of this session is a comparison table between applied ACAP's practices/routines during the project and best practices from the literature. Table 6-7 shows the result of the conducted session in LVB-AGY Company. The table allows the participants to compare their practices with the best practices at a glance and reflect about them based on their characteristics and their importance.

Table 6-7: Result of routines eliciting and enriching

Package	Best practices from the literature	Identified practices from the project	Characterising and evaluation
Package 1: before project Preparation	– Carrying out a systematic monitoring ahead of the project	-	– Not applied – **Important**
	– Determining relevant and important acquired knowledge with participating organisations. (including client)	– Even if the lab did not participate in this node, the mutual trust between partners allowed to continue to progress in serenity	– Applied – Collective – Satisfied – Emerging – Shared
	– Determining potential benefits and risks for the organisation.	-	– Not applied
	– Defining the goals of the project, partners' roles and responsibilities and share them with partners.	– Save time via consortium template and its prepared by financiers	– Applied – Collective – Satisfied – Emerging – Shared
	– Defining and sharing the collaboration modality (tasks coordination, deliverables and resources allocation).	-	– Not applied – **Important**
	– Introducing contractual relations between participating organisations	– Run a strategic committee whenever there is a valorisation question	– Applied – Collective – Systematic – Shared

Package	Best practices from the literature	Identified practices from the project	Characterising and evaluation
Package 2: During project Acquisition	– Consulting via partners about their requirements and constraints regarding to the project.	-	– Not applied – **Important**
	– Consulting via external actors (clients, experts) to obtain external knowledge related to the project.	– An external expert from guide us to work on "usage scenario"- Common vision on usage and functionality. – Sharing and adapting knowledge among partners	– Applied – Collective – Satisfied – Emerging – Shared
	– Mobilising the external knowledge resources such as conferences, databases, social networks etc. to the project.	-	– Not applied – **Important**
Package 2: During project Assimilation	– Involving actively the clients or potential users to integrate relevant knowledge to the project	– When we are blocking during the project and we cannot progress, we should call an external expert to see the things differently and solve the problem.	– Applied – Collective – Satisfied – Emerging – Shared
	– Organising exchanges with partners to integrate relevant knowledge to the project.	– We obtained our first results with an external actor to collect ideas for improving the method. – Encouraging exchanges between the different members of the group made it possible to better define the concepts – The first experimental session allows to understand better the interest of involving in the project.	– Applied – Collective – Satisfied – Emerging – Shared
	– Facilitating knowledge sharing during the project, through intermediate objects and computer resources.	-	– Not applied – **Important**
	– Be open and vigilant during knowledge exchange with participating organisations.	-	– Not applied – **Important**
Package 2: During project Application	– Cooperating with participating organisations if it is required.	– Group S brought us its experience in conducting a collaborative project	– Applied – Collective – Satisfied – Emerging – Shared
	– Testing innovation with client or potential users during the project.	– One of the partners (the research centre) plays the client role	– Applied – Collective – Satisfied – Emerging – Shared
	– Promoting innovation that is generated during events.	– Using communication tools for diffusing on social networks	– Applied – Collective – Satisfied – Systematic – Shared

Package	Best practices from the literature	Identified practices from the project	Characterising and evaluation
	– Using adapted resources to the contribution (technical, human, financial)	-	– Not applied
	– Formalising contributions	– Documenting contributions facilitated the reflection and called them into question	– Applied – Collective – Satisfied – Emerging – Shared
	– Raising doubts to avoid any misunderstanding among partners.	-	– Not applied
	– Stepping back from the details of contribution to improve the performance.	– Documenting contributions facilitated the reflection and called them into question – From the generated architectures, the consultation between Group S and AGY allowed choices on the possibilities of appearance of the device	– Applied – Collective – Satisfied – Emerging – Shared
Package 3: Learning from the project	– Organising steering meetings to collect experiences feedback.	– The device construction step and it allowed us to conduct experimentations. – We didn't know to remobilise Group S and put them in the loop of device redesign	– Applied – Collective – Satisfied – Emerging – Shared
	– Set up continuous learning during the project.	– Even if the lab did not participate, the information was exchanged continuously and informally between the lab and company A. It allowed to hold a correct scientific basis for the chosen solution.	– Applied – Collective – Satisfied – Emerging – Shared
	– Exchanging internally about relevant acquired knowledge during the project.	-	– Not applied – **Important**
	– Enhancing gained experiences during the project for improving your practices.	– The internal resources of an engineering school have not been well used to contribute students and teachers to develop and improve the device	– Not applied – **Important**
	– Encouraging active involvement of internal actors to leverage learning from the project.	-	– Not applied – **Important**
	– Encouraging the openness on the environment among internal actors.	-	– Not applied – **Important**

The last phase allows participants to reflect collectively on their practices and find alternatives to improve their organisational routines. This improvement can be achieved by replaying the same process considering "if" they performed "not-applied" routines that "should be applied", or by integrating enriched routines in their future projects and how they would apply them. It also can be considered "if" they apply systematically their emerging practices, or in other words, if they can routinize their identified practices.

In the following, we present the formalisation of the ISEACAP method through the map formalism, abstract syntax (metamodel) and concrete syntax (graphical notation).

5.5 Method formalisation

We formalised the ISEACAP through intentional map representation for the process of the method, a metamodel and a graphical notation.

The general map of ISEACAP was presented in section 5.2 with three main types of strategies: Analyse, Diagnostic and Amelioration. This PhD focuses on "Analyse" via proposing the process modelling and knowledge mapping and routines eliciting phases. Also the "Diagnostic" can be applied through the routines enriching.

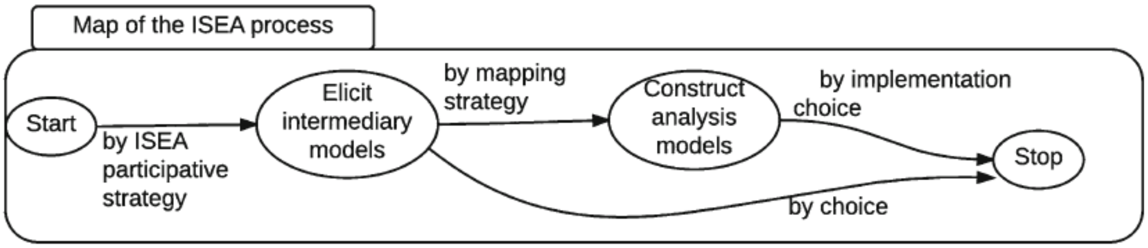
In the following we explain the formalisation of each phase through a map, a metamodel and a graphical notation. The graphical notation is defined through a set of symbols to provide a common visual representation for different components of the method.

5.5.1 Map and metamodel of process modelling

5.5.1.1 Map of the section <*Start, as-is, by process modelling strategy*>

The process modelling map is adapted from the ISEA method presented by Front et *al.* (2015). The ISEA process map consists of two intentions (i) elicit intermediary models to propose a business process model produced by organisation's actors (ii) construct analysis models to transform the intermediary models to standard models like BPMN. This PhD adapts "by ISEA participative strategy" and then continues to the Stop "by choice" strategy. The ISEA participative strategy represents all the participative and playful activities realised by the functional actors to obtain, evaluate and improve the intermediary business process models (Front et al., 2015).

Figure 6-20: Map of the ISEA process adapted from (Front et al., 2015)



5.5.1.2 Metamodel of process modelling

The metamodel of the process modelling is also adapted from the organisational perspective of ISEA method proposed by Front et al. (2015). Figure 6-21 displays the metamodel of process representation.

Figure 6-21: Metamodel of ISEACAP - Process Representation

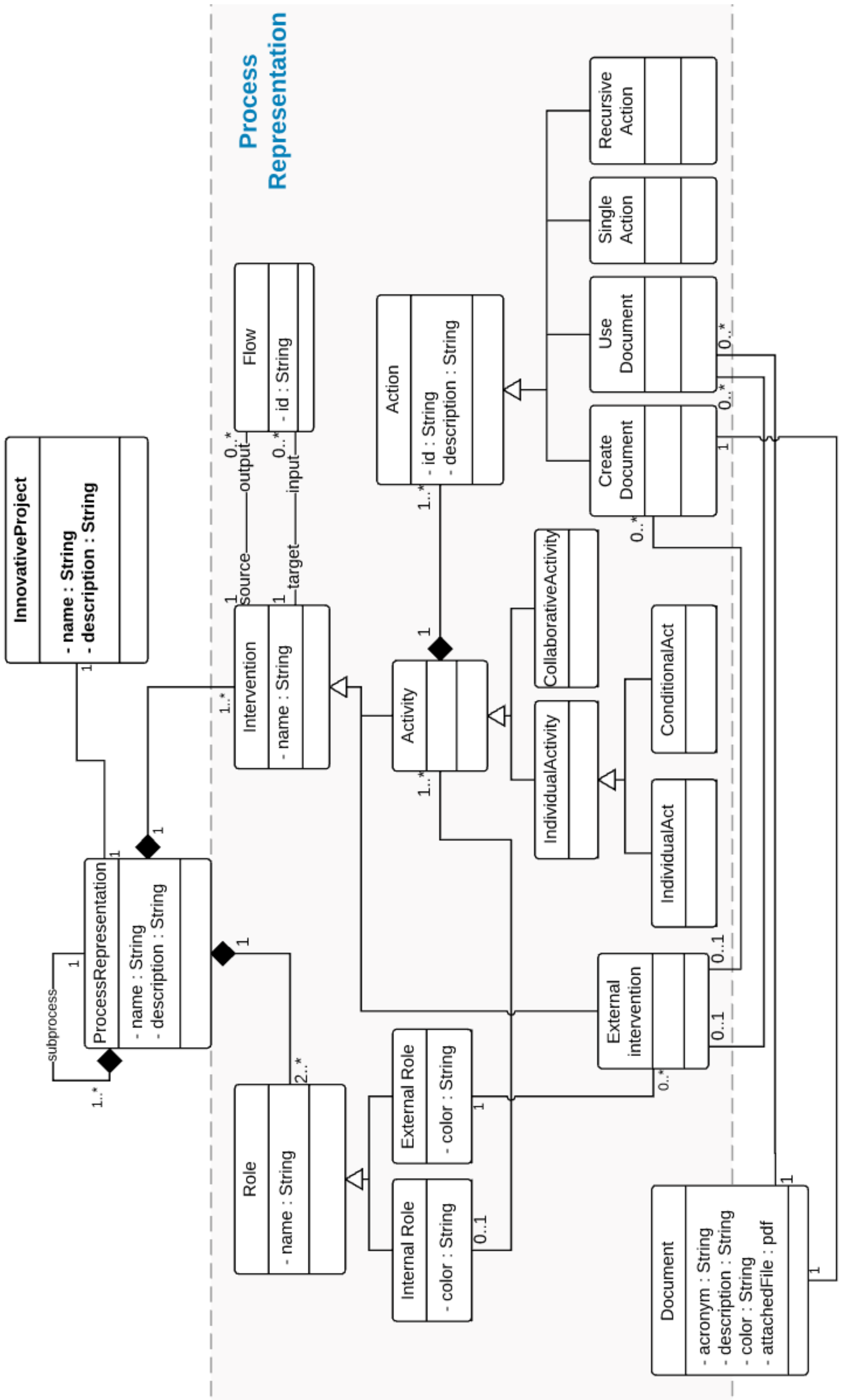


Table 6-8 presents classes of the process representation by describing each one and detaining the associations and attributes.

Table 6-8: ISEACAP metamodel – details of process representation package

Class	Details
Intervention	*Description*: the process representation contains one or several interventions of project's actors. • *Association*: – An intervention can be either internal or external. • *Attribute:* – Name(string):name of the intervention
Role	*Description:* played role by actor during project. It refers to his/her real role. • *Association*: – Actors who are around the table play internal role. – Project's partner(s) who has no representative around the table play external roles. • *Attribute:* – Name(string): name of the role
Activity	*Description*: performed activities during the project. • *Association*: – An internal actor can perform one or several activities. – An activity can be individual or collective. – An activity is composed of one or several actions. • *Attribute:* – Description(string): description of the activity provided by actor(s)
Individual activity	*Description*: an activity performed by an internal actor. • *Association:* – An individual activity can be conditional and start with "if", or not. • *Attribute:* – Id(string): identification of the activity
Collaborative activity	*Description*: an activity performed collectively by several internal roles • *Attribute:* – Id(string): identification of the activity
Action	*Description*: an activity is composed of several actions of different types : – create document : to create a new document – reuse document : to reuse an existing document – single action starting with "I…" – recursive action: a single action that can be repeated... • *Attribute:* – Id(string): identification of the activity
External intervention	*Description:* intervention of an external role (e.g. a partner) • *Association:* – An external role can make any or several interventions. – An external intervention can create or reuse zero or several documents. • *Attribute:* – Id(string): identification of the activity
Documents	*Description:* documents created or reused during the project towards the actions "Create document" and "Reuse document" • *Association:*

Class	Details
	– A document can be created once and reused any or several times • *Attribute:* – Acronym(string): the acronym of the document which is usually based on its name – Description(string): the description of a document – Colour(string): a specific colour for each document – AttachedFile(string): the PDF of the document uploaded and attached to the activity

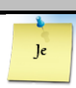
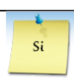
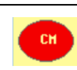
5.5.1.3 Graphical notation for process modelling

The graphical notation for process modelling is adapted from the ISEA method as following:

- **Yellow post-it**: represents the internal activities: "I…" for individual activities performed by an internal role, "We…" for collaborative activities and "If…" for conditional activities.
- **Pink post-it**: represents the intervention of external actors/partners during the project.
- **Doc:** represents the created or reused documents during the project.
- **Two-way arrow:** represents the recursive interaction between two internal activities or an internal activity with an external intervention.
- **Simple arrow:** represents a sequential interaction.
- **Stop**: represents the end of the process when the process model is completed.

Table 6-9 summarises the presented graphical notation for process modelling.

Table 6-9: Graphical notation - Process modelling

Representation	Component	Representation	Component
	Individual internal activity		Documents
	External intervention		Created document
	Conditional internal activity		Reused document
	Collaborative internal activity		Recursive interaction
	End of the process		Single interaction

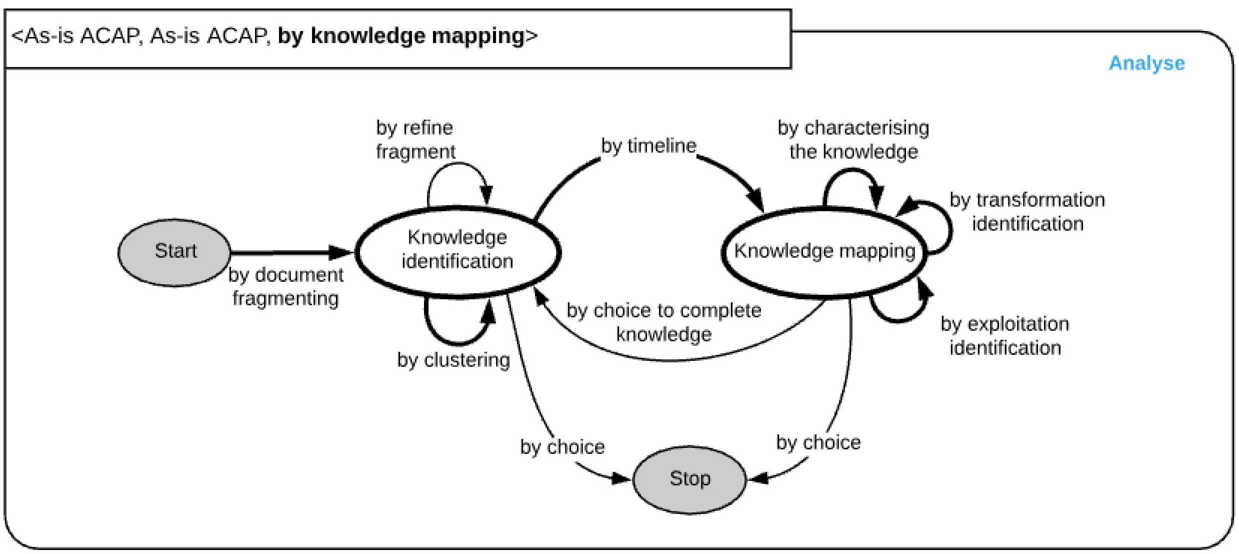
According to this graphical notation, the process model of LVB-AGY Company is presented in Figure 6-10 of section 5.4.1.

5.5.2 Map and metamodel of knowledge mapping

5.5.2.1 Map of the section <As-is ACAP, as-is ACAP, by *knowledge mapping strategy*>

The process of knowledge mapping phase is formalised through the intentional map shown in Figure 6-22. This map consists of two intentions and several strategies to realise these intentions. The “knowledge identification” intention aims at identifying applied knowledge during a collaborative innovation project by starting from the documents. The “knowledge mapping” intention aims at arranging identified knowledge and track the knowledge mobilisation and transformation happened throughout the project. In this dissertation, we explain only the realised strategies during the PhD that are bolded in Figure 6-22.

Figure 6-22: Intentional Map of knowledge mapping phase



a) *<Start, knowledge identification, **by document fragmenting**>*

This section represents all the steps of the protocol through which participants highlight important parts of created or reused documents during the project and bring out contained information of fragments. Referring to the presented protocol in section 5.4.2, this strategy consists of “document fragmentation”, “information cards” and “collective discussion”.

b) *< knowledge identification, knowledge identification, **by clustering**>*

In this section, participants gather information cards based on the proximity of contained information. The clustering strategy consists of “fragment grouping” and “knowledge cards”.

c) < knowledge identification, knowledge mapping, ***by timeline***>

This section is mainly collective and based on participative techniques to arrange groups of fragments based on their chronological order (time line and concept mapping techniques). This strategy is introduced as “identification of knowledge chronology” in the protocol.

d) < knowledge mapping, knowledge mapping, ***by characterising knowledge***>

This section is about knowledge characterisation in a participatory way. Through the applied strategy, knowledge must be characterised according to its application (general vs. specific) and origin (internal vs. external). This strategy is named “knowledge characterisation” in the protocol.

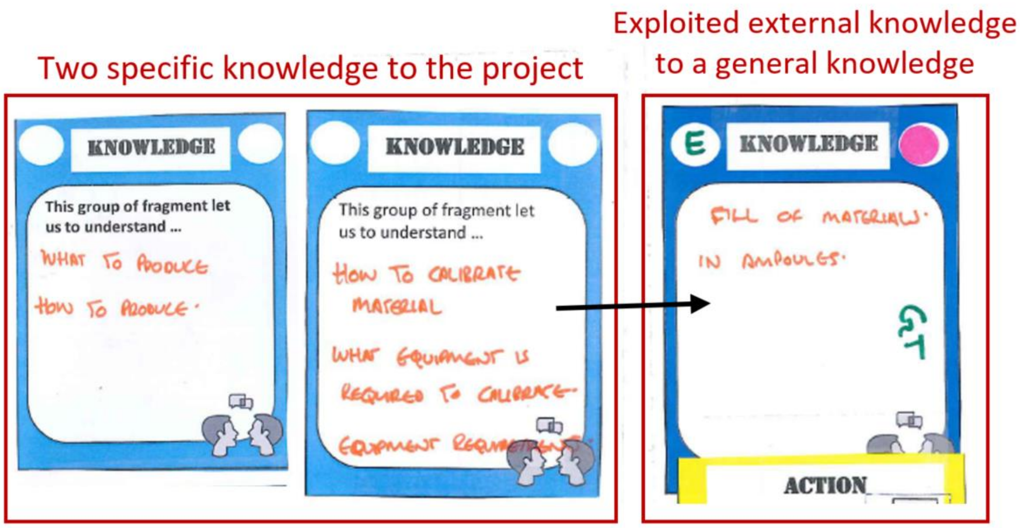
e) < knowledge mapping, knowledge mapping, ***by transformation identification***>

In order to make connection between knowledge cards, *‘mobilisation’* refers to external and general knowledge, while *‘transformation’* refers to specific knowledge. Both mobilisation and transformation are included in transformation identification strategy. This strategy is included in “transformation identification” step of the protocol.

f) < knowledge mapping, knowledge mapping, ***by exploitation identification***>

The exploitation strategy refers to the transformation of specific knowledge and mobilisation of external knowledge to exploit a new general knowledge, which is applicable in other projects of the organisation. We observed this strategy only in the case of company PRG. At the beginning of their project, they had a visit from the partner’s company and their ampoule-filling equipment. Thereafter, PRG had research about the equipment and decided to buy the required machinery. Thus, the mobilised external knowledge for using ampoule-filling equipment is exploited and became a general knowledge as shown in Figure 6-23. This strategy is also introduced in “transformation identification” step of the protocol.

Figure 6-23: Exploitation identification



5.5.2.2 Metamodel of knowledge mapping

Figure 6-24 presents the metamodel of knowledge mapping phase. As presented in the metamodel of process modelling, an innovative project consists of a process representation. In the same way the project consists of knowledge representation, or in other words, a map of knowledge. The class of 'Document' is the starting point for the knowledge mapping phase and shared between the process and knowledge packages. Table 6-10 presents the details of knowledge package.

Figure 6-24: Metamodel of ISEACAP - Knowledge mapping

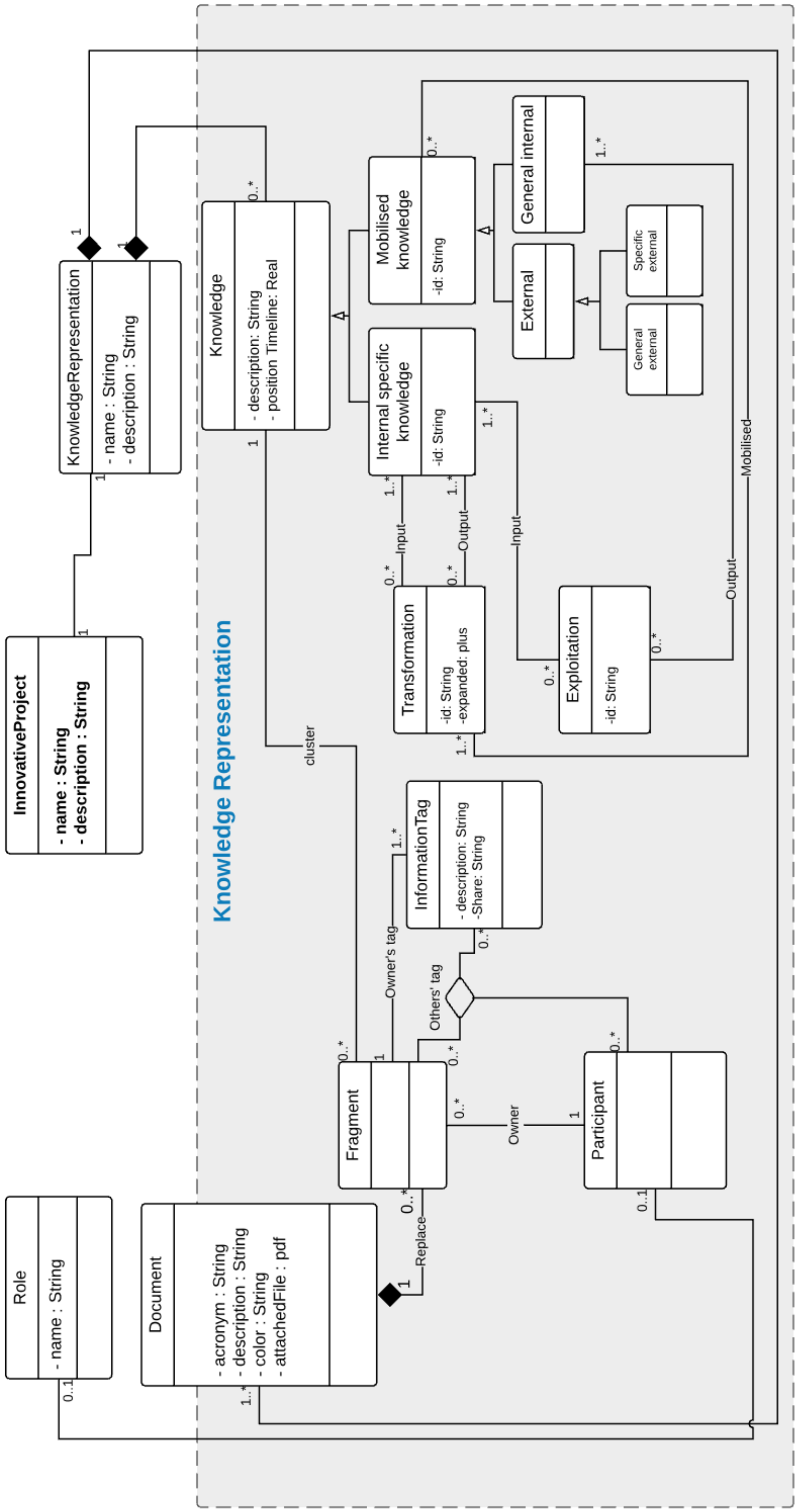


Table 6-10: ISEACAP metamodel - details of knowledge representation package

Class	Details
Participant	*Description*: a key actor of the innovative project who played an internal or external role during the project. • *Association*: – A participant chooses one or several documents identified during the process modelling. • *Attribute:* – Id(string): the identification of the participants
Fragment	*Description:* an important piece of a document selected and cut off by a participant. • *Association*: – A document can be cut into any or several fragments – A participant owns one or several fragments • *Attribute:* – Id(string): acronym of the fragment
Information Tag	*Description*: elicits the information contained in each fragment of the document. • *Association*: – Participant adds one or several information tags to a fragment. S/he is the owner of the information tag. – The other participants can also add any or several other information tag to others' fragment(s). • *Attribute:* – Description(string): shows the contained information in the fragment – Share(string): describes if the information is shared and with whom
Knowledge	*Description*: Participants' understanding from a group of fragments. It can be also applied knowledge during the project without being extracted from the groups of fragments. • *Association:* – Knowledge is based on any or several fragments. However, there is also knowledge which does not refer to any fragment of documents. – Knowledge can be specific to the project or general. • *Attribute:* – Description(string): name of the knowledge
Internal specific knowledge	*Description*: An internal knowledge which is also specific to the project • *Association:* – A knowledge is based on any or several fragments. – A knowledge representation/map consists of several knowledge • *Attribute:* – Description(string): name of the knowledge
Mobilised knowledge	*Description:* general or external knowledge which mobilised through the project to accomplish the specific knowledge transformation. • *Association:*

Class	Details
	– Mobilised knowledge is either a general internal knowledge or an external knowledge – Any or several mobilised knowledge can be applied to one or several transformations • *Attribute:* – Id(string): the identification of the mobilised knowledge
External knowledge	*Description:* mobilised knowledge by an external partner of the project. • *Association:* – External knowledge can be specific to the project or general and applicable in other project as well. • *Attribute:* – Id(string): the identification of the mobilised knowledge
Transformation	*Description*: the transformation of a specific knowledge to other specific knowledge • *Association:* – One or several internal specific knowledge can be the input of the transformation – Any or several mobilised knowledge can enter in a transformation – The output of transformation node is an internal specific knowledge • *Attribute:* – Id(string): the identification/number of the transformation node
Exploitation	*Description:* represents the creation of a new general internal knowledge • *Association:* – An exploitation can have one or several general internal knowledge as the output – One or several internal specific knowledge can be the input of an exploitation • *Attribute:* – Id(string): the identification of the exploitation

5.5.2.3 Graphical notation for knowledge mapping

The graphical notations used for the knowledge mapping phase are presented in the following:

- **Simple thin frame:** represents the knowledge created specifically for the project by the internal actors.
- **Dotted frame**: represents the external knowledge that can be either general (usable for other projects), or specific (applicable only to the targeted project).
- **Simple thick frame**: represents general knowledge mobilised by internal actors and applicable to other projects (e.g. actors' expertise).
- **Simple arrow**: represents the transformation of specific knowledge during the project.
- **Dotted arrow**: represents the mobilisation of external knowledge or general knowledge during the project for creating specific knowledge.

- **Simple circle**: represents transformation nodes where general or external knowledge is mobilised and specific knowledge is transformed
- **Dotted thick frame**: represents an external knowledge which has been absorbed by internal resources and now it is applicable to other projects.
- **Bulb**: represents the knowledge which is not issued from documents' fragments.

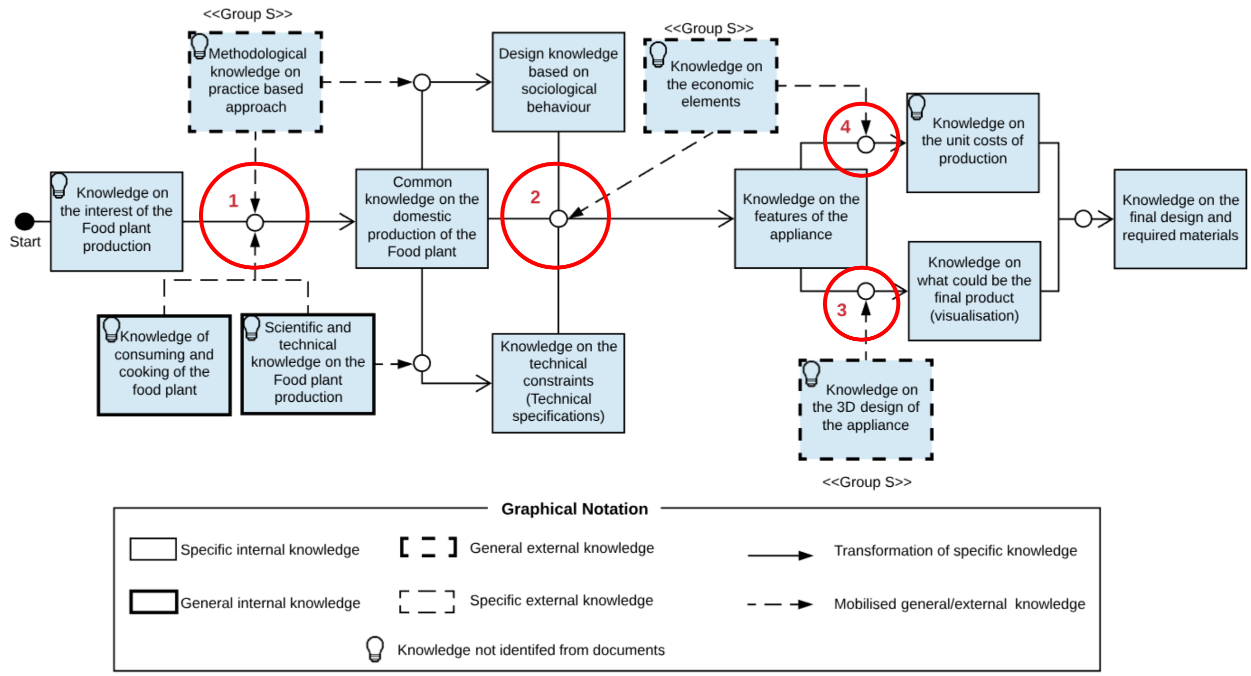
Table 6-11 summarises the defined graphical notation for knowledge mapping.

Table 6-11: Graphical notation – knowledge mapping

Representation	Component	Representation	Component
Simple thin frame	Internal knowledge specific to the project	**Bulb**	Knowledge not identified from the documents
Simple thick frame	Internal general knowledge	**Simple arrow**	Transformation of specific knowledge
Dotted thick frame	External general knowledge	**Dotted arrow**	Mobilisation of general and external knowledge
Dotted thin frame	External knowledge specific to the project	**Simple circle**	Transformation node where general or external knowledge are mobilised and specific knowledge transformed

Figure 6-25 presents an example of applying the graphical notations to produce a knowledge map. The starting point for next phase are the transformation nodes (shown with red circles in the figure) in the map where external knowledge is mobilised.

Figure 6-25: Use of graphical notations for knowledge mapping

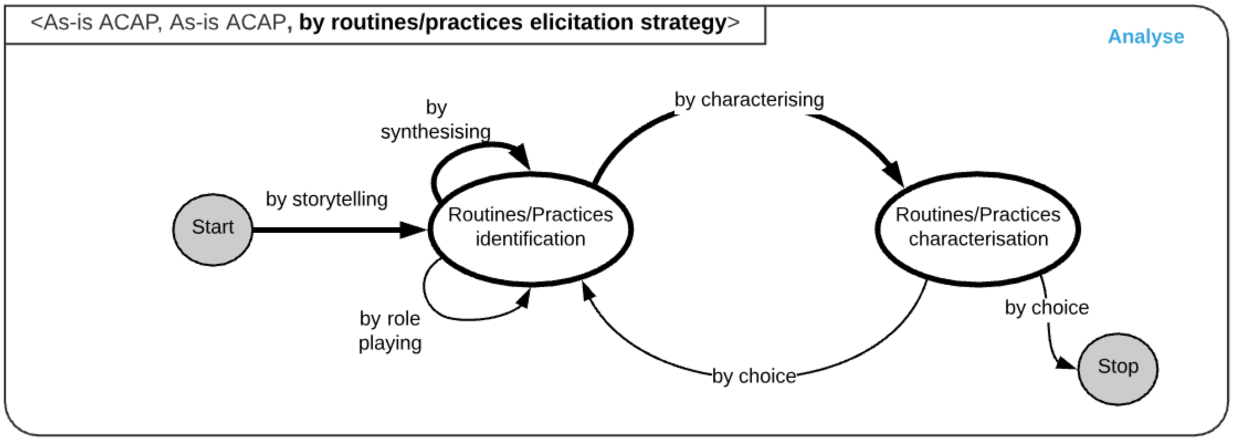


5.5.3 Map and metamodel of routines/practices eliciting and enriching

5.5.3.1 Map formalism of <As-is ACAP, as-is ACAP, *by Routines/practices elicitation strategy*>

Figure 6-26 presents the intentional map of routines/practices eliciting phases. These phases seek two principal intentions: (i) identify applied ACAP's routines or practices during an innovative project and (ii) characterise them. In order to achieve these intentions, we proposed the following series of strategies.

Figure 6-26: Intentional Map of routines/practice eliciting



a) *<Start, routines/practices identification, **by storytelling**>*

The storytelling strategy aims to encourage participants to open up the details of the identified transformation nodes. This strategy relies on a game board, storytelling and use of the buzzers to take the turn and complete others' stories (refer to the protocol of the routines/practices eliciting phase in section 5.4.3). This strategy is introduced as the first part of the "storytelling" step in the protocol.

*b) < Routines/practices identification, routines/practices identification, **by synthesising**>*

After each story, participants should make a phrase and summarise it. The main objective is to formalise the discussion in a short concrete phrase, which later represents ACAP's practices/routines. This strategy is introduced as the second part of the "storytelling" in the protocol.

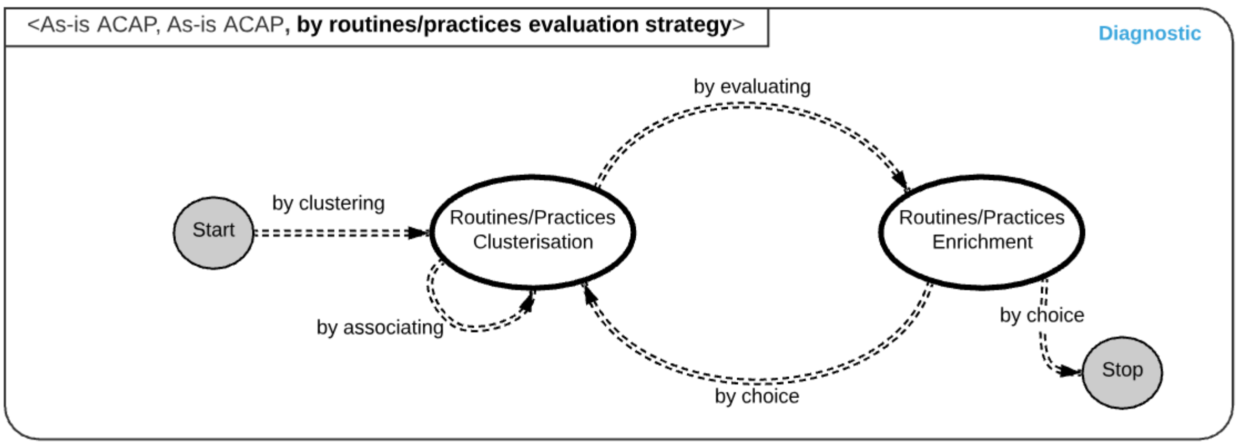
*c) < Routines/practices identification, routines/practices characterisation, **by characterising**>*

Characterising strategy aims at highlighting 'applied' or 'should be applied' ACAP's routines/practices during the project. In addition, participants characterise their practices in terms of systematic or emerging application. We consider systematic practices as routines. This strategy is called "practices characterisation" in the protocol.

5.5.3.2 Map of <As-is ACAP, as-is ACAP, by *Routines/practices evaluation strategy*>

The routines/practices evaluation phase relies on the Diagnostic of As-is/As-if ACAP. Figure 6-27 presents the map of this phase by illustrating two intentions: (i) routines/practices clusterisation to compare the identified routines/practices during the experimental session with the identified practices/routines from the existing literature. (ii) enriching routines/practices that can be achieved through the evaluation strategy.

Figure 6-27: Intentional Map of routines/practices enriching



a) *<Start, routines/practices clusterisation, **by clustering**>*

Clustering strategy allows participants to compare their identified practices with the best practices from the literature and group them based on the proximity of thematic. This strategy is named "clustering" in the protocol of routines enriching (refer to the section 5.4.4).

b) *< Routines/practices clusterisation, Routines/practices clusterisation, **by associating**>*

Through this strategy, participants link their practices to best practices with the help of the facilitator. They compare their routines/practices with the best practices and visually notice which best practices are not applied during the project. This strategy is called "associating" in the protocol.

c) *< Routines/practices clusterisation, routines/practices enrichment, **by evaluating**>*

After associating, the participants enrich their practices and routines by evaluating their importance. This evaluation must be carried out for the best practices as well, in particular which are not associated to participants' practices/routines. This strategy allows participants to think about what should be changed or enhanced in the future projects. This strategy is presented as “evaluating” in the protocol.

5.5.3.3 Metamodel of ISEACAP for routines/practices eliciting and enriching

Figure 6-28 presents the metamodel of ISEACAP for routines/practices package. An innovative project can rely on one or several routines representation since as the perspective of routines enriching phase, participants can reply the same project with enhanced routines. Table 6-12 presents the details of practices and routines package.

Figure 6-28: Metamodel of ISEACAP – Routines/Practices eliciting and enriching

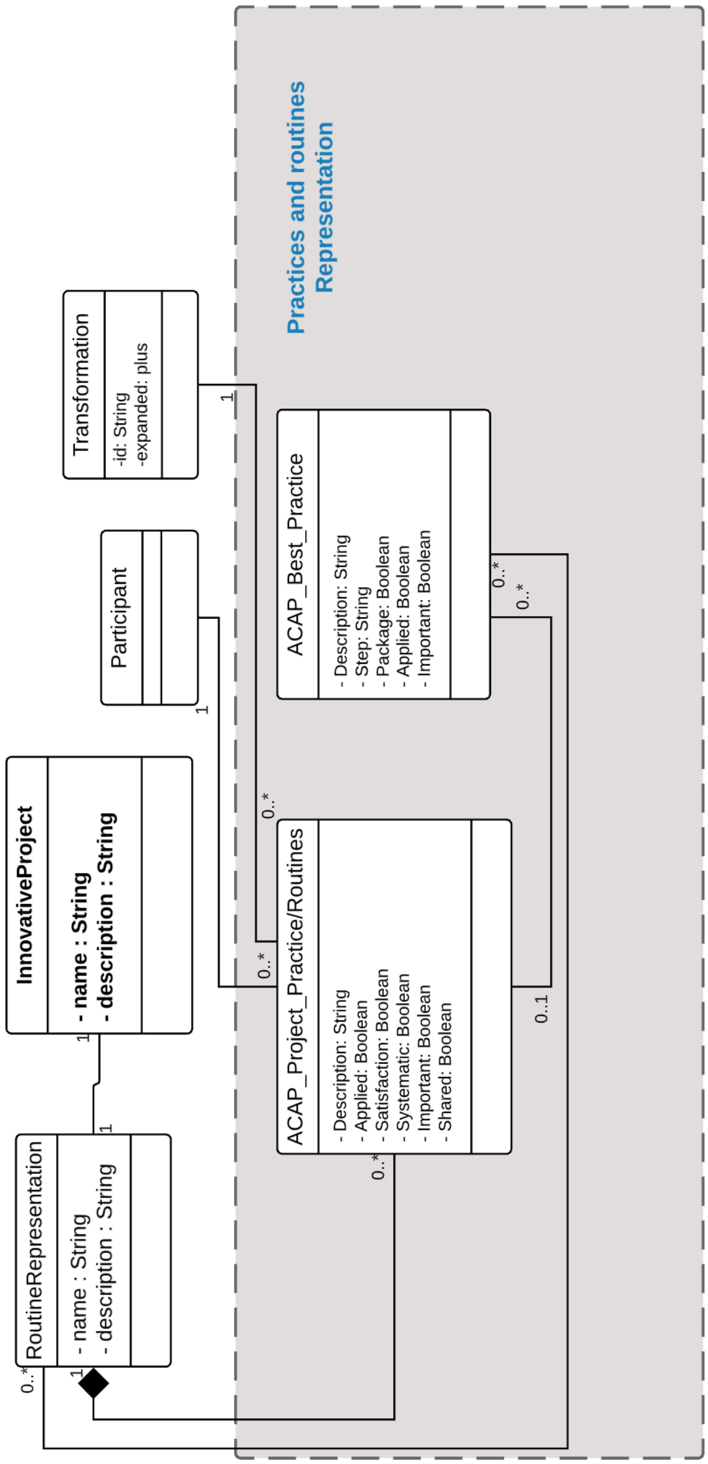


Table 6-12: ISEACAP metamodel - details of practices/routines representation package

Class	Details
ACAP_Project_Practice/Routines	*Description:* the practices or routines performed during the project • *Association*: – Each transformation node can be led to any or several project practices – A project practice can be associated to any or several *best* practices – A routine representation is associated to any or several project practices • *Attributes:* – Description(string): the description of the practice – Applied (Boolean): true if the practice was applied, false if it should have been applied. – Satisfaction (Boolean): true if the participants are satisfied by their performed practice. – Systematic (Boolean): true if the practice was performed systematically during the project. – Importance (Boolean): true if the practice is imperative to be applied in the future projects. – Shared (Boolean): true if the practice is shared with others and this refers to the routines characteristics
ACAP_Best_Practice	*Description*: ACAP best practices extracted from the literature and existing works. • *Association*: – Any or several ACAP best practices can be related to any or several routines representation. • *Attribute:* – Description (string): the description of each practices – Step (string): the step of the practices (acquisition, assimilation, application) – Package (string): before the project, during the project or after the project – Applied (Boolean): true if the best practice is applied – Important (Boolean): true if the best practice is important for the future projects

5.5.3.4 Graphical notation of routines/practices eliciting and enriching

Based on the metamodel of Routines/practices eliciting and enriching, we defined the symbols as following:

- **Simple thin frame**: practices/routines identified during the experimental session and called project's practices.
- **Simple thick frame:** best practices extracted from the literature; can be considered as general practices that are applicable in other projects as well.
- **Thumbs up**: practices/routines applied during the project.
- **Thumbs down**: practices which were not applied during the project while they should have been applied.

- **Star**: important practices/routines or best practices to be applied during the future projects.
- **Gear**: practices performed systematically during the project and can be considered as routine.
- **Bulb:** practices/routines identified during the collective discussion after the storytelling.

Table 6-13 summarises the presented graphical notation for routines eliciting and enriching phases.

Table 6-13: Graphical notation – routines eliciting and enriching

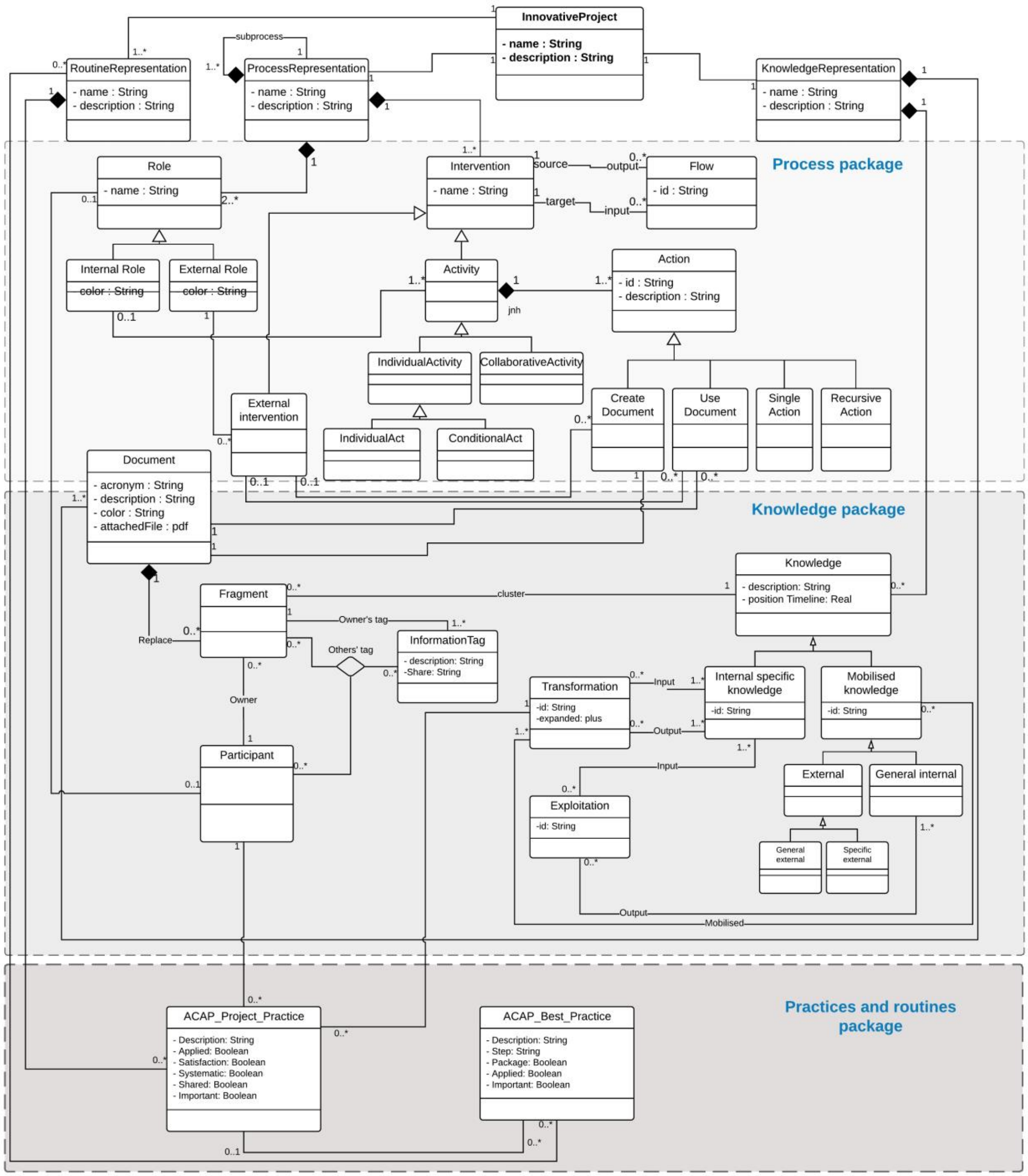
Representation	Component	Representation	Component
Thumbs up	Applied practices/routines during the project	**Bulb**	Practices/routines identified after the storytelling
Thumbs down	Not applied practices	**Simple thick frame**	Best practices
Star	Important practices/routines	**Simple thin frame**	Project's practices
Gear	Systematic practices = routines		

An example of the routines flow, final result of the method, is presented in Appendix 13.

5.5.4 Global vision on ISEACAP metamodel

Figure 6-29 provides a global vision of the metamodel of ISEACAP method. Based on that, an "innovative project" can be defined through three principal representations: Process, knowledge and routines/practices. Relying on the metamodel, the method is supported by an online tool, which is explained in the following.

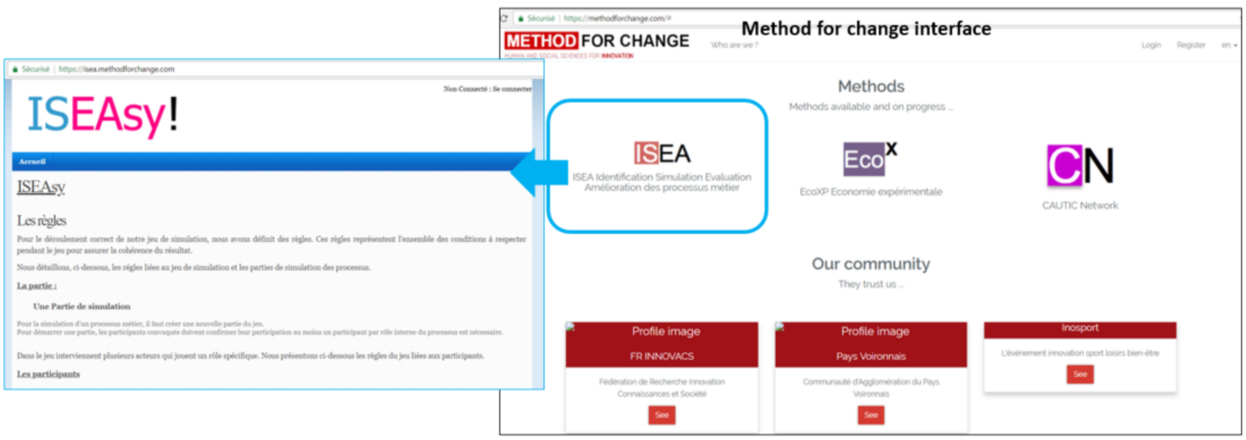
Figure 6-29: ISEACAP metamodel



5.6 Support tool for ISEACAP

The ISEACAP method is accompanied by a support tool called ISEAsy hosted on "MethodForChange" platform (the interface of the home page is shown in Figure 6-30). "MethodForChange" hosts series of the methods and tools that can be used to facilitate innovative projects (https://methodforchange.com/). These methods are the results of multidisciplinary researches associated to innovation conducted in the Université Grenoble Alpes. This platform is managed by Innovacs (federation of research in Innovation and knowledge society).

Figure 6-30: Interface of "MethodForChange" Platform



The first version of ISEAsy had been developed to support the ISEA method and consisted of a process modelling tool (Front et al., 2015; Oswaldo Santorum Gaibor, 2011).

To develop the ISEACAP tool, we evolved the ISEAsy tool for knowledge mapping and routines eliciting and enriching. To this end, based on the protocol and the metamodel, we provided the specification of the tool and contracted with a software developing. In the following, we present different interfaces of "knowledge mapping".

5.6.1.1 Knowledge mapping via ISEAsy

We have two possibilities for starting the knowledge mapping, either starting from the process modelling and identifying created or reused documents through this phase; or, starting directly from the documents. Revised protocol of ISEACAP for knowledge mapping on ISEAsy tool is presented in Appendix 8.

Figure 6-31 shows the interface of managing the knowledge mapping projects where we can (i) manage existing project by editing/removing/duplicating (ii) see in this interface the associated process if we started from process modelling (iii) add a new knowledge mapping project.

Figure 6-31: ISEAsy > Knowledge mapping > Project management

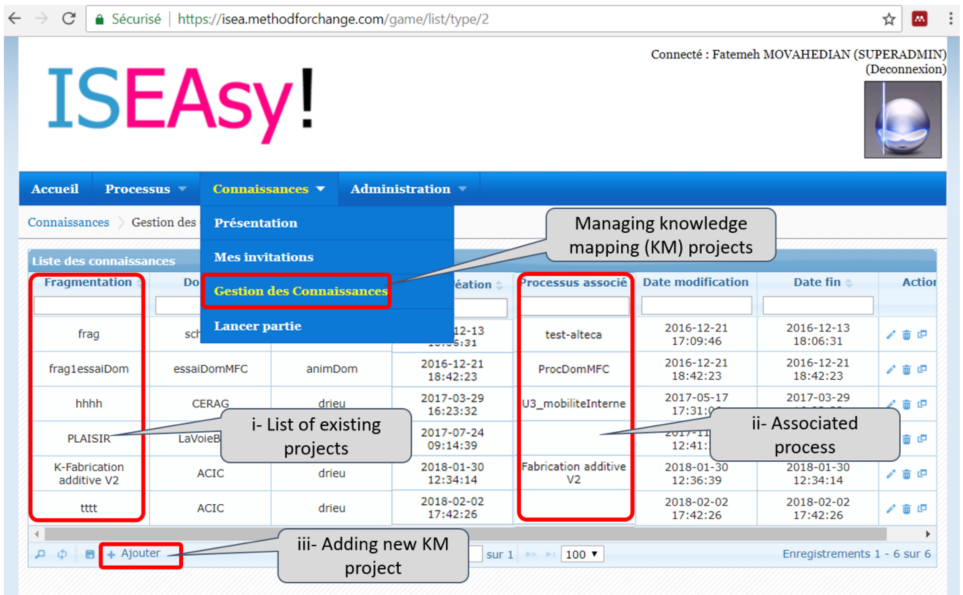
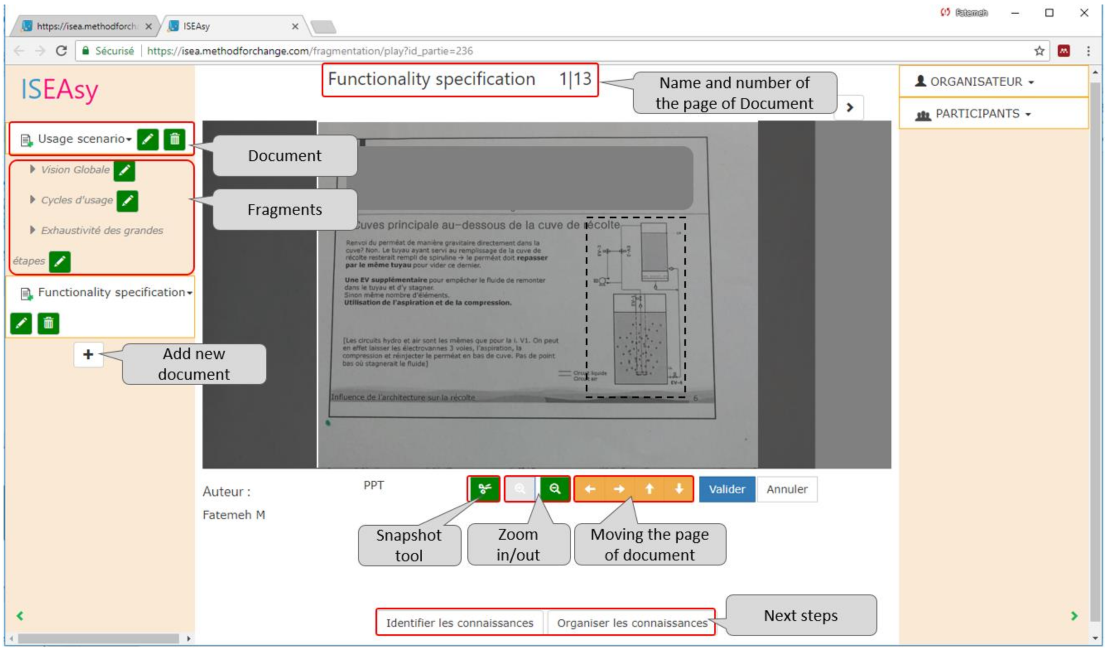


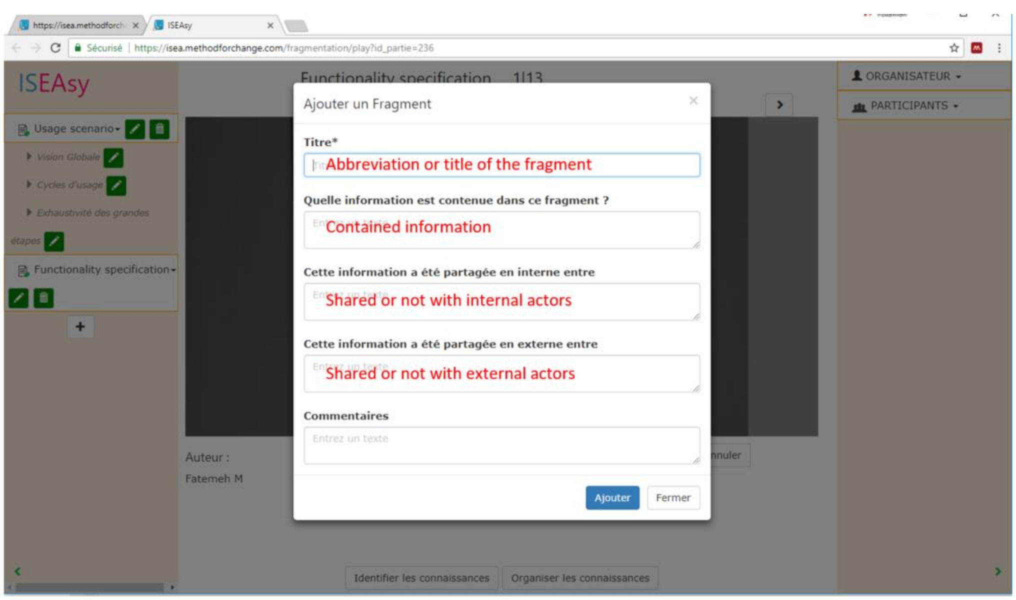
Figure 6-32 shows the fragmentation interface where we have the documents at the left side and we can add new document. The interface provides the required tools for the fragmentation such as snapshot tool, zoom, and paging the document. All participants have access to this page and they work individually. Participants can visualise others' fragments but they cannot edit them, while the facilitator has access and can edit all the fragments.

Figure 6-32: ISEAsy > Knowledge mapping > document fragmentation



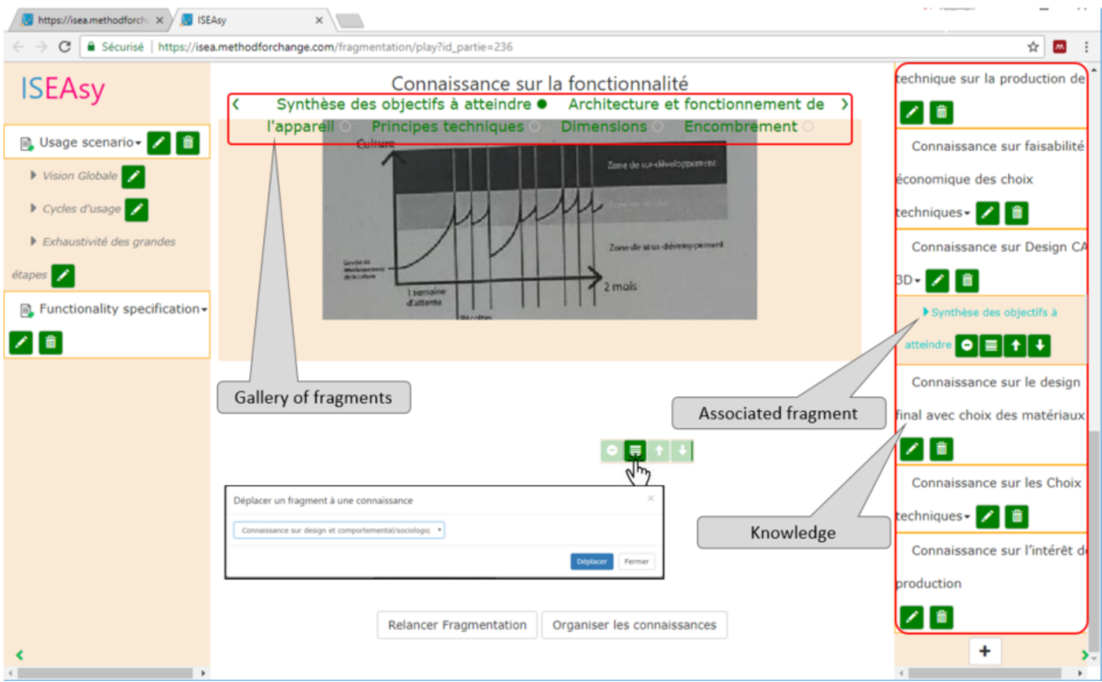
After selecting and cutting the fragment, a popup window appears which replaces the "information cards" in paper format (see Figure 6-33). In this window, participant explains what information is contained in the fragment and if this information is shared with internal and/or external actors.

Figure 6-33: ISEAsy > Knowledge mapping > document fragmentation > Information card



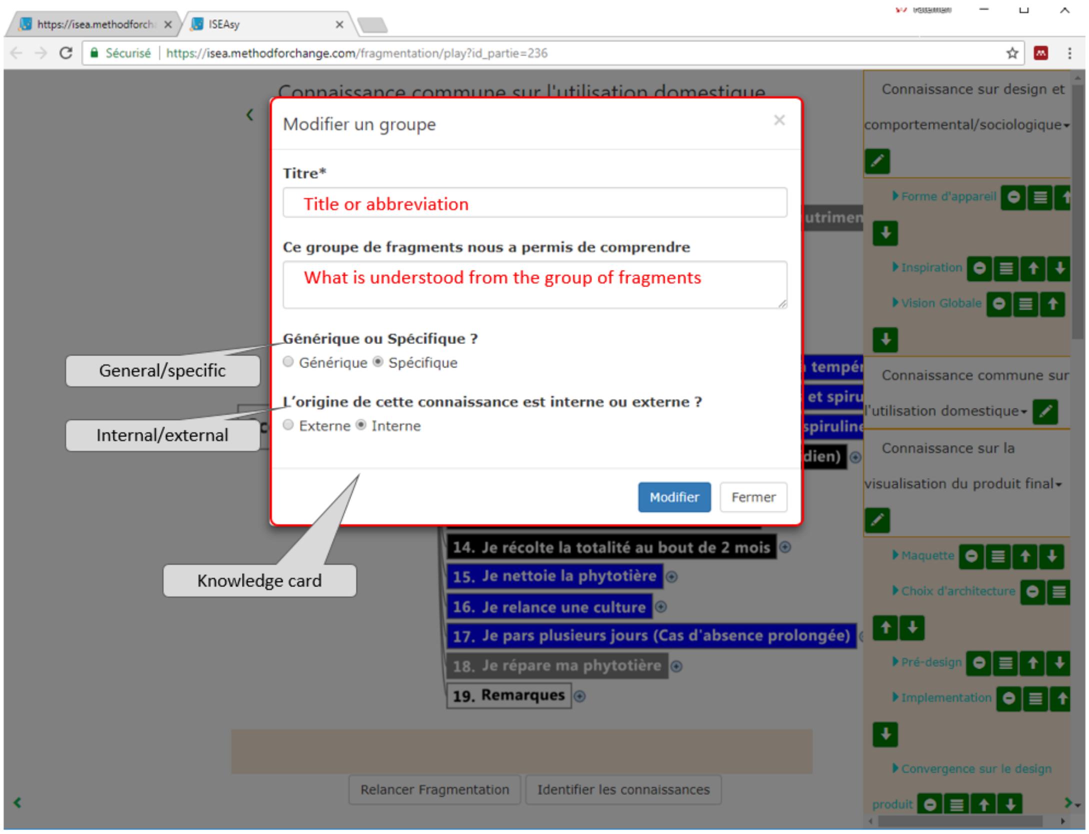
When participants complete the document fragmentation, they can go through the knowledge identification step. In this step, at the beginning, facilitator creates knowledge boxes in the right side without naming (by default the boxes are "Knowledge 1, "Knowledge 2 … Knowledge n"). Then Participants start to group their fragment and each of them has access to his/her own fragments. Participant can still visualise others' fragments as well as grouped fragments in right side of the window or on the top of the selected knowledge as a "gallery of fragments" (see Figure 6-34). To change the group of a fragment they should ask facilitator who has access to change the name of the knowledge, and can move or remove the fragments.

Figure 6-34: ISEAsy > Knowledge mapping > Knowledge identification



Afterwards, participants choose a name for each group of the fragments and characterise it. Then facilitator can complete the "knowledge card" shown in Figure 6-35 based on participants' ideas.

Figure 6-35: ISEAsy > Knowledge mapping > Knowledge identification > naming and characterisation



The next step is "knowledge organisation" where participants create their knowledge map with the help of facilitator. Users' (participants) interface allows them to visualise changes made by the facilitator in real-time. When participants or facilitator click on "knowledge organisation", they view the knowledge boxes with different borders as shown in Figure 6-36 based on the characteristics chosen in previous step. Participants with facilitator arrange knowledge boxes based on the chronological order (Timeline). In this step, they can also add new knowledge without using a fragment (it appears then with a bulb).

After organising the boxes, participants with facilitator make connection between knowledge boxes through collective discussion (see Figure 6-37). The users' interface allows them again to observe online on their monitors all the changes made by the facilitator.

Through all the steps, the buttons at bottom of the page enable participants to come back to the previous steps and add new documents, fragments or knowledge.

Finally, facilitator numbers the transformations nodes where there is external knowledge.

Figure 6-36: ISEAsy > Knowledge mapping > Knowledge organisation > Timeline

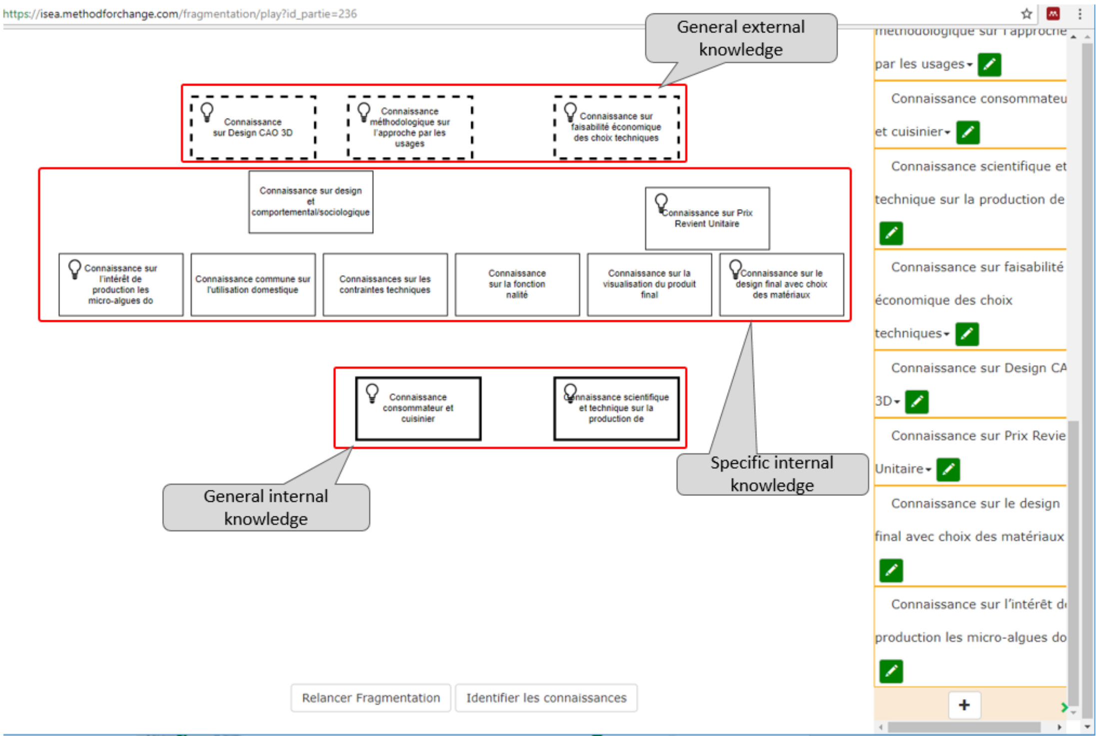
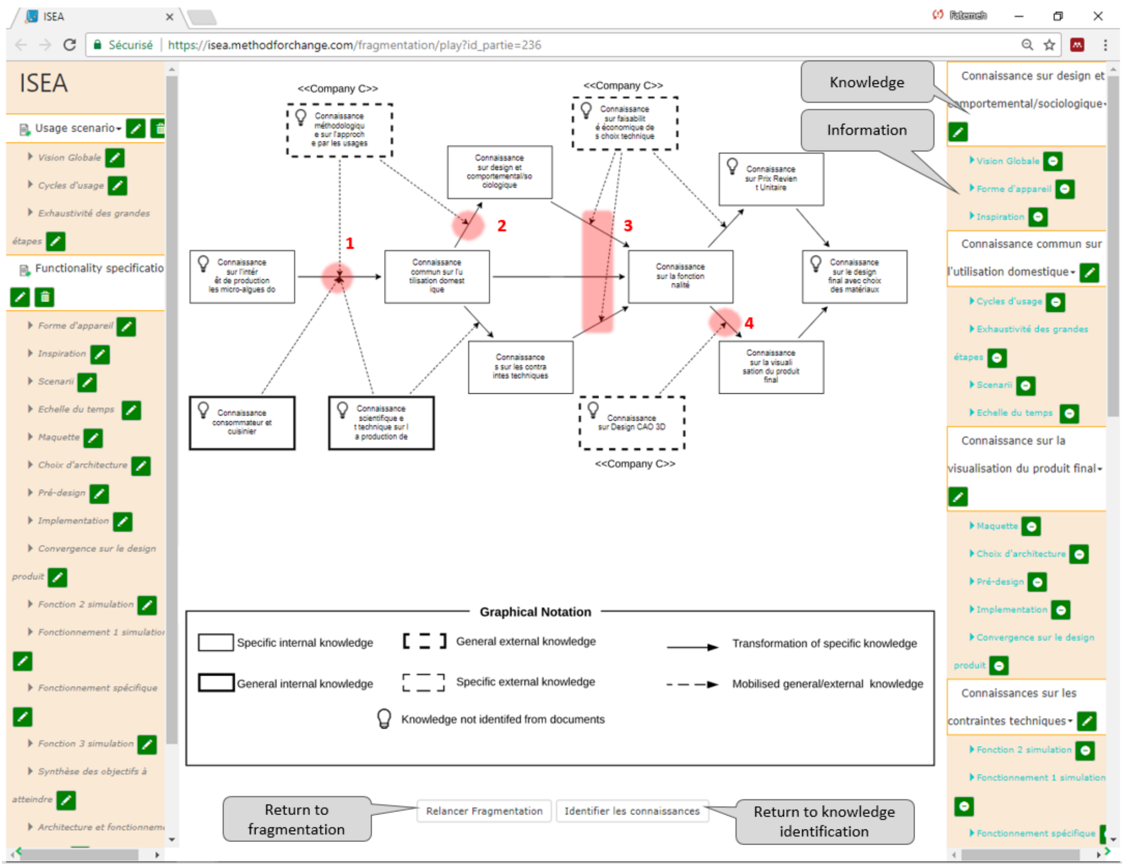


Figure 6-37: ISEAsy > Knowledge mapping > Knowledge organisation > Associating

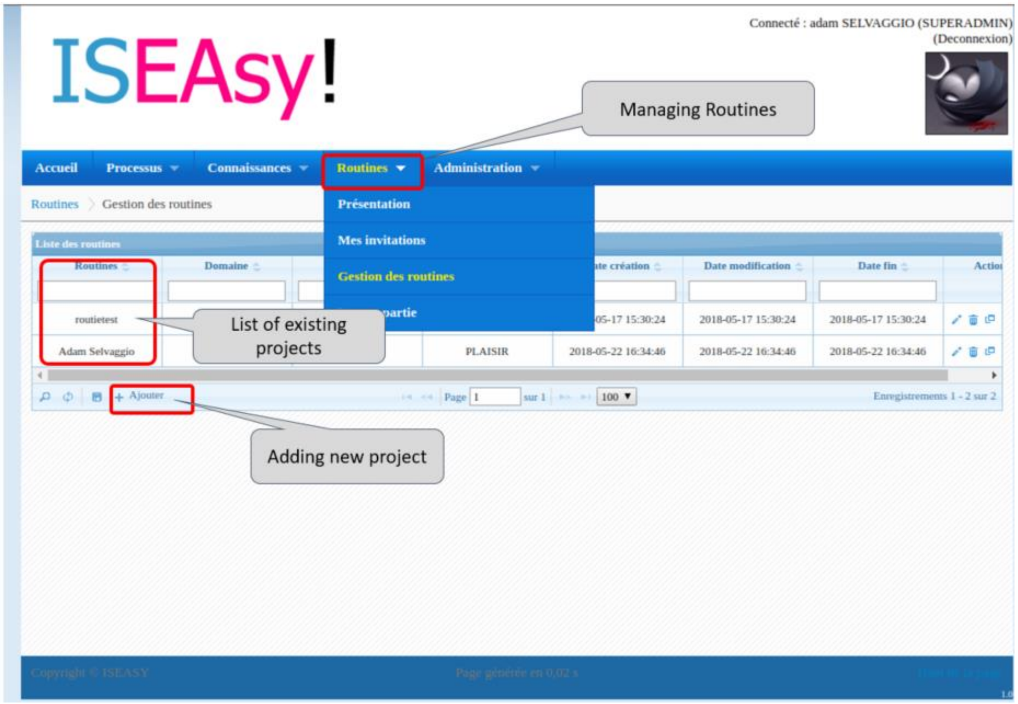


5.6.1.2 Routines eliciting and enriching

To develop the routines eliciting and enriching phases, we defined an internship project and recruited a second year professional bachelor student. A revised protocol of ISEACAP is presented in Appendix 9 for routines eliciting and enriching on ISEAsy tool.

Figure 6-38 shows that facilitator can see the existing projects, associated knowledge mapping projects and add a new routines project.

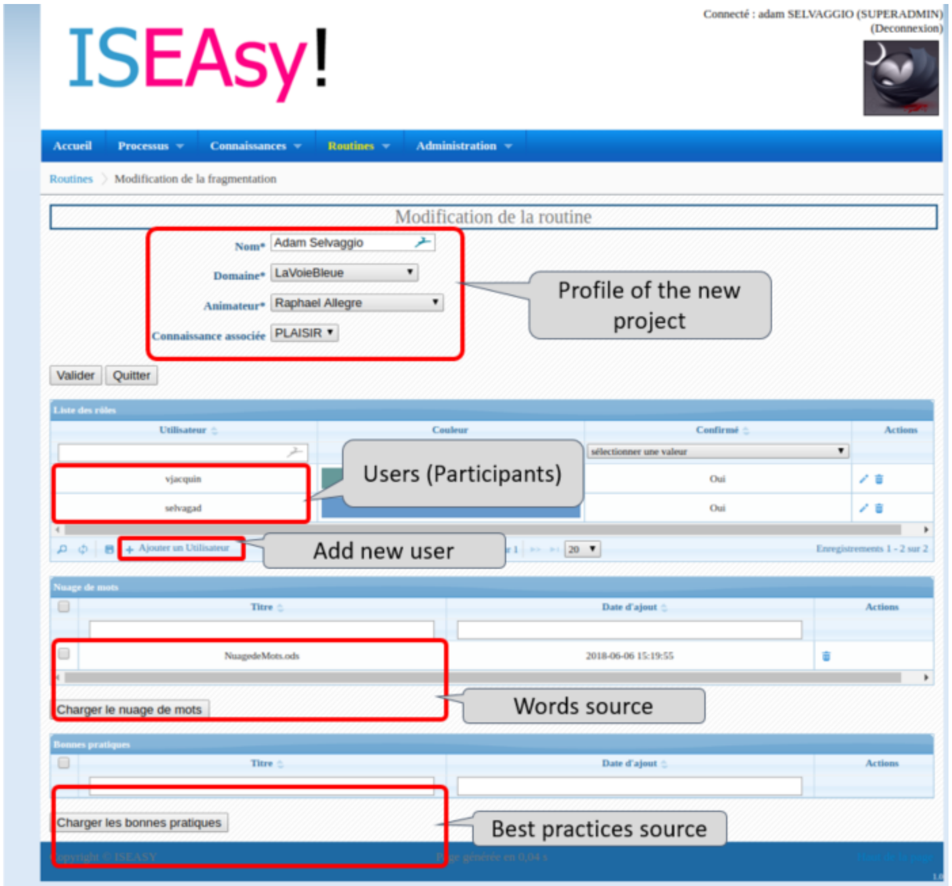
Figure 6-38: Routines eliciting > Routines Project management



When facilitator clicks on "Adding a new project", a new page appears as shown in Figure 6-39. In this page, s/he defines the profile of the project and associated knowledge mapping. Facilitator add users (participants) of the project and chooses a specific colour for each.

Facilitator has also access to modify the words used in the game board and the 3 packages of best practices extracted from literature for routines enriching phase. The words source is an Excel table that can be uploaded or deleted by facilitator (we defined both delete and upload options to enable him/her to systematically update the file after each experimental session based on the words proposed by participants that did not previously exist in the source). Following the same logic, the "*Best practices*" source is an Excel file that contains identified practices for which facilitator has access to remove/upload updated versions.

Figure 6-39: Routines eliciting > Routines Project management > Adding new project



After this parametrisation, the interface of storytelling appears as in Figure 6-40. The words of the game board are in the left and right sides of the windows. Each participant can click on a word or an idea to tell a story. Used words become grey and italic. When a participant clicks on a word, a popup window appears (see Figure 6-41) to summarise the story on a phrase and characterise it (satisfied/not satisfied, applied/not applied, emerging/systematic, and important/unimportant). The participant can also precise to which node of transformation the phase is related to.

Figure 6-40: Routines eliciting > Storytelling

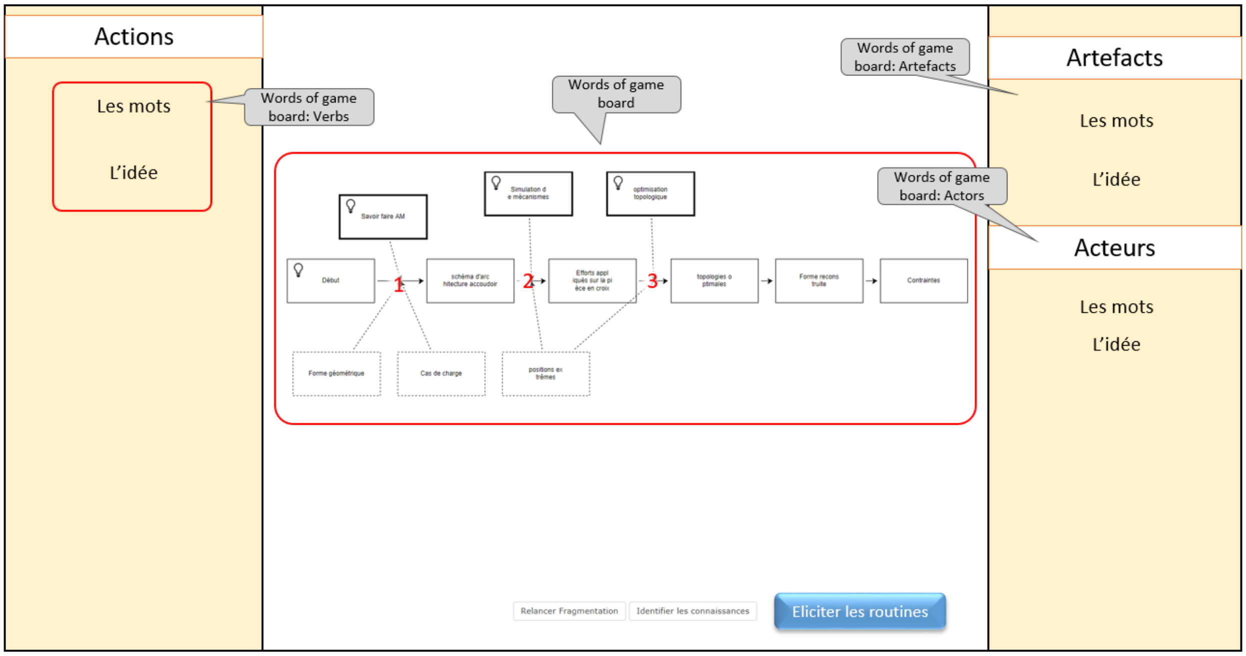
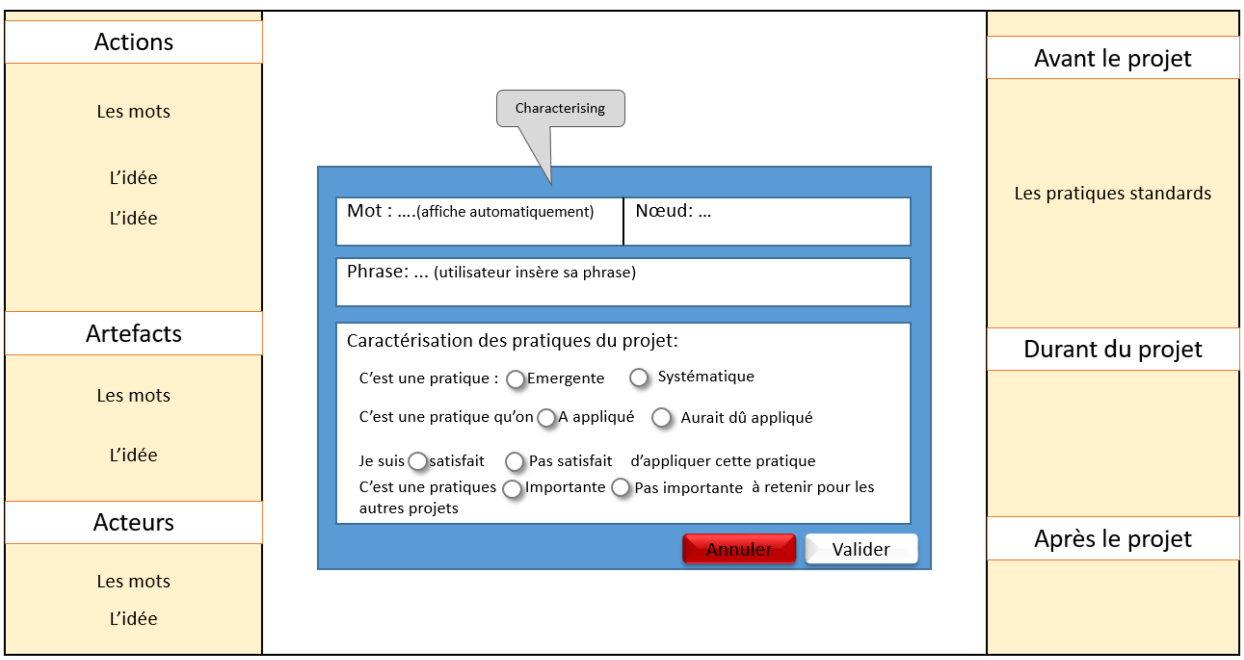
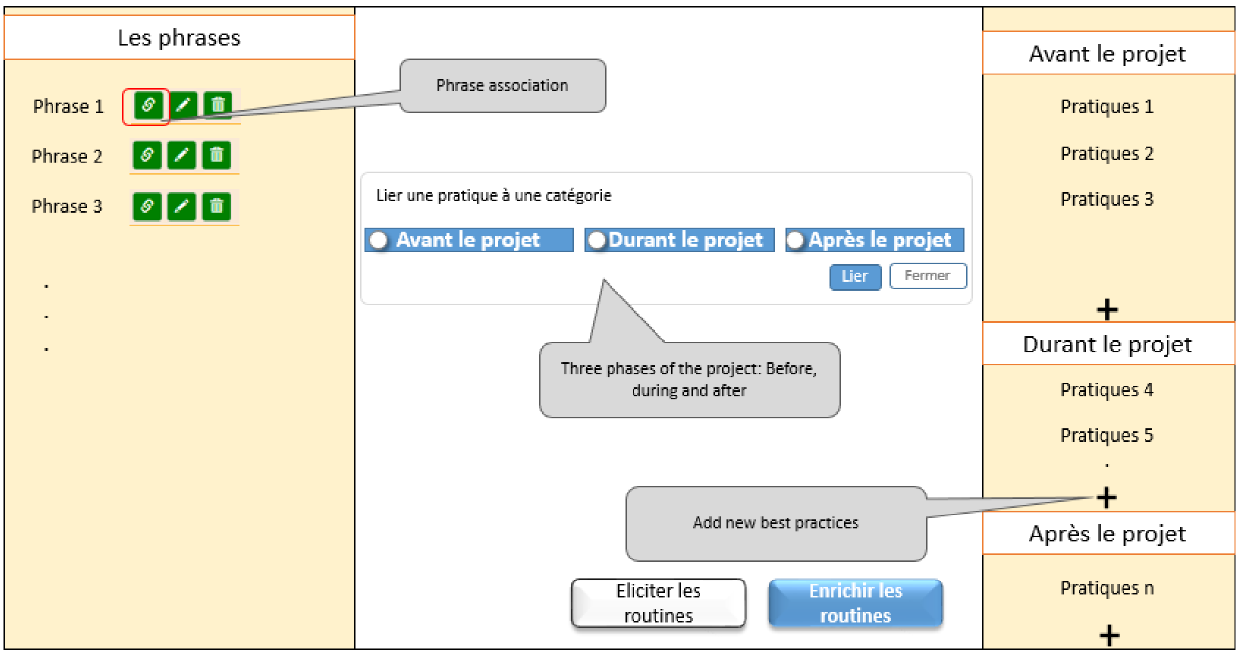


Figure 6-41: Routines eliciting > Storytelling>characterising



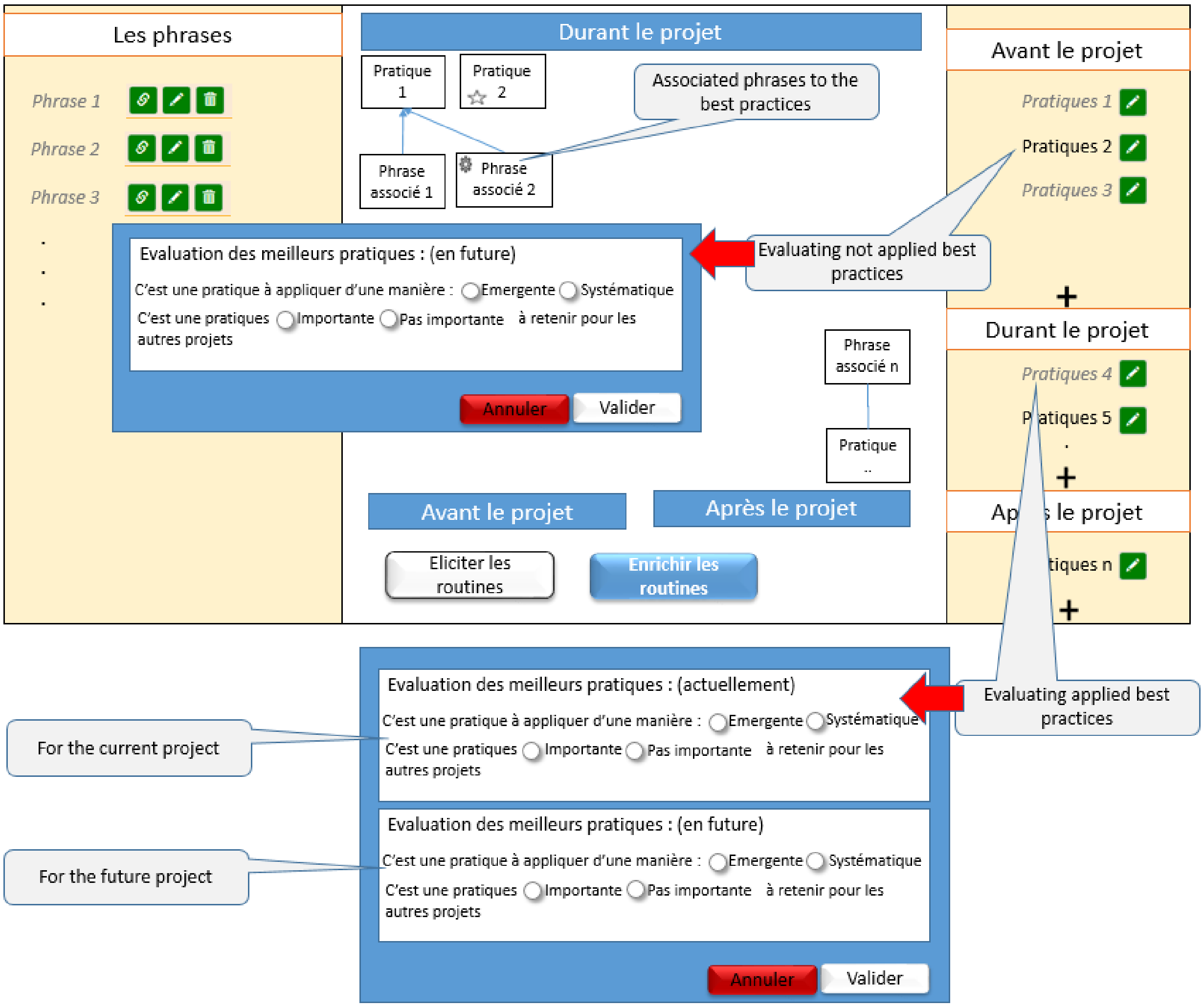
After characterising, participants can go through the routines enriching phase by starting the clustering and associating their identified routines/practices (the phrases) to the best practice (extracted from the literature). As shown in Figure 6-42, phrases created by participants are in the left side and best practices are listed in the right side of the interface. They can cluster their phrases based on the three phases of the project (before, during, after). If they cannot find the relevant best practice in the dropdown menu of the three phases, they can add new best practices.

Figure 6-42: Routines enriching > associating



As soon as participants choose them, the associated best practices will appear in the main interface (see Figure 6-43). Afterwards, with the help of facilitator, they evaluate applied and not applied best practices by reflecting and discussing on how these practices can be applied in future projects.

Figure 6-43: Routines enriching > evaluating



Up to now, the routines enriching phase is yet under development and a new internship will be proposed to consolidate the tool. In the following, we present validation of the four phases of the method by users.

5.7 Validation of ISEACAP by users

Users' validations were collected after each experimental session with our case studies presented in chapter 4.

The process modelling phase via ISEA method had been validated by end-users for recurrent processes. Therefore, we only verified the protocol and tools of ISEA for innovative projects process. As the result, the protocol and tool were both validated through the first experimental session by end-users.

For knowledge mapping, routines eliciting and enriching phases, we provided validation forms to be filled out by the participants at the end of each experimental session. The first part of the form, as presented in the previous section, was dedicated to collecting ideas for improving each phase, while the second part asked for the global vision of the participants about the session. In addition, we questioned them about the outcome of the method and session to improve their organisational routines/practices.

5.7.1 Ease of use

Table 6-14 presents the collected feedback about the ease of use of each phase and contained activities. In addition, we asked about the session's instruction and guidelines provided by the facilitators. We had the opportunity to conduct knowledge mapping phase in five companies and collected in total thirteen users' feedbacks. However, routines/practices eliciting and enriching phases were conducted only in LVB-AGY Company and three users' feedbacks were collected. Thus, in the future, it could be useful to conduct more sessions for these two phases and improve them based on users' feedbacks.

Table 6-14: First part of the validation forms - Ease of use

Phases	Activities	Easiest- N° users	Less easier N° users
Knowledge mapping	Document fragmentation	10/13	-
	Collective discussion and explain information cards	9/13	-
	Regrouping the fragments through silent brainstorming	4/13	3/13
	Naming the groups and knowledge cards	3/13	3/13
	Timeline and transformation identification	2/13	4/13
	Session's instruction and guidelines: Very easy 4/12, easy 8/12		
Routine s elicitin	Storytelling and game board	3/3	-
	Summarising the story in a short phrase	2/3	1/3

Phases	Activities	Easiest-N° users	Less easier N° users
	Characterising the phrases	3/3	-
	Session's instruction and guidelines: Very easy 2/3, easy 1/3		
Routines enriching	Clustering through silent brainstorming	3/3	-
	Associating the project's practices/routines to the best practices	2/3	-
	Evaluating the best practices and collective discussion	1/3	1/3
	Session's instruction and guidelines: Very easy 2/3, easy 1/3		

5.7.2 Satisfaction and usefulness

The second part of the validation forms asked the participants (i) if they were satisfied by the performed activities and the session (ii) and if the outputs of conducted session: knowledge map and ACAP's practices/routines flow could be useful for the future projects. Table 6-15 shows that the participants evaluated the method very useful and they were satisfied for the conducted session.

Table 6-15: Second part of the validation forms – Usefulness and satisfaction

Phases	Usefulness			Satisfaction		
	Very useful	useful	Not useful	Very satisfied	Satisfied	Not satisfied
Knowledge mapping	9/13	4/13	-	5/13	8/13	-
Routines eliciting	2/3	1/3	-	1/3	2/3	-
Routines enriching	2/3	1/3	-	1/3	2/3	-

5.7.3 Strengths and weaknesses

Through the validation forms, we asked participants about their general opinion about the method and if they had potential ideas to improve the method. Table 6-16 presents identified strengths and weakness through the participants' feedback.

The method facilitated the participants to step back and have an abstract vision on their project and practices, and to better comprehend the roles of other actors of the project. The method highlighted knowledge exchanges during the project between the partners, structured the actions and interactions. In addition, through the participative and gamification techniques, the team working between the participants was enhanced.

The general weakness of the method was the unclear final objective at the beginning of the session for the participants; however, step by step it became clearer. Additionally, through the knowledge mapping session, the concept of knowledge and regrouping the fragments required examples to be more understandable for the participants. For the future sessions, at the beginning of the session, we will describe more the final objective by providing examples of knowledge groups, knowledge map and routines flows.

Table 6-16: Third part of the validation forms - Strengths and weaknesses

Strengths	**Allows stepping back and have an abstract vision** ❖ **Verbatim** – *Project Manager, LVB: "It is interesting to step back and review what we performed as the practices".* – *Application manager, CSL: "It provided me a deep understanding of the project as well as a global vision on created knowledge and gained experiences during the project".* – *Research Manager, AGY: "productive sessions and provide abstract visions on what we have done".*
	Provides a better understanding of actors' roles and interactions ❖ **Verbatim** – *Workshop manager, Beta: "Enriching for me to understand the others' job and our interactions"* – *Commercial manager, Beta: "It was interesting for me because it allowed me to better comprehend the role of other actors… It articulated the roles"*
	Highlights knowledge exchange between partners ❖ **Verbatim** – *Project manager, PRG: "It was easy to follow and the result is useful to better understand knowledge transfer during the project"* – *Project manager, PRG: "Knowledge map allowed me to identify exchanged knowledge and understand that sometimes there is a risk of asymmetric knowledge exchange between partners"*
	Structures the actions and interactions ❖ **Verbatim** – *Project officer, Beta: "It illustrated the interactions between actors"* – *Technical manager, AGY: "verbalising the actions is interesting and helps make them clear in our mind".*
	Enhances team working ❖ **Verbatim** – *R&D engineer, Alpha: "It was concrete and easy to attend"* – *R&D manager, Alpha: "The participatory side was interesting"*
Weaknesses	**Unclear final objective** ❖ **Verbatim** – *Technical Manager, AGY: "it is interesting, but at the beginning the final objective was not clear for me".*
	Lack of the examples ❖ **Verbatim** – *Technical Manager, AGY: "knowledge is not easy to comprehend, giving some example can make it clear".* – *R&D manager, Alpha: "it is not easy to comprehend the nature of regrouping by knowledge cards; maybe some examples facilitate the understanding".*

The participants mostly considered the proposed method as useful, effective and powerful for understanding and improving their current and future projects. In addition, the method provided constructive discussions and reflexive space for the participants to improve their mutual understanding.

5.8 Conclusion

This chapter presented the ISEACAP method, which is a gamified participative method developed through user-centred design and end-user validation cycle. The method consists of four phases of process modelling, knowledge mapping, routines eliciting and routines enriching in order to provide a better understanding on ACAP's routines. Each phase relies on a protocol, a metamodel, a graphical notation and an intentional map.

ISEACAP is supported with an online tool, which is entirely developed and validated for knowledge mapping and routines eliciting phases. Routines enriching phase is partially developed and will be completed and validated by users in the future.

The construction of this method was the engineering objective of this PhD while the management objectives aimed at collect data via this method to provide a better understanding of ACAP's routines for both researchers and practitioners. To this end, through the next chapter we present the analysis of the data collected during the experimental sessions conducted via ISEACAP to (i) provide clear vision on ACAP's routines (ii) highlight the role of ISEACAP and facilitators in raising the reflexivity and (iii) show the role of reflexivity in learning about ACAP's routines.

Chapter 7. A better understanding of ACAP's routines and practices

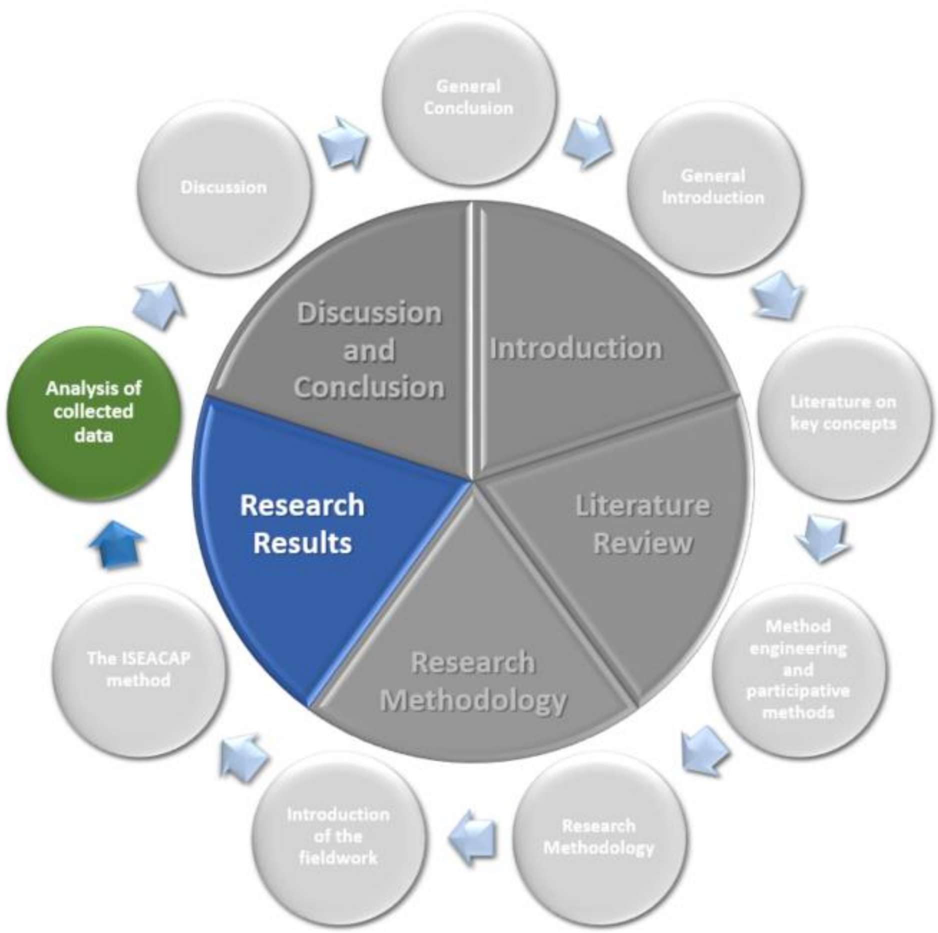
6.1 INTRODUCTION

6.2 STRUCTURE OF DATA ANALYSIS

6.3 A CLEAR VISION ON ACAP’S ROUTINES

6.4 SECOND STAGE: CROSS-CASES ANALYSIS

6.5 CONCLUSION



6.1 Introduction

This study relies on a general research question "how can we provide a better understanding of ACAP's routines?" which aims to provide a clear vision of ACAP's routines for both researchers and practitioners. In addition, through the "General introduction" chapter, three sub questions were raised as following "A. *What kind of method can we propose to highlight ACAP's organisational routines?*" *"B. How to provide a reflexive space for organisations' actors to have reflection on their ACAP's routines?"* And *"C. How can organisational learning about ACAP's routines be enhanced via reflexivity?* The first sub question "A" has been addressed through the two first chapters via the literature review on: ACAP, organisational routines, reflexivity and learning, along with method engineering approaches in computer science.

Question "B" has been partially answered through the previous chapter by presenting how ISEACAP was developed. Thereby, this chapter aims at completing the answer of question "B" by highlighting the role of the method and facilitators during experimental sessions to raise and enhance reflexivity between participants. The chapter addresses also question "C" by illustrating the role of reflexivity on organisational learning and in particular learning about ACAP's routines. In addition, to cover our general research question, we present revealed ACAP's routines during the experimental sessions and semi-structured interviews.

Our analysis is performed during two stages: Within the case studies and cross-case analysis. Within the case studies analysis focuses on recorded experimental sessions in Alpha and LVB-AGY as well as semi-structured interviews conducted in LVB-AGY. This stage of analysis highlights identified ACAP's routines during experimental sessions and interviews and addresses our *general research question* by providing a clear vision on ACAP's routines. In addition at the end of the first stage of analysis we provide a summary of identified ACAP's routines that can be useful other organisations that conduct collaborative innovation projects.

The second stage of analysis seeks the following objectives:

- Showing the complementary role of interviews and experimental sessions for revealing ACAP's routines; this objective addresses *sub research question A.*
- Studying ISEACAP as a reflexive space and what are the roles of facilitators during the reflexivity; this objective addresses *sub research question B.*

- Finally, considering ISEACAP as a reflexive space, how can it enhance organisational learning about ACAP's routines; this objective focuses specifically *sub research question C.*

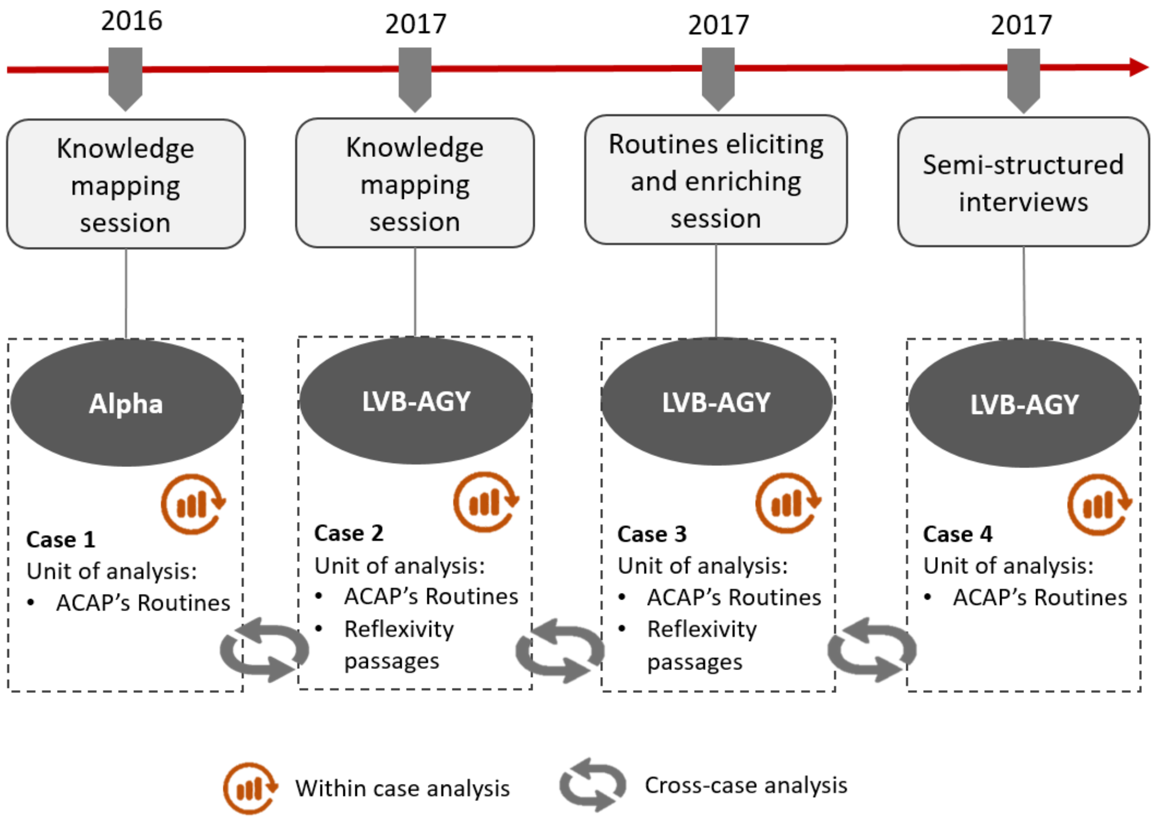
The chapter is structured in the same order of analysis stages and presents how far the objectives of each stages are fulfilled.

6.2 Structure of data analysis

To analyse our collected data, we refer to the definition of "case" in the dictionary of social science: a "case" can be an individual, an event or a social activity, a group, an organisation or an institute (Jupp, 2006, p. 20). Eisenhardt (1989) develops a widely respected data analysing method for theory-building case study. A theory-building research from case study involves two stages: within case-analysis and cross case-analysis in order to explore new insights which may reside in data (Eisenhardt, 1989; Miles, Huberman, & Saldaña, 2013). Detailed description of each case is provided within case analysis stage and there is no particular format for writing up a case analysis report (Eisenhardt, 1989). For instance, after each experimental session conducted via ISEACAP, we prepared a document and sent back to the company by email. Receiving approval from them ensured us about the accuracy of our analysis of each case.

Figure 7-1 sketches out the structure of our case studies. As explained in chapter four, we could record only three experimental sessions due to the confidentiality barriers: two knowledge mapping sessions in Alpha and LVB-AGY; a routines eliciting and enriching session in LVB-AGY. The experimental sessions in LVB-AGY had been organised in two sequential days and in parallel we conducted semi-structured interviews with the companies' actors who played key roles in the project.

Figure 7-1- Structure of data analysis



The first stage of analysis enables in-depth understanding of the project context and applied ACAP's routines in each case. The second stage was performed through a thematic analysis by relying on the main themes defined in the first chapter: ACAP, organisational routines, reflexivity and organisational learning. Additionally, through the second stage, we compare obtained results via ISEACAP and semi-structured interview to show how far these methods play complementary roles in studying ACAP's routines.

6.3 A clear vision on ACAP’s routines: the first stage of analysis within the case studies

This stage addresses our general research question “*how can we provide a better understanding of ACAP’s routines?*” To this end, conducted session via ISEACAP in Alpha, LVB-AGY as well as semi-structured interviews with the actors of LVB-AGY were transcribed and codified as the following:

1) Highlighting the routines related to the four ACAP’s dimensions;
2) Identifying the nature of the routine (managerial, technical or both);
3) Categorising routines through different themes, based on the researcher’s interpretation.

We had a general overview on the coding guidelines through the chapter of research methodology. Here we display them again to explain more in details. Coding Guideline 1 presents the definition of ACAP’s routines which relies on the literature and facilitates researchers to have a same understating for coding routines related to the four dimensions of ACAP.

Coding Guideline 1: ACAP's Routines

Main theme	*ACAP’s Practices or Routines*: When a participant describes a practice (could be a practice which is not applied during the project) it must be performed by multiple actors to acquire, assimilate, transform or exploit knowledge (Feldman, 2000; Zahra & George, 2002). The practice can be performed repeatedly previously (which is a routine) or evaluated as important to be repeated in the future projects (to be routinized).

Sub-themes	○ ACAP-Acquisition: applied practice/routine to identify and acquire external generated knowledge (e.g. mobilising external partners and experts during projects, using different techniques for sharing information, etc.) ○ ACAP-Assimilation: a practice/routine that allows to analyse, process, interpret, and understand the acquired external knowledge (e.g. discussing and reflecting about acquired knowledge, formalizing acquired knowledge via visual representations, etc.) ○ ACAP-Transformation: a practice/routine that can be applied for refining and combining existing knowledge and assimilated knowledge (e.g. synthesising assimilated knowledge, planning to integrate in operation, evaluating current actions based on the assimilated knowledge, etc.) ○ ACAP-Application: a practice/routine that can be applied to incorporate the transformed knowledge into the operations and enhance existing competencies or develop new ones (e.g. creating new designs, improving existing results based on the transformed knowledge, etc.)

6.3.1 Identifying ACAP's routines via ISEACAP: Knowledge mapping session in Alpha

The knowledge mapping session in Alpha was conducted with four participants around the table: Research Manager (RM), Research Engineer (RE), Operator (OP) and Chief Executive Officer (CEO). These participants were the key actors of the project.

6.3.1.1 Overview

Beforehand we had an interview with the RE to identify the process and the documents that had been created or reused during the project. At the beginning of the experimental session, we reviewed the process model of the project and the participants validated its accuracy. We also provided them a hard copy of their identified documents, the CEO named another document (Analysis results), as it seemed to him important.

Each participant focused on specific documents, which were more relevant to their role:

- RE took the "Laboratory notebook" as she managed it during the project and "documented communication" via their "Client Relation Management system - CRM".
- The CEO took "Analysis results" document. He believed that this document is the most valuable by showing the result of their product.
- RM focused on the "project specifications" and "technical forms".
- OP took "technical forms" as she had filled out most of them.

During the experimental session, we found out that Alpha's documents are very well organised via their CRM system and allows them to store all their communications with their partners as well as exchanged documents.

6.3.1.2 ACAP's routines

Following the first coding guideline, we analysed the knowledge mapping session conducted in Alpha, and identified their practices and routines for acquisition, assimilation, transformation and application of external knowledge.

- *Routines for knowledge acquisition*

Verbatim 7-1 presents examples of identified routines for knowledge acquisition in Alpha. The company acquired external knowledge through the documentation and exchange with their partners. These documentation and exchange were organised via their CRM system, and allowed them to stock all the information, forms, emails etc. which were accessible for all the internal actors of the project (Verbatim 7-1, A). This routine was applied not only for this particular collaborative project but also for all the other projects.

In addition, the company acquired valuable technical knowledge during the project by collaborating with an external expert for testing the adhesion of the thread and analysing the results of the test (Verbatim 7-1, B).

Verbatim 7-1- Routines for knowledge acquisition – Knowledge mapping session – Company Alpha

A: Documenting the exchanges with client during all the project

RM: "*I don't know if we explained you our ERP and CRM systems…we open a folder for all the projects even if it is not collaborative…within the folder we stock all the information, documents, emails etc.*"(KM, PN, p. 12)

B: Collaborating with an external expert to resolve the technical problem

RE: "*… the report of X, they intervened when we needed to analyse the threads… we developed several tests with them…* "(KM, AB, p. 35)

- *Routines for knowledge assimilation*

Verbatim 7-2 presents the examples of assimilation routines performed by company Alpha. Beside their CRM system, the RE took notes systematically of important points during their meeting or exchange with their partners in the Laboratory Notebook. She organised the notebook based on the project steps and partners, which helped the other internal project's actors in having a classified trace of meetings by consulting the notebook (Verbatim 7-2, A).

In addition, their internal communication in terms of technical findings was organised through various types of forms and templates. These documents provided them a unified sharing language and thereby facilitated the communication and knowledge transfer within the company (Verbatim 7-2, B). One of their communicative documents were a datasheet that allowed them to have a same understanding about what and how to use specific materials.

Verbatim 7-2: Routines for knowledge assimilation - Knowledge mapping session – Company Alpha

A: Classifying exchanged and shared knowledge with partners
RE: "*... in laboratory notebook, I put the colourful tabs...orange tab are related to the exchange with company Beta...in this notebook there is information about external experts as well... "* (KM, AB, p. 41)
B: Sharing technical findings via specific forms (templates) which are reusable and accessible for other internal actors
OP: "*...the right material...I didn't require to be shared with others as all the details are registered in technical forms*"
OP: "*... so the last one is the datasheet that explains the product ... we need to have a good understanding of what we want to do and what we should use as the specific material...and we should enter the correct value in the technical form*" (KM, GB, p. 43)

- *Routines for knowledge transformation*

Verbatim 7-3 presents the identified routines for transformation of assimilated knowledge. In company Alpha, the actors used different graphical representations and support to visualise what they had assimilated from their partners and external experts (Verbatim 7-3, A).

Additionally, during their collaboration with the external experts, the research team of the company observed the test to find out the potential weaknesses of the threads and associated root cause. Then, the research team communicated the results of the observation with the other internal actors. During the tests with the new machine, the OP entered regularly all the information and values in the system and hence the RE could follow her work and prepare analysis (Verbatim 7-4, B).

Verbatim 7-3: Routines for knowledge transformation - Knowledge mapping session – Company Alpha

<u>**A: Codifying created elements during the project through graphical supports and drawing**</u>

RM: "*We have graphical supports when we should make pieces… we conserve the delivery notes of pieces, something like that…*" (KM, PN, p. 47)

<u>**B: Following and updating systematically the technical documents**</u>

OP: "*… we used the correct material and in parallel we entered related information to the system …we had to enter the correct values in the system …* " (KM, PN, p. 24)

- *Routines for knowledge application*

The majority of identified routines associated to the application dimension are technical. As the Alpha's actors of the project applied what they had captured from their external sources, to achieve their final product.

In order to produce homogenous threads, the Alpha's actors had to make changes on their production routines and eliminate the washing phase before oiling and winding. In addition, they made changes on their process of twisting as they integrated a new machine within their production line. These changes helped improve the quality of their product and reduce the fragility of the thread (Verbatim 7-4, A).

To increase the adhesion effect of silicone on threads, it was required to apply a particular oil with specific characteristics (Verbatim 7-4, B). To find the right specifications for the oil, the actors launched several tests and in parallel, they registered all the information in the relevant technical documents. The oil specifications could be thereby reused during the installation of a new machine.

During this project, the company was not equipped with the required instruments to measure the efficiency of the product. This was challenging for them in particular at the end of the project to commercialise their product (Verbatim 7-4, C). However, one of their client provided them the analysis of efficiency and helped progress in their tests.

Verbatim 7-4- Routines for knowledge application – Knowledge mapping session – Company Alpha

<u>**A: Improving the quality of the product**</u>

RM: "*So, based on our observation for not washing and winding… in fact the conclusion of all these analysis … the wash created problems, washed and unwashed threads reacted differently to the oil … the first conclusion: it is not useful to wash to have more homogenous threads …*"(KM, PN, p. 23)

RM: "*... the second conclusion was the story of twisted or untwisted thread ...that made a problem in terms of ...process...on the machine... we shared this with our partners...* " (KM, PN, p. 24)
<u>B: Categorising the findings during the tests and refer to them</u>
RE: "*... it is true, to increase the adhesion effect we had to use a specific oil with specific characteristics... it was important that we had recorded this information somewhere ... we followed that written instruction for the new machine ...* " (KM, AB, p. 64)
RM: "*... exactly ...we found out the specification of the oil through several tests ...* " (KM, PN, p. 65)
<u>C: Measuring or evaluating the progress during tests</u>
RE: "*...specifications there, finally the document of test results that we provided for the X, in any case the first ones... to estimate the possibilities of finalising a test allowing to estimate the anti-slip ...we tried to understand the obtained results provided by our client who tried to measure the efficiency of our products ... to measure if there is a thread which was more effective than another one ...* " (KM, PM, p. 63)

6.3.1.3 Summary of the results

Following the ISEACAP's protocol for knowledge mapping session in company Alpha, the participants highlighted their applied knowledge during the project based on their documents and identified where external knowledge is entered to the project.

Table 7-1 summarises extracted ACAP's routines from the participants' discussions during the experimental session. We specify the nature of the routines in three categories: Managerial (M), Technical (T) or Technical&Managerial (T&M). To expand more in details the nature of the routines, we propose the following themes of application for the identified routines:

- **External documentation** facilitates knowledge and information capitalising during the project.
- **Collaboration with external experts** highlights the importance of external experts' interventions during project in coping with confronted blocking points.
- **Technical documentation** is about documenting and categorising all the technical aspect of the product such as tests results.
- **Internal exchanges** refers to all the routines/practices that facilitate internal communication between company's actors.
- **Visual representation** emphasises on visualising the results and findings through graphical supports.
- **Quality control and improvement** refers to systematically control the quality after each stage of the project through the tests and improve it based on the results.

- **Progress evaluation** emphasises on evaluating the progress at the end of each stage based on the medium-term objectives and tests results.

Table 7-1: Identified ACAP's routines in company Alpha – Knowledge mapping session

ACAP	Routines	Nature of routines*	Themes of ACAP's routines
Acquisition	Documenting exchanges with client during the entire project (Verbatim 7-1, A).	M	External documentation
	Collaborating with an external expert to resolve the technical problem (Verbatim 7-1, B).	M	Collaboration with external experts
Assimilation	Classifying exchanged and shared knowledge with partners (Verbatim 7-2, A).	M	External documentation
	Observing developed procedure by external expert and communicate it internally (Verbatim 7-2, D).	T&M	Internal exchanges
Transformation	Sharing technical findings via specific forms (templates) which are reusable and accessible for other internal actors (Verbatim 7-2, C).	T&M	Internal documentation
	Codifying created elements through graphical supports and drawings (Verbatim 7-2, C).	T&M	Visual representation
	Following and updating systematically technical documents (Verbatim 7-4, C).	T&M	Technical documentation
Application	Improving product quality through several testing based on external expert's feedback (Verbatim 7-4, A).	T	Quality control and improvement
	Categorising findings during different tests and refer to them to find solutions (Verbatim 7-4, B)	T	Technical documentation
	Evaluating the progress in the results of tests (Verbatim 7-4, D).	T	Progress evaluation

**Managerial (M), Technical (T) or Technical&Managerial (T&M)*

For instance, as the table 6-1 shows, in company Alpha, Managerial ACAP's routines were applied during knowledge acquisition via collaborating and communicating with external experts and documenting the exchanges. The Technical&Managerial ACAP's routines were applied for knowledge assimilation by classifying knowledge, observing the procedures (developed by external experts) and communicating them internally.

In addition, the Technical&Managerial ACAP’s routines were performed to transform acquired knowledge by providing visual representations and communicating internally the knowledge via different forms. In company Alpha, identified Technical ACAP’s routines focus on the application of transformed knowledge to control the quality, improving the results and evaluating the progress based on the their objectives.

This project was the first collaboration experience of company Alpha and they coped with challenges related to their agreement structure and communication with one of their partners. Company’s actors had clear documentation routines for their internal communication, while for the external communication during this specific project, they faced challenges in terms of structured exchanges with their partner to have clear vision and common understanding on the final product. The company’s actors defined these challenges as learned lessons for their future collaborative projects. In addition, the company bought the required equipment and machinery to make the tests and analyse them internally, which can provide product specification for commercialising their product.

6.3.2 Identifying ACAP's routines via semi-structured interviews in LVB-AGY

Before conducting the experimental sessions in LVB-AGY we had five interviews with the different key actors of the project. Thereafter the experimental sessions we had two more interviews with the Project and Research Managers. Table 7-2 presents the profile of interviews, company and duration of each interview.

Table 7-2: Summary of interviews with LVB-AGY and LSP

Interviewee	Initials	Company	Duration (minutes)	Modality
General director	GG	LVB	65'	Face to face
Economic planning expert	CD	LVB	50'	Telephonic
Technical Manager	AB	AGY	80'	Telephonic
General Director	JCB	AGY	90'	Face to face
Marketing officer	YZ	AGY	59'	Face to face
Communication officer	JS	AGY	32'	Face to face
Research Manager	PG	LSP	37'	Telephonic
		Total duration	413'	

6.3.2.1 Overview

Through the interviews, we aimed to comprehend the project context, identifying partners and documents of the project. In addition, during the seven interviews we had specific intention to identify ACAP's routines applied during the project. To this end, we conducted the interviews through an interview guide that consists of six parts (see Table 7-3).

1) **General information** collects general information about the interviewees and the company.
2) **Process and documents** aims at identifying the most important part of the project process and created or reused documents during the project.
3) **Collaboration** is about the structure of the collaboration and company's collaboration culture in running collaborative projects.
4) **Preparation of the project** focuses on performed practices beforehand to prepare the project and start the collaboration.
5) **Project development** identifies performed ACAP's practices or routines to acquire, assimilate, transform and apply external knowledge.

6) **Learning from the project** aims at bringing out learned lessons from the project. Table 7-3 presents a general overview of the interview guide (refer to chapter three section 2.6.1)

Table 7-3: Structure of interview guide

Section	Description
General information	○ Collecting general information about the interviewee's experiences and the company
Process and documents	○ Understanding the history of the project ○ Identifying mobilised knowledge in the project by the external partners ○ Identifying the most crucial parts of the project process in terms of innovation ○ Identifying created or reused documents ○ Identifying the important documents
Collaboration	○ Understanding the company's collaboration culture ○ Identifying existing facilities in the company to run collaborative project (IT/IS facilities) ○ Identifying the functionality and modality of the collaboration (sharing responsibilities, deliverables, frequency of meetings etc.)
Preparation of the project	○ Identifying performed practices to prepare the project and start the collaboration ○ Understanding shared responsibilities and expected objectives
Project development	○ Identifying performed practices and strategies to involve external partners in different stages of the project and acquire external knowledge ○ Identifying used communications and IT tools and strategies to better assimilate acquired external knowledge ○ Understanding the documentation culture of the company and how they documented their contributions during the project ○ Understanding how the transformed knowledge is finally applied to achieve the project's objectives
Learning from the project	○ Bringing out the learnt lessons from the project (strength/weaknesses/blocking points) and how they cope with the challenges ○ Identifying project's inputs in terms of internal organisational learnings

6.3.2.2 ACAP's routines

➢ *Routines for knowledge acquisition*

During the interviews the Marketing Officer of AGY, she explained the details of their internal exchanges. For instance they have two minutes morning stand up where all the actors of her team discuss about what they did yesterday and what they want to do today (Verbatim 7-5, A). In addition, they have collective discussion once per week to reveal their ideas and potential solution for confronted challenges. However, even though the Marketing Officer tried to diffuse this practice of knowledge sharing in other departments, the marketing team was practically the only one to perform these regular exchanges.

In addition, the project holders defined different types of meetings with external partners (Verbatim 7-5, B):

- *Strategic committee* where only one representative per partner attended and they were normally key actors of the project (internal and external key actors).
- *Scientific steering committee*, which run by the presence of all the actors. This type of meeting was operational and partners presented their works and progress.

They defined also other type of meeting with external partners called "Workshops". We categorise this meeting in Transformation routines.

Verbatim 7-5- Routines for knowledge acquisition in LVB-AGY – Interviews

A: Internal exchanges

❖ 2 minutes of morning stand-up with all the actors

MO: "*…there is something that I performed with my team … that comes from AGILE method that I know very well … it is morning stand-up… this allows to circulate the information… two minutes per person, every morning … what did I do yesterday and what I will do today… we exchange about that. Thus, everybody are informed...they can ask questions… sharing… as I know you want to do that and this can be helpful for you… (YZ, p. 22)*"

❖ Weekly exchange to collect the ideas of internal actors

MO: "*…every Monday we discuss about what we did last week, what I want to do this week…5 to 10 minutes per person … I try to promote others… for the moment it runs only in my office with my interns…and it works well (YZ, p. 22)*"

B: Defining different types of meetings with external partners

TM: *"…So at the beginning of the project we defined frequent meetings…3 to 4 months the frequency … I distinguish 3 types of meetings, strategic committee, scientific steering committee and workshops… (AB, p. 9)"*

- ❖ Strategic committee: a representative from each partner for planning and budgeting

TM: *"…only one representative per partner who manages the principal orientations of the project …planning…budgeting…they are mostly the general directors of the structures who participate in strategic committee (AB, p. 10)"*

- ❖ Scientific steering committee: operational meetings with all the actors of the project to present their works and progresses

TM: *"…the scientific and technical steering committee are the operational meetings…we have all the actors of the project who present their works and progress realised during last months…on the subject or related things (AB, p. 9)"*

➢ *Routines for knowledge assimilation*

The Technical Manager revealed us their assimilation routines by explaining how they collected and applied users' experiences for product development in two phases.

- In early stages of the project, they provided a 3D design of the product. They interviewed potential end-users to collect their opinion about the design and if they could imagine to use this appliance in the future (Verbatim 7-6, A). Thus, based on the interviewees' feedbacks, the company improved the design.
- Through the advertising on the social media, the company attracted early adopters for the appliance. The early adopters, accepted to buy the first version of the product, test it and provide the feedbacks. This fact, helped the company in improving the product.

The Economic Planning Expert (EX) explained us about what they did before starting the project. To apply for governmental funds for their innovation, they completed their application by integrating the economic model and planning of the project. Having reflection with their partners on the economic model and entrepreneurial aspects enriched their idea (Verbatim 7-6, B).

Verbatim 7-6- Routines for knowledge assimilation in LVB-AGY – Interviews

A: Integrating users' experiences

- ❖ Testing from the early stages of the product development

TM: "*…So we tested…we tested our usage scenarios on 3D models…then as soon as we had the first prototypes …we tested on …the testers… I talk about usage scenario…means that we ask people "… this appliance with these steps 1, 2, 3, 4… would you think it could be at your home? Would you use it as it is?"…(AB, p. 19)*"

- ❖ Applying the early adopters' experiences to improve the product

MO: "*… 10 earlier doctors… the functional and designed appliance that we wanted to commercialise in the future … these persons will send us the information of usage to tell us "so here, this thing and this one doesn't work for us! We need a round handle in this level…" …we will collect the information from different earlier doctors and improve our product …have a test phase here…it is not a scientific test…we call it earlier doctor because the people contribute and give us their point of view free of charge …they also paid…they paid to be first users… (AB, p. 17)*"

B: Reflection

- ❖ Embodying the idea via reflection on economical and entrepreneurial aspects

EX: "*…we had the initial idea which was not perfect… then we continued to push the ideas and started to reflect about the economical aspect… then…ideation… prototyping … the entrepreneurial and economic reflection… all of them are done in the same time and we add layers step by step… (CD, p. 16)*"

- ➢ *Routines for knowledge transformation*

The Economic Planning Expert discussed about the economic model and planning of the preparation phase (Verbatim 7-7, A). According to him, the objective of the model was to structure the ecosystem before starting the project and that helped identify required expertise and resources. Hence, the project holders could share and assign responsibilities based on the partners' expertise and skills.

In addition, identifying partners' expertise allowed the project holders to make relevant connections and to organise efficient meetings between them (Verbatim 7-7, B).

Verbatim 7-7- Routines for knowledge transformation in LVB-AGY – Interviews

A: Formalising the project idea

- ❖ Defining the economic model of the collaboration

EX: "*…somewhere… I am focalised to explain the model…it is not an enterprise economic model… it is an ecosystem economic model … with different actors… (CD, p. 11)*"

- ❖ Defining action plan besides theoretical framework

EX: "*…still the same… what I have presented…in fact we had the theory and we designed an action plan to decide how it could be realised… then how it can happen in the reality… (CD, p. 12)*"

B: Identifying and using the expertise of the partners

- ❖ Transversal meetings (workshops) between the actors of the project to resolve highlighted blocking points during steering committees

TM: "*...well the third type of our exchanges...the workshops...on the predefined topics beforehand during steering committees presentations... we can say that we see in steering committees there is a topic that required to be discussed transversally... then we asked the person who is expert in this term to conduct a multidisciplinary workshop...with different actors. These workshops are on specific topics... they are very enriching... (AB, p. 9)*"

- ❖ Make connections between partners based on their expertise aspects and their input to the project

TM: "*...On cultural and nutritional aspects we (AGY and LVB) have meeting with two other partners (IFR, and PRY)... at the beginning of the project we hold the meeting each three weeks... now it is monthly... as we resolve most of the problematics of these aspects. The same we had regular meetings with group S, on usage scenarios aspects. (AB, p. 14)*"

- *Routines for knowledge application*

The project holders shared responsibilities and AGY worked specifically on the technical specifications, market study and fund raising. LVB tried to federate all the partners (prospects, customers, early adopters, public and private companies, universities and schools etc.) of the project via its network. They also formalised the objective of the project at the very first stage and made it clear for all the internal actors of both companies.

AGY proposed the first version of the consortium agreement based on existing templates used for their other projects. The draft of agreement was circulated between the project partners until they agreed on a consensus form (Verbatim 7-8). According to the Research Manager, this collaborative preparation of the agreement worked very well for this project.

Verbatim 7-8- Routines for knowledge application in LVB- AGY – Interviews

Collaborative agreement preparation

- ❖ Sharing the responsibilities between project holders from the beginning the project

EX: "*...LVB federates all the actors of the project and AGY focalises on the market and should be efficient to raise funds. Going to the market in terms of material... it is in the structuration and sharing responsibilities between project holders...(CD, p. 7)*"

- ❖ Formalising the objectives at the beginning of the project and making them clear internally.

EX: "*...we thought to run a project... we prepared the application... we tried to understand each other...we prepared documents to explain to the stakeholders what we wanted to develop through this project and* *what is our vision. So we had a formalisation of our objectives to enable the discussion about them later…and see how we can involve actors of the company… (CD, p. 10)"*

❖ Preparing the consortium agreement collaboratively

RM: "*…I think they had a consortium agreement for other projects. Based on their other template, the project holders (AGY) analysed, customised the agreement, and then circulated between juridical parts of the different partners. The circulation continued until we achieved to a consensual form… it may be classical but worked very well…(PG, p. 12)"*

6.3.2.3 Summary of the results

Table 7-4 summarises extracted ACAP's routines through the interviews and shows 100% of these routines have Managerial (M) nature with the following themes:

- **Formalising the ideas**: it is about collecting and formalising the partners' ideas. For instance, before starting the collaboration and preparing the consortium, the initial idea for the new product required to be enough structured and evaluated.
- **Structuring the consortium**: this theme emphasises on the structuring of the agreement and sharing the responsibility before starting the project. For instance, in PL project the partner's feedback were collected to prepare and improve the agreement collaboratively.
- **External communication:** this theme relies on organising various meetings with external partners during the project. Through the PL project, the project holders organised different types of meetings to make connections between the partners.
- **Internal exchanges**: this is about the communication and exchanges between internal company's actors in a systematic way (daily/ weakly etc.).
- **Users' experience**: this theme is about collecting and applying users' feedbacks to improve the product. This can be performed from the early stages of the product development.
- **Collaborative knowledge creation:** this theme targets all the practices/routines that performed to create common vision with external partners. This could be also considered as a sub-theme of *external communication.*

Table 7-4: Identified ACAP's routines in AGY-LVB– Interviews

ACAP	Routines	Nature of routines*	Themes of ACAP's routines
Acquisition	Two minutes of stand-up morning with the staffs (Verbatim 7-5, A)	M	Regular internal exchange
	Weekly exchange tow collect internal actors' ideas (Verbatim 7-5, A)	M	Regular internal exchanges
	Scientific steering committees (operational meeting) with all the partners of the project (Verbatim 7-5, B).	M	External communication
	Strategic committee with the external actors (at least one representative from each partner) (Verbatim 7-5, B).	M	External communication
Assimilation	Testing from the early stage (Verbatim 7-6, A).	M	Users' experience
	Applying users' experiences to improve the product (Verbatim 7-6, A).	M	Users' experience
	Formalising the idea via reflection on economical and entrepreneurial (Verbatim 7-6, B).	M	Formalising the ideas
Transformation	Defining economical model of the collaboration (Verbatim 7-7, A).	M	Formalising the ideas
	Identifying and using the expertise of the partners (Verbatim 7-7, A).	M	Knowledge sharing
	Holding transversal meetings between the partners of the project to highlight and resolve blocking points (Verbatim 7-7, B).	M	External communication, collaborative knowledge creation
	Make connection between partners based on their expertise and their expected inputs into the project (Verbatim 7-7, B).	M	Structuring consortium
Application	Sharing the responsibilities between partners from the beginning of the project (Verbatim 7-8).	M	Structuring consortium
	Formalising the objectives at the beginning of the project and make them clear internally (Verbatim 7-8).	M	Structuring consortium
	Preparing the consortium agreement collaboratively (Verbatim 7-8).	M	Structuring consortium

**Managerial (M), Technical (T) or Technical&Managerial (T&M)*

The managerial ACAP's routines were applied for external knowledge acquisition through regular internal exchanges between the actors to explain what they captured from external resources or during their work experience. However, these internal exchanges were limited to the marketing department as the Marketing Officer highlights:

> "*...every Monday we discuss about what we did last week, what I want to do this week...5 to 10 minutes per person ... I try to promote others... for the moment it runs only in my office with my interns...and it works well (YZ, p. 22)*".

In addition, the Managerial ACAP's routines were performed to acquire external knowledge via different types of meetings with external partners. During these meeting, LVB-AGY's actors collected different ideas and proposed various possibilities of product design. These designs were tested by the users (early adopters) and their feedback helped improve the product design from the early stages of the project. Additionally, through the meetings with external partners, these designs propositions had been discussed and potential solutions were proposed.

These external meetings allowed the project's partners to discuss the drawbacks and find potential solution collectively as well as to better identifying each other's' expertise, which reinforced their connection.

6.3.3 Identifying ACAP's routines via ISEACAP: Knowledge mapping session in LVB-AGY

We conducted two experimental sessions within company LVB-AGY for knowledge mapping and routines eliciting and enriching. The two sessions were held with the same participants in two sequential days: Technical Manager (TM), Project Manager (PM) and Research Manager (RM). The knowledge mapping sessions aimed at providing map of mobilised knowledge during the project and highlight where external knowledge had been entered to the project.

6.3.3.1 Overview

Before the experimental session, we had two interviews with the Project Manager (General Director of LVB) and Technical Manager to identify key actors, process and documents of the project. As the result, three key actors confirmed their participation in both sessions and two documents were identified: (i) Xmind: a mind map, which was constructed collectively through a brainstorming during one of the steering committee of the project. (ii) PowerPoint: a collaborative document which was completed progressively during the project and presented in the project meetings. During the experimental session, the participants (all the three actors) used both identified documents.

In the following, we present identified ACAP's routines during knowledge mapping which is the analysis of the transcription.

6.3.3.2 ACAP's routines

➢ *Routines for knowledge acquisition*

By following the Coding guideline 1, two categories for routines of knowledge acquisition were identified. The first category is "exchanges with partners" (Verbatim 7-9, A). The company had regular meetings with the partners to share their findings. In addition, they involved external experts as sub-contractors when they confronted with knowledge and resource's scarcity to qualify the sanitary aspects of the product. The second category is "collecting partners' ideas" (Verbatim 7-9, B). During the project, the partners conducted brainstorming meetings to collect partners' ideas and improve the functionality of the product. One of these brainstorming was conducted through usage scenario to identify users' needs and evaluate the feasibility of product functions.

Verbatim 7-9- Routines for knowledge acquisition in LVB-AGY – Knowledge mapping session

<u>A: Exchange with partners</u>

❖ External communication: meeting and sharing findings regularly with partners

TM: "*…here…this is an exchange only between Group S and us…this one is about our meeting with all the partners to present the results but then we entered to an exchange cycle …(AB, Doc 1, p. 24)*"

❖ Collaboration: Involving external experts

PM: "*… for sanitary factors…we didn't have required information … we involved X and signed a contract with them…(GG, Doc 1, p. 31)*"

<u>B: Collecting partners' ideas</u>

❖ External communication: Conducting structured brainstorming with external partners

TM: "*… We had a focus group …which worked well in terms of partnership…project … idea(AB, Doc 1, p. 27)s*"

❖ External communication: Conducting usage scenario with partners

RM: "*… the usage scenario…we defined operational dimension at the beginning …how can we position the operation based on sequence of the project …what we had imagine is feasible or not…(PG, Doc 1, p. 28)*"

RM: "*...by being around a table and seeing step by step ... each partner asked him/herself as a user while they have also scientific knowledge to detect the ideas about dangers ...not only dangers ... (PG, Doc 1, p. 30)*

➢ *Routines for knowledge assimilation*

Verbatim 7-10 presents identified routines for knowledge assimilation. For instance, one of the important factors in the design was the capacity of the product. This capacity had been defined initially ten litters. However, during one of the brainstorming with all the partners and conducted via usage scenario, the partners of the project realised that ten litters is not easy to wash, fill and empty for all the users (Verbatim 7-10, A). Thus, they reduced the capacity to three litters and adjusted the design to be easy washing. In addition, they provided different possibilities of the design by leaving more margin to the designer and integrating different factors in the design (Verbatim 7-10, B).

Verbatim 7-10- Routines for knowledge assimilation in LVB-AGY – Knowledge mapping session

A: Considering functional requirements

❖ Specification: Analysing the result of brainstorming and identified users' needs

TM: "*...we previewed 10 litters, but during the brainstorming ... a problem raised... how to wash it in washing machine and move it...we decided to reduce it to 3 litres ... 10 litres is ok for me to carrying and washing but I am not sure about my little brother if he can easily carry this quantity ... (AB, Doc 1, p. 24)*"

TM: "*For me this is very important... this is really an external input ... brought us an inspiration and create a clear image of the product for us ...*" *(AB, Doc 1, p. 23)*

❖ Specification: Identifying economical aspects of environmental requirements

PM: "*... We identified techniques and requirements to grow the plant ...the lighting ... we look a little to the individual equipment ... (GG, Doc 1, p. 46)*"

B: Providing various possibility of design

❖ Specification: Leaving more margin to designer

TM: "*... Exactly...this is to avoid the constraints ... we don't figure the element...which means that to leave more margin ... we have up and back with designer ... this one is not working based on criteria and that one works ...(AB, Doc 1, p. 47)*"

TM: "*... Based on that ... briefly, the designer took three elements and proposed five architectures ...(AB, Doc 1, p. 25)*"

❖ Specification: Integrating the identified factors in design

PM: "*... finally we try to solve technical constraints by confronting with the constraints of unit price when we switch to development ...(GG, Doc 1, p. 46)*"

PM: "*... we find out three times ...means that how we use the product, what is its functionality...how to wash it...how to fill and empty it...(GG, Doc 1, p. 38)*"

➢ *Routines for knowledge transformation*

Based on the requirements and users' needs, a designer from group S proposed five different architectures. A collective brainstorming was held with all the partners to focus on the usage scenario based on the five proposed architectures. Resulting from the brainstorming, the project's actors decided to eliminate three of five which potentially couldn't cover users' needs (Verbatim 7-11, A). In addition, during the project, the TM provided a synthesis of expected results (Verbatim 7-11, B) and a schema of the plant cultivating completed this synthesis. His synthesis allowed the actors to comprehend better the project's objectives and remember expected objectives.

Verbatim 7-11- Routines for knowledge transformation in LVB-AGY – Knowledge mapping session

A: Testing different possibilities to choose the best design

- ❖ Technical documentation: Testing based on the users' needs

RM: "*…Then the simulation allowed us to calculate based on the different scenarios …to look if we go into a timescale when there is of danger, for example … if we dissolve a powder … if the powder puts 48 hours to be dissolved completely, there is no concern at the theoretical and industrial levels but in users level it can be a concern, if somebody puts himself in the idea to accelerate and thus to begin eat it earlier … here we are, there is a concern (PG, Doc 1, p. 29)*"

- ❖ Collective knowledge creation: Choosing collectively with partners and applying their ideas

TM: "*…based on the five proposed architectures by designer we had a meeting with the external partners to choose one of the architectures … during the first meeting we eliminated three of five … (AB, Doc 1, p. 25)*"

B: Synthesising the results of the tests

- ❖ Internal communication: Sharing the results of synthesis with the internal actors

PM: "*… It was very important for me what TM had done, a concrete synthesis of the tests results……(GG, Doc 1, p. 33)*"

- ❖ Visual representation : Reminding and considering the expected results and objectives

PM: "*…analysing expected results and preparing a schema which models the crop and harvest cycle of the plant …I believe that based on this schema our objectives became visible and understandable for the actors …(GG, Doc 1, p. 33)*"

➢ *Routines for knowledge application*

The acquired, assimilated and transformed knowledge is applied during the project by providing the first mock-ups of the chosen designs (Verbatim 7-12, A). In addition, the company AGY made a sub-contract with an external company to develop a simplified version of the appliance in parallel. To communicate with the sub-contractor and for externalising their product, they employed what they had learned from their partners in terms of communication skills such as structured brainstorming and usage scenario (Verbatim 7-12, B).

Verbatim 7-12- Routines for knowledge application in LVB-AGY – Knowledge mapping session

A. Specification: Providing a mock-up of chosen design

TM: *"…but… this is the first time we could see what it could be look like the final product…a mock-up played the role of take-off, and guided us to the details … in hidden zones of the appliance…(AB, Doc 1, p. 26)"*

RM: *"…this was the first step to realise the logical order of an appliance…here we made a prototype … (AB, Doc 1, p. 58)"*

B. External communication: Externalising the product

PM: *"… for us, this taught us as well …to work with our sub-contractors … we applied the same working methods design … physical representation of the appliance … different steps of usage scenario… and finally propose different architectural predesigns and choosing collectively through brainstorming …(GG, Doc 1, p. 27)"*

6.3.3.3 Summary of the results

Table 7-5 summarises extracted ACAP's routines from the transcript and highlighted the nature and themes of their application. In the same way as previous sections, we consider three types of ACAP's routines: Managerial (M), Technical&Managerial (T&M), Technical (T) with the following themes:

- **External communication** is about communication of company with the external partners such as meetings, formal and informal exchanges etc.
- **Internal communication** is about knowledge exchange among internal actors of company regarding project.
- **Specification** includes all technical and economic aspects of product such as economical model, design of the product and test analysis.
- **Collaboration** relies on structure (e.g. agreement between the partners) and functionality of collaboration.
- **Knowledge sharing** refers to the transparency and sharing obtained results and collected data during collaboration. This theme can be considered in certain cases as the sub-theme of collaboration.
- **Externalisation** emphasises on introducing new product/service to potential users or markets.

Table 7-5: Identified ACAP's routines in LVB-AGY– Knowledge mapping session

ACAP	Routines	Nature of routines*	Themes of ACAP's routines
Acquisition	Meeting and sharing findings regularly with partners (Verbatim 7-9, A).	M	Knowledge sharing and External communication
	Involving external partners (Verbatim 7-9, B).	M	Collaboration with external experts
	Conducting structured brainstorming with external partners through usage scenarios (Verbatim 7-9, B).	M	Collaborative knowledge creation
Assimilation	Analysing the result of brainstorming and identifying users' needs (Verbatim 7-10, A).	T&M	Specification
	Identifying economical aspects of environmental requirements (Verbatim 7-10, A).	T&M	Specification
	Providing various possibilities of design (Verbatim 7-10, B).	T&M	Specification
Transformation	Discussing with external partners about different possibilities of the design based on users' needs (Verbatim 7-11, A).	T&M	Collective knowledge creation, technical documentation
	Analysing the results of the tests and sharing with internal actors (Verbatim 7-11, B).	T&M	Internal communication, visual representation
Application	Providing a visual representation of the final product based on the chosen designs (Verbatim 7-12, A).	T&M	Visual representation
	Externalising the product by communication with the external community and subcontractors (Verbatim 7-12, B).	M	Externalisation

**Managerial (M), Technical (T) or Technical&Managerial (T&M)*

As Table 7-5 presents Managerial ACAP's routines were applied via different external communications and collaboration with external experts to acquire new knowledge during the project. To assimilate acquired knowledge Technical&Managerial ACAP's routines were applied through different technical documentations such as result analysing, various possibilities of design and economical aspects. The assimilated knowledge was transformed through Technical and Managerial ACAP's routines via collaborative knowledge creation and sharing. Finally, Technical and Technical&Managerial (T&M) routines applied for knowledge transformation via visual representation of the product and publishing on social media.

6.3.4 Identifying ACAP's routines via ISEACAP: Routines eliciting and enriching session in AGY-LVB

The same actors as knowledge mapping session were the participants of routines eliciting and enriching session. TM (Technical Manager), PM (Project Manager) and RM (Research Manager). The main objective of the session was identifying performed ACAP's routines during the project. In addition, as presented in previous chapter, we provided the participants the packages of ACAP's best practices extracted from the literature that allowed them to compare with their identified routines or practices.

6.3.4.1 Overview

The session started base on the created knowledge map during the previous session. The participants focused on the transformation nodes (simple circles on the map: represents transformation node where general or external knowledge are mobilised and specific knowledge transformed) and explained what happened, what did they perform or should be performed. Applied gamification techniques in this session encouraged the participants to have collective discussion and reflection about their ACAP's routines.

6.3.4.2 ACAP's routines

- *Routines for knowledge acquisition*

LVB-AGY involved their partners in all the stages of the project, in order to acquire the external knowledge from them. For instance, one of the Research Centres played the role of the first client (Verbatim 7-13, A) which allowed the actors to identify the potential clients' needs.

In addition, they conducted several brainstorming meetings to generate ideas collaboratively. However, for the simplified version of the product, the LVB-AGY did not involve their partners for "unit pricing estimation" and eventually did not collect their ideas for this part of the project. Despite this decision, the Research Manager believed that the Group S could bring valuable experiences in this term.

Another ACAP's routine that facilitated external knowledge acquisition was related to transparency of the partners during the project. For instance, all the partners were sharing their information even they did not assist in the meetings (Verbatim 7-13, B). This information and knowledge sharing was performed systematically along with creating mutual trust and kept them updated during the project about others' works.

Verbatim 7-13- Routines for knowledge acquisition in LVB-AGY – Routines eliciting and enriching

A: Mobilising external partners in all the stages of the project

- ❖ Collaborative idea generation: Playing the role of client by one of the partners

RM: "*…Can I choose a word?...I will choose "Client", from node 4, the company had the first client…the Research centre who played the role of first client … (PG, Doc 2, p. 22)*"

- ❖ Collaborative idea generation: Launching the reflection on unit pricing

RM: "*…I would like to choose "mobilising" and it is true that between nodes 3 and 4, we didn't know how to mobilise Group S and put them in the design cycle of the new product … I think they had valuable knowledge to bring in this part… to the specification and unit price estimation … it could be interesting to address them … (PG, Doc 2, p. 24)*"

B: Transparency and sharing information

- ❖ Knowledge sharing: Updating information by the partners, even if they did not assist in the meetings

RM: "*…I am still on the node 4… I touched "Exchange"… In fact even if the research centre did not attend to the meetings…I think we had a continuous information exchange… scientific or technique … (PG, Doc 2, p. 18)*"

- ❖ Knowledge sharing: Creating mutual confidence among partners through several exchanges

RM: "*…Maybe later… there was no problem that the RC did not participate in the meetings… we didn't regret to not be involved … this is a total confidence on what would be done without us… thus we could be absent in one node… that's what I wanted to add… (PG, Doc 2, p. 16)*"

- ➢ *Routines for knowledge assimilation*

In this project, visualising the results facilitated the project's partners to have a clear and common understanding on their objectives and identifying different required aspect of the product (Verbatim 7-14, A). In addition, these documents allowed the partners to create new knowledge collaboratively.

The partners share their knowledge base, which facilitated knowledge assimilation during the project. For instance, at the beginning of the project, an expert from Group S conducted a participative workshop with all the project's actors to collect their ideas in terms of usage scenarios (Verbatim 7-14, A). As the results of the workshop, they created a mindmap collaboratively and facilitates all the project's actors to concentrate and share the same sources of information. These exchanges enhanced mutual trust between the partners and encouraged them to share their knowledge (Verbatim 7-14, B).

Verbatim 7-14- Routines for knowledge assimilation in LVB-AGY – Routines eliciting and enriching

A: Considering functional requirements of the product

- ❖ Specification: Identifying different aspects of the product based on generated architecture

TM: "*...So on the node 3... when they said "concentrate" ... In fact based on the generated architectures...in ... in entering phase... we had a concentration with our partners to select two architecture and reduce the possibility fields on the appliance... (AB, Doc 2, p. 17)*"

- ❖ Visual representation: Enhancing reflection via visual representation of ideas

RM: "*... It was a good starting point...I choose "Thinking". We thought a lot to solve challenging points... I would like to choose putting in question, as we thought a lot to put in question the ideas...we used some means to do that I do not know... (PG, Doc 2, p. 12)*"

TM: "*...Visual representations... (AB, Doc 2, p. 12)*"

RM: "*...that allows us to see... (PG, Doc 2, p. 12)*"

- ❖ Knowledge sharing: Integrating the external partners' knowledge bases

TM: "*... So based on that... during a meeting with whom... we integrated knowledge based of other partners that are summarised with the three knowledge in these three nodes... the idea was to start to create a shared document... (AB, Doc. 2, p. 6)*"

B: Creating common visions

- ❖ Idea formalisation: Valorising the partners' ideas and creating common knowledge references such as mindmap

RM: "*...it was group S. An expert from this group... guided us to think about our usages scenarios... to work and think on the functionality of the appliance... creating a document Mindmap...extracting different ideas and providing a common document... that allowed us to concentrate and sharing the same sources of information (PG, Doc 2, p. 7)*"

- ❖ Collaborative knowledge creation: Creating common vision on usage and functionality of the final product by external partners

RM: "*...Providing a common document... that allowed us to concentrate and share the same sources of information...of the required functionality of the appliance... the knowledge on the usage...(PG, Doc 2, p. 8)*"

- ❖ Knowledge sharing: Creating mutual confidence among partners through several exchanges

RM: "*...I entirely trusted on what they had done... and ... without any problem... I think that we continued in our side and knew that our partners would send the result... (PG, Doc 2, p. 16)*"

- *Routines for knowledge transformation*

The common visions and collaborative documents had created a common referential that was shared with all the partners and allowed them to transform the assimilated knowledge and have a mutual progress (Verbatim 7-15, A).

During the exchanges, the project's partners identified constraints of the design and through visual representation (3D design), they revealed potential usage challenges, which had not been considered at the initiative design and even it became the priority to be resolved (Verbatim 7-15, B).

During various knowledge sharing between the partners through meetings and brainstorming, they achieved to create knowledge collaboratively. Knowledge creation happened by integrating the empirical knowledge captured during the project and combining partners' expertise.

Verbatim 7-15: Routines for knowledge transformation in LVB-AGY – Routines eliciting and enriching

A: Synthesising the process of project's stages

- Collaborative Progressing (mutual progress): Progressing in parallel based on common references created in the initial steps of the project.

TM: "*...This means that we had an exchange...we are in a meeting this node...a meeting with everybody. Here there is the result of shared common referential and then the parallel works...realised in parallel...(AB, Doc. 2, p. 13)*"

B: Identifying the constraints of the designs

- Visual Representation: Highlighting identified constraints via 3D design

PM: "*...Because I think the approach...the visualisation via 3D design...the usage constraints became the major constraints...they became priority...(GG, Doc. 2, p. 15)*"

- Collaborative knowledge creation: Converging different ideas and know-how of different partners to create solutions

PM: "*...In this moment we catalysed empirical knowledge and expertise of partners...so from different mobilised knowledge initially...it was the knowledge integration and convergence of different know-how that each internal and external actors brought to the project ... (GG, Doc 2, p. 10)*"

➢ *Routines for knowledge application*

In the time of experimental sessions in LVB-AGY, their project was still in progress and the general application routines were not identifiable. However, acquired, assimilated and transformed knowledge through several exchanges and brainstorming had been applied during intermediate stages such as providing the prototype and mock-ups (Verbatim 7-16, A). The first prototype provided a visual representation of the final product (appliance). This allowed the partners to converge their ideas about required pieces of the appliance and had unit cost estimation based on the provided prototype.

The LVB-AGY's actors externalised the product in the early stage via social media to attract early adopters and introduce their future product to the potential market (Verbatim 7-16, B).

Verbatim 7-16: Routines for knowledge application in LVB-AGY – Routines eliciting and enriching

A: Providing mock-ups of chosen design

- ❖ Visual Representation: Realising experiences via prototyping the product

RM: "*...It's my turn? On node 4, I did not tell that... Maybe I should choose "experimentation". For us, the node four was construction of the appliance prototype that allowed us to realise our experiences...(PG, Doc. 2, p. 21)*"

- ❖ Collaborative progressing (mutual progress): Integrating the identified factors in design

PM: "*... I choose the node 4... there is a word "Prototype". I think relying on this visualisation of final product we could assign the task of prototyping... that was the converging point for the required pieces for a unit of the appliance... also the pieces that should be produced. So their cost that depends on the number of production... (GG, Doc 2, p. 20)*"

B: Externalising the product

- ❖ Commercialising: Externalising the project in early stages via social media

TM: "*...To talk about another topic, the communication, based on ... in node 3 we started to dispose the communication tools... In fact applied to communicate on social media and externalise the product... (AB, Doc 2, p. 21)*"

6.3.4.3 Summary of the results

Table 7-6 summarises highlighted routines, their nature based on Managerial (M), Technical (T) or Technical&Managerial (T&M) categories and their themes. We defined a new theme called collaborative progressing (mutual progress) based on this part of the analysis.

- **Collaborative progressing (mutual progress)** means progressing in parallel based on the predefined milestones and informing the partners about the stages of progress.

Table 7-6: Identified ACAP's routines in LVB-AGY– Routines eliciting and enriching session

ACAP	Routines	Nature of routines	Themes
Acquisition	Playing the role of client by one of the partners (Verbatim 7-13, A).	Managerial	Collaborative knowledge creation
	Launching a collective reflection on unit price (Verbatim 7-13, A).	Managerial	Collaborative knowledge creation
	Updating information by the partners, even if they do not participate in meetings (Verbatim 7-13, B).	Managerial	Knowledge sharing
	Creating mutual confidence among partners through several exchanges (Verbatim 7-13, B).	Managerial	External communication
Assimilation	Identifying different aspects of the product based on generated architecture (Verbatim 7-14, A)	Technical	Specification
	Enhancing reflection via visualising the ideas (Verbatim 7-14, A).	Technical-Managerial	Visual representation
	Integrating the external partner's knowledge bases (Verbatim 7-14, B).	Managerial	Knowledge sharing
	Valorising the partners' ideas and creating common knowledge references such as mind map (Verbatim 7-14, B).	Technical-Managerial	Idea formalisation
	Creating common vision on usage and functionality of the final product by external partners (Verbatim 7-14, B).	Technical	Knowledge sharing
Transformation	Progressing in parallel based on common references created in the initial steps of the project (Verbatim 7-15, A).	Managerial	Collaborative progressing
	Highlighting the confronted constraints via 3D design (Verbatim 7-15, A).	Technical	Technical documentation, visual representation
	Converging different ideas and know-how of different partners to create solutions (Verbatim 7-15, B).	Managerial	Collaborative knowledge creation
Application	Realising the ideas through prototyping (Verbatim 7-16, A).	Technical	Visual representation
	Integrating identified factors in design (Verbatim 7-16, A).	Technical	Collaborative documentation

ACAP	Routines	Nature of routines	Themes
	Externalising the product in early stage of the project via social media (Verbatim 7-16, B).	Managerial	Externalisation

As Table 7-6 presents ACAP's managerial routines were employed for knowledge acquisition via collaborative knowledge creation and external communication. To assimilate the acquired knowledge, all the three nature of routines were applied to create visual representation.

Technical and Managerial ACAP's routines were applied to transform assimilated knowledge by collaboratively sharing knowledge between the project's partners. These two nature of routines were also performed to transform knowledge via prototyping the product and externalising through social media.

The company AGY was in a long relationship with the research centres before the project, thus the mutual trust had been shaped earlier. One of the partners of the project was a large group of domestic appliance productions, which had notable experiences to work collaboratively with other partners and develop innovation projects. Through this project, the group used their experiences to manage the collaboration via conducting structured brainstorming and creating collaborative documents for idea generation. Shared resources and having several exchanges created mutual trusts among the partners of the project. In addition, collective idea generation and knowledge creation enabled the partners to progress in parallel and sharing their findings regularly.

Nevertheless, in company AGY, internal communication and shared documentation was not detailed during the experimentations. Based on our observation, the company AGY was hosted in a university's buildings where technical department was located in a separated building from the commercial and marketing departments. The internal actors, in particular technical manager did not have daily interaction with the marketing actors. In the following section, we analyse the result of our interviews with the internal actors of the company and highlight confronted challenges due to their internal communications.

6.3.5 Synthesis of the first stage

The first stage of the analysis provided the details of the identified ACAP's routines through conducting experimental sessions via ISEACAP in Alpha and LVB-AGY and semi-structured interviews in LVB-AGY. Based on this part of results we propose Table 7-7, which summarises the identified ACAP's best practices/routines. This list might be helpful for SMEs that develop innovative projects in collaboration with other partners. In addition, the table clarifies identified themes/sub-themes to make the research replicable for other researchers and enables the research's generalisation.

Table 7-7: Summary of identified ACAP's routines

ACAP	Themes of routines	Definitions	Examples
Acquisition	External documentation	Documenting and classifying the exchanges with external partners	Documenting the exchanges with client during the entire project (Alpha, KM, Verbatim 6 1, A)
	Collaboration with external experts	Involving external experts to resolve confronted problems in each stage of the project	Collaborating with an external expert to resolve the technical problem (Alpha, KM, Verbatim 7-1, B)
	Regular internal exchange	Organising regular exchanges between the internal actors	Two minutes of stand-up morning with the staffs (LVB-AGY, Interview, Verbatim 6-6, A)
	External communication	Defining various meetings with the partners from the beginning of the project	Meeting and sharing findings regularly with partners (LVB-AGY, KM, Verbatim 6-10, A). Scientific steering committees (operational meeting) with all the partners of the project (LVB-AGY, Interview, Verbatim 6-6, B). Creating mutual confidence among partners through several exchanges (LVB-AGY, RE, Verbatim 6-13, B).
	Collaborative knowledge creation	Collecting and integrating partners' ideas by conducting brainstorming and creating new knowledge collectively	Conducting structured brainstorming with external partners through usage scenarios (LVB-AGY, KM, Verbatim 6-10, B). Playing the role of client by one of the partners (LVB-AGY, RE, Verbatim 6-13, A).
Assimilation	Knowledge sharing	Being transparent and sharing findings and collected data regularly with external partners	Classifying exchanged and shared knowledge with partners (Alpha, KM, Verbatim 7-2, A)
	Internal communication	Communicating acquired knowledge from external partners with the internal actors	Observing the procedure developed by external expert and communicate internally (Alpha, KM, Verbatim 7-2, D)
	Users' experience	Collecting and integrating users' experience to improve the product/service quality	Testing from the early stage (Verbatim LVB-AGY, Interview, 6-7, A). Applying users' experiences to improve the product (LVB-AGY, Interview Verbatim 6-7, A).
	Specification	Specifying the details of the product/service such as	Identifying different aspects of the product based on generated architecture (LVB-AGY, RE, Verbatim 6-14, A) Analysing the result of brainstorming and identifying users' needs (LVB-AGY, KM, Verbatim 6-10, A).

ACAP	Themes of routines	Definitions	Examples
Transformation	Idea formalisation	Collecting and formalising external partners' ideas	Formalising the idea via reflection on economical and entrepreneurial (LVB-AGY, Interview, Verbatim 6-7, B). Valorising the partners' ideas and creating common knowledge references such as mind map (LVB-AGY, RE, Verbatim 6-14, B).
	Internal documentation	Creating templates and standard codes to facilitate internal communications	Sharing technical findings via specific forms (templates) which are reusable and accessible for other internal actors (Alpha, KM, Verbatim 6 2, C).
	Visual representation	Visualising the results or findings via graphical facilities	Codifying created elements during the project through graphical supports and drawing (Alpha, KM, Verbatim 6 2, C).
	Technical documentation	Documenting systematically the technical findings	Following and updating systematically the technical documents (Alpha, KM, Verbatim 6-5, C).
	Collaborative knowledge creation	Collecting and integrating partners' ideas by conducting brainstorming and creating new knowledge collectively	Holding transversal meetings between the partners of the project to highlight and resolve blocking points (LVB-AGY, Interviews, Verbatim 6-8, B).
	Collaborative progressing	Progressing in parallel with project partners	Progressing in parallel based on common references created in the initial steps of the project (LVB-AGY, RE, Verbatim 6-15, A).
Application	Quality control and improvement	Testing the quality of the product/service in each stage of the project and providing a continuous improvement based on the previous findings	Improving the quality of the product through several testing based on what they captured from the external expert (Alpha, KM, Verbatim 6 5, A).
	Visual representation	Visualising the results or findings via graphical facilities	Providing a visual representation of the final product based on the chosen designs (LVB-AGY, KM, Verbatim 6-13, A).
	Technical documentation	Documenting and the tests results to enable all the actors to track the evolution	Categorising findings during different tests and refer to them to find solutions (Alpha, KM, Verbatim 6 5, B)
	Progress evaluation	Evaluating the progress after each stage based on the tests results	Evaluating the progress in the results of tests (Verbatim 6 5, D).
	Structuring consortium	Preparing the consortium agreement and sharing responsibilities from the beginning	Formalising the objectives at the beginning of the project and make them clear internally (LVB-AGY, Interview, and Verbatim 6-9). Preparing the consortium agreement collaboratively (LVB-AGY, Interview, Verbatim 6-9).
	Externalisation	Introducing the new product/service to the potential users and markets.	Externalising the product by communication with the external community and subcontractors (LVB-AGY, KM, Verbatim 6-13, B).

6.4 Second stage: cross-cases analysis

Through the first stage of analysis, we identified ACAP's routines from the experimental sessions and semi-structured interviews. Considering these results, through the second stage of analysis we aim at:

(i) Showing the complementary role of interviews and experimental sessions to refine provided answer through the two first chapters for our first sub research question: *"A. What kind of method can we propose to highlight ACAP's organisational routines?"*

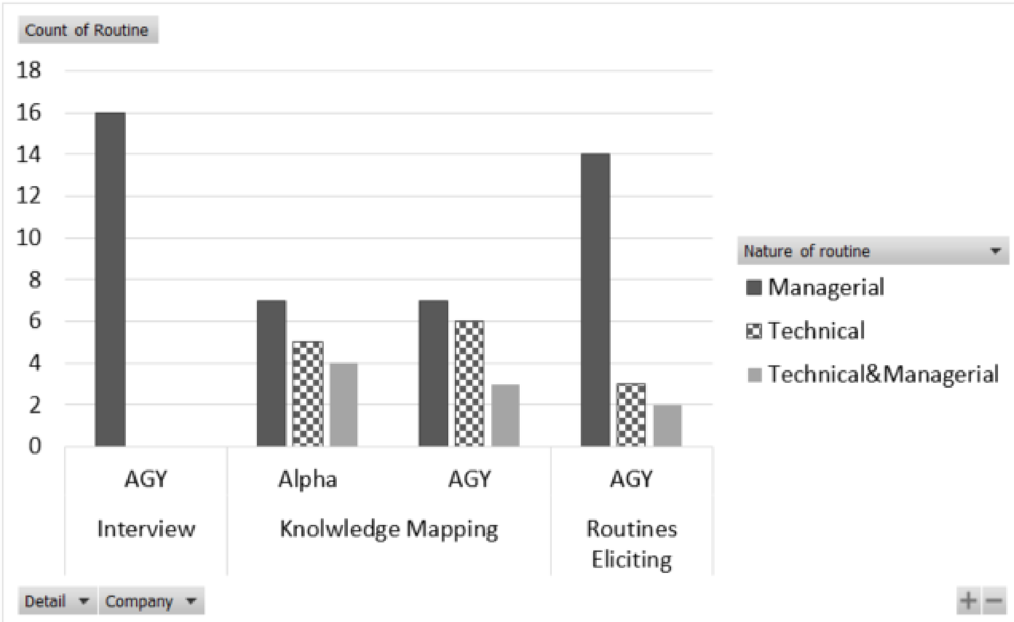
(ii) Focusing on the reflexive aspect of the ISEACAP and its role to raise the reflexivity among the participants. This part of analysis addresses the second sub question: *"B. How to provide a reflexive space for organisations' actors to have reflection on their ACAP's routines?"*

(iii) Showing the role of the conducted reflexivity through ISEACAP to enhance the learning about ACAP's routines. This part of the analysis targets the last sub research question "*C. How can organisational learning be enhanced via reflexivity?"*

6.4.1 Complementary role of ISEACAP and interviews to identify ACAP's routines (Q. A)

Figure 7-2 compares identified ACAP's routines in terms of nature and number. As the figure shows, knowledge mapping sessions have approximately the same shape in both Alpha and AGY companies to reveal all the three natures of ACAP's routines. During the knowledge mapping session, the participants started from the documents such as technical forms or project presentations that contained technical information and naturally, Technical (T) or Technical&Managerial (T&M) routines played imperative roles. Routines eliciting relies only on collected data from LVB-AGY as we didn't conduct this session in Alpha.

Figure 7-2: Comparing the nature of identified ACAP's routines



During the routines eliciting and enriching sessions, beside of the Technical and Technical&Managerial routines, the Managerial ACAP's routines took also an important part of the session.

During the interviews, we identified only Managerial routines but no Technical or Technical&Managerial routines. Referring back to the first stage of analysis we can consider that identified routines during the interviews complete the ones from experimental sessions in terms of content and details.

This comparison shows the complementary role of interviews, knowledge mapping, routines eliciting and enriching sessions to reveal all the types of ACAP's routines.

Going further in details of the identified routines, Figure 7-3 shows that majority of Technical routines were employed for knowledge application while Managerial routines played imperative role in knowledge acquisition.

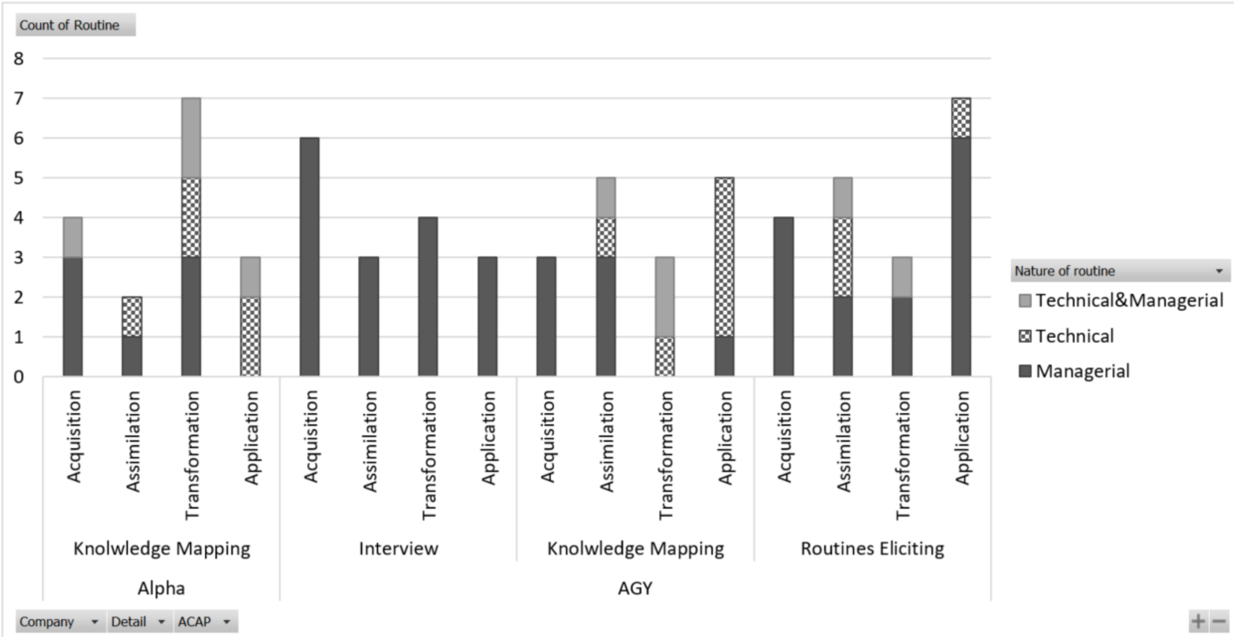
Considering obtained results from the experimental sessions, we can see in the figure that for knowledge assimilation and transformation all the three Managerial, Technical and Technical&Managerial are required.

Figure 7-2 allows us to compare interviews with experimental sessions as well and as it shows, during interviews any Technical or Technical&Managerial routines were not revealed while during experimental sessions a combination of all the three natures of the ACAP's routines are highlighted.

In addition, the figure allows us to compare knowledge mapping and routines eliciting sessions conducted in LVB-AGY. During 'routines eliciting', identified Managerial routines played imperative role in knowledge acquisition and application while in 'knowledge mapping' session, Technical routines were more active during knowledge application. This different refers to the protocol of the method as 'knowledge mapping' emphasises on the documents and naturally participants considered technical findings or tests results as the application of the knowledge. However, during routines eliciting the participants focused on their practices to explain how they could for example externalise their product, which is more in abstract level.

We can also compare conducted knowledge mapping sessions in Alpha and AGY-LVB. Applied routines for knowledge transformation have different natures in these two companies. Referring back to the details of these routines, we can consider that this different was due to the state of the projects and also different organisational cultures. In Alpha, transformation routines were applied by using technical forms for formalising the findings, while in LVB-AGY, it was about finding different design possibilities and analysing the tests results.

Figure 7-3: Comparison of identified ACAP's routines - ACAP's dimensions



6.4.2 ISEACAP as a reflexive space (Q. B): A comparison between different phases of the method

Reflexivity modes do not have the same effect on organisational learning. Several researchers argue that a "guided reflexivity" is needed to reach the highest outcome of **collective reflexivity** (Gurtner *et al.*, 2007; Gabelica *et al.*, 2014). Thus, this part of the analysis focuses on the collected data from experimental sessions to fulfil the "collective" criteria of "guided reflexivity". Hence, we did not consider interviews as a potential source of "reflexivity" since all of them were individual and conducted with the participation of only one interviewee.

In addition in order to compare the "knowledge mapping" and "routine eliciting and enriching" sessions, we focus on LVB-AGY case study to have equal conditions during the sessions in terms of number of the participants and facilitators. The collected data from both sessions had been analysed following the same codification process:

1) Identifying reflexive passages;
2) Interpreting whether the passages include learning;
3) Coding facilitators' roles to reach a typology of them.

Therefore, based on the reflexivity definition, we analysed the collected data to (i) compare the number of reflexivity passages through different parts of the ISEACAP's protocol (ii) identify the role of the facilitators during the sessions to impact the reflexivity (iii) highlight the role of reflexivity to enhance learning about ACAP's routines.

6.4.2.1 Frequency of reflexivity passages

We consider reflexivity when more than one participant intervene in a discussion on a particular subject. These discussion can happen in different moments of the experimental sessions. We define *a reflexivity passage as a continuous collective discussion among participants without any interruption by facilitator(s) or environmental factors.* The coding guideline for reflexive passages is summarised as the following:

Coding guideline 2: Reflexivity passage

An example of reflexivity passage coding is shown in the following:

(Knowledge Mapping session, LVB-AGY, DOC1, p. 13)

…

Facilitator: *"Someone from S?"*

Start of the reflexivity {

PM: *"He was a designer?"*

RM: *"I think he was a specialist of this kind of … it is not by chance, it's very good"*

TM: *"Yes, he knew well how to conduct the session"*

RM: *"I didn't know this types of approaches before that meeting, it was very good…"*

PM: *"for me it was very ensuring that we used a tool during this approach that we know all very well Xmind, but in a new way and it brought us a new approach without needing to use a new tool…"*

TM: *"I even didn't use a lot the tool previously, but the meeting and approach have motivated me to use it more..."*

RM: *"I neither, never used the tool before that meeting!"*

PM: *"I knew that, but I never used that in this way, it is not a complicated tool…"*

} end of the reflexivity

Facilitator: *"was there any other technical tool?"*

…

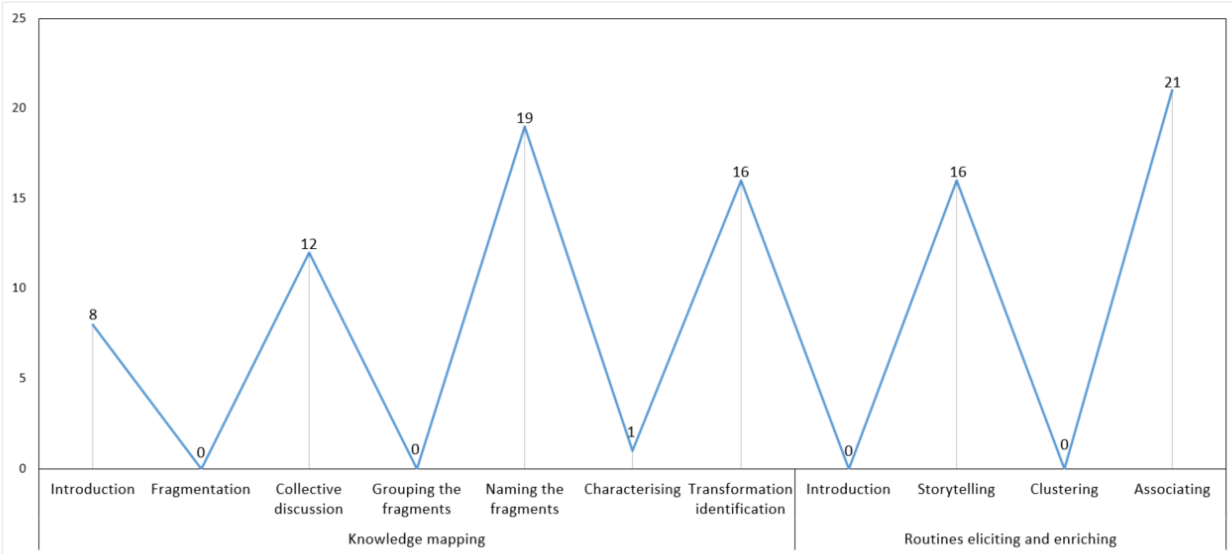
Based on our definition of "reflexivity passages" and presented in the coding guideline, we provide Table 7-8 below. This table establishes the frequency of passages and shows that via the ISEACAP method about 45% of the collected data were coded as reflexivity.

Table 7-8: Frequency of reflexivity passages during ISEACAP phases

	Passages	Duration in min	Words			Passages/total words %
			Sum (passages only)	Average (words per passage)	Total	
Session 1 – KM	66	130	10 717	162	21 282	50.36%
Session 2 – RE	37	82	4 109	111	11 623	35.35%
Total	*103*	*212*	*14 826*	*144*	*32 905*	*45.05%*

To complete the presented table, Figure 7-4 compares the number of reflexivity passages during the two sessions. Since activities of fragmentation (KM), grouping (KM) and clustering (RE) are done individually and silently by participants, there can be no reflexivity passages highlighted from these activities. The sinusoidal shape of the curve illustrates the interaction between the collective work phases versus the individual times within the two sessions. It is also interesting to note that the first session (KM) raised more reflexivity passages than the second session (RE). This can be interpreted by the need for researchers (as facilitators) to obtain more information (about the project, its members, the knowledge sharing activities, etc.) during this session. This information is then captured by researchers who no longer need as much details in the second session.

Figure 7-4: Number of reflexivity passages in different phases of ISEACAP - AGY and LVB



In the following, we explain more in details the reasons behind different reflexivity passages during each phases and activities of the protocol.

6.4.2.2 Knowledge mapping reflexivity passages

In knowledge mapping, there are reflexivity passages during the introduction when facilitator presents the method and objectives of the session and identify collectively with participants the important documents to focus during the session.

The document fragmentation is the next activity while it is individual and participants do not speak and just cut out the most valuable parts of the selected documents and fill out their information cards. Then they describe their information cards and their fragments. Based on the ISEACAP's protocol, other participants can express their ideas about others' information cards. This rule enables collective discussion and reflexivity between the participants.

After collective discussion, participants start to "grouping the fragments". During five minutes of silent brainstorming they make the groups with their information cards and fragments. Then, they "name collectively" the created groups. This phase has the highest number of reflexivity passages. Facilitators play imperative roles in this step. For this reason we study different roles of facilitators through in the section 6.4.3. In this step, the main purpose of reflexivity passages is to create common knowledge between participants and give consensus names to what they have understand from each group of fragment.

"Knowledge characterisation" and "transformation identification" were run in parallel in LVB-AGY and reflexivity passages focused on making relation between identified knowledge. These reflexivity allowed the participants to co-construct consensus results (a knowledge map).

6.4.2.3 Routines eliciting and enriching reflexivity passages

Despite of knowledge mapping introduction, during the introduction of routines eliciting and enriching in LVB-AGY there was no reflexivity passage since this session was held the day after the knowledge mapping session and thereby all the participants and the facilitators remembered how the knowledge map had been created. Thus, the session was started by a short explanation of the protocol and then the storytelling step. However, if in a case there is a gap between two sessions, it is required to have a collective discussion at the beginning to recall knowledge map for participants.

Through the storytelling step in LVB-AGY, the participants told their story in turn and in the middle, the facilitator checked the written phrase with the participants. Thus, there were several collective discussions between the participants and facilitators. The reflexivity passages during this step highlighted the important events of the project and participants shared their individual perceptions about these events (e.g. brainstorming, internal and external meetings). In addition, the protocol asked the participants about "what they should have done during the project?" thereby, they revealed confronted blocking points during the project and shared their individual point of view about alternative solutions.

After storytelling, the participants clustered their routines in five packages through a silent brainstorming and thereby there was no reflexivity passage in this step. Then, with the help of the facilitator, the participants associated their routines with routines from the literature. In this step we have a high level of reflexivity and the facilitators played imperative roles to enable reflexivity among the participants thereby in section 6.4.3 we study more in-depth different facilitators' roles.

6.4.2.4 Summary of the result

Based on what is explained, the frequency of reflexivity passages relies on the defined step of ISEACAP's protocol. In other words, reflexivity is more active during collective steps; in particular when the participants are encouraged to share their individual understandings. Although the individual steps are also required to provide the moments of individual reflection via different techniques and help the participants recall what they have done or perceived.

Beside of the ISEACAP's protocol, facilitators can play imperative roles to enhance the reflexivity. In the following, we study different roles of facilitators during each session.

6.4.3 Facilitator(s)' roles during reflexivity

The researchers played the role of facilitators during experimental sessions in LVB-AGY, while ISEACAP can be also conducted by practitioners who are familiar with its protocol.

Facilitators conduct the sessions by following the ISEACAP's protocol and intervene to raise collective discussion. In order to identify different types of facilitators' roles on participants' reflexivity, we analyse the transcriptions of the three sessions conducted in Alpha, and LVB-AGY companies by considering the Coding guideline 3.

Coding guideline 3: Facilitator's roles in reflexivity

Facilitator's roles: *Focusing on facilitator's verbatim just before each reflexivity passage to understand what kind of role are performed. Identified actions are determined as follows: Guiding (G); Clarifying (CL); Encouraging (E); Reorienting (R); Consolidating (CO).*

Table 7-9 presents identified roles based on the coding guideline. These roles are not totally exclusive, meaning that a facilitator can embody two or more roles when intervening at a single moment. We also provide examples of wording taken from transcriptions of experimental sessions.

"Guiding" is the main role of facilitator to explain the objectives of the method and guide participants systematically during sessions based on the rules of the protocol.

"Clarifying" role holds two sides: facilitator tries to (i) comprehend project's context and participants' roles (ii) eliminates the doubts.

"Encouraging" is the most imperative facilitator's role to encourage participants to express themselves and reveal their ideas. This encouragement can be realised by raising critical questions and generating discussion between participants. Through this role, facilitators should be attentive to ask concrete and useful questions as some questions can change the orientation of the discussion and make session longer. For instance, in LVB-AGY there were four facilitators and three participants. During the knowledge mapping session, the facilitators asked the participants certain questions that change the discussion orientation and make the session longer (about three hours instead of two hours). For this reason, another facilitators' role is "reorienting" through which they try to keep the discussion between participants in the line and reorient it when deviates from the basic objective.

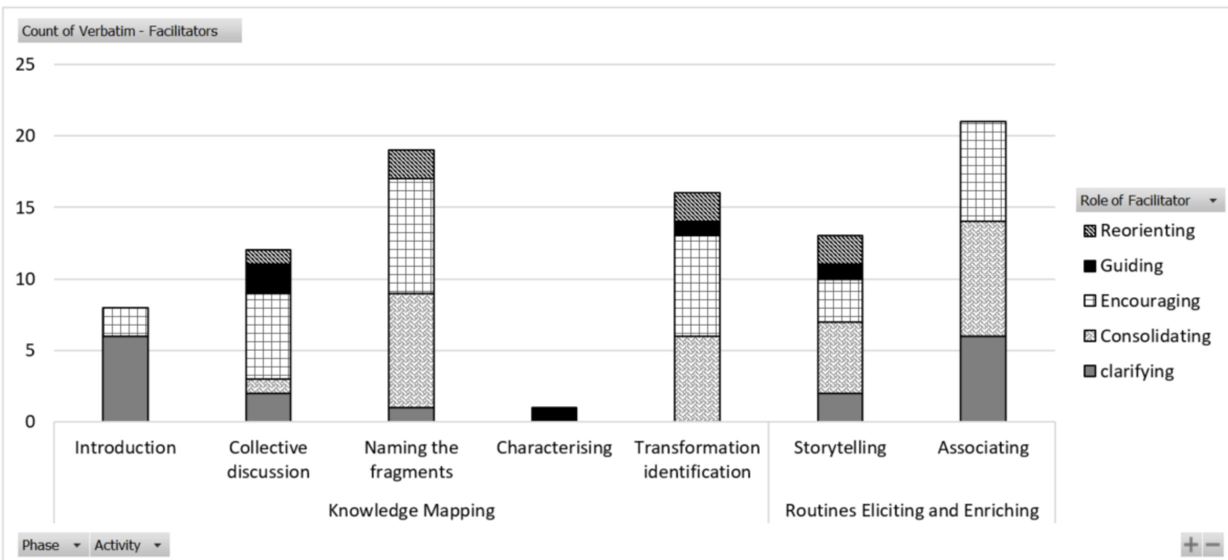
Facilitators aim to provide consensus results with the participants at the end of each session, thereby they play also the role of "consolidating" to make agreement between the participants and produce consensus results.

Table 7-9: ISEACAP Facilitators' roles in reflexivity between participants (Dominguez-Péry et al., 2018, p. 18)

Roles	Description	Extracts
Guiding	Introducing the objectives of the session and guiding participants step by step based on the protocol	*"On the same node, there could be several stories, as different actors may have different things to tell…"* (AGY, RE, p. 10). *"For this step, you have 10 minutes to cut off the most important parts of the documents…at least five fragments from each…"* (AGY, KM, p 16)
Clarifying	Questioning to gain further explanation of a previous idea provided by the participant. For instance: context, doubt elimination.	"*Parallelisation, what does it mean? How would you explain that?"*(AGY, KM, p. 14). *"You looked for other knowledge of design… is it provided by x?"* (AGY, KM, p. 79).
Encouraging	The facilitator encourages participants to develop their ideas, to provide more details, to explain technical elements, *etc*.	*"Did you read other items? So the monitoring dimension 'anticipating the potential risks and advantages for the organisation' …do these dimensions talk to you or remind you something?"*(AGY, RE, p. 31).
Reorienting	Helping participants to structure their understanding and reorienting the discussion to other topics of thought and/or opening the discussion to new topics.	*"Can we continue?"* (AGY, RE, p. 17). *"If we come back here, is it general?"* (AGY, KM, p. 68).
Consolidating	Creating consensus results within participants	"These are in parallel, aren't they? If we start from here and like that this knowledge, can intervene here? Do you agree with that?" (AGY, KM, P. 85)

Figure 7-5 shows adopted roles by the facilitators during two conducted sessions in LVB-AGY for different activities of the protocol and how far each role raised the reflexivity among participants. As the figure displays, the facilitators played crucial roles during "naming fragments" and "associating" by *encouraging* the participants to reflect collectively and *consolidating* the result of their discussion to have a concrete and consensus outputs. Therefore, we can identify "consolidating" and "encouraging" as the most effective roles to raise the reflexivity during these two sessions. However, we cannot generalise this as we should compare result of several sessions conducted in various companies with different participants and facilitators.

Figure 7-5: Roles of the facilitator on reflexivity during experimental sessions in LVB-AGY



In general, conducting an experimental session requires several roles. In the case of LVB-AGY, during the introduction, the facilitator firstly explained the steps of the protocol through the *guiding* role which stimulated the participants to reflect and discuss collectively. Through their discussion, the most important role of the facilitator was to *clarify* the arguments between the participants and bring out the details by asking questions (*encouraging*) based on the subjects that had been discussed earlier. Finally, the facilitator performed the *consolidating* role when s/he attempts to create consensus understanding in specific steps of the protocol such as naming the fragments in the first session and associating in the second session. The clarifying roles should be applied systematically during all the collective steps, while *guiding* is more at the beginning of each step to explain the activity and *consolidating* at the end of specific activities.

6.4.3.1 Summary of the results

During the experimental sessions, facilitators should assume different roles of guiding, clarifying, encouraging, reorienting and consolidating. The facilitators firstly explain the steps of the protocol through the guiding role. Most of the defined activities in the protocol stimulate participants to reflect and discuss collectively. Through their discussion, the most important role of the facilitator is to clarify the arguments between the participants and bring out the details by asking questions based on the subjects that have been discussed earlier.

To raise the reflexivity, facilitator also encourages the participants to name and involve more project's actors in the discussion and orientates them in the right direction based on the objectives of the session. Finally, the facilitator performs the "consolidating" role when s/he attempts to create a consensus understanding through specific steps of the protocol such as naming the fragments in the first session and associating in the second session.

Including more than one facilitator during the group sessions is helpful, as different tasks should be performed in parallel to conduct the session (e.g. during storytelling a facilitator should guide the session and another one takes note of phrases made by participants at the end of each story). It is not easy to follow the protocol, perform the tasks and raise the critical and relevant questions at the same time. However, if several facilitators conduct the session together, they should be watchful about the progress of the session based on the protocol and time, as they may raise questions to clarify details that can distract the participants from the main objectives, and then the session may last longer than planned.

6.4.4 Role of ISEACAP in learning about ACAP's routines (Q. C)

6.4.4.1 Novelty of emerged knowledge

To identify the role of ISEACAP in learning, three level of knowledge novelty (presented in Table 7-10) is defined to evaluate emerged knowledge during reflexivity passages.

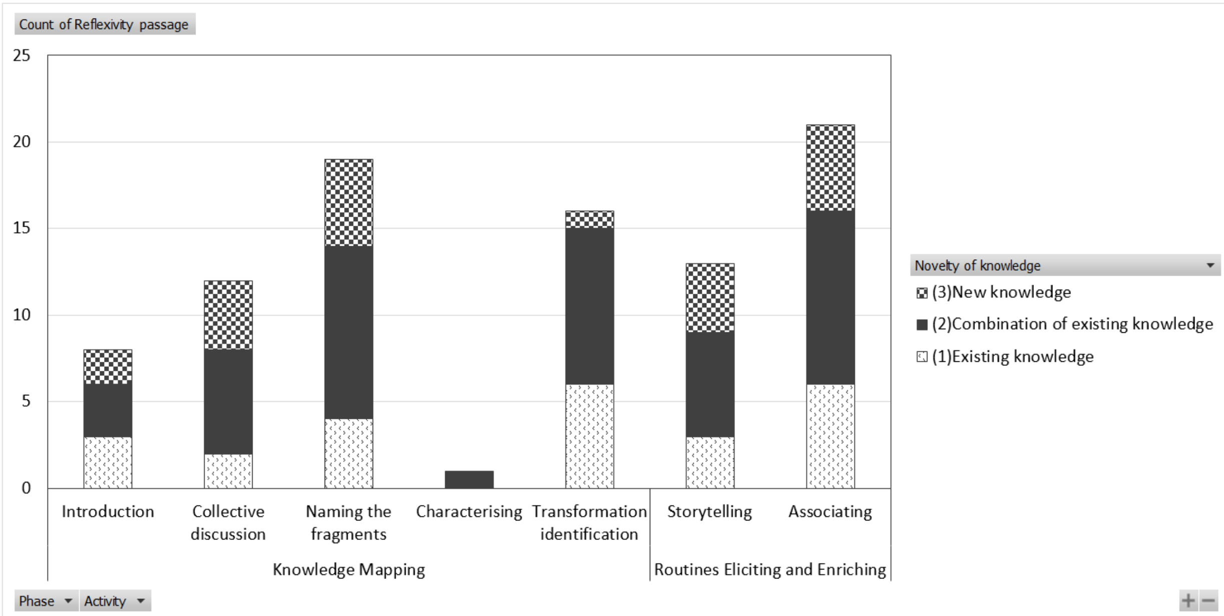
Table 7-10: Different levels of novelty of emerged knowledge during experimental sessions

(Dominguez-Péry et al., 2018, p. 15)

Novelty levels	Definitions	Verbatim & Case context examples
1 **Existing knowledge**	When a subject is not new and the participants have the same pieces of knowledge that lead to a similar understanding about it, it can be considered as existing knowledge.	"*We were aware of potential risks, in fact when you establish an organisation to start a project the risk is at the same time 0 and 100%*" (LVB-AGY, Session 2 – RE, p. 33).
2 **Combination of existing knowledge**	When a subject is not new to the project but participants have different pieces of knowledge related to the same subject and discuss together to create a combination of their knowledge to reach a common understanding or a consensus	*"It is highlighted, here we considered that the project shaped…visualising different aspects of the project with partners…"* (LVB-AGY, Session 1 – KM, p. 12).
3 **New knowledge**	When participants revealed a new knowledge that researchers have interpreted as level 3 due to its content.	*"… I didn't know this kind of approach… It was very useful…"* (LVB-AGY, Session 1 – KM, p. 13).

According to the presented levels, we compare the level of knowledge during each session of ISEACAP. In order to avoid any bias in the results we considered the transcriptions of two conducted sessions in company LVB-AGY to have similar number of participants and facilitators. Figure 7-6 shows the result of the comparison between these two sessions.

Figure 7-6: Level of novelty of emerged knowledge during each phase of ISEACAP-LVB-AGY



Based on the figure, identified knowledge during the first session (knowledge mapping in LVB-AGY) is mostly prior knowledge and the combination of prior knowledge. According to the protocol the participants firstly explained their chosen documents and why it was important during the project. Thus, during the introduction, the participants could discuss collectively and present their documents in a general way. Afterwards, the participants focused on their documents and elicited "what they understand from their documents" and "combine their understanding to group their fragments and name the groups". In addition, the participants were asked to arrange their knowledge in chronological order and to make connections between them. Making connections required highlighting expertise and technical knowledge which directly related to the product or service developed during the project.

During the routines eliciting and enriching session in LVB-AGY, the participants were encouraged to "tell what happened in the transformation nodes" through the storytelling activity. This activity allowed them to reveal their individual perceptions, discuss and reflect collectively to combine their prior knowledge. In addition, the participants highlighted how the knowledge had been absorbed from the external partners and they generated new knowledge internally.

Through the routines enriching phase the participants had collective reflection with the help of the facilitator to cluster their routines that allowed them again to share their individual perceptions and combine their prior knowledge.

Figure 7-6 shows also that the experimental sessions are much more conductive to the emergence of the second level "knowledge combination" which is present in a majority of reflexivity passages. Hence, we can argue that the ISEACAP's protocol is fundamentally collaborative which seems logical as participants tend to address knowledge collectively and combine during sessions.

6.4.4.2 Role of ISEACAP to bring out ACAP's routines

Highlighting performed ACAP's routines during experimental sessions can be basically considered as learning since participants share their understanding in a group level. To make this learning more clear, we identified the level of novelty of knowledge during the reflexivity passages raised by ISEACAP. This section aims at highlighting the role of ISEACAP to bringing out ACAP's routines. We differentiate three roles for the method: (i) *highlighting existing routines*, (ii) *revealing required routine* (routines that do not exist yet but are suggested, by the actors, to be created to improve the organisation); and (iii) *confirm the importance of first time used routines*. Table 7-11 presents the definition of each role and provides the case context examples. In the following we detail each role with verbatim examples.

Table 7-11: Different roles of ISEACAP to bring out ACAP's routines

Roles of ISEACAP	Definitions	Case context examples
Highlight existing routines	When during a reflexivity passage, the participants explain their applied ACAP's routine(s) during the project. These routines are applied for all the other project as well.	*Using technical forms in company Alpha to formalise tests results.* *Documenting all the interaction with clients via CRM system in company Alpha.*
Reveal required routines for future projects	When during a reflexivity passages the participants discuss about ACAP's routines that does not exist before the project and their absence creates problem during the project. They identify these routines to apply in their future projects.	*Considering explicitly the IP rights in the consortium agreement before starting the project (in company Alpha)* *Accessing to the final client and know how the final product can be used in the market (did not applied in company Alpha but it could be important)*
Confirm the importance of first time	When participants discuss about the ACAP's routines that are new to their framework and they applied them for	*Using scenario based design to provide a common understanding between project's*

Roles of ISEACAP	Definitions	Case context examples
used routines	the first time during this project and evaluate it important to perform in their future project as well.	*partner about the final product (applied for the first time in company LVB-AGY)*

➢ *Existing routines*

Via ISEACAP the participants shared their existing knowledge to highlight the ACAP's routines that existed before the project and were applied during the project as well. In addition, these routines were revealed through the combination of existing knowledge during the participants' collective discussion about what they had done during the project. Verbatim 7-17 provides two extracts taken from knowledge mapping session in Alpha and routines eliciting and enriching session in LVB-AGY. The first extract is about knowledge management and CRM (Client Relationship Management) routines in Alpha. The actors documented all the internal and external communications. Most of the internal technical communications were documented via various forms and recorded in system. The company's actors were satisfied by this system and would continue to use it in their future projects as well.

The second extract is about externalisation of the product from the early stage of the project development via social media in LVB-AGY. As the product was new to the market, it required to create the culture of the use. Thus, publishing relevant information on the social media could accelerate the acceptance of the market for the new product. Company LVB-AGY applied this routine for their other projects and would continue to use it for their future projects as well.

Verbatim 7-17: Identifying existing routines via ISEACAP

❖ **Knowledge mapping session in company Alpha: Knowledge management system**

During the collective discussion after the fragmentation, Operator describes one of her information cards and she talked about one of the technical forms that is recorded in their CRM system…

OP: *"[…] use the right material and understand CRM and …. The experience of laboratory, entering the right values in relevant CRM (Alpha, KM, PM, p. 41)"*

RM: "*It means that if we do not give her the information, she does not know what she should carry out (Alpha, KM, PN, p. 42)"*

RE: "*Especially after arranging them, you can also find the analyses (Alpha, KM, AB, p. 42)"*

CEO: "*Well-arranged file, well classified, we can come back to that…(Alpha, KM, PM, p. 42)"*

OP: *Yes, for sure, it is much easier (Alpha, KM, GB, p. 42)*

RE: *At the end, we can return to the files. All of us can consult them … that's right…so we are not obliged to ask all the time the Operator for the results…(Alpha, KM, AB, p. 42)*

- **Knowledge mapping session in company LVB-AGY: Predesign based on environmental factors**

During the storytelling, technical manager discussed about their communication via social media to externalise their product…

TM: "*…To talk about communication…we started to dispose the communication tools which used to communicate on social media…and the project became extern…a little bit more external… (Doc 2, p. 21)*"

PM: "Yes*…this created value, in fact social value for our product …it is very good… (Doc 2, p. 21)*"

Required routines

The second type of learning refers to the ACAP's routines that does not exist before the project and their absence creates problem during the project. In two cases of Alpha and LVB-AGY, these routines were highlighted in particular through the combination of existing knowledge and new knowledge. The participants discussed about these routines to clear how to apply them in their future projects. Verbatim 7-18 presents two examples of required routines in both Alpha and LVB-AGY companies.

The first extract is taken from knowledge mapping session in company Alpha. It is about one of the major challenges during this project for company Alpha. As described earlier, selected project in company Alpha was their first collaboration experience. At the beginning of the project they had not clarified the right of intellectual property in their consortium document, and company Beta, obtained a sole patent for the final product.

In Company LVB-AGY, revealed required routines are about creating the consortium documents collaboratively. They had several exchanges to provide the agreement. However, as the partners did not have a clear vision on the final product, there was a risk to confront some issues in the next steps of the project in terms of rights.

Verbatim 7-18- Highlighting required routines via ISEACAP

- **Knowledge mapping session in company Alpha: Consortium and Intellectual Property**

Before the document fragmentation step, the CEO asks for a document, which is not printed, and for him it is the most important one. The document is about an analysis report and he explained to others why it is important…

CEO: "*Yes, that's right, we never have had any analysis about our final product (Alpha, KM, PM, p. 21)*"

OP: *"(surprised) it's strange (Alpha, KM, GB, p. 21)"*

PM: *"Yes, especially that, in the end, Company Beta obtained a patent … with very large applications using our thread. A patent for their final application… on the French market, for now… our thread. So which means, in addition… somewhere… in their application… we could not anyway commercialise the product (Alpha, KM, PN, p. 21)"*

RE: *"Yes, and it's quite wide (Alpha, KM, AB, p. 21)"*

❖ **Routines eliciting and enriching: Consortium agreement document**

During the collective discussion to associate routines, Research Manager and Technical Manager talks about the document of the consortium. In fact AGY used the same template of their other projects for this project while it is a collaborative one with different size of the partners. They had several exchanges with their partners to make it acceptable for everybody.

RM: "*…in general, when we sign a consortium agreement, we don't have a clear vision on what we want to produce via the project…in fact we brought case by case and reunion the partners…and deciding and evolving idea regularly…each time a valorisation problem can appears… (AGY, Doc 2, PG, p. 36)*"

TM: "*…yes, exactly…such as publications…patents…(AGY, Doc 2, AB, p. 36)*"

➢ *Confirm the importance of first time used routines*

The third role of ISEACAP to enhance learning is confirming the importance of first time used routines. The method facilitates the participants to discuss about the routines which are new to their framework and evaluated imperative to perform in future projects as well. Verbatim 7-19 presents two extracts related to this role in both Alpha and LVB-AGY. The first extract is about the analysis of the product efficiency and how to transform the results of the analysis into commercial success in Alpha. This analysis was obtained by accessing to the client and having regular communication to collect their feedback for improving the product.

The second extract describes the predesign routine performed in AGY Company in the early stage of the project. The visualisation of the product based on the environmental factors allowed the actors to have an initial clear image of the appliance. As the predesign seemed helpful to the actors, they appropriated this technique and applied it for their product development with their sub-contractors.

Verbatim 7-19- Confirm the importance of first time used routines via ISEACAP

❖ **Knowledge mapping session in company Alpha: Accessing to the final client**

After the fragmentation, the CEO presents his Information cards, which are about an analysis report. He finds out during the project that it is important to have access to the final client and know more about the application of threads. He explained…

CEO: *"So I was interested in the results…we tried to know or to understand the efficacy of our product because we developed a Product … Generally, what we say is that we sell functionalized threads, which have special functions. So, we will try to measure the efficiency of this function and ... [...] We have to go further and this is all the difficulty in fact in a project like this: it is ... how we transform it into ... into commercial success. And so that is to say: to a real demonstration... the efficiency of the product [...] try to understand the results obtained by our clients […] try to measure if there is a wire that is more efficient than another. So after that there was a conclusion that allowed us to put in place an action …we bought a piece of equipment... (Alpha, KM, PM, p. 48)".*

RE: *"We did it in our company …(Alpha, KM, AB, p. 48)"*

CEO: *"Subsequently, at the end of the project, when we wanted to market the product, we communicated on ... well how we do our test and how we evaluate the characteristic of thread … (Alpha, KM, PM, p. 48)".*

RM: *"Because we communicated ... we introduced our product ... via this test we said "it is better than the competition on this test" since we compared the ... other products exist in the market…(Alpha, KM, PN, p. 49)"*

- **Knowledge mapping session in company AGY: Predesign based on environmental factors**

During the collective discussion after fragmentation, the Technical Manager describes one of his fragments, which contains several alternatives of the product's predesign. As all the three actors have fragmented the same part of the document, the technical manager argues about this fragment as below:

TM: "*…we are not yet in the design…we are in predesign… we do not have yet the notion of materials in this step… we have a predesign presented in this slide to save the time by making a choice…(AGY, Doc 1, AB, p. 27)*"

RM: "*…it is a predesign based on the environmental factors...I think this can be as the intermediate result of our works…(AGY, Doc 1, PG, p. 27)*"

PM: "*…we took the same work method with our sub-contractor… the predesign… modelling the appearance of the appliance (AGY, Doc 1, GG, p. 27)*"

We presented different roles of ISEACAP to bring out ACAP's routines during reflexivity passages. Now the question that arises is how ISEACAP as a reflexive space enables collective activities among participants to facilitate organisational learning?

6.4.4.3 Collective activities to enhance organisational learning via reflexive space ISEACAP

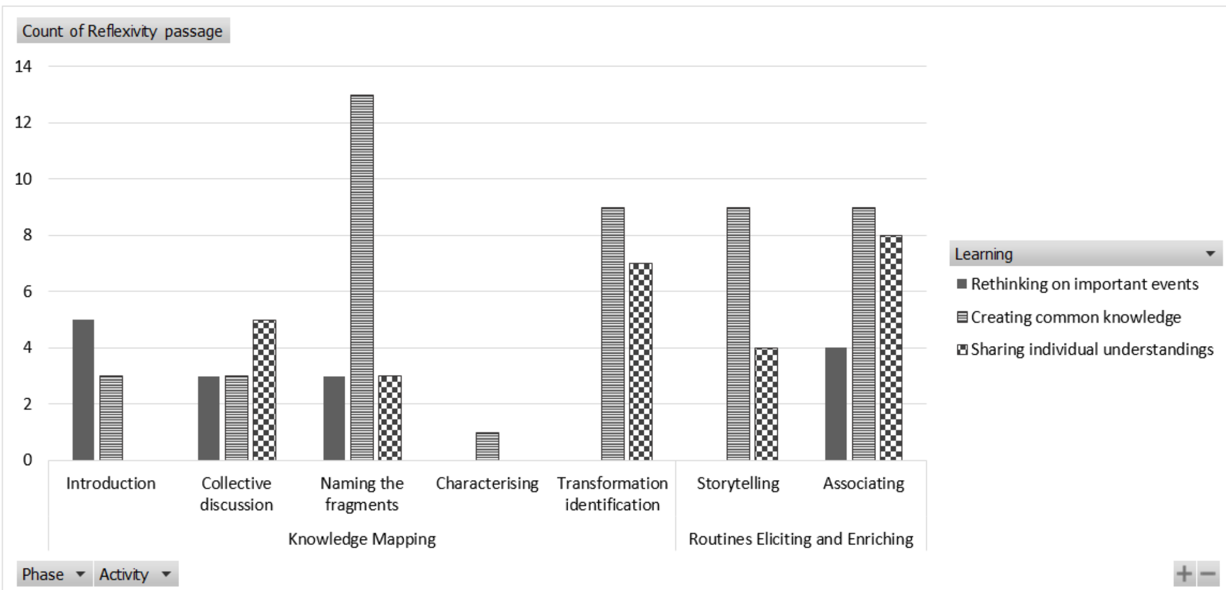
Different facilitators' roles to raise the reflexivity among participants have been discussed earlier. These roles are performed based on the ISEACAP's protocols and supports. Thus, the method plays the role of reflexive space by allowing the participants to reflect and learn collectively on their routines. By reviewing highlighted reflexivity passages in Alpha and LVB-AGY, we identified three main collective activities provided by ISEACAP as a reflexive space to enhance learning: (i) rethinking on important events (ii) sharing individual understandings (iii) and creating common knowledge. Table 7-12 defines these activities and provides case context examples.

Table 7-12: Main activities provided by ISEACAP a reflexive space to enhance learning

Activities	Definitions	Case context examples
Rethinking on important events	When during a reflexivity passage participants discuss and reflect about a specific event such as a meeting, or a blocking point that make remarkable changes in the continuation of the project.	*Discussion during knowledge mapping session in company Alpha about the communication challenges with company Beta.* *Discussion and reflection during routines eliciting session in LVB-AGY about the role of research centre during the project who plays also the role of client.*
Share individual understanding	When during a reflexivity passages participants reveal their individual understanding about a subject.	*Discussion during knowledge mapping in company Alpha, when the participants reveal their individual perception about obtained patent on the final product by company Beta.* *During routines eliciting and enriching session in company LVB-AGY, the participants express themselves about the involvement of project's partners.*
Creating common knowledge	When the participants try to create a consensus result or understanding through collective discussion.	*In company Alpha, the participants create common knowledge about the test result from the client and how it could be improved for their future projects.* *In company LVB-AGY, the participants discuss about the confronted challenges during the project and finally they create common knowledge about marketing aspect as the weakness during the project.*

Based on the identified activities, we analysed reflexivity passages in the case of LVB-AGY and Alpha for 'knowledge mapping' and 'routines eliciting and enriching' sessions. However, for visual comparison through Figure 7-7 between two sessions of ISEACAP, in order to have the same number of participants and facilitators, we consider only the case of LVB-AGY. The figure shows the presence of defined activities in different steps of the ISEACAP based on the number of reflexivity passages. Through the next section we explain the activities more in details and analyse the figure.

Figure 7-7: ISEACAP as reflexive space to enhance learning-LVB-AGY



➢ *Rethinking on important events*

Reflection about ACAP's routines allowed the participants to rethink about important events of the project such as meetings or confronted blocking points. This activity played imperative role during the introduction of knowledge mapping since the participants discussed about the crucial parts of the project and their important documents. During the second session, as the participants had rethought about these events previously, they discussed less on that and were more focused to share their individual understandings and create common knowledge.

Verbatim 7-20 presents two examples of rethinking on important events. The first example is taken from knowledge mapping session in Alpha. Through this reflexivity passage the participants discussed about sharing one of their findings with their partner, even though the partner did not follow their recommendation as they have to use different materials.

The second example is from the "routines eliciting and enriching" session in company LVB-AGY. During the routines enriching phase the participants discussed about the involvement of engineering school. Despite of their close relation with engineering schools, project's partners did not use this opportunity to introduce their product to the school's population (students and professors). According to their discussion, students could been seen as potential prescribers for their parents and networks.

Verbatim 7-20- Enhancing learning via ISEACAP as reflexive space-Rethinking on important events

Example of a reflexivity for rethinking on important events

- Knowledge mapping session in company Alpha during collective discussion after fragmentation

RM: "*…this an information that we shared with our partner company Beta…(Alpha, KM, PN, p. 34)*"

CEO: "*…above all we shared with them…but they didn't follow our recommendations…because they had to use polyamide…(Alpha, KM, PM, p. 34)*"

RM: "*…yes but it was from the beginning…(Alpha, KM, PN, p. 35)*"

RE: "*…they didn't want that...it was in the specification… (Alpha, KM, AB, p. 35)* "

RM: "*…there was above all…this thread with several retreating…(Alpha, KM, PN, p. 35)*"

RE: "*…Because we tested several polyesters with more or less success… (Alpha, KM, AB, p. 35)* "

OP: "*…which one? (Alpha, KM, GB, p. 35)* "

CEO: "*…here…we decided to change the supports…to deliver directly… (Alpha, KM, AB, p. 36)* "

- Routines enriching session in company LVB-AGY during storytelling

TM: "*…Communicate…I think we did not well use the internal means and capabilities…in engineering school…influencing a population…about the project… as a client…by using the appliance…(AGY, Doc 2, AB, p. 25)*"

PM: "*…Not only as a client… but also as…(AGY, Doc 2, GG, p. 25)*"

TM: "*…as prescriber? (AGY, Doc 2, AB, p. 25)*"

PM: "*…Prescriber for their parents… they are eventually all students and engineers… all the school network…(AGY, Doc 2, GG, p. 26)*"

TM: "*…A dynamic environment… (AGY, Doc 2, AB, p. 26)*"

RM: "*…it could be the same for professors…by the way I had another idea…organising a formation team about this topic(AGY, Doc 2, PG, p. 26)*"

TM: "*…yes…above all it could be a part of our target … (AGY, Doc 2, AB, p. 26)*"

➢ *Sharing individual understandings*

In addition of allowing the participants to rethink on important events, the method allows them to share their individual understanding by encouraging them to talk about their individual perceptions and elicit their applied knowledge via different techniques. As Figure 7-7 shows, the method inspired the participants to share their individual understandings through the majority steps of the ISEACAP's protocol.

Verbatim 7-21 illustrates the example of individual perceptions shared during the experimental session via ISEACAP. The first example is from knowledge mapping session in company Alpha which refers to the fact of patenting by their partners. The partner company Beta, obtained a patent on the final product of the project which can be largely used all around the country while the other collaborators have not been involved in.

The second extract of verbatim is taken from routines associating step in company AGY. The technical manager and project manager revealed their individual perception about one of their partners who had filtered the information during the conversation. Based on their discussion this partner was not very comfortable to share all the obtained results with the others.

Verbatim 7-21- Enhancing learning via ISEACAP as reflexive space -Sharing individual understanding

<u>Example of a reflexivity for sharing individual perception</u>

❖ Knowledge mapping session in company Alpha during document identification

CEO: "*…finally the Beta deposit a patent…with our thread …patenting their final application in the French market, for the moment with our thread…what is explained in their application…we cannot commercialise our product…(Alpha, KM, PM, p. 20)*"

CEO: "*…it was …actually their patent… they could have it…I don't know if they talked about that with you…the patent is about the usage of ardent thread in threading chain …(Alpha, KM, PM, p. 21)*"

RE: "*…the usage is large… (Alpha, KM, AB, p. 21)* "

CEO: "*…it is very large in France…we were not very happy with this fact…(Alpha, KM, PM, p. 21)*"

❖ Routines enriching session in company AGY during routines association

TM: "*…Company X…they are a little bit strange in this case…(AGY, Doc 2, AB, p. 43)*"

PM: "*…It is true that group S, in technical part there was no problem, visibility, engagement, for Group S, I thought that all the collaborators are the same as S and can have a good communication…but for company X we started to see that …there is turnover here, from the beginning of the project…we felt that*

this part is less clear…I thought that it is because of the actors and it is not the company's strategy… this is an actors who said that this is a secret and we won't share it...(AGY, Doc 2, GG, p. 44)" **TM**: "*…I agree it is more about a person, who is now quitting the company… it is very simple when you find this person with her supervisor in a meeting she said that: well it is not a secret we can share it with you… (AGY, Doc 2, AB, p. 44)*"

➢ *Creating common knowledge*

Finally, the ISEACAP enables the participants to create consensus ideas and common understanding about their applied knowledge. The common knowledge is represented through the knowledge map and flow of routines at the end of the sessions and can be useful for the future projects of the companies. Referring back to the Figure 7-7, it shows that creating common knowledge is the most carried out activity during the reflexivity passages which was completely expected based on the ISEACAP's protocol and objectives to create consensus results at the end of each session. By following the ISEACAP's protocol, participants find the opportunities to create common understanding of mobilised knowledge during their project and performed ACAP's routines.

Verbatim 7-22 presents two examples of reflexivity passages for creating common knowledge among the participants. The first example is chosen from "knowledge mapping" session in company Alpha. The Operator and Research Engineer had a reflexive discussion on the feedback of their client about one of their tests results and finally they could create a consensus idea about the raised question. The second example is taken from "routines eliciting and enriching" session in company AGY. The Project Manager and Technical Manager revealed collectively the confronted challenges in different aspects of the project and finally they created a common knowledge about the identified issue.

Verbatim 7-22- Enhancing learning via ISEACAP as reflexive space-Creating common understanding

Example of a reflexivity for creating common understanding ❖ Knowledge mapping session in company Alpha during collective discussion after fragmentation **OP**: "*…we did not have any feedback, was there any feedback?...(Alpha, KM, GB, p. 18)*" **RE**: "*…yes…yes…we did…(Alpha, KM, AB, p. 18)*"

OP: "*...what was about? Any problem?...(Alpha, KM, GB, p. 18)*"

RE: "*...in general...when I went to see them... they evaluated on a surface, on a tissue with these dimensions... they evaluated the number of silicone threads...basically the threading as it concerns a little the sheath... they counted the number silicon threads and if it is acceptable.... (Alpha, KM, AB, p. 18) "*

- ❖ Routines enriching session in company AGY during routines association

PM: "*...Maybe it is because of lack of experiences... I think so... means that every lot needs a leader, machine. It is not easy... where it is collective...(AGY, Doc 2, GG, p. 49)*"

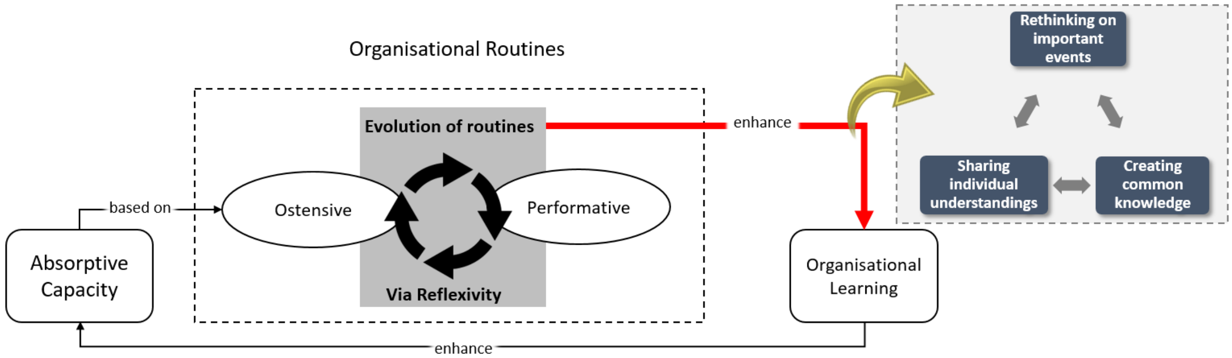
TM: "*...I think differently...For me it is more about marketing aspect...where there is no technical aspect...in technical aspect we had a real synthetic work ...(AGY, Doc 2, AB, p. 50)*"

PM: "*...Yes...yes...I agree ...(AGY, Doc 2, GG, p. 50)*"

6.4.4.4 Summary of results

In this part of our analysis, we studied the role of ISEACAP in providing a better understanding of ACAP's routines. By focusing on reflexivity passages, we firstly identified three different levels of novelty for revealed knowledge throughout each passage. In addition, we identified three different roles of ISEACAP to bring out ACAP's routines: highlight existing routines, reveal required routines and confirm the importance of first time used routines. These findings allowed us to investigate more in depth on how ISEACAP can enhance learning among the participants as a reflexive space. As the result, the method allows participants to rethink on important events, share their individual understandings and create common knowledge during their reflexivity. Based on these three core activities of ISEACAP as a reflexive space, we extend our theoretical model as shown in Figure 7-8 and open up the learning mechanism during reflexivity passages. The ISEACAP facilitates participants to recall the important events of the project, thereafter they are guided to share their individual understandings during different steps of the protocol and finally they create consensus results which allows them to create common understandings about revealed ACAP's routines. The figure will be expanded more in details through the next chapter "discussion".

Figure 7-8: Enhancing organisational learning via ISEACAP as a reflexive space



6.5 Conclusion

This chapter was presented in two main parts: Within case studies and cross-case analysis by applying multiple case study strategy. The analysis was carried out on collected data during experimental sessions conducted in Alpha and LVB-AGY and semi-structured interviews conducted in LVB-AGY.

The first stage of analysis was based on ACAP's routines as the unit of analysis. Through the "within case study" we presented identified ACAP's routines and characterised them by defining their nature and application themes.

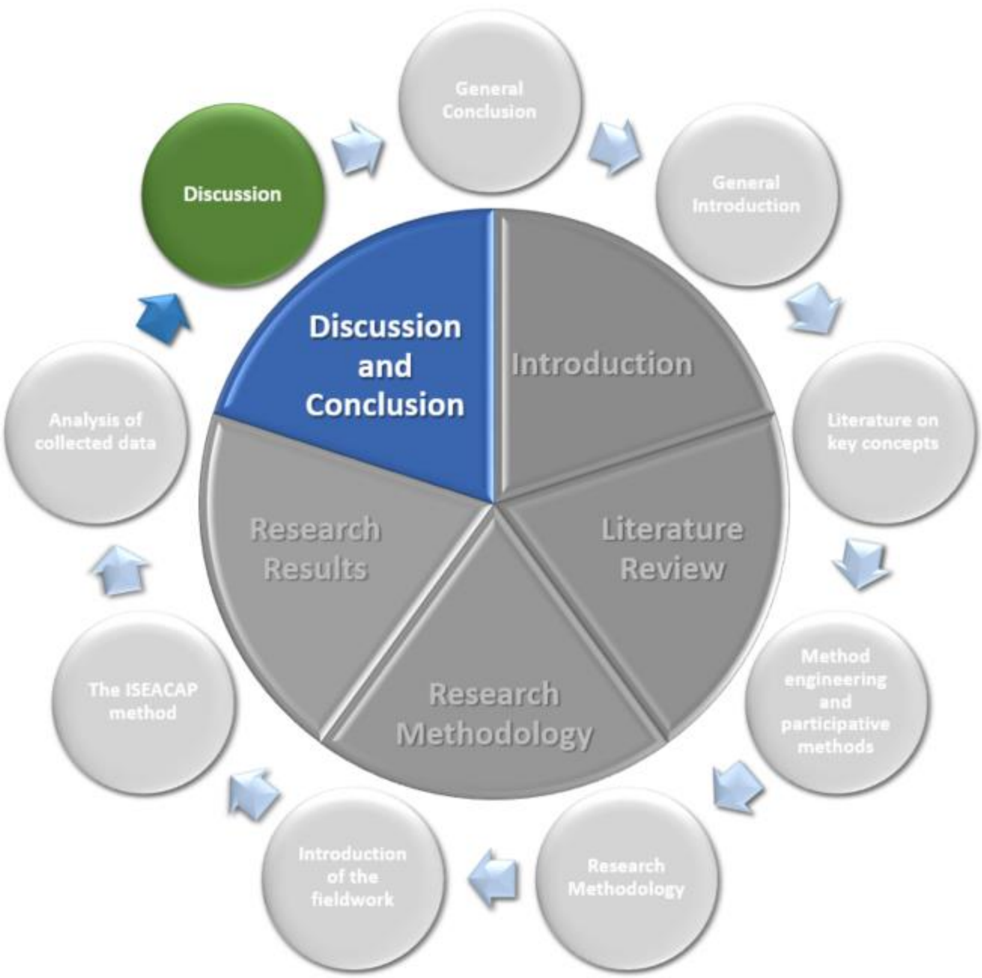
Considering the obtained results from the first stage of analysis, we carried out the "cross-case" analysis by providing a global vision on identified routines, showing the complementary role of experimental sessions and interviews in terms of highlighting different types of routines, which allowed us to find out that during the interviews the managerial ACAP's routines were more visible than technical, while through the experimental sessions both managerial and technical were revealed.

In addition, the cross-case analysis highlighted the role of ISEACAP as a reflexive space and how the facilitators can play different roles during the reflexivity passages. The analysis focused on the role of ISEACAP in learning about ACAP's routines by illustrating and comparing the different levels of knowledge novelty and emerged routines. In addition, this part of analysis highlighted how ISEACAP can launch reflexivity among participants and enhance organisational learning.

These findings will be integrated in our theoretical model and complete the details. In the next chapter "Discussion" we will present the revised model and position our results.

Chapter 8. Discussion

7.1	INTRODUCTION
7.2	ISEACAP: A REFLEXIVE SPACE FOR LEARNING ACAP'S ROUTINES
7.3	STUDYING ROUTINES VIA ISEACAP
7.4	AN INTERDISCIPLINARY RESEARCH PROJECT
7.5	CONCLUSION



7.1 Introduction

Organisations' potentials to learn and improve ACAP's routines can play an imperative role in coping with knowledge and resource scarcity during collaborative innovation projects. In the previous chapter, we analysed the results of experimental sessions and highlighted the role of ISEACAP method as a reflexive space that enables a better understanding of ACAP's routines in addition to enhancing organisational learning via collective activities. During experimental sessions via ISEACAP, researchers play the role of facilitators through which they raise and guide the reflexivity among participants.

In this perspective, in this chapter, in order to sketch out the theoretical contributions of the research, we will discuss obtained results by expanding our conceptual model and positioning identified key elements in reflexivity besides learning ACAP's routines. Finally, we will discuss the reliability and validity of the research besides highlighting the methodological contributions.

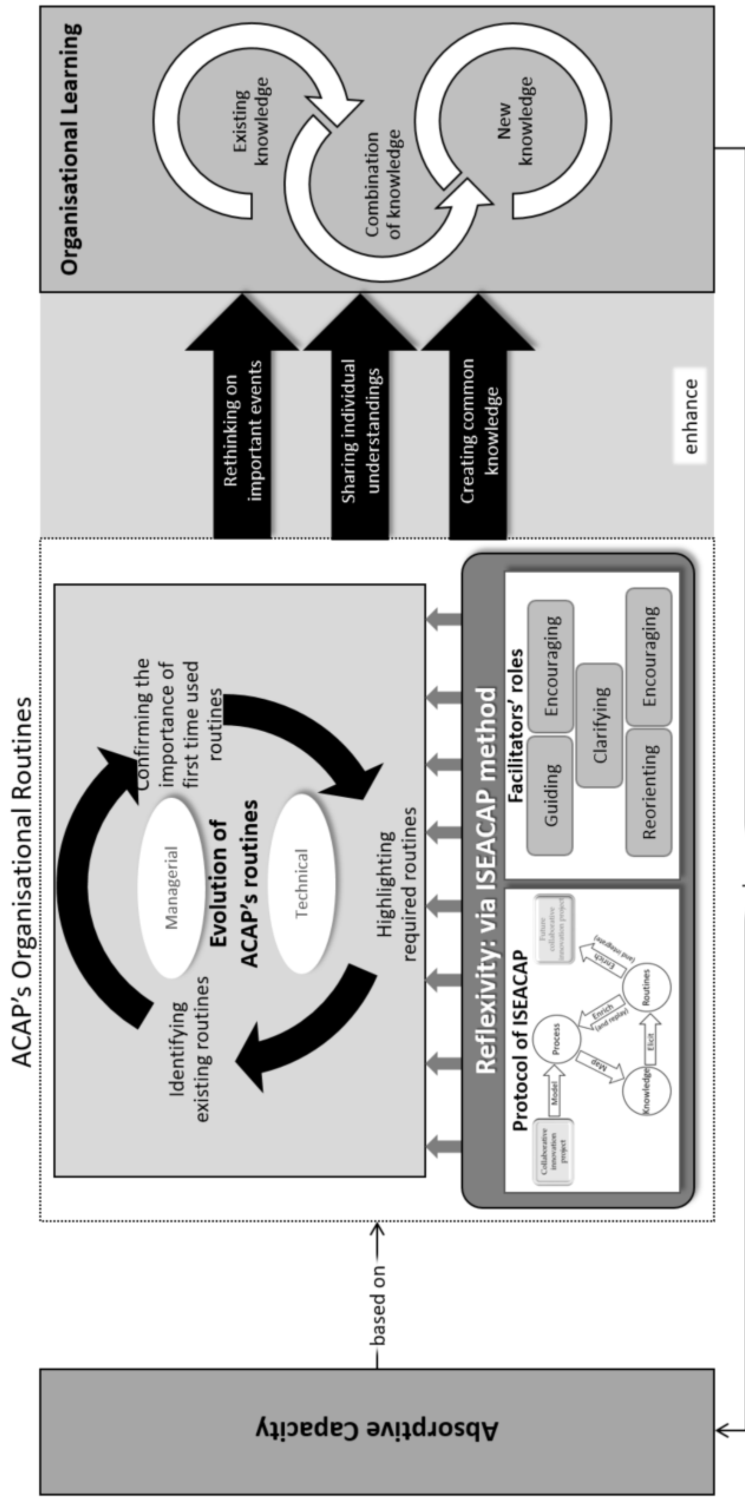
7.2 ISEACAP: A reflexive space for learning ACAP's routines

7.2.1 Expanded conceptual model

As discussed in the first chapter, absorptive capacity is defined by scholars as the set of organisational routines for acquiring, assimilating, transforming and applying external knowledge. To enhance this capacity, the organisations need to evolve their ACAP's routines by engaging in learning at the collective level (Spicer & Eugene, 2006). Knipfer et *al.* (2013) recognised the reflexivity as the driving force that leads to organisational learning. The outcome of collective reflexivity facilitates the integration of individual and team learning into organisational best practices and envisages to imply in future situations that go beyond mere adaptation to a current situation (Knipfer et al., 2013, p. 10). Besides, according to Pentland & Feldman (2005) and Dittrich *et al*. (2016), reflexivity and collective conversation of actors are the powerful way to change routines' dynamics.

Figure 8-1 presents the expanded version of our conceptual model based on the obtained results. The figure highlights the role of ISEACAP method as a reflexive space which supports the collective and guided reflexivity. Bucher & Langley (2016) defined "reflexive space" as dedicated time and spaces to reflexive activities which are disconnected from the original routines on which actors are reflecting upon. These spaces may bring new insights into intentional variations of routines. To this end, ISEACAP as a reflexive space should be conducted by facilitators through the defined protocol for all the phases. In each phase of the method, different levels of identified routines in managerial and technical terms are distinguished which approve the complementary role of different phases. In addition, facilitators play different roles during the session to raise the reflexivity among participants. The ISEACAP helps the participants identify existing routines, highlight required routines or confirm the significance of first time used routines in both managerial and technical aspects. In this regard, Levitt and March (1988) argued that identifying the organisational routines is critical for learning. The ISEACAP method enables participants to rethink about the important events happened during their collaborative innovation projects and share their individual understandings to create a common knowledge on their performed ACAP's routines. These activities enhance a more structured and mastered process of learning on ACAP's routines while organisational learning enables organisations to develop routines for reusing external knowledge (Rezaei-Zadeh & Darwish, 2016).

Figure 8-1: Expanded conceptual model



7.2.2 Importance of the routinisation

Regarding the importance of organisational routines, Nelson and Winter argued that individual skills are the analogue of organisational routines (Nelson & Winter, 1982). In this sense, an understanding of the role that routinisation plays in organisational functioning is therefore obtainable by considering the role of skills in individual functioning (*ibid*). Routinisation is relatively more important as a feature of organisational behaviour than skill as a feature of individual behaviour (Nelson & Winter, 1982; p: 15). In both realms, close examination of the nature of skilful/routinized behaviour brings to light the shortcomings of optimisation notions as an approach to understanding the basis of the effective functioning of an individual/organisation in an environment (*ibid*).

It is easy enough to suggest that a plausible answer to the question “Where does the knowledge reside?" is "in the organisation's memory" (Nelson & Winter, 1982), but where and what is the memory of an organisation? (Becker et al., 2005). Nelson and Winter (1982) proposed that “the routinisation of activity in an organisation constitutes the most important form of storage of the organisation's specific operational knowledge. They pointed out that organisations remember by doing (Becker et al., 2005; Nelson & Winter, 1982). Furthermore, they argued that “the understanding of individual skills facilitates the understanding of organisational functioning: the contribution at the level of metaphor. Routines are the skills of an organisation (Nelson & Winter, 1982; p: 16)”.

Routinisation of an activity depends however on the evaluation of the activity based on the interpretation of the organisation of “best-practice”. In this perspective, Becker et al. (2005) pointed out that there is always a range of flexibility within which the routine can ‘evolve”. Hence, the influence of management on ‘shaping’ organisational routines is generally limited (Becker et al., 2005; p: 779). However, within these limits, it consists, in particular, of picking templates (‘best practices’), encouraging and enforcing a more or less fast and more or less precise roll-out and replication and putting in place criteria for stopping certain practices (*ibid*). In addition, it provides feedback to other organisation members indicating whether their efforts are, or are not, ‘satisficing’ with respect to managerial objectives (*ibid*). All of this takes place in different phases of the ISEACAP by collecting the participants’ opinions in a collective way along with evaluating identified practices to highlight the important ones to be routinized by applying systematically.

7.2.3 Validity and reliability

The quality of research relies on the principal items of reliability and validity which are fundamental in any study that intends to be recognised as a rigorous one (Avenier & Thomas, 2015, p. 14; Gibbert et al., 2008). In this perspective, Yin (2009, p. 40) defined internal and external validities and reliability as the key items to justify case study based researches.

7.2.3.1 Internal validity

Internal validity is considered for explanatory or causal studies (Yin, 2009, p. 40) by relying on positivism paradigm and their validity refers to the causal relationships between variables and results (Gibbert et al., 2008, p. 1467). It also concerns the definition of central concepts, unit and level of analysis and how inferences are made. Here, the issue is whether the researcher provides a plausible causal argument, logical reasoning that is powerful and compelling enough to defend the research conclusions (*ibid*).

Our result highlighted five different roles that are undertaken by the researchers to ensure the active participation of the actors during the experimental sessions. However, it gives rise to fundamental issues concerning epistemological perspectives regarding the intervention of the researcher on his/her field of investigation (De-Benedittis, Movahedian, Farastier, Front, & Dominguez-Péry, 2018). Indeed, through the multiple interactions the researcher had with the participants (by guiding, encouraging, validating, rephrasing or reorienting), there is a high risk that the situation will stop being neutral if it is tainted by the researcher's implication (Avenier & Thomas, 2015). This would consequently affect the internal validity of the research.

Furthermore, considering the epistemological implications of the ISEACAP method (compared to traditional qualitative approaches), some limitations may interfere with the fundamental principles of justification of generated knowledge that are generally required (construct, internal and external validity and research reliability) (Avenier & Thomas, 2015). The validity of the construct necessitates specifying and defining the concepts studied by the researcher (De-Benedittis et al., 2018). The ISEACAP method deepens the study and the understanding of these concepts through a more micro approach thanks to the confrontation of the perceptions from several actors implicated in the experimental sessions (*ibid*). Moreover, the validity of the construct is improved as knowledge has been co-constructed collaboratively among the participants (Yin, 2018). This co-construction of knowledge can, however, introduce a bias in the way they are developed as some participants may influence the direction the group will take in choosing the knowledge (leadership effects in the group) (De-Benedittis et al., 2018). This bias can have negative effects on the internal validity of the research. To cope with this challenge, the use of data triangulation (Miles *et al.*, 2013), in particular secondary data (documents), consolidated the internal validity of our research.

7.2.3.2 External validity

External validity or generalizability is grounded in the intuitive belief that theories must be shown to account for phenomena not only in the setting in which they are studied, but also in other settings (Gibbert et al., 2008). In other terms, researchers should define the domain in which their findings can be generalised (Yin, 2009). Two different generalisations are discussed: statistical and analytical. Statistical generalisation is devoted to the quantitative studies, while analytical generalisation refers to the generalisation from empirical observations to theory (Gibbert et al., 2008; Yin, 1994). In analytical generalisation, researchers should provide a good basis of case studies, a clear rational for their case study selection and details of the case study context (*ibid*).

Relying on analytical generalisation by using multiple case study strategy is to achieve a generalisation from which the researcher aims at extending a particular set of results to a broader theory (Yin, 2018). The construction of the method through end-user validation cycle was applied in five different companies in different context and countries. This variety of application consolidated the generalisation of the method and approved its adaptability in different project context. However, provided analysis on collected data from the tape recorded experimental sessions can be still more enriched and generalised by studying other companies with different context of projects.

7.2.3.3 Research reliability

Reliability of a research demonstrates that the operations of a study (such as the data collection procedures) are replicable for any other researcher with the same results (Yin, 2009). The key words here are transparency and replication (Gibbert et al., 2008). Transparency can be enhanced through measures such as careful documentation and clarification of the research procedures. For instance, by producing a case study protocol, a report that specifies how the entire case study has been conducted (*ibid*). To this end, we provided all the coding guidelines and details of ISEACAP construction and highlighted potential bias that could be happened during the analysis of the results. The extended participants' guides and the presentation of the protocol specifying each step taken during the sessions allow the researchers to present the progress of the data collection in detail.

In addition, provided coding guidelines enable other researchers to accomplish the data analysis in the same direction. In this context, the PhD supervisor coded a part of the data based on the provided guidelines in order to compare the PhD student's results and verify the research reliability. In addition, through the previous chapter, we used examples of the verbatim for each step of analysis in order to make it more understandable for other researchers.

7.3 Studying routines via ISEACAP

7.3.1 Existing challenges to study routines

While describing routines, it seems helpful that researchers articulate their methodology in order to indicate precisely which ontological level they refer to during their study (Becker et al., 2005, p. 748). The distinction between the ostensive and performative level that Pentland and Feldman introduced in their paper allows unpacking organisational routines and examining their internal structure (*ibid*). Pentland and Feldman (2005) compared interviews with observations in their study and conducted interviews to highlight ostensive aspects of routines while tapping into the performative aspect through observation (Pentland & Feldman, 2005, p. 799).

The performative and ostensive aspects of routines are mutually constitutive; the ostensive guiding performances (but not determining it), but in turn being created from the performances (Becker et al., 2005; p: 782). Since the performative aspect of routines can be best understood as inherently improvisational, it is impossible to specify routines in a complete way (*ibid*). These two levels (concrete and abstract) do not only describe slightly different, if connected, things, but also "pragmatic, local and temporary solutions to a problem to which rules provide only a theoretical, abstract and general response" (*ibid*).

Accordingly, scholars have highlighted two basic challenges, which arise from limited observability and explicability of the routines through the current methods and techniques (Becker et al., 2005, p. 875). Descriptions of routines on the performative level through the "real time" observation made by different participants in the routine can be incomplete and even sometimes contrasting (*ibid*). Consider, for instance, contrasting narratives provided by those who attach normative value to the routine as "what we are trying to do around here" and those who find such expectations oppressive or manipulative and who may tend to doubt the sincerity of anyone that explicitly endorses such norms (*ibid*). Even if we admit as candidate accounts all the accounts that participants provide, we cannot necessarily assemble a scientifically acceptable account of "the real routine" from these (*ibid*).

7.3.2 Relevance of ISEACAP for a better understanding of ACAP

Several researches studied the micro-mechanisms that are carried out at individual level and their impact on the creation or re-creation of routines at the organisational level (Belmondo & Sargis Roussel, 2012; Dionysiou & Tsoukas, 2013; Pentland et al., 2012). The main question lies in understanding how were these routines created and how can we now observe them. To address these questions, the relation between the organisational routines and practices of actors and actions id required to be clarified (What actors "do"? (Orlikowski, 2002)). Actions are the observable elements of activity and are fundamentally related to the relations between actors and also between actors and artefacts (Pentland & Feldman, 2008).

In this regard, participative approaches, such as ISEACAP, facilitate in observing dynamics of routines by involving actors within the research process development (Callon, Pierre, & Barthe, 2001; De-Benedittis et al., 2018). Applying the participative method during collaborative action research allows researchers to produce knowledge in collaboration with actors (Anadón & Savoie-Zajc, 2007, p. 5). However, in all the cases, researchers should precisely clarify specific practices to be investigated during the research (Anadón & Savoie-Zajc, 2007, p. 4), which, in our research, concentrated on the ACAP's practices. The researchers aim to co-produce knowledge related to these practices at a fine level.

7.3.3 Appropriate methodology

Simulations, lab experiments, cross-sectional field studies and longitudinal field studies do not yield the same level and kind of information at the diverse ontological levels of routines (Becker et al., 2005; p: 786). For instance, Becker et al. (2005) argued that the abstract part of routines (their ostensive aspect) cannot always be discerned in simulation, lab experiments and the field studies. Most of the time, the ostensive aspect is assumed as given in those methodologies, whereas longitudinal studies offer more opportunities to study this aspect (Becker et al., 2005;

p: 786). However, the longitudinal studies are costly and time consuming with limitation in terms of generalizability of the captured routines.

In this regard, we are proposing ISEACAP as a supporting tool for conducting researches on routines. The method starts by eliciting routines performed during specific project and actors. Thereafter, it helps the participants generalise captured routines at an abstract level and make them replicable in their other projects. The method feeds the dynamics of routines and helps explicit the abstract level of routines through a collective and guided reflexivity while several authors have pointed out the importance of reflexivity for learning and the accumulation of knowledge and understanding (Becker et al., 2005).

7.4 An interdisciplinary research project

7.4.1 Creating common understanding

It has been already mentioned that the development of ISEACAP was carried out through an interdisciplinary research by bringing together researchers from three disciplines: Computer science, industrial engineering and management science. A question then arises, "How, through several iterations, knowledge was integrated into the research process by different members (research group) and allowed creating new knowledge that focuses on a final objective: ISEACAP method?"

The problem of knowledge integration into a project group has been the focus for many scholars such as (Carton & Farastier, 2012; Maaninen-Olsson, Wismén, & Carlsson, 2008; Sargis-Roussel & Deltour, 2010). The first limitation in a project is focusing on specific goals and tasks which leads generally to carry out specific routines and structures rather than what is usually performed during permanent activities. Furthermore, each actor of the project belongs to a wider community of origin and potentially participates in different projects. They can bring their knowledge and previous experiences to the project. Nevertheless, it could be challenging while the project actors are from different fields as they can have different lenses to see the same concepts. For instance, at the beginning of the project, even for basic concepts such as knowledge or routines, each researcher had her/his own vision and definition. One of the unsolved concepts was different understandings of "experimental or experimentation" in computer and management science. Thus, for all key concepts including experimental sessions, we provided a unique definition based on the existing ones. In other words, to create a common understanding, we have created a common dictionary among the researchers from different sciences. Scholars considered shared objective and common understanding as the foundations of knowledge integration (Nahapiet & Ghoshal, 1998).

This common understanding was characterised in particular by the concept of social capital defined by (Nahapiet & Ghoshal, 1998). The social capital developed by the project provides internal cohesion which is necessary to acquire and integrate external knowledge (see also: (Sargis-Roussel & Deltour, 2010)). Knowledge integration can also be based on boundary objects or boundary actors (Carlile, 2004) or knowledge brokers for (Wenger, 1998). These objects and/or actors are identified as belonging simultaneously to different environments by possessing the cognitive codes and styles of different interpretive environments (Maaninen-Olsson et al., 2008). They can potentially play the role of mediator elements by participating in the emergence, in practice, of an area of shared interest and knowledge, where common meanings and interpretations can be developed. Realising the association between environments, these objects and / or "boundary" actors will be the key elements in the knowledge integration process.

Through our research project, common understanding about different subjects that are foundations of the project (such as concepts of the process, individual and organisational knowledge and, in particular, organisational routines) between different researchers was required for integrating knowledge by the whole group and creating collectively new knowledge. Knowledge integration was facilitated through several elements:

- *An initial object*: we did not start our research from scratch as the ISEA method (including its supporting tool ISEAsy) was adopted as the initial object and starting point. We carried out a primary experimental session via ISEA and its tool to model the process of an innovative project besides evaluating the feasibility of our research project.
- *An intermediate object*: ISEACAP evolved through an iterative process while it played the role of an intermediate object (See Fig. 7.2) that allowed researchers from different disciplines to integrate progressively the concepts and languages of other disciplines.

- *A collaborative method*: as mentioned earlier, this research work has been developed through collaborative research between researchers and practitioners. Moreover, we have developed the method gradually through several face-to-face plenary meetings.

7.4.2 The initial object: ISEA method

The research project for developing the ISEACAP method was initiated following the first experimental session carried out in a previous research project to model the process of a collaborative innovation project developed by a small company.

The modelling session was conducted through ISEA and its tool ISEAsy (previous version). This experimental session played an imperative role in inspiring and motivating researchers (actors of the research project) to contribute to the development of ISEACAP.

For researchers from the computer science laboratory who designed the original ISEA method, this first experimental session played the role of a feasibility study. Through the session, besides the formalisation of the process of innovation led by the actors, they studied the importance of the method to develop a wider method aiming at the identification of knowledge and the elicitation of practices and routines for absorbing external knowledge mobilised during the project process.

For researchers from management sciences and industrial engineering, the experimental sessions revealed the value of the method for facilitating participative sessions and developing a reflexive analysis with the actors themselves on the activities carried out during an innovation project.

7.4.3 The intermediate object: ISEACAP method

Final object of the research process, which is ISEACAP method, played also the role of intermediate object by allowing researchers from different fields to create shared area of understanding and interpretation from the early stage of the research. Moreover, a dictionary of concepts, as explained earlier, was created at the beginning of the research project by the researchers themselves that could be used as a common reference. Thus, the method and its protocol (as an artefact) played naturally the role of an intermediate object by giving materiality to the concepts and allowing to better understand the paradigms, in which the researchers are coming from different fields.

7.4.4 Integrating gamification techniques in collaborative researches

A collaborative working method based on face-to-face plenary brainstorming meetings bringing together all the researchers in the subgroup and mobilising gamification techniques of the method itself bonded people together very quickly, creating trust among them and fostering convergence towards a shared objective and language.

Figure 8-2: ISEACAP as an intermediate object to facilitate interdisciplinary research

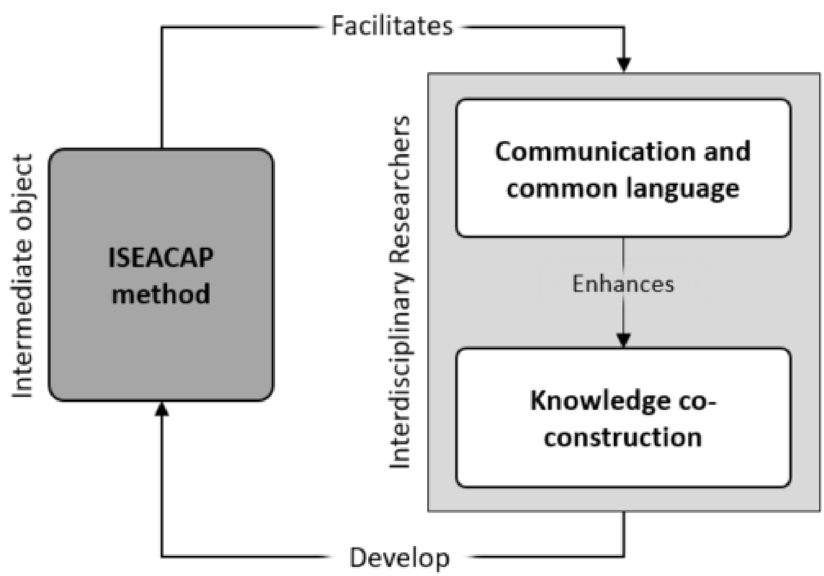


Figure 8-2 shows that we had an iterative cycle where the method facilitated the communication and creating common language between researchers. This facilitated in the knowledge co-construction among the researchers and developing the ISEACAP method.

7.5 Conclusion

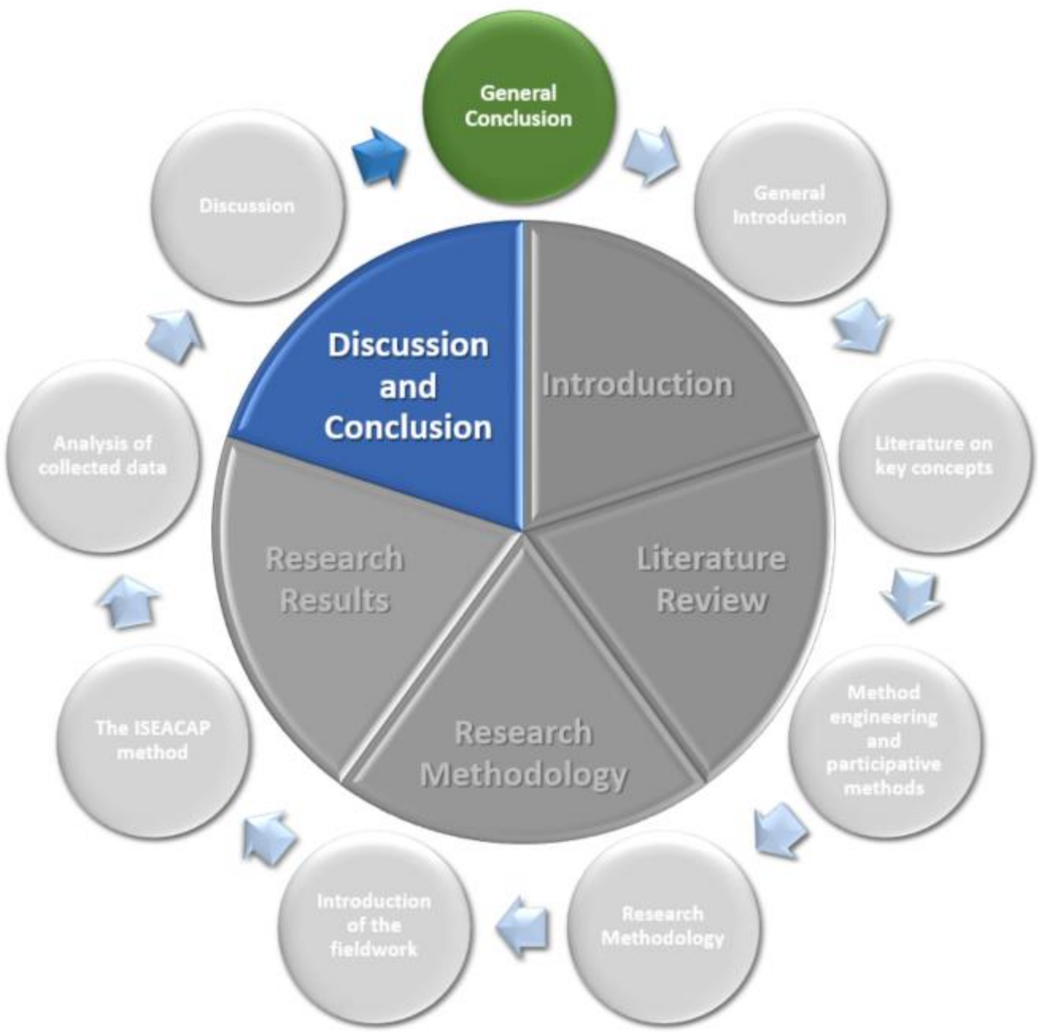
The ISEACAP group sessions allowed both researchers and actors to study routines at the micro-level through the identification of actors' actions, their interactions and different artefacts they use in their daily practices (Fauré & Rouleau, 2011). The collective reflexivity carried out by the actors facilitates the elicitation of the ostensive dimension of routines (Feldman & Pentland, 2003). This allows participants to reflect on their experiences and researchers, observe and help them shape their reflexivity, which in turn favours the performative dimension of the practices/routines.

The ISEACAP provides a reflexive space (Bucher & Langley, 2016) where the participants learn about their ACAP's practices/routines and think about routinisation of the best practices for their future projects. Besides the method, the researchers played imperative roles during the experimental sessions to raise the reflexivity among the participants, encourage them to be highly involved during the session and help them produce consensus results.

Through this interdisciplinary research, the method played the role of boundary object during the research to create a common language between the researchers from different sciences along with facilitating the knowledge co-construction among them. Additionally, by producing the visual representations at the end of the sessions as the outputs of the method, we could achieve the consensus results between both researchers and actors.

Chapter 9. General Conclusion

8.1	SUMMARY OF CONTRIBUTIONS
8.2	LIMITATIONS
8.3	PERSPECTIVES



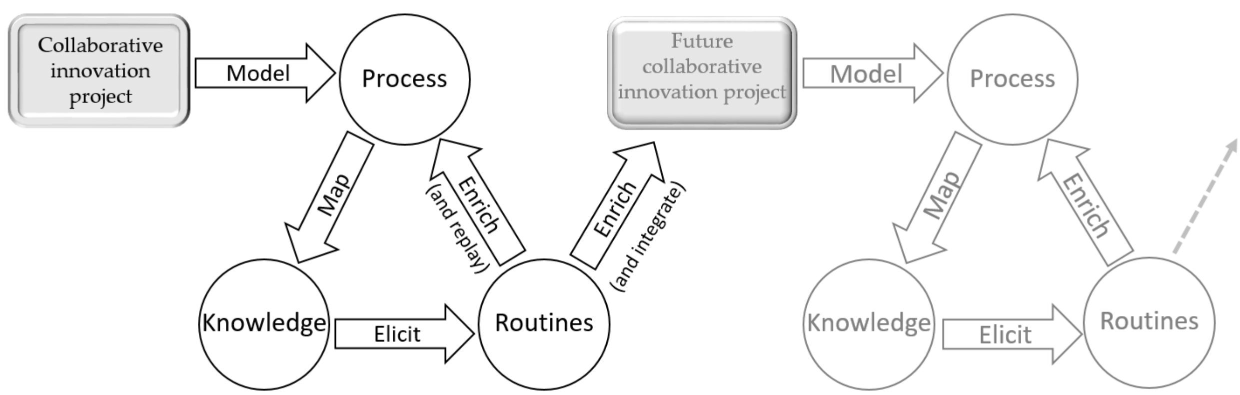
8.1 Summary of contributions

In this thesis, we have presented the construction and application of a participative method called ISEACAP, which aims at providing a better understanding of ACAP's routines. This thesis contributes in both managerial and computer sciences by applying method engineering approaches to construct the method and conducting several experimental sessions to collect and analyse data on ACAP's routines. These contributions can be classified into four categories; (i) engineering (ii) theoretical (iii) methodological (iv) and managerial. In the following, we will explain these fours aspects comprehensively.

8.1.1 Engineering contributions

Figure 6-2 summarises our principal contribution in information system engineering. The ISEACAP relies on continuous improvement of ACAP's routines via four phases; (i) modelling the process of collaborative innovation projects (ii) mapping the mobilised knowledge during these projects (iii) eliciting applied routines to acquire, assimilate, transform and apply external knowledge (iv) and finally enriching ACAP's routines for the future projects.

Figure 9-1: Virtuous cycle for enriching ACAP's routines



The method contributes in IS engineering by proposing the following results:

- **A method for knowledge management**

The ISEACAP method provides a map of knowledge journey during a project besides characterising mobilised knowledge. In order to produce the knowledge map and routines flow, all the participants share their individual understandings with others and codify these understandings via information cards, knowledge cards and storytelling. The map can be considered as a knowledge source in which the required knowledge and expertise are highlighted to be applied during a similar project. The routines flow provides a general picture on what should be performed before, during and after similar collaborative innovation projects to absorb external knowledge from the partners more efficiently. One of the other advantages of the method is to highlight the knowledge circulation between organisations' actors as well as external partners.

- **A user-centre designed method**

We developed ISEACAP method through a user-centre design. For each phase, we applied end-user validation cycle. We collected the validation of the participants as well as their feedback for the method improvement and this was done systematically during all the phases of the method development. To this end, we conducted several experimental sessions via the ISEACAP protocol and improved it step-by-step.

- **Using gamification techniques**

The ISEACAP method employs elicitation techniques which are enriched by gamification techniques and should be applied at the collective levels. The gamification techniques provide a playful ambiance during the experimental sessions and stimulate the participants to be highly involved. This helps also in motivating the participants to bring out the knowledge and routines which are highly rooted in their actions.

- **Proposing a new domain specific language**

A modelling language supports ISEACAP method which relies on a metamodel (abstract syntax) and graphical notation (concrete syntax). The process model of the method is also formalised via map formalism. Furthermore, the ISEACAP was not developed from the scratch as we adapted the process representation of the ISEA method and developed both syntaxes for knowledge and routines representations.

8.1.2 Theoretical contributions related to management science

- **Role of documents in reflexivity on routines**

Technological artefacts can play the role of meditator of activities and co-evolve with routines (Lazaric, 2011; p. 11). Relying on this point of view, we can emphasise on the role of produced documents. Knowledge mapping, routines eliciting and enriching start with produced documents through the previous sessions. Knowledge mapping starts with process model and the identified documents. Routines eliciting starts with the knowledge map along with identified routines table. The role of documents is highlighted through the protocol of the ISEACAP which plays the role of catalyst to accomplish the final objective; identifying and enriching ACAP's routines.

Using the documents to launch the reflexivity among the participants, producing documents as the outputs of sessions as well as relying on the protocols to conduct the sessions all highlight the role of documents as a part of organisational routines and the starting point for reflexivity on routines. From this perspective, the documents allow actors to highlight the abstract level of ACAP's routines and reflect on the performance of their routines in past and future situations.

Besides, the produced artefacts during the sessions (process model, knowledge map and routines flow) play the role of physical manifestation of the routines (Pentland & Feldman, 2005) that provides an opportunity to capture detailed data about the execution of ACAP's routines (Pentland & Feldman, 2008; p. 249).

- **New level of vision on ACAP's routines identification**

Many IS researchers treat the specific routines that constitute a firm's absorptive capacity as a "black box" (Duchek, 2013). To address this issue, the results of this study have added a new level of vision about ACAP's organisational routines. The ISEACAP method allows both researchers and practitioners to study routines at the micro-level through the identification of actors' actions, their interactions and different artefacts they use in their daily practices (Fauré & Rouleau, 2011).

- **Reflexivity on organisational routines: enhancing the organisational learning**

As the result of applying bottom-up coding, this thesis explores and shows how reflexivity on ACAP's organisational routines can enhance the organisational learning. In addition, we highlighted the role of a reflexive space such as ISEACAP to launch the reflexivity among actors of organisations that facilitates the elicitation of the ostensive dimension of routines (Feldman & Pentland, 2003) by allowing participants to reflect on their past experiences, which in turn favours the performative dimension of the routines.

In addition, we identified five different roles for researchers to enhance the reflexivity among actors including guiding, reorienting, clarifying, consolidating and encouraging. These roles enable the facilitator to conduct the sessions efficiently based on the protocol in a specified limited time, high implication of participants to generate the knowledge and at the end of the sessions to achieve consensus results.

8.1.3 Methodological contributions

- **ISEACAP: a new method to study organisational routines**

As discussed earlier in chapter 1, various methods and strategies have been applied to study ACAP and table 1-8 presented examples of researches that aim at studying ACAP's practices. These studies are mostly conducted through semi-structured interviews and surveys. In this perspective, Duchek argued that empirical analysis of absorption practices poses a great challenge for researchers as it is an endeavour to understand complex, embedded and context-dependent patterns of knowing and acting (Duchek, 2013). Organisational practices and routines are typically dispersed over time and space (Pentland & Feldman, 2008) and identifying a particular routine necessitates complex qualitative methods (Pentland et al., 2012). Researchers must immerse themselves in the life of target organisation and conduct time consuming and costly longitudinal studies(Charreire Petit & Huault, 2008).

Our results present the ISEACAP as a new method to provide an in-depth understanding of ACAP's routines. Several analysis compared obtained results from the experimental sessions conducted via ISEACAP with the semi-structured interviews (Dominguez-Péry et al., 2018) and how far these two play complementary roles to understand the ACAP's routines and practices more in depth and at the finest level.

8.1.4 Managerial contributions

- **Abstract vision on applied knowledge and routines**

The map of knowledge enables the actors of the organisation to be aware of the created or mobilised knowledge during the project, how far they could absorb external knowledge to develop their project besides the identification of artefacts that were mobilised during the project. The routine flow generated during routines eliciting and enriching session enables a better understanding of how external knowledge acquired, transformed and exploited through the project by explaining the actions carried out at collective level.

- **A reflexive space for creating knowledge collectively**

The provided reflexive space by ISEACAP contributes also in knowledge creation defined through SECI model by (Nonaka & Takeuchi, 1995).

- To enable *socialisation* aspect, experimental sessions gather key actors of project around a table and the protocol of the ISEACAP bestows the organisation's actors an opportunity to discuss their past or current experiences. Facilitators guide their discussion systematically with different rules. In addition, applying gamification techniques motivate actors to be actively involved during entire session.
- To *externalise* knowledge and ideas, we applied several elicitation techniques that help the actors highlight their experiences which are highly rooted in their actions. Additionally, in several steps, they have an opportunity to articulate their ideas more easily and discuss collectively about that.
- During collective discussion, the actors *combine* different ideas to create new knowledge collectively. The knowledge map and routines flow are two explicit examples of knowledge that are created collectively through the combination of different ideas and knowledge.
- Finally, the actors *internalise* the obtained results, conduct reflexivity via the abstract vision of what they have performed previously and raise ideas for their future projects.

8.2 Limitations

This study is based on a general question, "How can we provide a better understanding of ACAP's routines?" which has been addressed by identifying ACAP's routines through the analysis of collected data from our multiple case studies. However, routines have emerged through two case studies and reaching a more consolidated generalisation needs to be developed on further cases in different context.

The study also presents different roles of the facilitators (researchers) to enhance the reflexivity among the participants (actors of the organisations). However, regarding the intervention of the researcher through the multiple interactions (by guiding, encouraging, consolidating, clarifying and reorienting), the risk can be high for the phenomenon to stop being neutral as it could become tainted by the researcher's implication (Avenier & Thomas, 2015). This would consequently affect the internal validity of the research and the researchers who play the role of facilitators should be attentive in this term. To cope with this issue, we recommend the researchers who play the role of facilitators during the sessions to assume all the five identified roles and balance based on the requirement of each step of the protocol. For instance, the facilitators primarily explain the steps of the protocol through the guiding role. Most of the defined activities in the protocol stimulate the participants to reflect and discuss collectively. Through their discussion, the most important role of the facilitator is to clarify the arguments between the participants and bring out the details by asking questions based on the subjects that have been discussed earlier. To increase the intensity of the reflexivity, the facilitator also encourages the participants to involve more actors in the discussion and get them orientated in the right direction based on the objectives of the session. Finally, the facilitator performs the "consolidating" role while attempting to create a consensus of understanding in specific steps of the protocol such as naming the fragments in the first session and associating in the second session. A recommendation that we can draw from the conducted sessions is that the clarifying role should be applied systematically throughout all the collective steps, while guiding is more at the beginning of each step to explain the activity and consolidating at the end of specific activities of the protocol.

Another limitation of this research was finding case studies in different sectors and collecting their authorisation for recording the sessions. As discussed earlier, we targeted several SMEs in two different countries France and UK. However, at the final stage, we could have only one complete case study where we conducted all the phases of ISEACAP and allowed to record the sessions. Firstly, for SMEs, it is not easy to find common availability between their actors for two sessions of two hours. Secondly, most of the innovative projects are in progress and the organisations could not grant us the permission of recording.

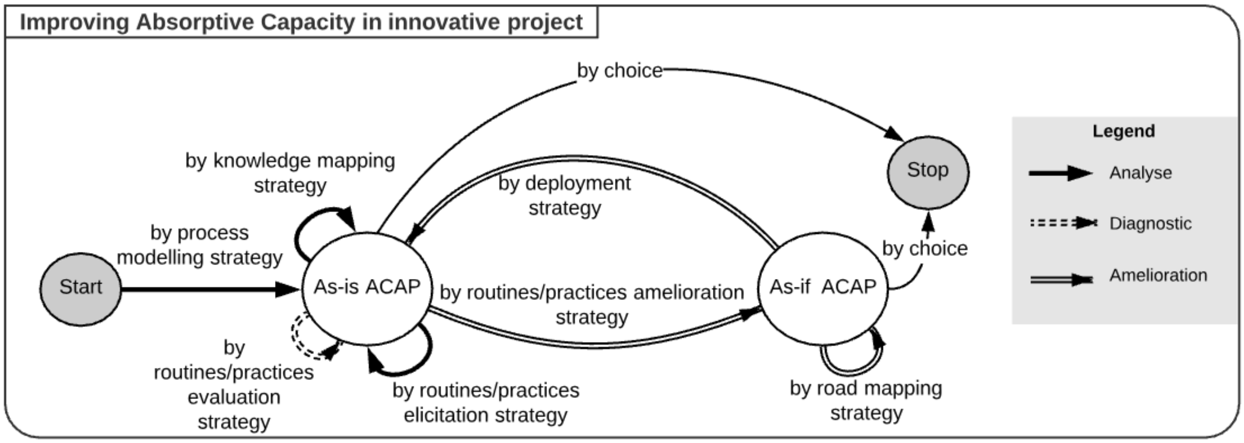
8.3 Perspectives

8.3.1 IS engineering perspectives

Figure 6-1 shows the general Map of ISEACAP that highlights two principal intentions: *Characterise As-Is ACAP system* and *As-If ACAP system*. This thesis developed the analysis and diagnostic of as-is ACAP through the four phases of the method. Therefore, for the future steps of this research, the method could be evolved by integrating relevant phases for amelioration strategies. Two potential propositions can be argued at this stage:

1. Replaying routines eliciting and enriching phases for the same project by integrating identified practices which are not routinized yet or not all applied during the previous projects while they are evaluated as important. The objective is to see how, when and by whom these practices should be applied and how the other practices or routines should be evolved based on this new integration. This stage emphasises also on continuous improvement aspect of the method.
2. The second scenario is to play the phases of the method for an innovative project with the same actors. Afterwards, a future development could integrate the best practices identified routines in the context of each SME in a collaborative network. We can study the influence of method application on organisational behaviour during their future projects and how far the method could help them improve their ACAP's routines.

Figure 9-2: General map of ISEACAP



In addition, the support tool of the ISEACAP called ISEAsy has been developed and validated by the end-users for the knowledge mapping phase. However, routines eliciting and enriching are under development and need to be validated by the end users as the next step.

8.3.2 IS management perspectives

The ISEACAP helps the organisations better understand their ACAP's routines. As the future step of this research, this could highlight the dimension of continues improvement of the method. In addition, conducting participative workshops and collective reflections can enhance the trust among the participants and it could be interesting to investigate on cultural changes that this kind of the method can bring to the organisations.

This research shows us the imperative role of gamification techniques in motivating the participants to be highly involved during the experimental sessions. This could be more highlighted by studying the role of gamification in organisational learning and increasing knowledge sharing among organisations' actors.

In terms of enriching obtained results about the identified themes of ACAP's routines, we can add frequency dimension to each theme and count how many times it has appeared during each session and in each case. This might guide us towards the variety of organisational cultures to react during collaborative innovation projects and open new avenues for developing further theoretical and practical aspects of this research.

8.3.3 Educational perspective

The ISEACAP could be potentially employed in courses of project and knowledge management related topics. The method can be conducted through three consecutive sessions with groups of four or five students. The protocol needs to be reviewed in order to be replicable in a general context.

The application of the method in education relies on the "learner-centred" approach. Learner-centred pedagogy perceives students as autonomous learners and lays emphasis on the active development of knowledge rather than its mere transfer and/or passive learning experiences. The learners' prior knowledge as well as their experiences in the social context are the starting points for stimulating learning processes in which the learners construct their own knowledge base. Learner-centred approaches require learners to reflect on their own knowledge and learning processes in order to manage and monitor them. Educators should stimulate and support those reflections. Learner-centred approaches change the role of an educator to one of being a facilitator of learning processes (instead of being an expert who only transfers structured knowledge) (Barth, Michelsen, Rieckmann, & Thomas, 2015).

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Appendixes

Appendix 1: Methods and techniques of research in social science extracted from (Jupp, 2006)

	Method/Technique	Definition
1	Action research	Action research is a type of applied social research that aims to improve social situations through change interventions involving a process of collaboration between researchers and participants. The process is seen to be both educational and empowering. Action research should not be confused with evaluation research which attempts to measure the impact of interventions without the active collaboration of participants.
2	Applied research	Research that focuses on the *use* of knowledge rather than the pursuit of knowledge for its own sake. A motivation behind applied research is to engage with people, organizations or interests beyond the academic discipline and for knowledge to be useful outside the context in which it was generated.
3	Auto ethnography	A form of self-narrative that places the self within a social context. It includes methods of research and writing that combine autobiography and ethnography. The term has a dual sense and can refer either to the ethnographic study of one's own group(s) or to autobiographical reflections that include ethnographic observations and analysis.
4	Case study	An approach that uses in-depth investigation of one or more examples of current social phenomenon, utilizing a variety of sources of data. A 'case' can be an individual person, an event, or a social activity, group, organization or institution.
5	Community study method	An approach that uses a range of research strategies and methods to study communities in a holistic manner, usually with the close involvement – and sometimes participation – of researchers in those communities.
6	Covert research	Research that is undertaken without the consent or knowledge of respondents. This type of social research is most strongly associated with participant observational work where a researcher joins a group or organization assuming a covert role in order to observe first-hand the functioning and daily life of the group.
7	Discourse analysis	Detailed exploration of political, personal, media or academic 'talk' and 'writing' about a subject, designed to reveal how knowledge are organized, carried and reproduced in particular ways and through particular institutional practices.
8	Document analysis	The detailed examination of documents produced across a wide range of social practices, taking a variety of forms from the written word to the visual image. The significance of the documents may be located in the historical circumstances of production, in their circulation and reception of the item and also the social functions, interpretations, effects and uses that may be associated with them.

	Method/Technique	Definition
9	Ethnographic interviewing	A form of interviewing conducted in the context of a relationship with interviewees with whom the researcher has, through an ongoing presence, established relations of rapport and respect sufficient for a genuine 'meeting of minds' and that enable a mutual exploration of the meanings the interviewee applies to their social world (Heyl, 2001).
10	Ethnography	A research method located in the practice of both sociologists and anthropologists, and which should be regarded as the product of a cocktail of methodologies that share the assumption that personal engagement with the subject is the key to understanding a particular culture or social setting. Participant observation is the most common component of this cocktail, but interviews, conversation and discourse analysis, documentary analysis, film and photography, life histories all have their place in the ethnographer's repertoire. Description resides at the core of ethnography, and however this description is constructed it is the intense meaning of social life from the everyday perspective of group members that is sought.
11	Ethnomethodology	An approach of studying the social world developed by Harold Garfinkel in the early 1950s which focuses on how social order is created, ongoing, in and through the practices by which people make sense of what others are doing, and display that understanding through their actions. In doing so it recommends a re-specifications of the focus of sociological inquiry, away from a concern with explaining the causes, development and/or effects of social processes or institutions.
12	Evaluation research	The systematic identification and assessment of effects generated by treatments, programmes, policies, practices and products.
13	Experiment	A research design used to draw causal inferences regarding the impact of a treatment variable on an outcome variable.
14	Exploratory research	Exploratory research is a methodological approach that is primarily concerned with discovery and with generating or building theory. In a pure sense, all research is exploratory. In the social sciences exploratory research is wedded to the notion of exploration and the researcher as explorer. In this context exploration might be thought of as a perspective, 'a state of mind, a special personal orientation' (Stebbins, 2001: 20) toward approaching and carrying out social inquiry.
15	Focus group	A method for collecting qualitative data through a group interview on a topic chosen by the researcher. A focus group typically consists of a tape-recorded discussion among six to eight participants who are interviewed by a moderator.

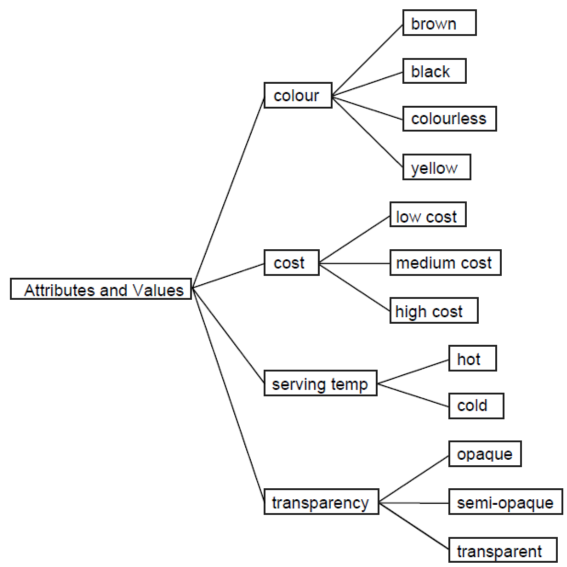
	Method/Technique	Definition
16	Grounded theory	Grounded theory is an approach to research that was developed in response to concerns over the predominance of quantitative methods in social sciences and the tendency for research to be undertaken to test existing grand theories. Glaser and Strauss (1967: p. vii) perceived that there was an 'embarrassing gap between theory and empirical research'. They proposed instead an inductive process in which theory is built and modified from the data collected.
17	Interview	A method of data collection, information or opinion gathering that specifically involves asking a series of questions. Typically, an interview represents a meeting or dialogue between people where personal and social interaction occur. However, developments in computer and information technology have resulted in other formats, for example, Internet interviews.
18	Literature review	'A critical summary and assessment of the range of existing materials dealing with knowledge and understanding in a given field… Its purpose is to locate the research project, to form its context or background, and to provide insights into previous work' (Blaxter et al., 1996: 110).
19	Longitudinal study	Any social or developmental research involving collection of data from the same individuals (or groups) across time. Observing change in these individuals gives a better basis for causal inference than a cross-sectional study, because of the temporal sequencing involved. In this sense the longitudinal study (without manipulation of the sample) is a form of 'quasi-experimental design'.
20	Micro ethnography	Research that attends to big social issues through careful examination of 'small' communicative behaviours. Analysts study the audible and visible details of human interaction and activity, as these occur naturally within specific contexts or institutions; micro-analysis may be coupled with ethnographic methods such as informant interviews and participant observations, all in an effort to better understand social organizations, practices and problems.
21	Mixed methods research	The combined use of both quantitative and qualitative methodologies within the same study in order to address a single research question.
22	Narrative interviewing	A form of interviewing that involves the generation of detailed 'stories' of experience, not generalized description. Narratives come in many forms, ranging from tightly bounded ones that recount specific pas events (with clear beginnings, middles, and ends), to narratives that traverse temporal and geographical space – biographical accounts that cover entire lives or careers.

	Method/Technique	Definition
23	Ethnography	Ethnography conducted on the internet; a qualitative, interpretive research methodology that adapts the traditional, in-person ethnographic research techniques of anthropology to the study of the online cultures and communities formed through computer-mediated communications (CMC).
24	Oral history	A method that seeks to open novel routes for understanding the past, the relation of past to present and the lives of others through time, by listening to the voices of individuals talking extensively about the events and experiences through which they have lives. The characteristic form through which oral history data are gathered is the in-depth interview.
25	Participant observation	A qualitative method of social investigation, whereby the researcher participates in the everyday life of social setting, and records their experiences and observations.
26	Participatory action research	One of the categories into which actin research (PAR) consists in an approach that includes both understanding a situation (creating knowledge) besides changing or acting upon that situation – using participatory methods, that is, challenging the dichotomy between researchers and researched.
27	Practitioner research	Research concerned with issues and problems that arise in professional practice. It is conducted by practitioners and aims to bring about change, or influence policy in the practice arena. Practitioner research provides a framework for formulating practice knowledge and allows such knowledge to be disseminated to other professionals.
28	Prospective study	A study that follows cases forward in time, measuring attributes at multiple time points. Change is measured by examining differences between each time point or study wave. Unlike experimental designs, prospective designs do not include randomized control groups or experimental interventions.
29	Quasi-experiment	An experiment that attempts to test a hypothesis about the effects of an intervention by methods other than those used in a 'true experiment', where the latter is deemed to require random allocation to experimental and control conditions.
30	Questionnaire	A set of carefully designed questions given to exactly the same form to a group of people in order to collect data about some topic(s) in which the researcher is interested.
31	Retrospective study	A study that involves collecting data about past events. This design is mainly employed to measure and understand change and to include a time dimension to the data that can be used to identify causal factors contributing to any observed change. The capacity of a retrospective study to adequately detect change and ascertain causes depends on how well the investigator can reconstruct the past from the vantage point of the present.
32	Simulation	An experiment performed on a model and aimed at imitating the operation of systems over time for the purpose of analysis or of creating virtual worlds.

	Method/Technique	Definition
33	Social survey	A method of social research with three defining characteristics – its type of content, its form of the data and the method of analysis employed (Marsh, 1982). Its content is social, the form of data is systematic, structured and based around variables and the method relies on comparisons across groups.
34	Structured observation	A systematic method of data collection, where there is considerable pre-coding and the observation takes the form of recording when, how often, or for how long the precoded behaviours occur. Observing usually means watching and listening, although it may entail just watching *or* listening. By contrast, informal or casual observation is unstructured, and may form the basis of future structured observation. Informal or casual observation methods are sometimes seen as less objective than structured observation, because the observer may be focusing on behaviours without a clear theoretical framework, and may not be coding the behaviours in a reliable that is, repeatable way. The counter viewpoint is that a theoretical framework can act as a strait-jacket that distorts reality.

Appendix 2: Knowledge elicitation techniques

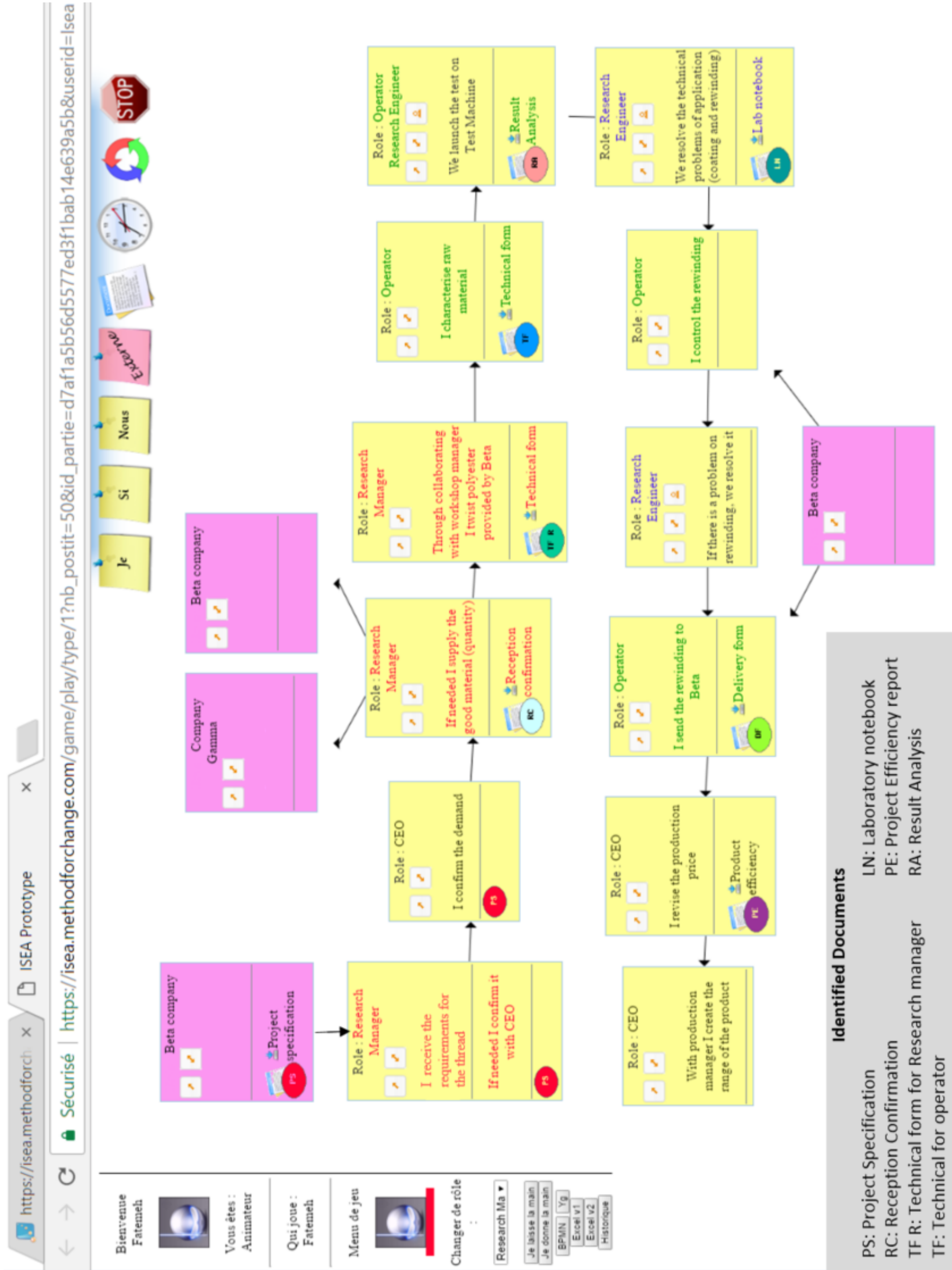
Technique	Definition
Unstructured interview	The unstructured interview has very little planning and is a freeform chat with the expert. This can be used in the early stages of elicitation to get some basic knowledge of the domain but is not normally used for most elicitation sessions, as it is not very efficient (Milton, 2007).
Semi-structured interview	The semi-structured interview is the main technique for eliciting explicit knowledge. It uses a pre-defined set of questions that are sent to the expert beforehand, and supplementary questions that are asked at the interview.
Structured interview	The structured interview uses a pre-defined set of questions and no supplementary questions. It often involves a questionnaire that is filled-in at the session. This is usually preferable to sending questionnaires to people, as they rarely respond to them.
Time Line	A timeline is a diagram that shows time along the horizontal axis and contains concepts as nodes. The width of each node shows when the concept starts and finishes. This can be used to show the phases of a project or the order of events or tasks.
Laddering	Laddering model or tree diagram shows a hierarchical arrangement of nodes. Each node represents a concept in the k-base and each link represents a relationship between a pair of concepts (Milton, 2007). When using laddering stakeholders are asked a series of short prompting questions, known as probes, and required to arrange the resultant answers into an organised structure (Zowghi & Coulin, 2005). A primary assumption when employing laddering is that the knowledge to be elicited can actually be arranged in a hierarchical order (Zowghi & Coulin, 2005). For this technique to be effective, the stakeholders must be able to express their understanding of the domain and then arrange it in a logical way (*ibid*).

	Figure 0-1: An attribute tree showing the properties of drinks 
Process Mapping	A process map shows the way a task (process, activity) is performed. The main elements on a process map are the sub-tasks of the task that is being modelled (Milton, 2007). These sub-tasks are placed on the map in the order in which they are performed (*ibid*).
Teach back	The expert explains something to the elicitor who explains in turn the same thing back to the expert for verification.
Scenarios	Scenarios are used to place the expert in specific situations in which he/she performs a task or set of tasks that are of interest to the project. There are two types of scenarios: (i) Real situations that have occurred to the expert or to other experts; (ii) Realistic situations that could occur in the future.
Concept Mapping	A map is a diagram that shows an arrangement of nodes linked by arrows. Each node represents a concept in the k-base and each link represents a relationship between a pair of concepts.
Limited Information Tasks and Constrained processing tasks	Limited-information and constrained-processing tasks are techniques that either limit the time or limit the information available to the expert when performing a complex task. These techniques can provide a quick and efficient way of establishing strategies and information used by the expert. For the limited-information task, you can do the following: - Identify a complex task to be explored; - Ask the expert: "If you were to perform this task, but only had three pieces of information, what would these be?"

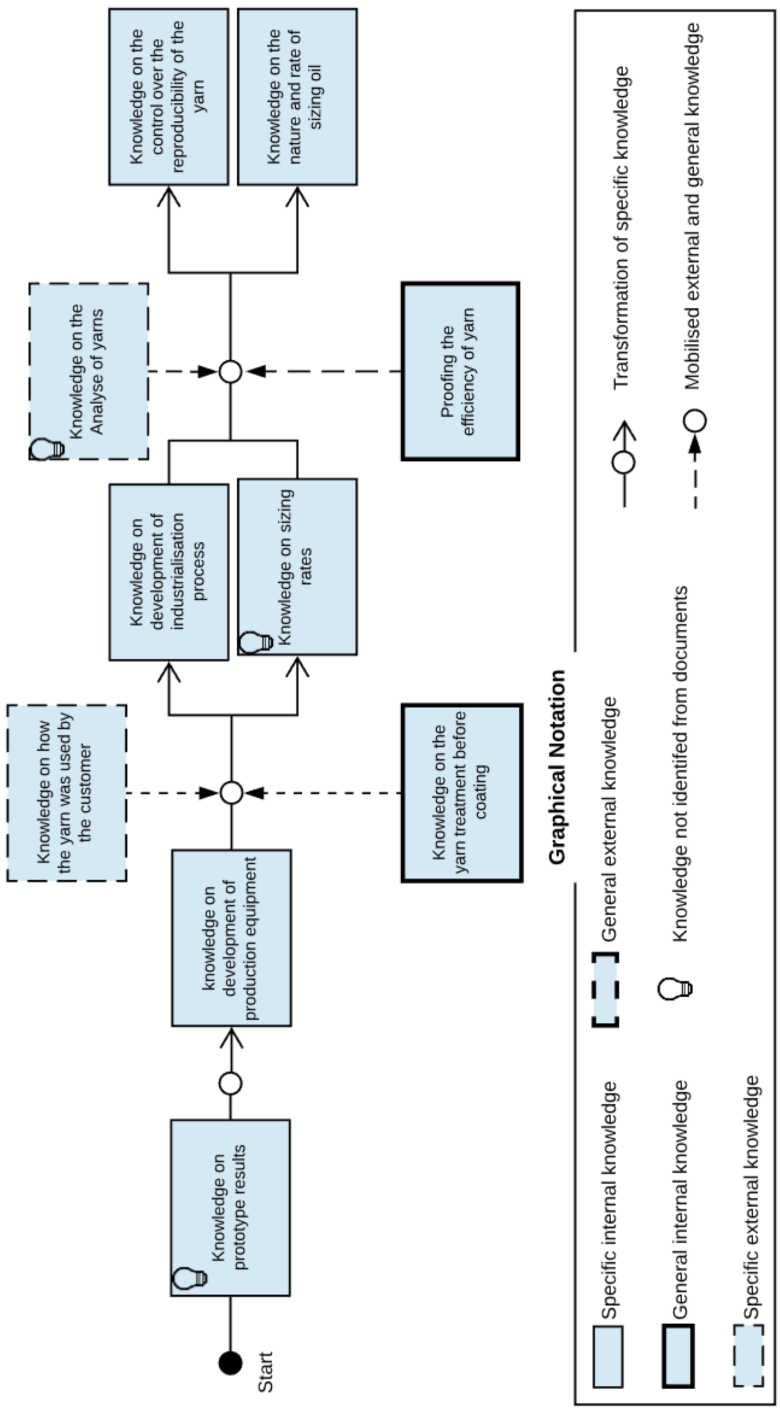
	- After the reply, ask: "If you had three more pieces of information, what would these be?" - Repeat this until the expert can provide no more information
Critical decision making	CDM is an interview technique in which particular past events and incidents are examined in great detail to expose the thought-processes that the stakeholder uses to make decisions. The focus is on non-routine incidents, the idea being that these are usually the richest source of data about the stakeholder's capabilities (assuming less expert practitioners can handle the routine incidents). A semi-structured interview is used to examine the incident. The questions probe for: (i) The subtle cues that the stakeholder relies upon but that can be missed by novices; (ii) The inferences and strategies that the stakeholder used during the incident; (iii) The options that were selected and those that were rejected.
Commentary	This technique involves the expert describing a task as it is performed. The basic technique here is the self-report, in which the expert provides a running commentary of his/her thought-processes as a problem is solved or a task is performed. One problem with the self-report technique is that of cognitive overload, i.e. the mental effort required by the expert to provide the commentary can interrupt and affect his/her performance of the task.
Concept sorting	Sorting techniques are an efficient method of capturing the way an expert compares and orders concepts, and can lead to the revelation of knowledge about classes, properties and priorities. The simplest form is card sorting. Here the expert is given a number of cards each one displaying the name of a concept. The expert is set the task of sorting the cards into piles such that the cards in each pile have something in common. Each time the cards are sorted, it will be based on an attribute and each pile will represent a value. Here is the procedure to use: - Decide which class of concepts you require to explore in detail, particularly their properties (attributes and values); - Write the name of each concept on a separate card or piece of paper; - At the session, explain to the expert what is to happen, - Ask the expert to sort the cards into piles, so that the cards in each pile are similar in some way; - Ask the expert to name each pile; - Write down (or photograph) the results of the sort (code letters or numbers on each card can help reduce the time to do this); - Collect the cards together and ask the expert to sort them again; - Repeat these steps until the expert can sort no more

Repertory Grid	Repertory grids involve asking stakeholders to develop attributes and assign values to a set of domain entities (Zowghi & Coulin, 2005). As the result, the system is modelled in the form of a matrix by categorising the elements of the system, detailing the instances of those categories, and assigning variables with corresponding values to each one (*ibid*). This technique is similar to concept sorting but allows the stakeholder to provide ratings (scores) of each concept for an attribute rather than just placing it in one pile or another. In addition, it provides more detailed than concept (card) sorting, and to a lesser degree laddering, repertory grids are somewhat limited in their ability to express specific characteristics of complex requirements (Zowghi & Coulin, 2005, p. 42).

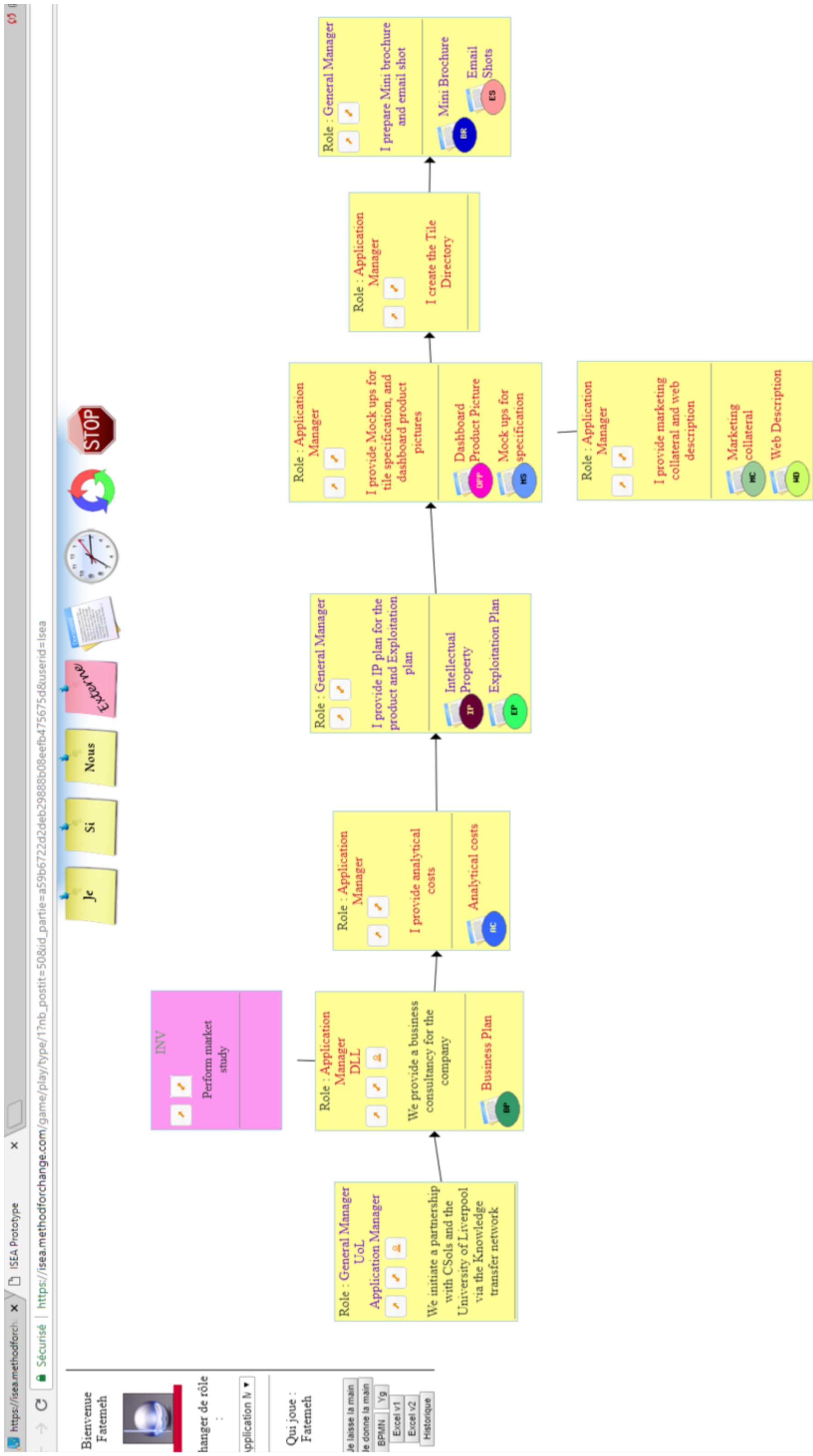
Appendix 3: Process model of the collaborative innovation project in Alpha - Industrialisation phase



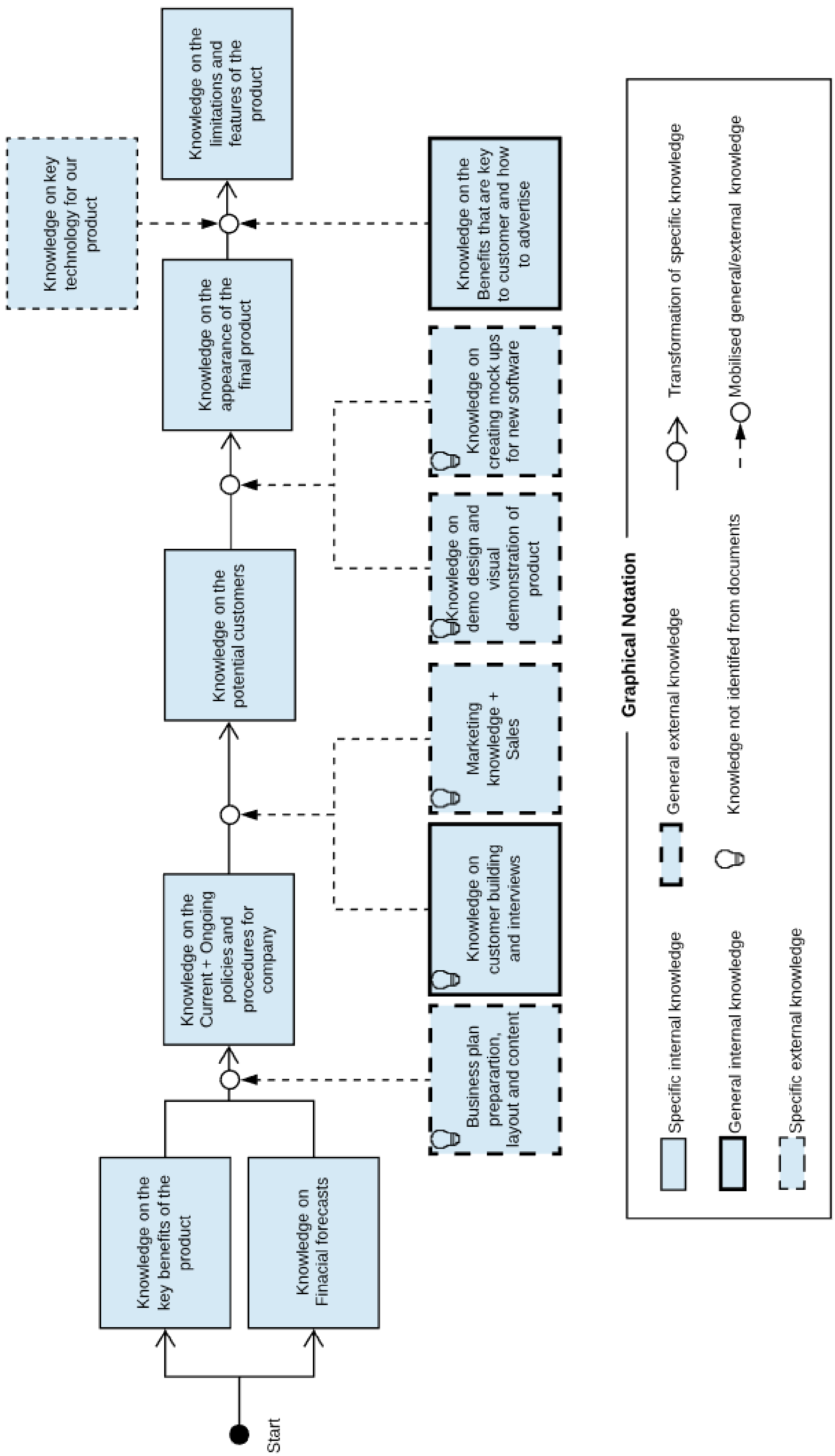
Appendix 4: Knowledge map of Alpha Company



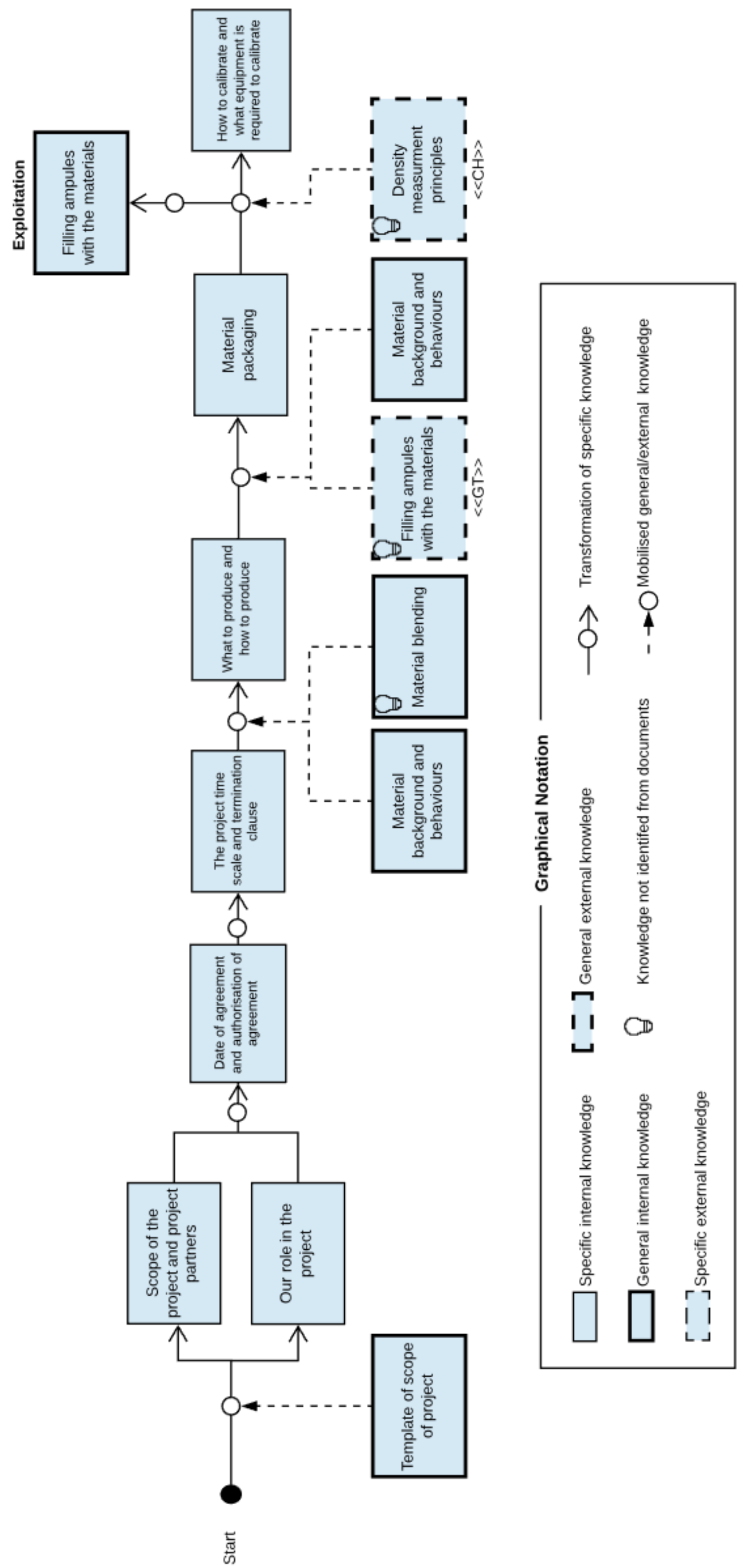
Appendix 5: Process model of the collaborative innovation project in CSL – Planning phase



Appendix 6: Knowledge map of CSL Company



Appendix 7: Knowledge map of PRG Company



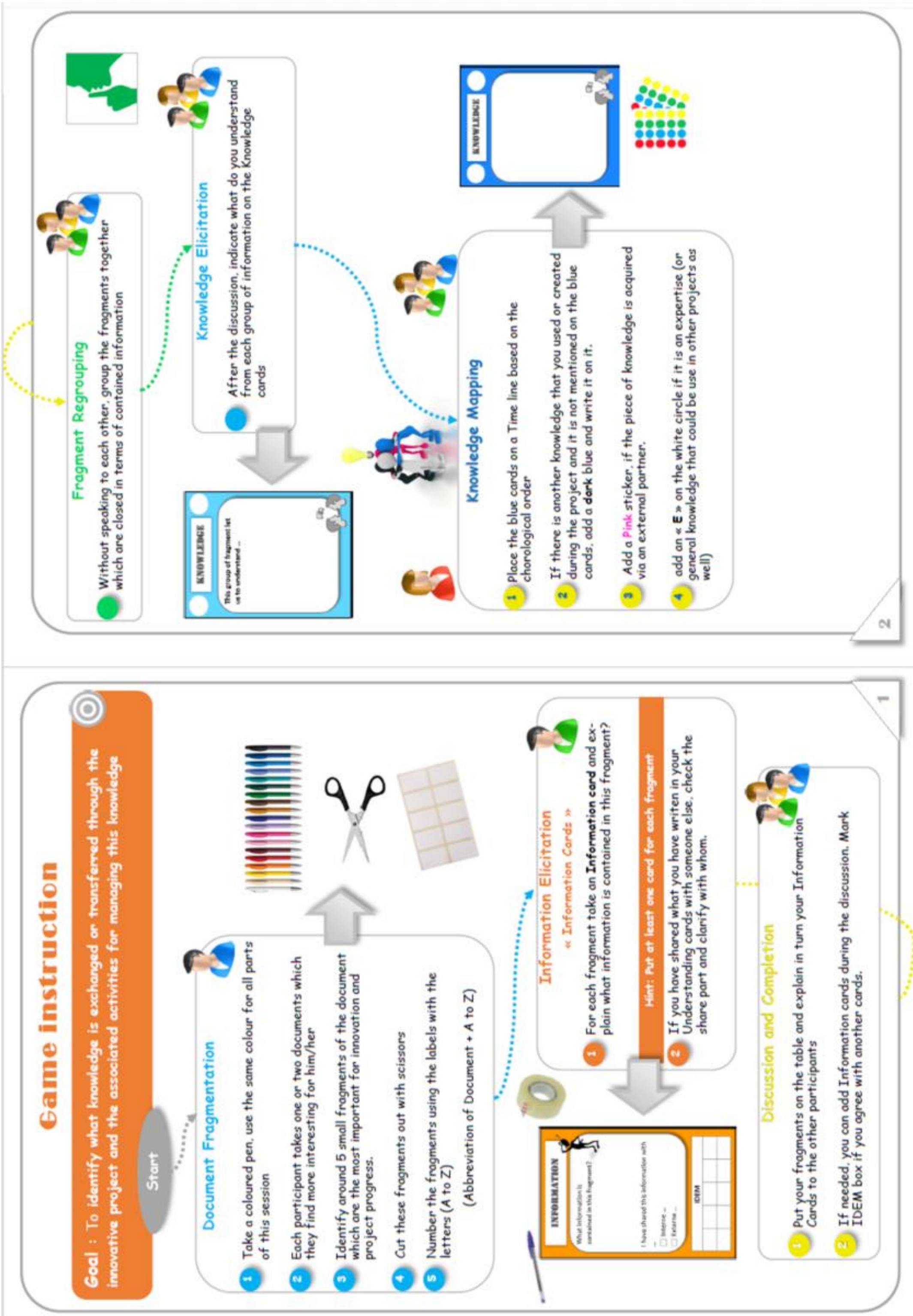
Appendix 8: Revised protocol of ISEACAP for knowledge mapping on ISEAsy tool

Activity and Description	C/ I*	Duration
Introduction: the session begins with an overview of the process model provided in the process modelling phase. All participants re-enact the precise role they played and intervene where necessary.	C	15 min
Document fragmentation: Each actor adds the documents that seem important for enhancing innovation along the project, use the icons to cut the most valuable part of the document. After cutting the information card should be completed. The facilitator can also new documents and removes.	I	10 min
Collective discussion: each participant describes what he/she has written on his/her information cards. They can also see the others' fragments.	C	15 min
Fragment grouping: Before starting, the facilitator should create several knowledge group without naming them. Then the participants put the fragments in different groups based on the proximity of the contained information by answering this question: "*which fragments are close in terms of contained information?*" To this end, they should click on chain icon.	C	5 min
Knowledge identification by knowledge cards: the facilitator clicks on each group and asks the participants "*what did you understand from that group of fragments*?" The facilitator helps them to find a consensus name for each group. In parallel, they should select the characteristics of each group in terms of: – External/Internal – Specific to the project/general	C	15 min
Identification of knowledge chronology (timeline): The facilitator clicks on the "organising the knowledge" and the knowledge boxes appear on the screen. With the help of the participants, the facilitator makes connection between the boxes. If the participants intend to add a new knowledge, they can come back to the previous steps and add documents or knowledge card.	C	20 min

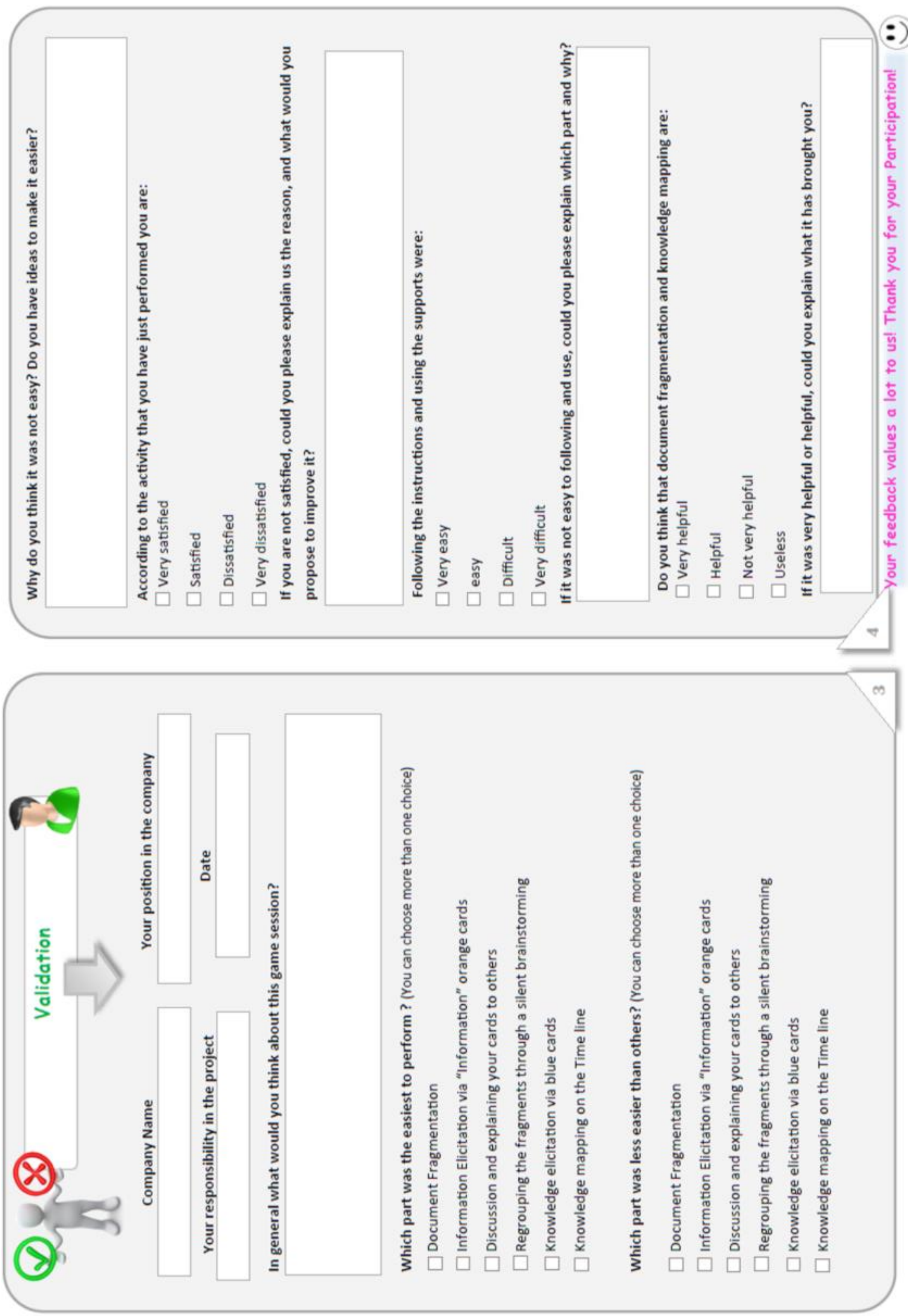
Appendix 9: Revised protocol of ISEACAP for routines eliciting and enriching on ISEAsy tool

Activity and Description	C/ I*	Duration
Introduction: the session begins with the knowledge map produced during the previous session. The facilitator explains that participants should focus on the transformation nodes which are numbered and there is a branch of external knowledge. The main objective is to illustrate what was performed to acquire, transform and exploit external knowledge.	C	10 min
Routines/practices eliciting: In the left side of the interface the participants can choose a word to start their story. After clicking on the word a pop-up window appears and the participants should fill the form for each word. They insert the number of the nodes as well as their phrases. In the same window they choose the related characteristics for their written phrase (systematic/emerging to highlight routine or practice)	C	30 min
Clustering: After inserting all the desired phrases by the participants, they can click on the next step. The participants can see their phrase in the left side of the page and "best practices" on the right side. By clicking on the chain icon, they can link their phrase with the related group presented in the right side. Each participant can link only her/his own phrases. But the facilitator has access to all.	C	15 min
Enriching by evaluation: The facilitator has access to the editing icon for each phrase or best practices in right side. The participants can only visualise the modifications. With the help of the participants, the facilitator evaluates all the practices or routines (best practices and phrases). By clicking on edit icon for each phrase or best practice the facilitator asks the participants regarding the current project and future projects in terms of "Importance" and "systematic or emerging application".	C	25 min
The participants can visualise their routine/practices flow which can be useful for their future projects.	C	5 min

Appendix 10: Knowledge mapping game instruction



Appendix 11: Knowledge mapping validation form



Validation

Company Name

Your position in the company

Your responsibility in the project

Date

In general what would you think about this game session?

Which part was the easiest to perform ? (You can choose more than one choice)

- ☐ Document Fragmentation
- ☐ Information Elicitation via "Information" orange cards
- ☐ Discussion and explaining your cards to others
- ☐ Regrouping the fragments through a silent brainstorming
- ☐ Knowledge elicitation via blue cards
- ☐ Knowledge mapping on the Time line

Which part was less easier than others? (You can choose more than one choice)

- ☐ Document Fragmentation
- ☐ Information Elicitation via "Information" orange cards
- ☐ Discussion and explaining your cards to others
- ☐ Regrouping the fragments through a silent brainstorming
- ☐ Knowledge elicitation via blue cards
- ☐ Knowledge mapping on the Time line

3

Why do you think it was not easy? Do you have ideas to make it easier?

According to the activity that you have just performed you are:

- ☐ Very satisfied
- ☐ Satisfied
- ☐ Dissatisfied
- ☐ Very dissatisfied

If you are not satisfied, could you please explain us the reason, and what would you propose to improve it?

Following the instructions and using the supports were:

- ☐ Very easy
- ☐ easy
- ☐ Difficult
- ☐ Very difficult

If it was not easy to following and use, could you please explain which part and why?

Do you think that document fragmentation and knowledge mapping are:

- ☐ Very helpful
- ☐ Helpful
- ☐ Not very helpful
- ☐ Useless

If it was very helpful or helpful, could you explain what it has brought you?

Your feedback values a lot to us! Thank you for your Participation!

4

Appendix 12: Routines eliciting and enriching validation form

Validation form
Routines Eliciting and Enriching

Company name

Your position in the company

Date

In general what would you think about this session?

Which part was the easiest to perform? (You can choose more than one choice)

- ☐ Storytelling and Game board
- ☐ Summarising a story to a short phrase
- ☐ Clustering the yellow-post its in 3 groups through silent brainstorming
- ☐ Associating your identified practices to the best practices from literature
- ☐ Qulaifying and reflecting on the practices to identify important ones for the future
- ☐ Other

Which part was less easier than others? (You can choose more than one choice)

- ☐ Storytelling and Game board
- ☐ Summarising a story to a short phrase
- ☐ Clustering the yellow-post its in 3 groups through silent brainstorming
- ☐ Associating your identified practices to the best practices from literature
- ☐ Qulaifying and reflecting on the practices to identify important ones for the future
- ☐ Other

Why do you think it was not easy? Do you have ideas to make it easier?

According to the activity that you have just performed you are:

- ☐ Very satisfied
- ☐ Satisfied
- ☐ Dissatisfied
- ☐ Very dissatisfied

If you are not satisfied, could you please explain us the reseason, and what would you propose to improve it?

Following the facilitators' instruction and using the supports were:

- ☐ Very easy
- ☐ Easy
- ☐ Difficult
- ☐ Very Difficult

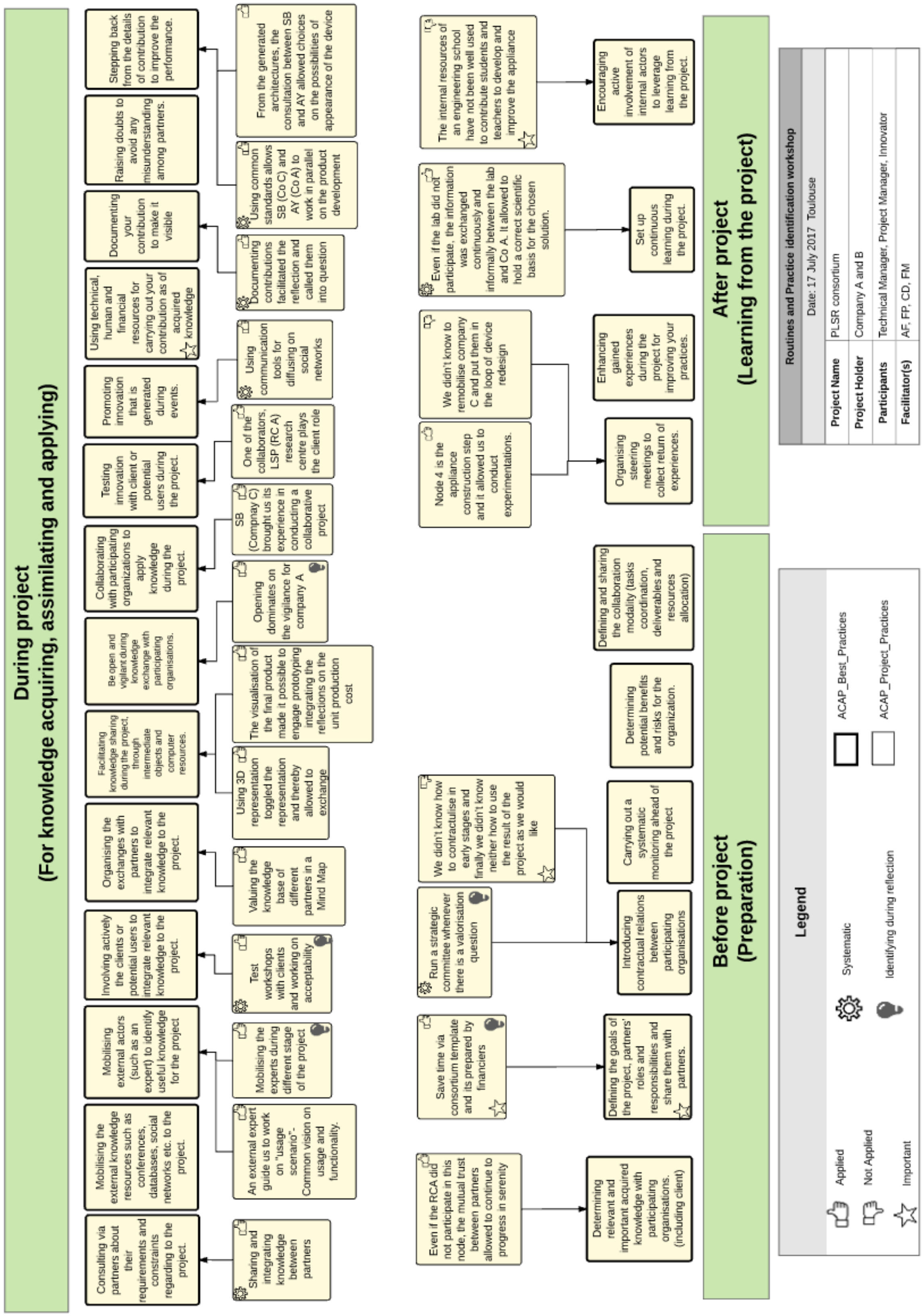
If it was not easy to following and use, could you please explain which part and why?

Do think this session was

- ☐ Very helpful
- ☐ Helpful
- ☐ Not very helpful
- ☐ Useless

Thank you for your participation!

Appendix 13: Routines Flow- Routine eliciting and enriching-LVB-AGY



Appendix 14- A snapshot from the data Excel file (AGY and LVB case) – Facilitators' roles and knowledge novelty

1	Phase	Activity	Reflexivity passage	Novelty of knowledg	ACAP Routines	Role of Facilitator	Verbatim - Facilitators
57	Routines Eliciting and Enriching	Storytelling	AB Là, on a raconté trois histoires. PG On a raconté trois histoires, oui... GG Elles sont proches. Enfin, il y a...il y a...	(1)Existing knowledge	No	Clarifying	AF Non. Sur...sur un même nœud, il peut y avoir plusieurs histoires parce que les différents acteurs ont peut-être vécu des choses différentes, hein. P. 10
58	Routines Eliciting and Enriching	Storytelling	AB On reste sur le point 4 ou... ? FM Non. AB à partir...à partir du nœud 3...on a...commencé à disposer de...d'outils de communication qui ont...enfin, notamment servi à...à communiquer sur les réseaux sociaux. Le...le projet est devenu externe. Un peu plus sur l'extérieur. (...) C'est un peu le visuel qui règne en maître. C'est vraiment le visuel qui règne en maître sur les réseaux sociaux, pas sur les...la communication. GG Oui, l'image c'est... AB La valeur, enfin la valeur sociale...si, la valeur sociale c'est pas mal.	(2)Combination of existing knowledge	Yes	Clarifying	FM C'est quel nœud ? P. 21
59	Routines Eliciting and Enriching	Storytelling	AB Oui, cela va. C'est bien. (...) GG Oui, oui. Je ne sais pas. C'est un peu transversal. Bon, on va dire que cela pique au nœud 3. « Remettre en question ». Pourquoi remettre en question ? Parce que, je pense que l'approche...par l'usage et...la visualisation de...d'un design en 3D a...a fait basculer le...l'approche...technique et fonctionnelle que...que l'on avait de l'appareil, voilà, parce que...les contraintes de...d'utilisation sont devenues des...des contraintes majeures et...et prioritaires à prendre en compte. Et les contraintes moins techniques de...d'opération de la...enfin, de fonctionnement de l'appareil, en tout cas de...qui sont...liées à l'utilité de l'appareil...lui-même...sont vues asservies par...les contraintes d'usage...du scénario d'usage. Voilà. (...) C'est la	(2)Combination of existing knowledge	Yes	Consolidating	FP Donc j'ai mis : « le référentiel commun a permis, à et , de travailler en parallèle pour faire avancer la définition de la phytotière ». P. 14
60	Routines Eliciting and Enriching	Storytelling	AB C'est tout à fait complémentaire. PG C'est complémentaire. AB Il faut que tu appuies. Si tu n'appuies pas ce n'est pas bon.	(2)Combination of existing knowledge	No	Consolidating	FP Donc la première phrase que j'ai notée : « valorisation des bases de connaissances des différents partenaires dans un mind map ». Et la deuxième : « un expert externe de chez SEB nous a guidé pour travailler sur un scénario d'usage pour avoir une vision commune des fonctionnalités d'usage de la phytotière ». p. 9
61	Routines Eliciting and Enriching	Storytelling	PG ...en continu, de façon informelle, on va dire. FP ...en continu (...) de façon informelle ont permis de... » AB ...(Début discussion en même temps que FP) avec des mots...sur deux pages. PG Là-dessus, tu prends cela, je peux te faire. AB Lui, c'était plutôt sur l'aspect gouvernance...gouvernemental, enfin...gouvernance de...de...du département... PG Du pilotage total. AB L'aspect réunion... PG On raconte une histoire qui n'existe pas. AB De toute façon, c'est le principe hein. PG Sur un projet qui n'existe pas.	(2)Combination of existing knowledge	No	Consolidating	FP « Même si le labo n'a pas participé, les infos échangées entre le labo p. 18

Appendix 15- A snapshot from the data Excel file (AGY&LVB and Alpha cases) - ACAP's routines

	A	B	C	D	E	F	G
1	**Company**	**Detail**	**ACAP**	**Routine**	**Nature of routine**	**Theme**	**Verbatim**
30	**AGY**	**Routines Eliciting**	**Application**	Externalising the project in early stages via social media (Commercial)	Managerial	Commercialisation	AB: Pour parler d'un autre sujet, la communication, à partir...à partir du nœud 3...on a...commencé à disposer de...d'outils de communication qui ont...enfin, notamment servi à...à communiquer sur les réseaux sociaux. Le...le projet est devenu externe. Un peu plus sur l'extérieur. (Doc 2, p. 21)
31	**AGY**	**Routines Eliciting**	**Acquisition**	Playing the role of client by one of the partners *(Exchange with partners)*	Managerial	Collaboration	PG: Je peux choisir un mot ? Je choisirai le mot « client » (00 :33 :31), à partir du nœud 4, a pris un premier client, c'était nous. On leur a acheté l'expérience. (...) Est-ce que vous avez eu un deuxième client. (Doc 2, p. 22)
32	**AGY**	**Routines Eliciting**	**Assimilation**	Synthesising the process that applied to achieved the results in each stage of the project (*Synthesising the results of the tests*)	Technical	Technical - Sythesis	AB: La chose qu'on...qu'on ne fait jamais et...La chose qu'on ne fait jamais, on ne sait jamais comment s'y prendre c'est...c'est contractualiser. Ce mot-là est très bien. Et...et c'est quelque chose...Il y a eu tout un cycle, en fait où...où on n'a pas...on n'a pas réfléchi à ces notions-là et s'est posé la question, à la fin, de comment on utilise la...les résultats de...de ce processus et...la seule réponse à...qui a été donnée c'est : on ne l'utilise pas. D'où...d'où peut-être la nécessité de...d'anticiper cette...cette contractualisation. (Doc 2, p. 23)
33	**AGY**	**Routines Eliciting**	**Acquisition**	Mobilising external partners in all the stage of the project. *(Exchange with partners)*	Managerial	Collaboration	PG: Moi je veux bien alors. Sur...sur « mobiliser ». Et...et c'est vrai que, entre le nœud 3 et le nœud 4, pour moi on n'a pas su remobiliser pour les mettre dans la boucle du design de...de Je pense qu'ils ont des...des connaissances et...à...à apporter un regard critique qui serait utile parce que là, il y a des...des orientations qui...sur le PRU, notamment...qui se sont écartées de...de notre cahier des charges initial et...et...pour moi, ce serait intéressant de les solliciter en fait. (Doc 2, p. 24)
34	**AGY**	**Routines Eliciting**	**Application**	Identifying and using all the potential sources to externalising the product (Commercial)	Managerial	External communication	GG: Oui. « Communiquer ». Je crois qu'on n'a pas bien utilisé les...les moyens internes...à l'école d'ingénieurs pour...toucher toute une population...sur le projet et, éventuellement, comme un...comme un client à travers...en utilisant (Doc 2, p. 25)
35	**AGY**	**Routines Eliciting**	**Application**	Customising and compeleting the agreement based on the collected information from all the partners (Collaboration) (Collecting partners' ideas)	Managerial	Collaboration	AB: C'est ce que je disais tout à l'heure, là sur ce...sur ce nœud 3 en fait. Dans l'accord, on dit que...en gros on dit : « mais...au moment où il y aura des connaissances partagées...les partenaires qui sont...parties prenantes de ces connaissances... ...discuteront entre eux les moyens de valorisation ». Soit ! Enfin voilà, j'ai envie de dire : « ...oui, c'est...c'est »...pour moi, cela serait...ce sont deux pages en fait. Il pourrait se résumer en deux pages, l'accord de consortium. Un template qu'on donne à tous les projets...et...et qui évite à chaque...à chaque institution de définir son propre template mais c'est important aussi parce que... Ce qui fait qu'on passe du temps là-dessus c'est que l'I a son accord de consortium, a son accord de consortium, a le sien, etc. et du coup, après, il faut essayer de...de faire une espèce de mix entre tous ces accords-là qui ne sont pas...enfin qui...qui regroupent la même chose. Enfin, qui regroupent les mêmes informations. (Doc 2, p. 34)
36	**AGY**	**Routines Eliciting**	**Application**	Clarifying intellectual property, patents and publications from the beginning	Managerial	Collaboration	AF: Donc, grosso modo, comme...lorsqu'on signe l'accord de consortium on n'a pas une vision nette sur ce que va produire le projet, en fait on est toujours amené, au cas par cas, à réunir les partenaires et à décider, ponctuellement...à chaque fois qu'il y a un...la problématique de la valorisation se pose. AB: Oui, c'est cela. Publication, brevet...(Doc 2, p. 36)
37	**Alpha**	**Knolwledge Mapping**	**Transformation**	Documenting the exchanges with client during all the project	Managerial	Documentation	RM : Il y a cela et la partie...tout ce qu'on met...nos fiches de réglage, etc. Donc on a - je ne sais pas si on vous a expliqué - on a un système un ERP, où on a aussi une gestion de relation clients, ce qu'on appelle une et donc chaque projet...où même développement, où même si ce n'est pas un projet collaboratif, on ouvre un dossier ein...qui est rattaché à un client, ou pas - puisque des fois on peut le faire...le faire avec un client mais ça ne lui est pas réservé pour autant - et là-dedans, on stocke toutes les infos... : fiches de réglage, etc., les expéditions... RE : Oui, parce que moi j'ai mis des onglets dans le cahier, des onglets orange ou rose parce que je n'avais plus d'orange, qui correspondent à...à des parties avec en fait parce que, dans le cahier tu sais, il n'y a pas que pour : il y a , justement, il y a d'autres...d'autres trucs.
38	**Alpha**	**Knolwledge Mapping**	**Acquisition**	Collaborating with an external expert to resolve the technical problem	Technical&Managerial	Collaboration	RE: Ça c'est un...les deux, ce sont des rapports de...Science et Surface quand on a fait...donc, c'est un intervenant extérieur à qui on a fait faire des analyses sur les fils qu'on travaillait pour pour comprendre l'adhérence, par exemple. On a fait plusieurs essais avec eux, voilà. Je ne sais pas comment on peu l'appeler mais...
39	**Alpha**	**Knolwledge Mapping**	**Application**	Improving the quality of the product through several testing based on the what they captured from the external expert	Technical	Technical	RM : Oui. Oui... Donc, il y avait des observations « non lavés, non tordus » et « lavés et tordus ». Et en fait...quand on...la conclusion de...d'un peu toutes ces analyses c'est que...le lavage... En plus, le lavage nous donnait des problèmes chez nous mais...au niveau des observations en fait, entre...le fil lavé et non lavé on retrouvait toujours les traces de...des...de l'ensimage primaire... (...) et puis...au niveau de la tenue de la gaine, il n'y avait pas...de différence non plus. C'est-à-dire qu'on avait la même gaine, à peu près homogène, etc. Donc, pour nous...la conclusion était de dire : « et bien...ce n'est pas utile de laver finalement ». Cela a été la première conclusion. La deuxième conclusion qu'on ne voit pas là mais...c'était...l'histoire du fil non tordu ou tordu et, en fait...on a...- ce qui ne se voyait pas d'ailleurs en observation - mais...on a quand même...préféré le tordre parce que...cela posait des problèmes derrière, nous, au niveau du process de...sur la machine quoi. Donc ça, ce sont des choses qu'on a partagées en interne et avec L'action, cela a été de...de ne plus laver quoi.

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