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Exploring the antecedents of innovation-based performance: the
case of a research unit in Aristotle University of Thessaloniki

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*“Dedicated to my colleagues who offer me
an inspiring everyday working life”*

Abstract

Research on R&D teams within HEIs or Research Centers working intensively on R&D projects to advance science, advance economic development and tackle societal challenges, achieving innovative research outcomes has attracted unprecedented resonance during the last decades. Most empirical research up to now has explored a number of factors that enable or inhibit innovative team outcomes, such as leadership variables, management styles, tools and techniques, the characteristics of the work environment as perceived by team members or the characteristics of the team members and in-house capabilities. However, there has been limited research on the decision-making processes and knowledge transfer processes, such as planning or problem-solving strategies, as well as, learning processes, by which R&D team members actually achieve breakthrough research. In this dissertation, we aspire to fill this void by exploring the decision-making processes along with learning processes and other factors driving innovation based performance in R&D contexts.

To that end, we take a qualitative (case study) approach and use a research team established in Aristotle University of Thessaloniki in Greece as our research setting. The research unit operates since 2006 and employs roughly 40 researchers, who work intensively to produce original research and achieve innovation in the fields of medical informatics, medical education, assistive technologies, biomedical technology, neuroscience etc. The research unit is funded by competitive grants obtained through various funding schemes like H2020, Erasmus+ etc, or national funds. The funding depends on the unit's performance in succeeding grant proposals.

This research concentrates on the causation and effectuation decision-making logics applied while learning processes are being examined through the observation of learning capability of the entity, as well as, exploration and exploitation learning processes. The findings demonstrate how an ambidexterous R&D team balances between exploitation and exploration through its decision-making processes and is qualified to achieve incremental and radical innovation.

Keywords

Innovation, R&D, effectuation, decision-making, organizational learning, open innovation

Περίληψη

Η έρευνα που διενεργείται σε ΑΕΙ ή Ερευνητικά Κέντρα από ομάδες που εργάζονται εντατικά σε έργα Ε&Α για την προώθηση της επιστήμης, την προώθηση της οικονομικής ανάπτυξης, την αντιμετώπιση κοινωνικών προκλήσεων και την επίτευξη καινοτόμων ερευνητικών αποτελεσμάτων έχει προσελκύσει πρωτοφανή απήχηση κατά τις τελευταίες δεκαετίες. Οι περισσότερες εμπειρικές έρευνες έως τώρα έχουν διερευνήσει έναν αριθμό παραγόντων που υποστηρίζουν ή αναστέλλουν καινοτόμα αποτελέσματα μιας ομάδας/μονάδας, όπως το στυλ ηγεσίας, τις μορφές διοίκησης, άλλα εργαλεία και τεχνικές, τα χαρακτηριστικά του εργασιακού περιβάλλοντος όπως τα αντιλαμβάνονται τα μέλη της ομάδας ή τα χαρακτηριστικά των μελών και τις εσωτερικές ικανότητες της ομάδας. Ωστόσο, υπήρξε περιορισμένη έρευνα σχετικά με τις διαδικασίες λήψης αποφάσεων και τις διαδικασίες μεταφοράς γνώσεων, όπως ο σχεδιασμός ή οι στρατηγικές επίλυσης προβλημάτων, καθώς και οι διαδικασίες μάθησης, με τις οποίες τα μέλη της ομάδας Ε&Α επιτυγχάνουν πραγματικά πρωτοποριακή έρευνα. Σε αυτή τη διατριβή, επιδιώκουμε να καλύψουμε αυτό το κενό διερευνώντας τις διαδικασίες λήψης αποφάσεων μαζί με διαδικασίες μάθησης και άλλους παράγοντες που οδηγούν στην υψηλή απόδοση με βάση την καινοτομία σε περιβάλλον Ε&Α.

Για το σκοπό αυτό, ακολουθούμε μια προσέγγιση ποιοτικής αξιολόγησης (μελέτη περίπτωσης) και χρησιμοποιούμε μια ερευνητική ομάδα που δραστηριοποιείται στο Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης στην Ελλάδα ως ερευνητικό περιβάλλον μας. Η ερευνητική μονάδα λειτουργεί από το 2006 και απασχολεί περίπου 40 ερευνητές, οι οποίοι εργάζονται εντατικά για την παραγωγή πρωτότυπης έρευνας και την επίτευξη καινοτομίας στους τομείς της ιατρικής πληροφορικής, της ιατρικής εκπαίδευσης, των βοηθητικών τεχνολογιών, της βιοϊατρικής τεχνολογίας, της νευροεπιστήμης κ.λπ. Η ερευνητική μονάδα χρηματοδοτείται από ανταγωνιστικές επιχορηγήσεις που λαμβάνονται μέσω διαφόρων προγραμμάτων χρηματοδότησης όπως το Η2020, το Erasmus + κ.λπ. ή τα εθνικά κονδύλια. Η χρηματοδότηση εξαρτάται από την απόδοση της μονάδας στην επιτυχία των προτάσεων επιχορήγησης.

Αυτή η έρευνα επικεντρώνεται στη λογική λήψης αποφάσεων αιτιότητας και υλοποίησης, ενώ οι μαθησιακές διαδικασίες εξετάζονται μέσω της παρατήρησης της μαθησιακής ικανότητας καθώς και των διεργασιών μάθησης εξερεύνησης και εκμετάλλευσης. Τα ευρήματα αναδεικνύουν το πώς μια αμφιδέξια ομάδα Ε&Α ισορροπεί μεταξύ

εκμετάλλευσης και εξερεύνησης μέσω των διαδικασιών λήψης αποφάσεών της και είναι ικανή να επιτύχει σταδιακή και ριζική καινοτομία.

Λέξεις – Κλειδιά

Καινοτομία, Έρευνα & Ανάπτυξη, λήψη αποφάσεων, οργανισμοί μάθησης, ανοικτή καινοτομία

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1. Introduction

1.1 Introduction

Research on R&D teams within HEIs or Research Centers working intensively on R&D projects to advance science, advance economic development and tackle societal challenges, achieving innovative research outcomes has attracted unprecedented resonance during the last decades. Innovation is about conceiving ideas that can be developed, or adopting innovative solutions, or even processes that are executed within an organization which are innovative and can foster the achievement of excellent performance. Open innovation refers to inflows and outflows of knowledge, i.e inbound and outbound Open Innovation, which enhance internal innovation and extend potential, as companies exploit joint ventures or alliances and do not rely entirely on internal research. OECD has pointed out (2008) that companies are embracing open innovation either by scanning the available ideas and knowledge within companies and in the environment, or by acknowledging that they need to be part of networks and communities who exchange knowledge.

Performance of research units in obtaining grants is subject to various award criteria, which are not necessarily the traditional research quality criteria such as patents and publications. There is a need for further elaboration on the factors that influence innovation-based performance of R&D teams.

Most empirical research up to now has explored a number of factors that enable or inhibit innovative team outcomes, such as leadership variables, management styles, tools and techniques, the characteristics of the work environment as perceived by team members or the characteristics of the team members and in-house capabilities. However, there has been limited research on the decision-making processes and knowledge transfer processes, such as planning or problem-solving strategies, as well as, learning processes, by which R&D team members actually achieve breakthrough research. In this dissertation, we aspire to fill this void by exploring the decision-making processes driving innovation based performance in R&D contexts. Learning processes have also been neglected within the R&D sector in relation to innovation. This work examines these processes evolving within the R&D context along with other factors leading to innovation. In doing so, it employs a case study approach (qualitative research) and use a Research Unit of Aristotle University of Thessaloniki in Greece as a research setting. The research unit operates since 2006 and

employs roughly 40 researchers who work intensively to produce original research and achieve innovation in the fields of medical informatics, medical education, assistive technologies, biomedical technology, neuroscience etc. The research unit is funded by competitive grants obtained through various funding schemes like H2020, Erasmus+ etc, or national funds. The funding depends on the unit's performance in succeeding grant proposals.

This research concentrates on the causation and effectuation decision-making logics applied while learning processes are being examined through the observation of learning capability of the entity, as well as, exploration and exploitation learning processes. Decision-making affects all aspects within the Research Unit, so does the strategic intent (Andriopoulos and Lewis, 2009) which demonstrates how the need to exploit together with exploration opportunities foster the motivation of individual knowledge workers, the people who can create value for an organization by creating new knowledge and developing innovations.

In this study, innovation performance refers to innovation outcomes in terms of research funded projects, i.e. the number of new projects evaluated and accepted for funding by various funding programmes and schemes. Decision-making is demonstrated by implicit or explicit choices, which have been, in the case of the Research Unit in question, effectual at first and more balanced later, all contributing to the creation of a dynamic team of researchers to develop state-of-the art and innovative technological solutions for healthcare and medical education. Overall, the results of this study contribute to the theory of decision-making and effectuation, as well as, to the R&D units who aim to create an organizational culture that will cultivate an ambidexterous R&D team balancing between exploitation and exploration through its decision-making processes and qualifying for achieving incremental and radical innovation.

1.2 Purpose and Research Questions

The purpose of this dissertation is to contribute to the academic research on innovation performance in R&D and explore the processes and factors that affect the performance of a small but successful research unit. More specifically, this dissertation explores the creation and the growth process of an R&D unit of the Aristotle University of Thessaloniki.

In particular, the research questions of this thesis are:

1. Which strategies do successful research units employ to grow over time? Which are the decision making processes of small but successful research units? How do they make their decisions forward?
2. Which are the learning processes of small but successful research units (i.e., what types of knowledge they build, what is their learning capability, how do they build and transfer knowledge over time)?

1.3 Outline of the Dissertation

The rest of the thesis is organized as follows. In section 2 a short overview of the main concepts driving the topic of this dissertation is provided. Section 3 includes the literature review and theoretical discussion on decision-making and organisational learning which is relevant for the rest of the analysis. In section 4 I describe the methodology I use to analyze the research unit, as well as, the research instruments developed. In section 5 I present the Research Unit under investigation, while in Section 6 I present my main results. In the first part I discuss the decision-making processes, and then the learning processes as they have been evoked by the qualitative analysis of the case. Section 8 presents a discussion on further outcomes and assumptions, while section 9 includes the conclusions and comments on limitations and future research.

2. Concepts and motivation

Innovation in simple words is about introducing something new, developing ideas and opportunities to create growth and respond to social, technical and organizational needs in a context of a rapidly changing global environment. It is about conceiving ideas that can be developed, or adopting innovative solutions, or even processes that are executed within an organization which are innovative and can foster the achievement of excellent performance. According to the Frascati Manual of OECD (2015), R&D activities are aimed to achieve specific or general objectives and look for new findings based on original concepts. They are planned, budgeted and need to satisfy 5 core criteria: to be novel, creative, uncertain, systematic, transferable. The R&D projects of academic or research institutions are applying basic research, applied research or experimental development.

Scientists at universities are increasingly targeting a variety of funding opportunities especially in a context where national funding in research is limited. Funding is offering the possibility for collaboration and stimulate productivity especially in the long run (Grimpe, 2012).

Performance of research units in obtaining grants is subject to various award criteria, which are not necessarily the traditional research quality criteria such as patents and publications. Funding, especially the Framework Programme of the EC funding is more targeted to teams of science increasing collaboration behaviour (Grimpe, 2012). According to his study, not all funding processes are strictly meritocratic. Awarding may be subject to several conditions such as competition, ability to strengthen firms competitiveness, usefulness for policy making, matching thematic priorities, representation from various countries, ability to effectively administer funds, size of the research group, past performance, reputation (Grimpe, 2012).

The Research Unit examined has been funded over 10 million euros in the last 15 years, the unit has achieved sustainable innovation and is continuously striving for long-term successful innovations. Along this period, many decisions were to be taken related to the management, priorities, resources, to enhance success and achieve competitive advantage. The most important attribute in all decisions has been the recognition that knowledge needs to be shared within networks, and know-how can be exchanged and enriched by wider communities of experts who develop novelties. This has been the mentality of the Lab's team leader, the so-called principal investigator of projects, and has been conveyed to all team members along the years.

3. Literature review

3.1 Factors influencing Innovative Performance

The OECD Frascati Manual (2015) clearly defines which activities can be considered as innovation R&D activities, depending on a classification, and respecting clearly defined criteria for exclusion of activities in different areas. The case study of this Dissertation is only examined taking into account innovation R&D activities. The Unit undertakes also business or other activities, for example a pilot R&D project that has been completed and

switches to operating as a commercial product sold to individuals or other entities is not considered innovation R&D and is not included in this study.

Thamhain (2003) has attempted to identify the factors that influence innovation-based performance of R&D teams, by identifying barriers and drivers and entail guidelines for effective management of the R&D teams. Such factors may be external or internal, they are interrelated, and many of them can be influenced by leadership and interpreted in many ways.

External factors	Internal factors
Competition	Leadership
Economy	Organizational Environment
Market, customers	People
Regulations	Processes
Social/Political Ambience	Strategy
Suppliers	Tasks
Technology	Technology
Timing	Tools & Techniques

Figure 1. Thamhain (2003) Factors influencing innovative performance

According to Dew et al (2008), entrepreneurship is focusing on generating an opportunity to create new value in society. Therefore it is not a negative complexion to compare the activity of a research unit with entrepreneurship; in this case, entrepreneurship was initiated by a unique person, the so-called "Principal Investigator" who acted in collaboration with other stakeholders, created processes and structures, employed staff, and begun the dive into a scientific pool of innovation opportunities.

According to literature (Grimpe, 2012) grant awarding in different programmes (European Commission Framework Programme, industry grants, government and foundation grants) is based on different award criteria and characteristics, and scientists usually specialise in certain grants. The case of the present Research Unit demonstrates the opposite, because it has been awarded around 50 grants from approximately 20 different funding programmes, as described in section 5.1.5.

3.1.1 Innovation

There exist numerous definitions of innovation in literature, most of them focusing on new product developments. OECD has pointed out (2008) that companies are embracing open innovation either by scanning the available ideas and knowledge within companies and in the environment, or by acknowledging that they need to be part of networks and communities who exchange knowledge. Internal capabilities may be limited or very demanding in terms of expert personnel, while external sources may offer other paths to combine and exploit innovations and thus create an open innovation environment (Chesbrough, 2003). It is argued by Nguyen (2018) that companies that have difficulties in reactive in a flexible manner may not be able to innovate in the long-term.

Metrics for innovation have been studied by researchers to measure the inputs and outputs related to innovation, in order to assess innovativeness, to better manage it and improve it. One of the well-known innovation metric for nations is called the Global Innovation Index (GII) which ranks the nations in terms of innovation. However, this metric cannot be used for Corporate innovation metrics, nor for the Research Unit in question.

3.1.2 Performance Measurement

Franco-Santos et al (2007) have reviewed a large number of business performance measurement (BPM) systems found in the literature and have identified the key characteristics of a BPM system and pointed out that each individual analysis may define the conditions which are relevant, sufficient and necessary for their study.

According to numerous studies as summarized by Lazzarotti et al (2011), a popular approach for measuring R&D performance is the balanced scorecard one, which takes into account five aspects which contribute to performance: 1) financial, 2) customer, 3) innovation and learning 4) internal business 5) alliances and networks. Such measurement systems utilize input and output indicators such as annual spendings for R&D, training expenses, number of employees engaged in R&D and networking (inputs) and sales, number of patents, number of new markets, number of R&D projects, number of alliances (outputs).

3.1.3 Open Innovation

The open innovation concept expressed by Chesbrough (2003) reflects activities of firms in sectors not only technological, but also traditional industries who look to assess how external ideas can create value for other businesses, tying firms not only with formal agreements and alliances but various forms of collaboration (Ebersberger et al, 2012). Specifically, it refers to inflows and outflows of knowledge, i.e inbound and outbound Open Innovation, which enhance internal innovation and extend potential, as companies exploit joint ventures or alliances and do not rely entirely on internal research.

Apart from advantages in open innovation, some companies are reluctant in cooperating with external partners as this might entail associated risks which have been neglected. (Ullrich and Vladova, 2016).

There exist limited managerial methodologies to support the open innovation implementation and assure competitiveness. One of them is based on the analysis of value drivers' dimensions, and identifying trends in the value creation process (Rogo et al, 2014).

Ebersberger et al (2012) propose a framework of indicators which include the examination of open innovation practices, the intensity of them and the overall measures of open innovation, with the aim to examine open innovation across multiple dimensions. For the analysis they utilize the Community Innovation Survey (CIS) data.

The study of Lowik et al (2017) explores individuals' capabilities and activities from a knowledge management perspective; it explores their absorptive capacity, i.e. their ability to recognise, assimilate, transform and exploit external knowledge, and demonstrates that they contribute to an organisation's open innovation.

3.1.4 Human Capital

Collins and Smith (2006) argued that commitment-based HR practices are positively related to firm performance. They developed and tested the theory about how these practices affect the organizational social climate that promotes employee collaboration and knowledge exchange that leads to new knowledge and positive firm performance, especially in rapidly changing environments. According to the authors, "knowledge workers" are those who can create value for an organization by creating new knowledge and developing innovations. Data was collected on their views on how a social climate that facilitates trust, cooperation

and shared language motivates employees to achieve greater experimentation and devotion to their work endeavors. The findings of this study suggest that HR practices should be carefully chosen because they can indeed contribute to the creation of new knowledge and lead to high performance and growth.

Lepak and Snell (1999) describe the value of human capital and the uniqueness of human capital as primary determinants of the HR architecture. They utilize a matrix depicting strategic characteristics of human capital. Inspired by that matrix and trying to isolate important information on the Research Unit's HR component matrix, we extract the data which is relevant and fundamental, and come up with the following graph.

High

Uniqueness	Unique skills, specialized knowledge Trusted, mutual investment in the relationship Team-based production Social complexity Cannot be duplicated or imitated	Core employees Unit-specific skills Participating in decision-making Possess Tacit knowledge and expertise Contribute to the competitive advantage or core competence of the firm Core assets Offering strategic benefits to customers
	Peripheral assets Generic skills and capabilities Limited strategic value for the organization Conformant to work standards Explicit Knowledge	Valuable skills available in the labor market Careerists Talented employees who can excel in a variety of organisations Empowered to make decisions that impact value
Value		
Low	Low	High

Figure 2. Adjusted HR value and uniqueness matrix (based on Lepak and Snell, 1999)

The value and uniqueness of an organization human capital is not static nor stable. It evolves through time and is affected by numerous factors and more significantly by HR strategies and policies. On one hand managerial capabilities can create a context that affects employee perceptions of a high commitment employer-employee relationship. On the other hand these capabilities can lead to competitive advantage and higher firm performance (Collins & Smith, 2006). The role of the CEO as explained by Collins and Smith (2006) as a person having managerial cognition which has the adequate mentality, reasoning and emotional

regulation can have a significant effect on establishing a high-commitment human resource strategy which can motivate employees in acquiring the knowledge, skills and quality of “valuable” and “unique” employees.

3.1.5 Decision-making in the R&D context

The R&D literature examined focuses on the exploitation of opportunities, relying on opportunities, how these are exploited and what are the factors that can be utilized to measure the degree of innovativeness. Over the years there haven't been introduced nor discussed many theoretical perspectives regarding processes affecting the innovative performance. The decision-making process as described by the concept of effectuation has not been adequately addressed and examined in the context of R&D, although the logic of effectuation fits the uncertain situations that the R&D sector exposes. Learning processes have also been neglected within the R&D sector in relation to innovation. This work examines decision-making processes pointing at causation and effectuation logic behind them. It also examines the learning/knowledge processes evolving within the R&D context learning to innovation.

3.2 Decision-making logic

The two approaches examined in the domain of decision-making logic are Causation and Effectuation.

3.2.1 Causation

Causation as a concept reflects conventional planning and prediction. It is strongly linked with the predictive theory and the logic of prediction because it focuses on pre-determined goals and possible means (Politis and Gabrielsson, 2006). The goals are the first to be set, while entrepreneurs start with planning, they try to predict the future and adapt based on their analysis.

As Politis and Gabrielsson (2006) explain, in causation it is assumed that the market pre-exists and the goal of the entrepreneur is to reach that market and embrace it in the most profitable way. This is why the entrepreneur gathers all necessary information, performs plans and develops strategies to enable them to materialise their plans and spot inconsistencies.

Chandler et al (2007) create a framework for assessing causation which include steps such as a) analysis of long-run opportunities and select the best returns, b) research and select target markets to perform competitive analysis, c) design and plan business strategies, d) organise and implement control processes to make sure objectives are met.

Similarly, according to Sarasvathy (2001) the principles of causation include (1) maximization of the expected returns and focus on optimal decision, (2) competitive analysis, (3) exploitation of pre-existing knowledge, and (4) focus on predictable aspects of an uncertain future.

3.2.2 Effectuation

Effectuation has been introduced by Sarasvathy (2001) to describe a new concept in entrepreneurship, the one of effectuation, which opposes to the casual model of economics. The science of effectuation is illustrated by Sarasvathy by business examples and realistic experiments in which the entrepreneur starts with a set of tools, seeks control of an unpredictable future, while the goals emerge progressively. The author noted that among causation and effectuation there is no better or worse approach, but their efficiency depends on the case and circumstances, because their main difference is the underlying logic, where causation predicts an uncertain future, while effectuation focuses on the controllable aspects of the future. Besides, uncertainty is dominant in innovative R&D projects, therefore the effectuation theory is well adopted in the formation of a conceptual basis in this area (Sarasvathy, 2001).

In 2007, Sarasvathy and Dew proposed an entrepreneurial framework relying on the commitments made by stakeholders, adopting effectual logic in decision making. As demonstrated in the graph below, the process starts with 3 resources: 1. who am I, 2. what I know, 3. whom I know. Entrepreneurs begin acting, interacting and negotiating with potential stakeholders, and shaping together the innovation achieved.

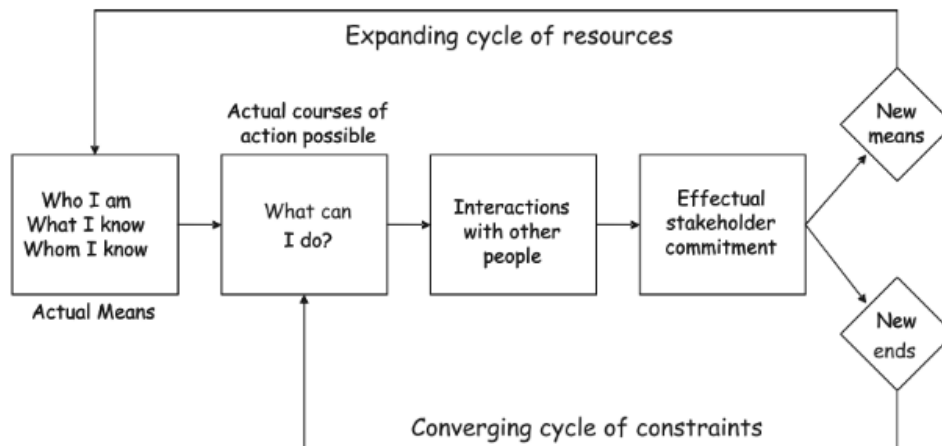


Figure 3. Entrepreneurial framework, Sarasvathy, 2006

The effectuation process proposed by Sarasvathy (2008) relies on 5 principles:

- Creating new means and goals
- Getting customers and income early
- Setting affordable loss
- Spreading risk to others
- Finding truly new and useful market opportunities by leveraging constraints and new information

During the process of effectuation the entrepreneur uses five principles:

- The bird in hand principle: It suggests that the entrepreneur starts with what he already has. It also involves negotiating with stakeholders who are willing to make actual commitments to the project.
- The affordable loss principle: It consists in predicting what the entrepreneur is willing to lose instead of wasting time in calculation about expected returns of the project.
- The crazy quilt principle: This point implies building a network of self-selected stakeholders and the creation of something new with existing means rather than discovering new ways to achieve given goals.
- The lemonade principle: This element indicates leveraging unexpected happens for benefits rather than trying to avoid them, overcome them, or adapt to them.

- The pilot in the plane principle: This final element urges reliance on, and working with, people as the prime driver of opportunities and not limiting entrepreneurial efforts to exploiting factors external to the individual.

In the context of R&D projects Brettel et al (2010) have applied the effectuation principles to demonstrate that, to create an outcome based on existing means, the project builds on team members previous experiences, knowledge and networks instead of forming specific outcome expectations reflecting the causation logic. Furthermore, the affordable loss principle considers the potential risk in a project and not the expected return, as well as, the partnerships with external stakeholders and additional competency support instead of market analysis. Similarly, unexpected events are endeavored as sources of opportunity in effectuation, while in causation projects aim to reach the targets with consistency without surprises. The table hereunder depicts the key dimensions.

Delineation of effectuation and causation in R&D context: key dimensions.

Dimension	Effectuation characteristics	Causation characteristics
Dimension 1: Means vs. goals	R&D approach is driven by given means.	R&D approach is driven by given project targets.
Dimension 2: Affordable loss vs. expected returns	R&D approach is guided by advance commitments to what one is willing to lose.	R&D approach is guided by expected project returns.
Dimension 3: Partnerships vs. competitive market analysis	Uncertainty is reduced through partnerships and pre-commitments of self-selected stakeholders.	Uncertainty is identified and avoided through market and competitor analyses.
Dimension 4: Acknowledge the unexpected vs. overcome the unexpected	Contingencies/surprises are seen as a source of opportunities.	Contingencies/surprises are avoided or quickly overcome to reach given project targets.

Figure 4. Brettel et al (2010): Delineation of effectuation and causation in R&D context: key dimensions

Sarasvathy together with other researchers have studied thoroughly the decision theory and its contribution to the effectuation theory composition. Decisions traditionally involve the goals to be achieved, the means for achieving it, the constraints, as well as the criteria for selection between means. On the contrary, the effectuation logic starts with a given set of means, a set of possible effects which can generate goals, the relevant constraints and the criteria for selecting between effects. As Dew et al (2009) discuss, effectuation does not take into consideration pre-determined goals. The goals emerge as interaction with stakeholders emerges, because stakeholders frame a set of opportunities that can be realised, and shape or transform the environment in which the entity operates.

Dew et al (2008) have discussed perspectives on the behavioural theory of the entrepreneurial firm and have identified aspects of effectuation related to the innovation, concluding in the suggestion that effectuation processes are positively related to innovation

performance. Besides, effectual thinking is believed to be a determinant factor in increasing the capacity to create sustainable outcomes in the long-term (Huff, 2016).

Roach et al (2015) have attempted to refine effectuation scales within the context of firm-level innovativeness, by adapting existing effectuation scales and come up with a model that allows the testing of effectuation principles in innovation. The study of Roach et al confirmed the link between firm-level innovativeness and effectuation. Roach et al have used the 3 most widely used measures of firm-level innovativeness and emergent effectuation scales. Nguyen et al (2018) argue that effectuation logic may be especially suited for approaches that evolve to meet the challenge of innovation. According to Brettel et al (2010), the level of innovativeness in R&D requires different R&D approaches and thus, effectual logic allows researchers to deal with innovative projects and establish internal processes that allow a co-creation approach in innovation.

Rondani et al (2013) have studied the contribution of the effectuation theory in building a conceptual basis for open innovation practices. They adopted the effectuation theory as a basis for managerial practices and decision-making processes, in order to identify valid microfoundations for open innovation. They claim that, the more an organization relies on external collaboration to innovate and create new knowledge, the more suitable is the effectual reasoning in their case. Furthermore, they have proposed a framework that relates open innovation management practices to effectuation, by suggesting the most appropriate approach (causal vs effectuation) for each open innovation management practice they have identified.

In this study, we capture effectuation using Chandler et al.'s (2011) conceptualization, according to which, effectuation comprises four dimensions, namely experimentation, affordable loss, flexibility, and pre-commitments which are being investigated in the case of the Research Unit. Following Chandler's (2011) example, we perceive experimentation as a series of activities in an effort to identify and establish a viable bases for competing, affordable loss as an experiment in which losses are contained and additional resources will only be added if results seem to be promising, pre-commitments as the strategic alliances who assist in controlling the future instead of predicting it, and finally, flexibility as the advantage of grasping opportunities and abandon unfruitful experiments.

3.3 Learning processes

3.3.1 Learning processes towards Organisational Learning

Organisation learning has been defined by Kane and Alavi (2007) as a dynamic process of creation of new knowledge which is then transferred to where it can be effectively used and thus contribute to the development of new knowledge. Learning affects primarily the individuals, and it does not necessarily lead to organizational learning, unless the organization integrates it into organizational learning (Wand and Ahmen, 2003). The ability of the organisations to learn can significantly contribute to their organizational performance (Kane and Alavi, 2007).

Individuals socialize into an organisation and as they are educated into its code of beliefs, they modify their own beliefs. At the same time, the individual beliefs affect and adapt the organisational code. Such processes are affected by the speed of socialisation of individuals, for example existing staff have knowledge available in the code (March, 1991).

Wang and Ahmed (2003) identified in the literature five (5) aspects of Organisational Learning:

- Focus on collectivity of individual learning: the organization should value, manage and enhance individual learning of employees who are interacting and creating the Organisational Learning.
- Focus on process or system: Organisations act as learning systems on their own, they process and interpret information, within and outside of them, and they manage their experiences.
- Focus on culture or metaphor: there exist a cultural perspective in a learning organization, which shapes values, attitudes and behaviors. They may adopt a team approach or focus on processes, and establish a way to involve people and utilize their knowledge in reaching their goals.
- Focus on knowledge management: Organisational learning is deeply associated to knowledge management, as there exists knowledge transfers between individuals, groups, and stakeholders. Knowledge is stored into individuals, as well as, in documents, records, rules and formulate the organizational knowledge base.
- Focus on continuous improvement: a Learning Organisation constantly and consciously tries to improve processes, facilitate learning and achieve total quality management which allows continuous improvement.

but at the same time they acknowledge the need for updating the concept of organisational learning with further focus on creativity and innovativeness which will facilitate changes and enable the organization to succeed in new business environments.

Borredon and Ingham (2005) investigated learning and mentoring in the R&D sector and found out that in this segment mentoring can play a very important role; there exist different mentoring styles which can be complementary and they improve knowledge creation, they enable dialogue and the ‘atmosphere’ that favours learning through the creation of learning teams.

3.3.2 Managing exploitation/exploration activities targeting innovation

Organisation learning incorporates **exploratory and exploitation activities**: The exploration of new alternatives in skills acquisition, and exploitation of existing competences, not only at the individual level but also at the organisational and social ones. (March, 1991). Kane and Alavi (2007) also recognize two forms of Organisational Learning, the exploration which is about developing new knowledge or replacing knowledge in the organizational code or memory, as well as the exploitation which refers to incremental learning and reuse of knowledge that already exists within the organization.

The exploration and exploitation activities in R&D have been studied by Puumalainen et al (2013), however the research protocol does not fit very well the needs of the Research Unit, because it involves the research on entities that have an R&D section, instead of entities having R&D as their main activity.

According to Andriopoulos and Lewis (2009) exploitation is widely associated with incremental innovation as it extends current knowledge aiming to efficiency and improvements, while exploration is associated with the development of new knowledge, experimentation and radical innovation.

March (1991) argues that a key factor in prosperity within an organisation is the maintenance of the appropriate balance between exploration and exploitation (March, 1991). Kane and Alevi (2007) agree that this balance influences the short and long-term performances of organisations.

Furthermore, the research by Kane and Alevi (2007) demonstrates that there exist various learning mechanisms which have different effects on exploration and exploitation processes.

Some mechanisms reduce knowledge heterogeneity and promote exploitation, while others promote exploration leading to improved long term results.

Lin et al (2013) acknowledge as "learning capability" the practice of knowledge transfer between employees, between organisations, and the open culture that promotes knowledge sharing. They have investigated - utilizing the resource based view (RBV) - how these practices facilitate learning that leads to the achievement of both incremental and radical innovation (also known as innovation ambidexterity) and have proven that indeed, learning capability facilitates innovation ambidexterity which fosters business performance.

3.4 Theoretical background of the study

In our study we aim to investigate:

- a) The decision-making processes harnessed by the Research Unit investigated using the 4 dimensions of Chandler et al's (2011) conceptualization
- b) The learning processes that drive ambidextrous results using the example of Lin et al (2013). Specifically, we aim to investigate if the Research Unit has:
 - an organisational culture and values that promote engagement in internal and external collaboration, promoting the exchange of information and knowledge.
 - an open culture where researchers take risks in trying out new ideas, and trust and respect each other
 - the ability to combine exploitative and exploratory activities to create a learning capability that creates innovation ambidexterity and improve its performancetherefore the relevant questions are being included in the interview questionnaire.

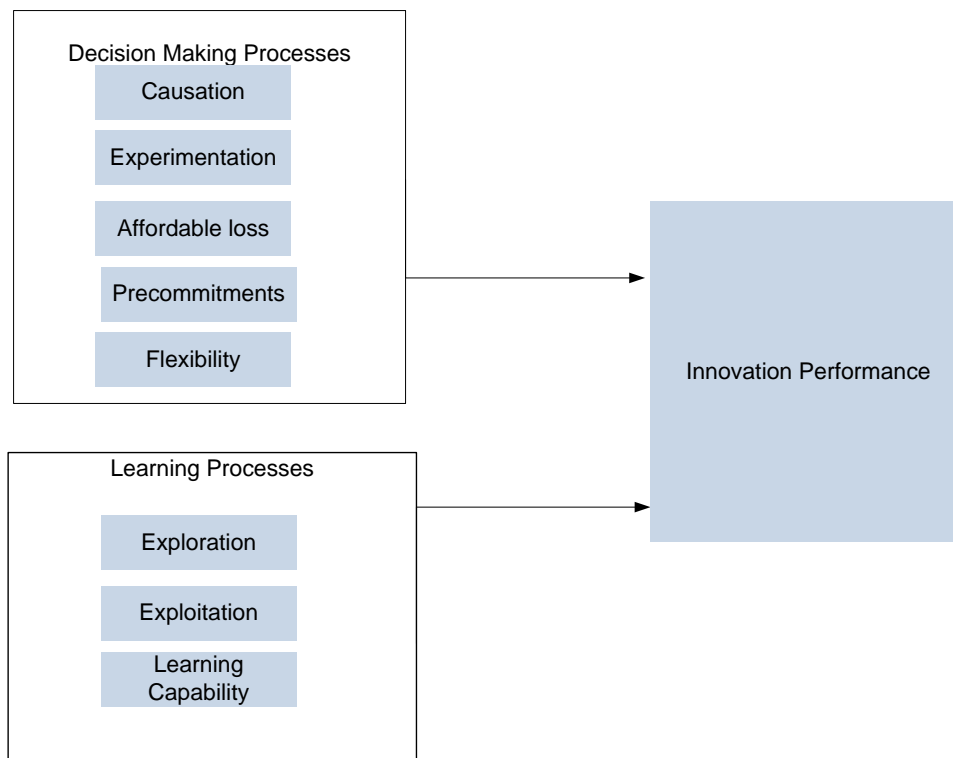


Figure 5. Theoretical framework of the study

4. Research design and methodology

The following chapter explains the methodology of this dissertation. In particular, we employed a case study methodology, based on a successful Research Unit operating at the Aristotle University of Thessaloniki. It starts with a description of the research design, then a description of the empirical approach for data collection, the research method which discusses the reliability and validity of the theory, as well as, the instruments utilized in the study.

4.1 Research Instruments (questionnaires, interviews)

To develop our interview open ended questions, we worked as follows:

1. For investigating the decision making processes we relied on the four dimensions of effectuation as described by Chandler et al (2011).
2. To investigate the learning processes, we followed

- a. the study of Lin et al (2013) which explores the Learning Capability of individuals in 3 dimensions: Open organizational culture, Interorganizational partnering, Interorganisational learning
- b. the study of Lennerts et al (2020) on exploration and exploitation learning and their mutual effects on incremental and radical innovation performance.

An interview protocol was designed with the decision-making processes in mind. Interviews began with general questions and gradually became focused on the topics of our interest.

4.2 Data Collection

The data collection methods included at first observations and examination of the Unit's internal documents and records. Then, semistructured face to face or online interviews with the Principal Investigator, or Research Unit Leader, and the employees of the Unit have been conducted and analysed. The employees have been selected based on an extraction process. Specifically, we have asked the Unit Leader to identify the Uniqueness and Value of all internal personnel (described in section 5.1.8) and classify individuals in the adjusted HR architecture matrix of Lepak and Snell (1999) described in section 3.1.4. We have utilized the upper right frame of the matrix which includes the most Unique and Valuable employees (research associates) which included 9 members of the team who constantly contribute to the decision-making of the Research Unit. Semistructured interviews have been carried out with them, lasting approx. 40 minutes each. Each informant was asked to provide their views on the decision-making of the research unit in 2 different time periods, i.e. the year 2013 and the year 2021. Three of the research associates who have not been in the Research Unit from 2013 were asked to provide their view on whether they have noticed any differences between the time they have joined the team, and the understanding they have for 2021.

Table 1 . Interviewees' table (anonymous)

	Position and profile	Year employed	Education
1	Principal Investigator, Leader of the Research Unit	2004	BSc, MSc, PhD

2	Senior Project and Financial Manager	2006	BA, MSc, MBA
3	Senior Researcher, Leader of one of the Research Groups	2006	BSc, MSc, PhD
4	Project and Financial Manager	2009	BSc, MSc, PhD
5	Senior Researcher, Leader of one of the Research Groups	2009	BSc, BA, MSc, PhD
6	Senior Researcher, Leader of one of the Research Groups	2013	BSc, MSc, PhD
7	Senior Researcher, Leader of one of the Research Groups	2013	BA, MSc, PhD
9	Junior Researcher	2018	BSc, MSc, PhD Candidate
10	Project Manager, Research Associate	2019	BA, MSc, PhD Candidate

5. Presentation of the Research Unit

5.1 The Research Unit

The Research Unit was founded and is hosted by one of the Labs of Aristotle University of Thessaloniki, having a mission to excel in training and multi-disciplinary research in a setting that fosters creativity and synergy.

The Laboratory itself is dedicated to training the students of its Faculty through several compulsory and elective courses and participates in several Inter-University postgraduate programmes. It is a dynamic, interactive community, home to a large number of students, research associates and 3 faculty members who are working as pioneers in research fields such as applied neurosciences, radiodiagnosis and non-ionizing radiation, medical education, assistive technologies, medical imaging, semantic web, affective computing and other contemporary thematic areas. The Research Unit Leader is the recently elected Director of the Lab (as of 01.09.2021) and the leader of 9 research groups, experts in their respective specialties, which pursue innovative research projects. The Research Unit has been recognized internationally for their research excellence and have been funded by a wide spectrum of sources ranging from FP6, FP7, INTERREG, LIFELONG LEARNING

PROGRAMME, to national funds from the Ministry of Education, Ministry of Health, General Secretariat of Research and Technology and other national and international authorities.

5.1.1 The Fields of operation

The Research Unit operates in two of the 6 main institutional sectors of R&D (OECD, 2015);

- Engineering and technology
- Medical Sciences

aiming to produce knowledge-based outputs, and operates in the Higher Education sector, which includes all universities and research institutes in which R&D is the primary activity.

5.1.2 Foundation of the Research Unit

The Research Unit has first been established at another Lab of the same Faculty where the Unit Leader had been first elected Lecturer. The Unit Leader, as a new staff member, further to his teaching enthusiasm, has been motivated by various research questions which he has tried to exploit by interacting and liaising with other academic staff members of the Faculty. His mentors at that time have been encouraging these endeavors and supported his activities. In 2005 the Research Unit Leader has had his first research proposal approved by the Greek General Secretariat for Research and Technology (recently renamed into General Secretariat for Research and Innovation) in the field of neuroscience, which was relevant to his PhD Thesis topic. The second successful proposal has been funded by the Interreg IIIA Programme and allowed him to hire his first 4 research assistants who have worked with him to implement these successfully and capitalize on their outcomes.

In the period 2006-2009 the field of Education became the core venture of this small team, in undertaking additional research projects, all funded by the Interreg Programme, until 2009 when the first large European research project has been accepted for funding by the eContentPlus Programme, and a few months later an ICT PSP was accepted for funding under the overall coordination of the Research Unit Leader. In 2012 the research assistants of the team had become 12, directly remunerated by the above funds, taking into consideration only the internal staff working in the research activities overall, although there

have been numerous more who have been assigned specific time-limited tasks, which are considered as “external” staff in the present study.

Having reached the milestone of the establishment of this Research Unit and its consolidation into a capable and highly motivated team of researchers, the Leader has requested in 2013 an administrative transfer and relocation to the Lab hosting the Research Unit until today.

5.1.3 Growth of the Research Unit and launch of diverse Research Groups

The ICT PSP project mentioned in the previous section had its focus on elderly care and ambient assistive living and its successful coordination by the Unit Leader has led to the business exploitation of its outcomes, together with some of the participating partners. The Unit initiated in 2013 a self-funded project as a service provider for people requiring the service, and investigated alternative user groups who could benefit from this intervention, such as parkinson’s patients or Persons with Down Syndrome (PwDS) and Persons with Intellectual Disabilities (PwID). At the same time, the Principal Investigator has managed to purchase a Nihon-Kohden 128 channel EEG recording system which has significantly contributed to a holistic examination and research on interventions’ impact.

The above studies, have enabled the focus of the Unit into other domains additional to the Research Group on Education, and the formation of supplementary advanced Research Groups: one on Assistive Technologies which works with major research & development in e/mhealth, Active and Healthy Ageing (AHA)/AAL, as well as one on Biomedical Engineering, and one on Neuroscience.

In 2015 the Research Unit has founded a Living Lab which is an an effective member of the European Network of Living Labs (ENoLL) and its activities’ ecosystem has been acknowledged as a 2-star EIPonAHA Reference Site. The focus of the Research Unit activities has been placed on exploring shifting paradigms in technology enhanced care and co-creation, elderly healthcare, innovations & breakthroughs of mobile/web technologies. More recently, the Research Unit Leader has submitted proposal on calls from the H2020 Programme and several projects have been accepted for funding under his coordination, applying a user-centered co-designing methodology.

More research endeavours have led to the funding of more research studies and to the creation of additional Research Groups. The Research Unit's infrastructure will soon be expanded with a multi-channel whole-head MEG system to advance research and its impact. Also, a multidisciplinary team of bioscientists, software developers, signal processing experts, 3D medical artists, teachers and medical doctors are working intensively on games and gamified experiences for immersive learning using immersive technologies like Virtual and Augmented Reality (VR/AR) or mixed reality. Current research endeavours of this group are aiming to the creation of escape rooms for education and exploitation of escape room pedagogies in online teaching.

The Research Unit's growth is depicted in the following figure.

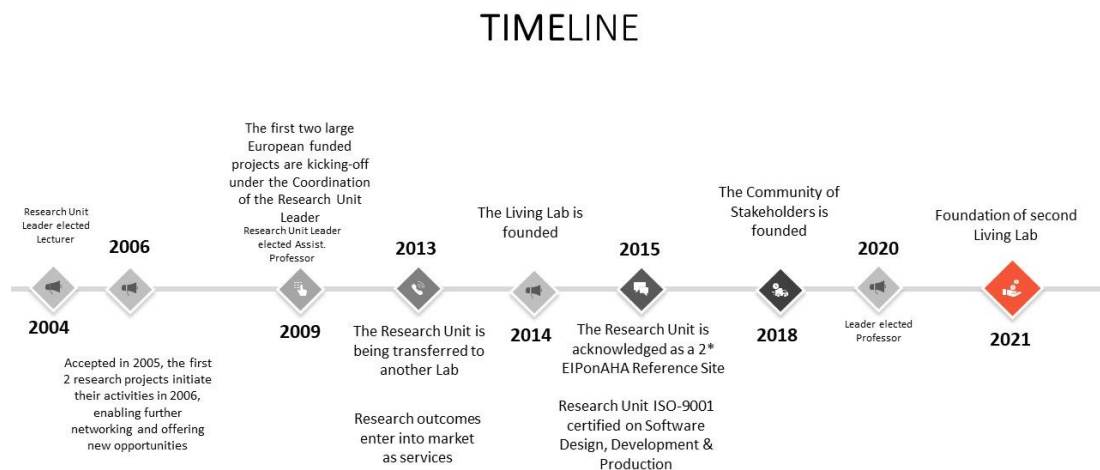


Figure 6. Timeline

5.1.4 The Research Unit Certifications

The Research Groups of the Unit have made significant efforts to excel in their activities, and add credibility in their processes, in order to retain knowledge and demonstrate that the products and services meet the domain's expectations. Therefore, the Unit is ISO-9001 certified on Software Design, Development & Production – Design and implementation of Education/Training programmes since 2015. Recently, in 2020 it has also been certified in ISO 13845, in the Design & Development of medical device software for cognitive and physical enhancement and well-being of vulnerable groups. Besides, the Unit is an authorized clinical trial recorder at AUTH and has been accredited as an EEG centre to serve RTOC's multi-centre European software deployment trial study.

5.1.5 Funding of the Research Unit

The research funds of the Research Unit consist of funding of around 50 competitive research grants. There exist some funding coming from governmental (Greek) sources, but the majority of the funds originate from the research programmes of the European Commission, which are addressed to all member states, as demonstrated in the Figure below.

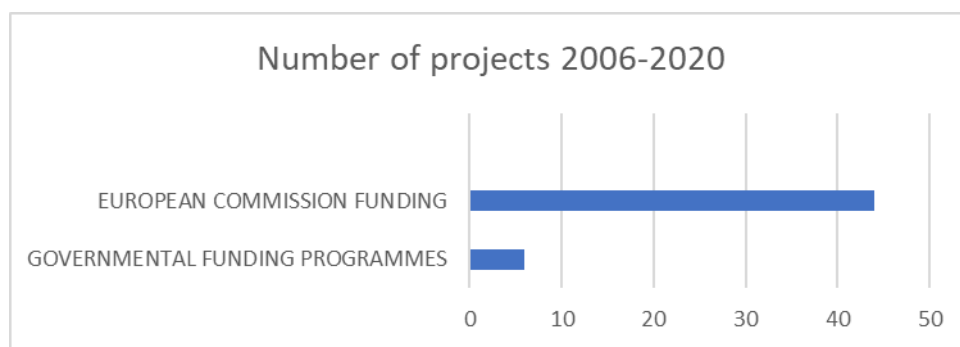


Figure 7. Number of projects 2006-2020

More analytically, the Funding Programmes involved include the cross-border collaboration projects of the INTERREG programmes, Framework Programme 7 projects, eContentplus, ICT PSP, Pilot projects, Joint actions, and a large number of Erasmus+ projects of all strands (Knowledge Alliance, Capacity Building, Strategic Partnerships). The distribution of funded projects in number of projects is demonstrated in the graph below.



Figure 8. Number of projects per funding programme

The number of projects in each funding programme is not equivalent to the funding in Euros. There are programmes which provide much lower numbers in funds and effort rates than others. The strategic partnerships as an example, offer funds which are not adequate to be used for research activities; they are mostly focused on the establishment of partnerships which are able to apply existing research solutions and provide links to the local societies and specific target groups. On the other hand, Horizon 2020 projects include Research and Innovation Actions (RIA) which promote the research on innovative and sustainable outcomes, bringing together highly qualified institutions across Europe which form consortia with increased capacity to collaboratively produce outcomes that will make a difference to the quality of life in the EU. The table below demonstrates the total funding achieved through each funding programme, depicting the variance between number of projects and funding budget for each funding programme.

Table 2. Funds and number of projects per funding programme

FUNDING PROGRAMME	BUDGET FUNDING IN EURO	Number of Projects
H2020	4884627	9
ΕΣΠΑ	829269	3
FP7	672913	3
ERASMUS+ STRATEGIC PARTNERSHIP	661107	14
INTERREG CBC	602500	3
ECONTENTPLUS	586455	1
ICT PSP	530817	1
INTERREG ARCHIMED	358396	2
ERASMUS+ KNOWLEDGE ALLIANCE	335025	2
PILOT PROJECT (PPPA)	180830	1
H2020 - MARIE SKLODOWSKA-CURIE	153000	1
ERASMUS+ CAPACITY BUILDING	149816	1
TEMPUS	134772	1
JOINT ACTION	111494	1
ΥΠΕΠΘ-ΕΠΕΑΕΚ	102300	1
ΕΣΠΑ ΕΔΒΜ	72100	1
GSA	70882	1
LIFELONG LEARNING	61201	1
LEONARDO DA VINCI	59073	1
ΓΓΕΤ ΔΙΑΚΡΑΤΙΚΕΣ ΣΥΝΕΡΓΑΣΙΕΣ	50000	1
Grand Total	10606578	50

The distribution of funds into years is demonstrated in the graph below. The revenue is tangible, measurable, and signifies a high success rate in the research unit performance, which relies in various factors explored and assessed in this study.

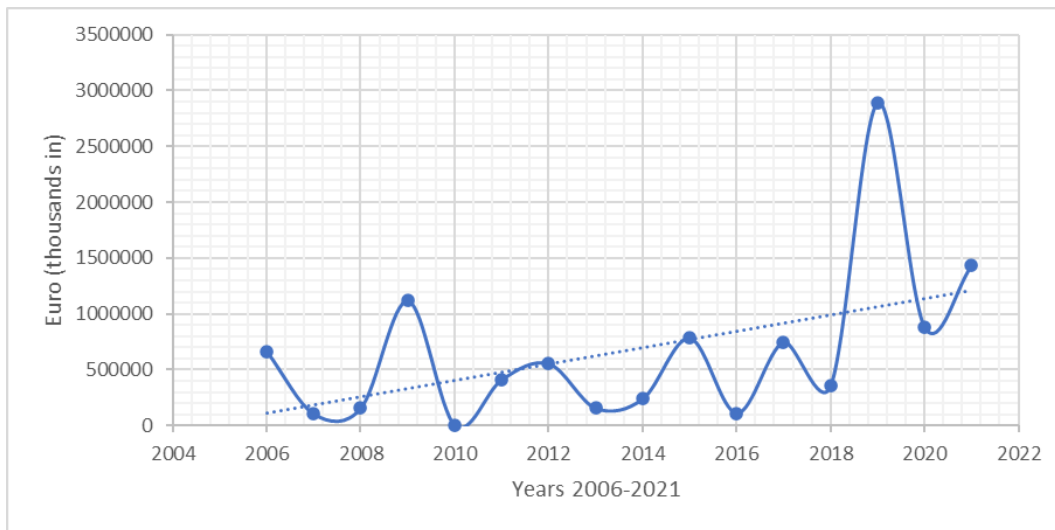


Figure 9. Funds per year

The value of each research collaboration project is however not limited to its funding. Its contributions is extended to not only the know-how gained, but also to the number of collaborations achieved and to the number of stakeholders increase.

5.1.6 The Stakeholders of the Research Unit

In line with the open innovation principles on creating and capturing value from external sources (Lowik et al, 20178) the Research Unit aims to mobilize all sectors related to digital innovations, to encourage policy reform and raise awareness of the effective implementation of its interventions in society. Along with the perception of the Principal Investigator that it is important to build mutually beneficial innovative synergies that bridge the gap between research and practice, he has initiated an innovative collaborative framework within a quadruple helix model. Open innovation involves various organizations, entities and individuals, co-creating knowledge together across different levels. The phenomenon should be regarded as a dynamic process rather than static behaviour. The Research Unit's quadruple helix includes researchers, academics, society, industry, governments and health systems, NGOs and others.

Research Unit Quadruple Helix Components

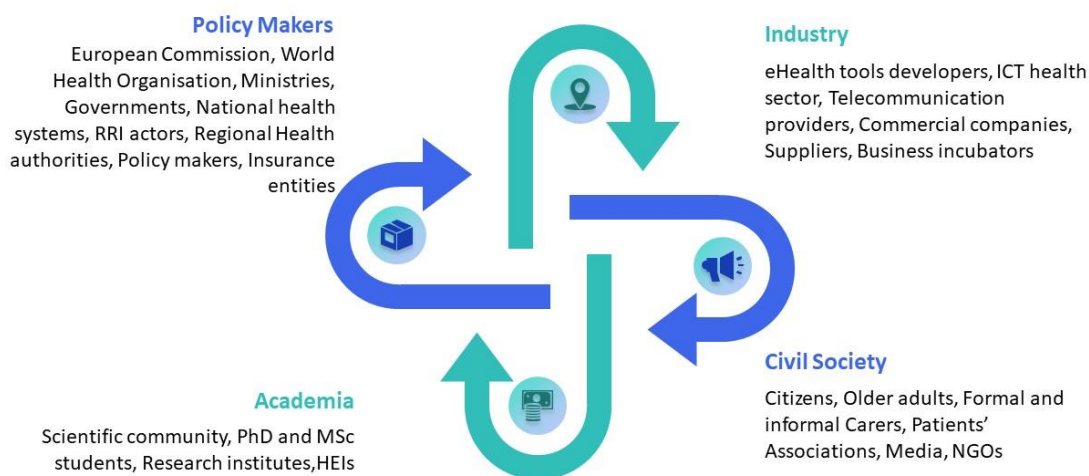


Figure 10. Stakeholders - QH Components

Associate partners

The Research Unit is closely linked to some entities, associate partners, such as scientific societies and nonprofit organisations focusing on networks and openness. The Research Leader is also representing the Faculty's entity for research and education.

Health services establishments

The Research Unit collaborates actively with several governmental sector-related establishments in Thessaloniki, and numerous relevant private sector-related entities within the municipality of Thessaloniki. Partnerships in this case offer mutual benefits to all participants, as they provide their knowledge, expertise and pilot sites while they have the possibility to explore novel research outcomes and take part in state-of-the-art research activities.

Policy makers & innovators

A wide network of the Research Unit's stakeholders is composed of policy makers and innovators who seek to tackle broad challenges of the society and its populations. Public

agencies are indeed performing systematic thinking about the future challenges and look for synergies in the academia. The Research Unit participates since 2014 in the EUROPEAN INNOVATION PARTNERSHIP on Active and Healthy Ageing and contributes significantly to its activities. The Research Unit Leader is also one of the working group leaders of the European Commission's JRC City Science Initiative (<https://ec.europa.eu/jrc/communities/en/community/city-science-initiative>) and promotes synergies on this thematic challenge with the participation of more of its stakeholders, such as the Region of Central Macedonia and the Municipality of Thessaloniki.

One of the most valuable partnerships of the Research Unit is the one with the Hellenic Hellenic Inter-Municipal Network. The Network seeks to tackle challenges by turning to innovation and technology and utilizes the Research Unit's research outcomes to address the needs of the related societies.

Academia & Research

The Research Unit is in continuous collaboration with all academia & research actors of the region, the city and the European Union establishments. It collaborates with the Aristotle University of Thessaloniki Technology Transfer Office in its role to transform the University into an entrepreneurial university meeting the needs of researchers, companies and society. It also collaborates with the NOESIS, the Science Center and Museum of Technology in its aim to offer to the general public a suitable environment for getting to know and understanding the positive sciences and inform them about technological developments. It is a research associate of the European Space Agency shaping the development of Europe's space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe.

Target group associations

The Research Unit has established strong partnerships with many end-user or target group Associations, Universities and Technological Centers working in the field of delivering knowledge and tools for supporting services and Associations of Professionals working in the field of care and assistance for people with disabilities or specific conditions. For example, the Unit collaborates with the Greek Association of Down Syndrome in some

research projects in the field of application of ICT aiming at developing actions and training materials for improving the Quality of Life of Persons with Down Syndrome. It is also a member of several networks of experts in the field of the application of ICT to the Quality of Life of Adults with Special Needs. It has a strong partnership with the Parkinson's disease patients and friends association of Northern Greece, but also with the Women Association with Breast Cancer "Alma Zois" Thessalonikis. These are all devoted to offer mutual assistance, psychological support and rehabilitation or consultation to patients and their families. It also liaises with a number of educational establishments (schools and Day Care Centres) for persons with intellectual or other disabilities of the region.

Last but not least, the Research Unit has established the **Collaboration & Research Community of Stakeholders** composed by more than 70 individuals, collaborators of its Living Lab, participating in research and social innovation activities, providing experience, ideas, feedback on the Research Unit's prototypes and systems. The members of this team are recruited from the pool of friends and followers of the Unit, and are registered as members of the Research Unit Community. Respecting all ethics and data protection requirements, the community members are given a membership card which indicates their details and registers their participation to the Unit's co-creation activities.

5.1.7 Co-creation activities with stakeholders

The Research Unit applies participatory Design (PD) which is considered as one of the most important requirements of good and effective design as it relies on the active involvement and engagement of the stakeholders in the design process. As a result, stakeholders become participants and co-designers in the design process for research objectives. Especially in cases where requirements elicitation is necessary, the Unit is more and more utilizing agile methodologies, which include frequent demonstration of working prototypes to the users, to maintain their interest, satisfaction and engagement through the processes of Design Thinking and Ideation, Lean startup approach and SCRUM framework.

Scrum is an Agile, lightweight framework that provides steps to manage the Research Unit's development processes and addresses the stakeholders views, while productively and creatively delivering products of the highest possible value (Srivastava et al, 2017). Within

the scrum sprints, researchers trigger the definition of use case scenarios exploring the real needs of the target groups and their design ideas.

5.1.8 The Research Unit Personnel: internal and external staff

The success in obtaining grants of the Research Unit relies on a large number of collaborating researchers, who are all guided and supported by the Research Unit Leader, acting as the Principal Investigator in all involved projects.

The personnel of the research Unit is composed of 43 people (see table 3. below), who are mainly electrical and computer engineers, computer scientists, physicists, biologists, medical doctors, psychologists. These 43 people can be considered as **R&D internal personnel** because they have direct contribution to projects and fulfil the relevant definition of the OECD manual (2015). Doctoral and Master students are included as internal personnel, because there are only contributing in the research Unit as regularly paid remunerated personnel as part of a contract of employment for the services provided in funded research projects. There exist also additional personnel in the Administrative section of the entity, the Special Account for Research Funds, providing central financial, legal, and monitoring activities for the same R&D projects. This type of personnel is not part of the research unit studied, although their costs are included in the expenditure of the projects. In addition, there exists **external personnel** in various projects. This refers to R&D personnel which is not internally available at all times, but it is brought in the Unit when a specific set of knowledge and skills are required for a project. Their work, lasting for a rather limited amount of time (for example the project duration), is managed by the Principal Investigator. The present study will not take into account the external personnel of the period 2006-2021 which is composed by a much larger number of people – approximately 60 in 2021 – who are assigned specific tasks in current projects. The external personnel includes medical doctors who have their clinical work as their main occupation, but contribute to research for specific tasks in limited time for a limited period. It also includes research associates who are employed by other research units of Aristotle University of Thessaloniki and are currently contributing to research projects of the Unit as part of their employment relationship with other Principal Investigators. These affiliated research units are becoming part of the large network of collaborators and stakeholders of the Unit.

Table 3. Number of internal personnel

Internal Personnel in 2021	
MALE	23
FEMALE	20
Grand Total	43

As for the contractual conditions of internal personnel, the situation is as follows: The Unit, due to legal and bureaucratic constraints existing in Greece, has the possibility to only employ contracting independent workers and their costs are claimed as personnel/staff/labour costs in all projects. Nevertheless, the long-term consecutive contracts of all Unit personnel, without in-between no employment periods, justifies their classification as internal personnel. It cannot develop a proper HR architecture (Lepak, 1999) with different employment modes and employee relationships. Nevertheless, the HR practices applied have allowed the Research Unit to develop the skills and capabilities which are necessary for long-term firm performance. The human resources contributing to the selection and implementation of the above mentioned projects have a variety of background education and expertise, with a background mainly in positive sciences (engineers, computer scientists, mathematicians) but also other disciplines (psychologists, pedagogists), while medical doctors offer their valuable insights in a part-time basis or task-based consultations.

The OECD manual (2015) suggests also that the measurement of R&D personnel should involve 3 measurements: a) number in headcounts b) measuring their activities in full-time equivalent of person-years, c) measuring their characteristics, in order to have comparable results in a study.

This measurement will take into account actual involvement of R&D personnel, even if in some cases it is not equal to the contractual (statutory) involvement of internal staff, because of effort rate restrictions which do not necessarily depict the actual involvement of researchers in their tasks.

The graph below demonstrates the employee number growth in years 2006-2021. It is evident that the team was increasing gradually until 2016-2017, while at that time a more sharp increase, which coincides with the increase in the number of projects and their funding.

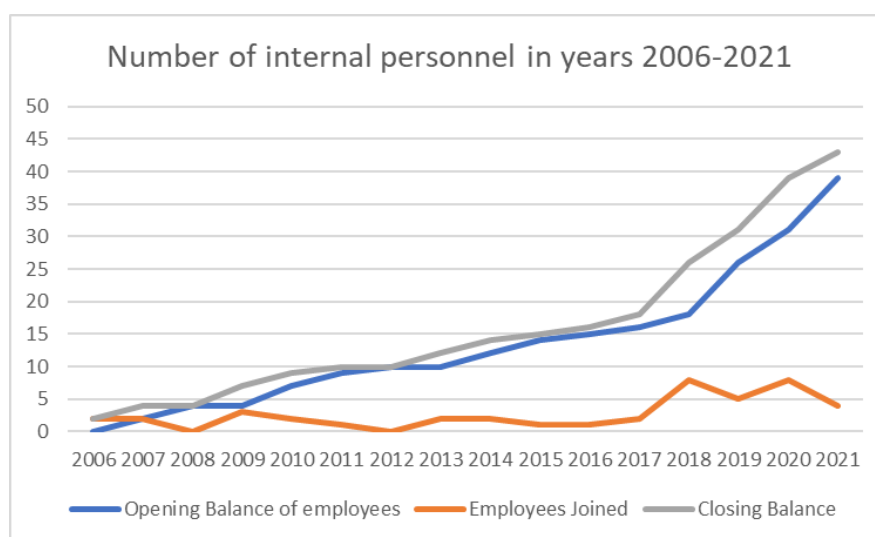


Figure 11. Employee number growth

The team growth over the years, as well as the employee retention, is depicted in the following table:

Table 4. Employee growth and retention

Year	Opening Balance of employees	Employees Joined	Employees exit	Closing Balance
2006	0	4	0	4
2007	4	4	0	8
2008	8	2	0	10
2009	10	3	1	12
2010	12	3	0	15
2011	15	1	0	16
2012	16	0	3	13
2013	13	2	2	13
2014	13	2	1	14
2015	14	3	0	17
2016	17	1	1	17
2017	17	3	0	20
2018	20	8	1	27
2019	27	7	0	34
2020	34	10	5	39
2021	39	4	0	43

5.1.9 Acknowledgements & Awards

In the context of its research policy, Aristotle University of Thessaloniki promotes and implements Excellence Awards. The Research Unit Leader together with his research associates have been awarded an impressive number of Excellence Awards within the AUTH Faculty, for outstanding academic and research performance, as well as, awards for scientific excellence or teaching (e.g. publications and teaching awards).

6. Results and Findings

6.1 Data analysis

Analysis of raw data has been accomplished to allow identification of specific tensions. Based on the case study of the research unit, we identified two points in time which constitute major milestones of the Research Unit's growth: 2013 and 2021 as the present point in time.

In 2013 the Research Unit has been transferred from another department of the Faculty, it was also the time of initiation of business exploitation of some precedent research activities, and mainly, it was the beginning of a period of strategic alliances with all kinds of stakeholders and partners.

The process followed can be described as follows:

- Identification of broad topics of interest for each interview
- Grouping the concepts and linking data from multiple interviews
- Conduct cross-employee comparisons
- Representing the findings
- Discussion on the findings

6.2 Results & Findings

6.2.1 Decision-making logic

6.2.1.1 Causation

With regards to the Causation decision-making logic the interviewees were interrogated if at the beginning of a research project they have a clear vision of what they want to do, whether they analyse opportunities or expected returns before committing to a new

research or proposal; they were also asked if the final results of their works are similar to what they had originally in mind, and if control processes are implemented to ensure successful results.

2021

“We are driven by facts and interactions, we are agile”

This is the response of one of the senior research associates of the Research Unit, as opposed to the clear vision and plan for the outcome of each activity. It is evident among all respondents that there exist no clear vision of the research outcome at the beginning of every new endeavor. Instead, there exist a general vision, an outline of the envisaged outcome, even restrictions and options, which are formulated during the implementation process. One of the respondents was very much aligned with the causation logic and he stated that, himself, always has a very well-defined vision of the outcome. Another one thinks that if we had a solid vision we would feel more restricted and less flexible. The principal investigator on the other hand believes that some of the activities undertaken are very well thought and planned, because they make part of a longer future plan for which he has a very clear vision, while others are generalized and take their shape during implementation.

Regarding the analysis of expected returns it is generally accepted that this is being done to a certain level, because otherwise we are not able to define the impact of an activity and decide whether to undertake it or not. This analysis is not always very well structured or methodologically efficient, but we do try to assess the value, the resources required, the knowledge to be acquired and the experience gained by the team.

Control processes exist within the project plans, as they have timelines, deadlines, performance indicators to be reached, but at the organization level there is no control framework at the Research Unit.

“Control processes would delay our growth, not foster it” is the opinion of one researcher, another one thinks that in some occasions some control processes are defined by the Principal Investigator but there is no mechanism to sustain them, therefore they do not take place in practice. Younger associates, who happen to have working experience outside the academic sector believe that due to our current size the control processes should start taking place like in the case of companies which have sectors, hierarchy, processes because if the team continues to grow we will not be able to sustain quality and continuous development.

Furthermore, the Principal Investigator thinks that control is very limited, but he is also concerned that such processes might lead to the loss of trust. He feels that until now the absence of control mechanisms has not created trouble, but he points out that the Covid-19 pandemic has exposed significant drawbacks because distance work is even more difficult to monitor.

Nevertheless, the ultimate outcomes of our activities are always fulfilling the goals of each project. The outcomes is usually not identical to the one visioned – especially because vision has not been solid as explained above – but it is always accomplished, and most likely exceeding expectations because opportunities for optimization have not been overseen. As stated by the Principal Investigator: *“at the end of each project I feel satisfied and frustrated at the same time because prospect and expectations have increased during implementation, so the contractual obligation is not fully rewarding, we always have new objectives that we want to fulfill”*.

2013

In 2013 the team was less experienced and less confident, therefore it was trying harder to conceptualize earlier the outcomes of each project, however mentality was not significantly different. All respondents think that the team was already analyzing to a limited extent the expected returns, the impact and the opportunities. The Principal Investigator was sharing decision-making with fewer people at that time, because of the size of the unit. He also explains that in 2013 the research was not undertaken based on a well-thought decision on expected returns, because funding was a driving force on its own, while in 2021 the value of each project is assessed based on the learning opportunities, the know-how the team will acquire, the impact of our activities to society.

Causation-centric mechanisms focus on achieving a set of well defined objectives with control mechanisms that control the validity of the outcomes (Shan Pan, 2014). Such processes were not in place in 2013 as they are not in place in 2021, however control was easier at that time because there was a smaller team, a smaller ‘production line’, therefore even during discussions and ad-hoc demonstrations some sort of control was executed, aiming to guarantee successful outcomes and provide further guidance and advice.

6.2.1.2 Effectuation

The effectuation decision making logic has been studied in the Research Unit in its four dimensions: Experimentation, Affordable Loss, Pre-commitments and Flexibility as described in section 3.2.2.

Experimentation

2021

The experimentation dimension of effectuation is enormously cultivated at the Research Unit. All respondents agreed that they look for research opportunities in all parameters and areas within and outside funded projects. One respondent noted that experimentation is not deeply “experimental”, its is mainly the exploration for identifying opportunities within a given context, e.g. a funded project. It is also noticeable in the decision-making on preparation of new proposals, when the teams do not rely on existing knowledge and capacity, but ventures on the unknown which may hide an added value to the Research Unit in terms of know-how, capacity, partnership.

There are cases where we initiate an activity in a “conservative” way, following the plan and pre-existing know-how, but as a researcher quotes “as soon as achieve some part of what we have promised, we become more confident and start “hunting” for additional challenges which can be embedded in a given context”.

On the other hand, when the Principal Investigator of a funded project is the overall Coordinator of the project and the partnership, the team tends to become more reluctant in experimentation and new opportunities; in such cases, the Scientific Coordination is already a high-risk process, as well as, time consuming, and a possible risk would affect multiple organisations and a very large amount in funds so experimentation exists but is more limited.

2013

Experimentation was indeed even more evident in 2013, when available skills and capacity was more limited. The respondents agreed that at that time we had the time to explore and experiment; at the same time we were committed in the Research Unit evolution and growth, and we would undertake tasks with a high level of uncertainty – lack of experience – having faith that we would work hard to accomplish them.

Affordable Loss

2021

The opinions of respondents on affordable loss dimension is a bit diverse in the Research Unit. One of the managers stated that *“we’ll do what we’ve chosen to do even if we’ll have to pay for it from our own pockets, this is our leadership’s view”*. Others mention that they acknowledge that we invest in time, materials, equipment, resources in general because we are driven by a potential benefit. However, the workload and the size of the team do restrict such practices. The Principal Investigator himself numbered during the interview several endeavors that started as experimentation, without funding, and mentioned the outcomes of such activities and how they contributed to growth and innovation. On the other hand, he mentioned that he is trying to control such practices and devote a limited amount of funds, or a limited period of time working on high-risk activities because of lack of human resources. One of the senior researchers mentioned that he devotes his private time of his personal life to experiment with issues that trigger him scientifically, if they are not funded, because there is “no time any more” for experimentation.

2013

Research interests were a major driving force in 2013. All respondents agreed that experimentation was prevailing any risk mitigation attitude, while the size of the Unit and the number of projects allowed this approach. In fact, they have all acknowledged the mentality of the leader of the Research Unit which favored such practices and mentioned all the benefits that this period has offered not only in research outcomes but also in team building and collaboration.

Pre-commitments

2021

“Our partnerships are the most significant assets of our team” is the response of one of the managers of the Research Unit. All interviewees agreed that we have strategic partnerships with entities and individuals who are engaged as much as the Research Unit is, to excel in innovative outcomes and provide value to combat health and societal challenges. The network of the Research Unit is not a single network, because each research group has

developed its own partnerships. The Principal Investigator is highly engaged in openness and performs several activities that liaise the partnerships and induces opportunities for further collaborations. One of the research associates mentioned that *“What we have achieved in terms of network is unique. Not all research units have managed to establish such a strong network of stakeholders and collaborators”*. Another one stated that *“We rely on our forces, but we always have a backup. There are people who are there, they have capacity and skills and will help us if we ask them to”*, therefore, she continues that this is a control process on its own and its is the outcome of a strategic decision to allow inbound and outbound transfer of knowledge acknowledging that will contribute to open innovation.

2013

In 2013 the team had acknowledged already the value of partnerships, however networking was not very elaborated, the collaboration opportunities were limited at that time. The Unit could not “rely” on partnerships at that time, but it relied in good practices, motivation, collaboration.

Flexibility

2021

The flexibility dimension of effectuation is dominant at the Research Unit. Respondents feel that the teams are always open to identify opportunities and endorse them, although the contractual obligations are always respected. The responses in this aspect seem to be aligned with the discovery-centric decision mechanism as described by Shan Pan (2014) who suggests four configurations of decision mechanism: effectuation-centric, discovery-centric, causation-centric and tactics-centric, all having distinct features and interplaying according to tactical choices. In discovery-centric mechanisms, the organisation is ready to change with better or more realistic goals as long as the firm accumulates new knowledge. This approach is proven by Pan that fits well research projects where specific means co-exist with flexibility.

One of the respondents mentioned that although his team is flexible in exploring opportunities, the unexpected outcomes are reduced. Another researcher responded that *“in our proposal-writing activities we are very flexible and very open to new opportunities even if uncertain”* because the team has grown in a culture of exploration. However within the

contexts of projects, one of the leaders of a research group mentioned that *“when we see an opportunity, we follow our initial plans at a micro-level but we open up the macro-level of our results to embrace that opportunity”*.

2013

It is interesting that respondents have a very diverse view on the flexibility dimension of effectual decision-making in 2013. Some have responded that we were a lot more flexible because we were constantly exploring new opportunities. Some others think that we were less flexible because we were not so experienced and confident in order to deviate from the original concept and plan. The Principal Investigator believes that in 2013 the Research Unit did not have as many opportunities and invitations to explore new paths and uncertain situations.

6.2.2 Learning processes

Starting the analysis of the findings regarding learning processes it should be stated that following observation at the Research Unit there exist no central knowledge-sharing system in place such as documentation systems and report-filing systems. The documentation is stored in project-specific repositories which may be individual drives or project management systems (several have been used over the years such as Open Project, Teamwork, MS Teams and others) accessible by members of the research unit actively participating in those specific projects. Therefore, knowledge retrieval is not possible in a centralized way and sharing is possible “on demand” of a specific document (e.g. project proposal, deliverable, report), demands should be addressed to individuals members.

Furthermore, there exist no activities for organized learning such as frequent progress meetings, workshops on “lessons learned”. Some update meetings or specific presentations are taking place but they are spontaneous, rare, unsystematic.

6.2.2.1 Learning Capability

Learning Capability in the Research Unit is examined in 3 axes: Open Organisational Culture, Interorganisational Partnering and Interorganisational Learning (Lin et al, 2013).

Open Organisational Culture

With regards to the Open Organisational Culture the interviewees were interrogated regarding the mutual trust and respect, and activities towards knowledge sharing. The creation of such a culture facilitates the exchange, synthesis of knowledge and collaboration between co-workers.

2021

Respondents have different views on whether trust and respect exists, and they all agree that there exist no systematic knowledge sharing. It is widely accepted that trust and respect exists under conditions, that mentality is very diverse and people tend to have trust and respect towards some people, mostly their research groups or close teams and some people they have worked together in multiple projects.

Two respondents share the view that trust and respect is very well established in the Lab, these are respondents who have recently (in 2018 and 2019) joined the Unit, who also agree that one needs to provoke or look for knowledge and collaboration otherwise he can get isolated. On the contrary, the most experienced ones agree that competition between researchers does not allow these virtues to develop. Some people think that the size of the unit, the intensity of the work and time limitations do not allow people to interact with each other socially and loosely, in order to develop interpersonal relationships based on trust. The main drawback identified is the lack of a sharing culture which needs to be developed and supported centrally as a top to bottom approach.

There exist also an opinion that if a hierarchical structure with stable sub-teams existed the respect and trust would have been developed across those co-workers, that lack of hierarchy promotes conflicts, and that interdisciplinary and scientific collaboration between research groups in central meetings would reinforce respect and knowledge sharing.

With regards to diversity, it has been quoted that *“A new research collaborator will replicate the attitude of his peers”* which means that the research group he will be appointed to, will influence his behavior.

With regards to motivation for knowledge sharing, there exist a view that sharing is only enabled when people believe they will benefit from it, for example by gaining value from it, as quoted *“I only share knowledge and views to people who have something to offer to my idea or project and have the capacity for it. I have no other reason to do it”*.

A senior project manager stated that a possible solution to such weaknesses would be to create couplings between senior and junior researchers where mentoring will be facilitated

or even enforced, so that juniors are supported in their learning processes. Of course, enforcement does not create an atmosphere conducive to learning. Borredon and Ingham (2005) reflect on how dialogue and context, as well as, actors' perceptions influence mentoring relationships and the required balance between factors that lead to achieving scientific breakthrough.

The opinion of the Principal Investigator in this aspect is that topics of collaboration and research opportunities open the way for knowledge sharing, trust and respect, which do exist in general although fragmented in some few cases.

2013

Respondents share the view that in 2013 the size of the Unit was smaller, which allowed more direct and frequent interactions between co-workers, which enabled knowledge sharing and other virtues. Also, in a smaller unit the projects were more or less shared, i.e. at least half of the members of the unit were working on a project together, therefore they had opportunities to collaborate and cultivate trust. Furthermore, back then, the researchers were all at a lower academic level, e.g. there were no post-doctoral researchers, all of them were master's students or PhD candidates therefore the competition was limited. Through the years, researchers who have been in the Lab for long have developed knowledge and capacity. Their knowledge is already reflected in the organizational code, there is redundancy. This kind of staff is rarely able to contribute new knowledge to the organization and its code (March, 1991).

Interorganisational Partnering

With regards to the Interorganisational Partnering the interviewees were asked their opinion on partnerships with other organisations and how they contribute to innovation.

2021

The vast majority of respondents agree that partnerships, networking and openness is significantly contributing to the innovative character of the Lab. Some researchers feel they want to cultivate this aspect more at their personal level because they acknowledge its contribution to the results and sustainability. Some others believe that the Unit engages in partnerships without filtering them and scales up networking at all possible levels, however benefits do exist at all partnerships in various aspects.

Only one of the respondents feels that partnerships are neutral in benefits and that neither external organisations nor the Research Unit share their ideas or intellectual property with others. This view is conflicting with the views of all other respondents though.

The opinion of the Principal Investigator on this aspect is that all partnerships have something to offer: some contribute to innovation, some others to the impact of our activities, other reinforce our research. We opt to partnerships with all social actors locally and internationally while innovation is a constant requirement which drives all our initiatives as we struggle to add value to our endeavors.

Significantly one of the research associates commented: *“Since 2019 we open up more and more. Everybody knows our work!”*

2013

In 2013 we had acknowledge the value of partnerships and their contribution to sustainability therefore we were aiming for it, but had not reached a significant intensity.

In 2013 the team was focused mainly in projects and their specific goals.

“Around 2013 I stopped relying on [the Principal Investigator] to have contacts with partners and stakeholders or approve my initiatives and did it on my own, this is when I cultivated partnerships which have contributed to the team’s development”.

“Back in 2013 all our project proposals were our own initiatives and we struggled to create partnerships and consortia, while nowadays we receive many invitations for collaboration from external organisations”

Interorganisational Learning

With regards to the Interorganisational Learning the interviewees were asked whether they share their initial thoughts on a new idea problem or project with one of their colleagues or the principal investigator himself.

2021

Most respondents do share their initial thoughts with a person or a small group. They claim that depending on the topic they know exactly to whom they will address to. When the idea matures they attempt to share it also with the Principal Investigator.

“We rely on our experience” is the statement of one of the associates. As Wang and Ahmed (2003) notice, organizational memory is the root of knowledge accumulation where

absorptive capacity is reflected, and the leadership needs to promote exchange and interactions in order to reinforce it.

2013

Sharing thoughts with the Principal Investigator in 2013 was an everyday activity, and this resulted to cohesion and interorganizational unity, while nowadays he does not have the time to allocate to each and every one of the researchers daily.

An interesting view is also that, when the team was smaller, an idea would be implemented if all the members of the team agreed on it, almost all participated in discussions, while nowadays a sub-team decides and implements ideas which do not need to reflect the opinions of all researchers.

Time available in 2013 also contributed to sharing information on new ideas, while in 2021 this is a restricting factor.

6.2.2.2 Exploration

With regards to the Exploration Learning the interviewees were asked to what extent they commit to undertake research in areas in which they have had no prior experience, and if activities involve experimentation and high risk.

2021

There is wide consensus between respondents that the Research Unit does undertake research in new areas very often. Some research groups do it more intensively, others are more focused. The team has got great experience and expertise in many domains and explores extensively new opportunities in research. There is knowledge which is emotive and experiential which we try to endorse scientifically. *“There exist a very wide sector of research which we explore in all its dimensions”*. Learning processes increase knowledge without however increasing average performance and variation. Knowledge makes performance more reliable because the techniques are solid and standardized, but this stability reduces the time required to accomplish tasks and the quality of task performance (March, 1991). Besides, organisational learning needs to encompass creativity and radical innovation as strategic components for achieving competitive advantage in the new economy (Wand and Ahmed, 2003).

The opinions on experimentation and high risk have similarities and diversities. All respondents believe that activities involve a high level of experimentation, but at the same time, there exist the confidence that goals can and will eventually be fulfilled therefore “*when one knows where to reach for a solution, there is no risk*”. Two of the respondents believe that experimentation and high risk are not associated, because in some cases the Research Unit experiments with new methodologies or tools or practices, while at the same time they know that the goals will eventually be fulfilled. One quotes that “*As experience grows the risks are decreased*”.

The Principal Investigator envisages all activities as high risk activities due to their complexity. He believes that the volume of the activities is some times a risk on its own, however the team is not reluctant to explore and experiment, although always struggles to be efficient.

2013

Experimentation, high risk and new areas has been extremely intense in 2013 when the Research Unit had no experience in many domains in which today there exist high expertise. It was also necessary at that time to experiment, since there were not plenty of project opportunities available therefore the Unit needed to engage in various domains and gain the funds that would offer sustainability.

6.2.2.3 Exploitation

With regards to the Exploitation Learning the interviewees were asked to what extent the Research Unit undertakes activities to strengthen the knowledge in which they possess significant experience, and if the Research Unit invests in improving efficiency.

2021

There exist a lot of learning activities, trainings and capacity building, as well as, conferences in which the researchers participate, however there exist no processes targeted to efficiency and this is where some drawbacks exist. Horizontal coordination meetings would contribute to efficiency but these are rarely organized due to lack of time. Many researchers believe that internal “regulations” or policies would also be beneficial, as well as, systematic involvement in self-development activities. It is appreciated that the research unit encourages lifelong learning and it is quoted that “*in all our activities we rely on*

previous knowledge and try to build new knowledge around it” however in some domains this should become more systematic. Furthermore, conferences offer a great opportunity for learning and all researchers are encouraged to participate to them. On the other hand, the lack of systematic learning activities leads to slower individual learning rate which, as Kane and Alavi (2007) state, may be more beneficial to exploration because it extends heterogeneity of individuals’ knowledge.

2013

Improving efficiency is achieved through learning activities, which used to be more intense in 2013, mainly due to the time available and initiative of researchers. The spectrum of topics was also limited at that time, therefore a lot more activities were necessary in order to strengthen knowledge and acquire the necessary skills for accomplishing the lab’s goals. Again, the size of the entity has a significant role because individuals in large organisations are organized into teams which influence the nature and effectiveness of organizational learning (Kane and Alavi, 2007) while the centralization of 2013 offered the same opportunities to all members of staff.

7. Discussion

7.1 Discussion of Findings

We have examined in this study the decision-making processes, as well as, the learning processes of the Research Unit. Decision-making is demonstrated by choices, which may be implicit or explicit (March, 1991). It has been demonstrated that in 2013 where the Research Unit had been developed but was still small and emerging new areas of research and development, the logic of decision-making was effectual. His strategies were not goal-driven but means-driven, even though he had a vision on the Unit development and specific goals associated with research domains. The goal was vague but strong: to create a dynamic team of researchers and work with them to develop state-of-the art and innovative technological solutions for healthcare and medical education.

As the Research Unit expands and grows, exploration is still the driving factor but it allows some space to causal decision-making logic, which relates to increased responsibility for fulfilling specific objectives and contractual obligations stemming from funded projects. It

is therefore the application of two logics that dominate decision-making and relate to the proposal writing and undertaking funded (European Commission) research grants, one governs the decision on new proposals preparation and venture for extraordinary endeavors, while the causal logic is more restricted, but reflected in some of the processes within project implementation where the setting is very well described from the beginning, the goals and performance indicators are concrete, the methodology is specified. The Research Unit may have increased benefit by the differentiation of activities in which different decision-making logics are applied (Ciszewska-Mlinaric, 2016).

Kuepper et al have studied effectuation in R&D and they liaise the decision-making logic with the degree of innovativeness involved in R&D. They differentiate dimensions in project performance, which are linked to 1) process efficiency and b) the project outputs. Their results demonstrate that effectuation approaches are associated with highly innovative R&D projects, while causation enhance significantly the performance in low level innovativeness. Similarly, Roach et al (2015) have established a relationship between firm-level innovativeness and effectuation through the use of the three most widely used measures of firm-level innovativeness and emergent effectuation scales.

Regarding Organisational Learning processes the outcomes of the qualitative analysis presented above seem to be consistent with the decision-making processes taking place at the Research Unit. According to Szameral et al (2020) there exist two perspectives on research on how firms overcome innovation barriers: the mindset-based view (organisation culture and values) and the action-based view (management processes, leadership etc). It is in this case evident that action-based view is not very much elaborated, but the mindset-based view is dominant. However, organization culture and organization values do not seem to foster knowledge sharing, trust and respect, to a satisfying level. This is a peculiar observation which is not consistent to many other observations of the study. It seems that, the culture and values introduced by the Leader are not embraced by all researchers, at least not all the ones chosen to participate in this study. All interviewees trust the leader, and the leader trusts them and relies on them, on their knowledge, capacity and skills to perform the activities required to achieve innovative outcomes in the respective field. Future research should attempt to shed light to the factors contributing to the development of an organizational culture and values that will enable uninhibited collaboration and knowledge sharing. Besides, the learning organization is the one who needs to foster the integration of individual learning into organizational learning (Wang and Ahmed, 2003).

Furthermore, the Research Unit is a low-turnover environment (Kane and Alavi, 2007) as the personnel is not shifting significantly and many of the research associates have been in the Unit for a long period of time. In fact, as demonstrated by Table 4, as the Research Unit has been growing, only a few members have left which was mainly due to their accomplishment of getting an academic position. On the other hand, the Research Unit is a highly turbulent (Kane and Alavi, 2007) environment as the research focus is changing and progressing, so do the knowledge requirements for achieving successful performance. The research associates are constantly acquiring new knowledge and skills which are necessary for their work. According to March (1991) both organizational turnover and environmental turbulence enhances the level of knowledge acquired by the organization and introduces an exploratory influence, although it reduces average knowledge levels of individuals. Organisations with a high degree of turnover can benefit by the use of learning mechanisms that reserve the valuable knowledge in the organization, while turbulent organizations can benefit by the use of exploration learning mechanisms that preserve knowledge heterogeneity. Besides, as Andriopoulos and Lewis (2009) argue, R&D is an innovation-intensive setting that relies on knowledge workers demanding that the organization excels at both exploitation and exploration. Researchers must reinforce existing competencies and build new capabilities. Innovation requires attention to existing knowledge and knowledge creation which activates individual knowledge workers.

8. Conclusions

In the present study we attempted to contribute to the academic research on innovation performance in the R&D sector and explore decision-making processes and learning processes which affect the performance of a specific Research Unit in Aristotle University of Thessaloniki. The decision-making logic examined is the causation and the effectuation logic, while learning processes were examined through the observation of learning capability of the entity, as well as, exploration and exploitation learning processes.

Decision-making affects all aspects within the Research Unit. The strategic intent described by Andriopoulos and Lewis (2009) affects the balance between contractual obligations of research activities within projects, with the novel and revolutionary outcomes that are opted

by researchers; the need to exploit together with exploration opportunities foster the motivation of individual knowledge workers.

Organisational Learning, as we have analyzed in the previous sections, entails structures and strategies which contribute to innovation. Wand and Ahmed (2003) stated that focus on continuous improvement is aimed to achieve incremental innovation, therefore effective learning mechanisms can fulfill this objective. At the same time, they concede that there should be a focus on creativity and innovation in order to succeed in highly demanding environments; this focus possesses several features such as triple-loop learning, organizational unlearning, creative thinking and others, which incorporate the perspective of radical innovation. Exploitation may be the adequate approach to enable incremental innovation while exploration supports experimentation, novelty and variation required for radical innovation (Andriopoulos and Lewis, 2009).

In this study, innovation performance refers to innovation outcomes in terms of research funded projects, i.e. the number of new projects evaluated and accepted for funding by various funding programmes and schemes. Overall, the results of this study demonstrate that the Research Unit examined can be considered as an ambidexterous entity which balances between exploitation and exploration through its decision-making processes and is qualified to achieve both incremental and radical innovation (innovation ambidexterity). It is also observed that the Research Unit has a strong capacity in integrating and assimilating new knowledge from exploration without disrupting organizational routines and overall productivity. Lennerts et al (2020) argue that explorative learning leading to radical innovation performance can benefit from supplementary exploitation learning activities which can help an entity transform distant knowledge effectively however this should be balanced and not hinder the performance of the Research Unit which excels in radical innovation as a result of exploration.

8.1 Limitations and suggestions for future research

This work aimed to explore the factors that influence innovation-based performance of R&D units. It has focused on decision-making and learning processes within the research unit, which have contributed to deriving important conclusions, however it could be expanded if

other individual factors could be examined in a future study. Moreover, innovation performance has been assessed through innovation outcomes in terms of research funded projects, i.e. the number of new projects evaluated and accepted for funding but there exist additional metrics that could be utilized and contribute to more valuable insights on the matter.

Furthermore, the Research Unit is increasingly extending its activities to commercial activities through a university start-up which will bring innovative solutions into the market. It is also being involved in industrial involvement through industry-funded subcontracts or industry-led innovation hubs and collaborations, which however have not been included in this study.

Future research should attempt to shed light to the abovementioned topics, as well as, to factors contributing to the development of an organizational culture and values that will enable uninhibited collaboration and knowledge sharing.

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Appendix A: Questions guiding semi-structured interviews

Questions leading semi-structured interviews

DECISION-MAKING PROCESSES	CAUSATION		At the beginning of a new research endeavor/project do you have a clear and consistent vision for what you want to do?
			Do you perform an analysis of possible opportunities or expected returns before committing to a new research endeavor (e.g. when writing and submitting a new proposal)?
			Do you organize and implement control processes to make sure you met objectives?
			Is the ultimate product/service/outcome of the research endeavor quite similar to what you originally had in mind?
	EFFECTUATION	Experimentation	To implement a new research project, do you experiment to identify research opportunities, or do you try to achieve what has been originally conceptualized (do you define the final objective up front)?
		Affordable loss	funded projects, are you reluctant in committing resources and risking them, or are you mostly driven by the potential benefit? Is there a limit in the resources you are willing to lose if the project proves to be unsuccessful?
		Pre-commitments	long-term relationships and commitments with strategic partners (suppliers, other organizations, people,...) in order to reduce the amount of uncertainty, or do you design and plan research strategies to control uncertainty?
		Flexibility	Do you appreciate uncertain situations, as they arise, in the hope of capitalizing on these? Do you start out very flexibly and try to take advantage of unexpected opportunities? Or do you prefer to exploit/capitalize on pre-existing capabilities and resources?
LEARNING PROCESSES	LEARNING CAPABILITY	Open Organisational Culture	Do you think that in the Lab there is mutual trust and respect, and that knowledge is widely shared?
		Interorganisational Partnering	What is your opinion about partnerships with other organisations? Do they contribute to innovation?
		Intraorganisational Learning	If you are working on a new idea or problem, how possible is it that you will share your initial thoughts with one of your colleagues, or the principal investigator himself?
	EXPLORATION		To what extent has your team committed to undertake research in areas in which it had no prior experience?
			To what extent do your tasks involve experimentation and high risk?
	EXPLOITATION		To what extent has your team undertaken activities to strengthen the knowledge in which you and your colleagues already possess significant experience?
			Have you invested in enhancing skills for improving efficiency of existing activities?

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Author's Statement:

I hereby declare that, in accordance with article 8 of Law 1599/1986 and article 2.4.6 par. 3 of Law 1256/1982, this thesis/dissertation is solely a product of personal work and does not infringe any intellectual property rights of third parties and is not the product of a partial or total plagiarism, and the sources used are strictly limited to the bibliographic references.