Career expectations of young Portuguese researchers and organisational support in engineering R&D institutions

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Biographical Note

Isabel Ferreira Macedo was born on the 26th of December, 1980, in France. In 1995, along with her parents and young brother, she came to live in Portugal. Currently, she is married and expecting her first child.

Academically, driven by her early interest in political science and intercultural studies, she got a degree in International Relations at University of Minho, in 2002, finishing top of her graduating class, with the final grade of 16 (in a scale from 1 to 20) and a Merit Award. In 2008, she completed the General Management Course at EGP – University of Porto Business School, an executive education programme aimed to better prepare her to professional demands and support the early development of her career. More recently, in 2009, she joined the Master in Economics and Human Resource Management at the Faculty of Economics of the University of Porto, where she improved her knowledge in management studies and areas such as economics, law and social sciences. The present dissertation is the final step to the completion of this Master.

At a professional level, since 2003, she holds a position of management support in a private non-profit association dedicated to scientific research and technological development. Over the years, she progressively was assigned tasks in the support to her Head of Department and, since 2007, also directly to the Board of Directors of the institution. The different challenges, namely in human resource subjects, allowed her to get acquainted to and develop interest in this particular area of management, persuading her to develop her qualifications in the area and perhaps redirect herself towards a new professional orientation.

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Nevertheless, for any errors or inadequacies that may remain in this work, the responsibility is entirely my own.

Resumo

O elevado nível de insegurança laboral dos jovens investigadores no mundo académico e em instituições de I&D sem fins lucrativos, caracterizado por soluções temporárias e incertas, nomeadamente bolsas sucessivas, está a levar a um crescente criticismo em relação à estruturação das carreiras de I&D nessas instituições. Uma mudança deste paradigma mantém-se difícil devido a restrições orçamentais e a políticas governamentais, contudo, algumas ações deveriam ser encetadas no sentido de garantir que os pós-graduados e as respetivas instituições de acolhimento recebem o máximo da sua colaboração mútua e provisória.

O objetivo desta investigação é entender, de que forma, estes recursos humanos transitórios consideram poder ser mais bem apoiados pelas suas instituições de I&D de acolhimento, especialmente na área de recursos humanos, e mais bem preparados para aproveitarem as oportunidades futuras de carreira, sem um acréscimo significativo de custos para as suas instituições. Estas questões são exploradas neste estudo mediante uma investigação baseada em entrevistas a jovens investigadores em engenharia eletrotécnica desenvolvendo investigação nas suas áreas de especialização numa instituição de I&D sem fins lucrativos sita no Norte de Portugal.

Ainda que de difícil generalização, os nossos resultados revelam que algum planeamento a longo termo, melhor comunicação, uma orientação de carreiras específica e *networking* estratégico por parte das instituições, poderia responder, sem encargos adicionais, a necessidades relevantes dos jovens investigadores, atenuando a falta de contratos de trabalho ou outras regalias. Além disso, aspetos motivacionais e compensatórios alternativos, como o reconhecimento interno e externo, a flexibilidade de horários ou uma atividade desafiante são muito valorizados por esses recursos humanos. Finalmente, mediante a implementação de práticas específicas de gestão de recursos humanos, os gestores poderiam garantir uma significativa melhoria no desenvolvimento pessoal e profissional dos jovens investigadores, começando a geri-los e não só a acolhê-los, beneficiando também, a longo prazo, a instituição.

Palavras-chaves: Desenvolvimento de carreira; jovens investigadores; insegurança laboral; carreira científica; gestão de recursos humanos; organizações de I&D sem fins lucrativos.

Abstract

A high level of job insecurity among junior researchers in academia and non-profit R&D institutions, characterised by temporary and uncertain positions, namely successive grants, is leading to growing criticism on the way R&D careers in these institutions are structured. If a change in their formal work relations is arduous due to budget restrictions and governmental policies, nevertheless, actions could be undertaken in order to make sure that postgraduates and their host institutions receive the most of their mutual and provisional collaboration.

The purpose of this research is to understand, in what ways these transitional human resources consider they can be better supported by their host R&D organisations, more specifically in the human resource area, and become better prepared to seize their future career opportunities, with no significant increase in costs for their institutions. These issues are explored in this study through an interview-based investigation to junior researchers in electrical engineering performing research in their field of expertise in a non-profit R&D organisation located in the North of Portugal.

Though our results may be difficult to generalise, our findings reveal that institutions balancing the lack of employment contracts or other benefits with some long-term planning, improved communication, a specific career guidance and strategic networking could respond to junior researchers' relevant needs with no additional costs. Furthermore, alternative motivational and compensation aspects such as external and internal recognition, time flexibility or challenging activity are highly valued by these human resources. Finally, through the implementation of specific human resource management practices, management could get a significant improvement in personal and professional development of junior researchers, starting "managing" them instead of just "hosting" them, which could be, in the long-term, also beneficial for the institution.

Keywords: Career development; junior researchers; job insecurity; scientific career; human resource management; non-profit R&D organisations.

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Chapter 1. Introduction

Every year, in Portugal, hundreds of postgraduates decide to follow the path of Research and Development in their scientific area (Eurostat, 2012). As a result of the great efforts made by Portuguese authorities in the last years, the number of research grants in all research fields has considerably increased, reducing the gap between Portugal and other European Union Member states in terms of the number of researchers.

However, the expectation that postgraduates would go to industry in order to contribute to the Portuguese economy is not being fulfilled and many of them choose, for different reasons already extensively studied (Cotgrove, 1970; Blume, 1974; Cabral-Cardoso *et al.*, 2003; Hakala, 2009), to stay in academia or in non-profit R&D organisations for a number of years after graduation either by enrolling in Master or Doctorate Programmes or by applying to research positions in R&D projects (Cabral-Cardoso, 2001; Morano-Foadi, 2005).

The growing number of postgraduates in academia and non-profit R&D institutions in order to pursue their R&D careers leads to some saturation of the labour market, with some erosion of the working conditions (Cabral-Cardoso *et al.*, 2003). Due to budget restrictions, most of the positions available for junior researchers are temporary and uncertain, namely successive grants, funded on "soft" or governmental money with limited prospects for career progression. With poor career perspectives and limited social security benefits (ABIC, 2008; Perista & Silva, 2004), junior researchers often struggle with job security problems, delaying for several years their personal and professional fulfilment, and even plans of family formation (Edwards & Smith, 2009; Melin & Janson, 2006). Many times, this position does not even provide a step to a tenured position in the area or research environment, forcing them to leave their positions and find new career opportunities.

This level of job insecurity among young scientists is leading to growing criticism on the way R&D careers in academia and non-profit organisations are structured (Perista & Silva, 2004), an issue that should be urgently addressed (Harman, 2004; Hakala, 2009). Moreover, with the emergence of more complex collaboration networks between academia, research centres and industry, many junior researchers find themselves

trapped in new types of arrangements and career structures that challenge the traditional separate spheres of industry and university (Lam, 2005; Lam, 2007).

In 2003, the *ABIC – Associação dos Bolseiros de Investigação Científica* (Scientific Research Grant Holders Association) was created in order to support the creation of better conditions for young scientists, namely in terms of employment. However, with the budget restrictions and the pressure in the labour market from the supply side, positions available remain temporary (Perista & Silva, 2004). Consequently, for several years, young and bright researchers are "hosted" as transitory human resources rather than duly "managed".

In contrast with R&D careers in industry, the scientific career in academia or non-profit organisations, namely in its early years is, in general, much poorly developed in the existing literature. However, these highly skilled Portuguese researchers who have invested years of their lives in a specific path and are a priceless asset to their country's future should deserve more attention. If not much can be done regarding their formal work relations with their host institutions, research and actions should be undertaken in order to guarantee that postgraduates and their host institution receive the most of their mutual collaboration.

Thus, the present work aims to contribute to fill this gap and bring positive changes to the management of junior researchers in academia or other types of non-profit R&D organisations. The purpose of this research is to understand in what ways these transitional human resources (most of them, young researchers) can be better supported by their host R&D organisations and become better prepared to seize their future career opportunities, with no significant increase in costs for the institutions.

To achieve our aim, our study focus on young electrical engineers developing research in a non-profit R&D private institution and seek to understand their career prospects and their current and future needs. We then try to identify good practices and make suggestions about possible improvements in R&D management and formulate some recommendations to human resource management of non-profit R&D institutions.

A qualitative methodology was considered the more useful approach in order to explore and reveal junior researchers' understandings about their career needs and prospects, from their own point of view. Our sample selection is made up of individuals, male or

female, graduated in electrical engineering, at the time performing research in his/her field of expertise in a non-profit R&D organisation located in the North of Portugal and at an early stage of their careers. Through semi-structured interviews with open-ended questions and the content analysis of the answers, our aim is to suggest some recommendations to “manage” instead of just “host” these junior researchers, though this study is exploratory and its results may be difficult to generalise.

The present dissertation is structured as follows. In the next chapter, the relevant literature is reviewed in order to identify the concepts and framework to adopt in this research. In Chapter 3, the methodology used to collect our empirical data is detailed and justified. In Chapter 4, a comprehensive account of our results is presented and discussed. Finally, in Chapter 5, the main conclusions are drawn and some limitations of the present study, as well as its contributions to the existing literature and management practices are highlighted.

Chapter 2. The early stage of a scientific career in Portugal – A literature review

2.1. Initial considerations

Traditionally, Portuguese effort in Research and Development (R&D) is one of the poorest when compared to European standards (Cabral-Cardoso *et al.*, 2003; Teixeira & Fortuna, 2010; GPEARI, 2010). The limited level of schooling and qualifications of its human resources is identified as one of the major obstacles to the development of the country (Cabral-Cardoso, 2001; Teixeira & Fortuna, 2010).

Since the early 1990s, a huge attempt was made by the Portuguese authorities in order to improve the qualifications of its human resources, enforcing new science policies and, specifically, rising considerably the number of MSc and PhD grants in all research fields (Cabral-Cardoso, 2001; Perista & Silva, 2004; Fiolhais, 2011). In 2009, the number of researchers per thousand active population reached 8.2 ‰, being for the first time above the EU average (GPEARI, 2010). [1]

The expectation was that postgraduates would go to industry contributing to the development of the economy. However, these expected results weren't so successfully achieved (Cabral-Cardoso, 2001). As stated by Sonia Morano-Foadi (2005), "In Portugal, R&D activities are largely under-developed in the business enterprise sector. Recent policy measures aiming, for example, at the recruitment of masters and PhD holders by companies have been rather unsuccessful. A science career in the industry sector, for men and especially for women researchers, is thus not a common situation in Portugal." (Morano-Foadi, 2005, p. 152).

Therefore, the majority of Portuguese postgraduates dedicated to R&D are recruited by public institutions (Cabral-Cardoso, 2001; Melin & Janson, 2006), a wide spread situation that has led to the disseminated idea that the State should be the one to ensure the professional careers of these individuals, through public higher education or research institutions (Cabral-Cardoso *et al.*, 2003).

[1] Although, as mentioned by Perista & Silva (2004), this number also reveals "a growing presence of foreign post-graduate students, among grant holders in Portugal" (Perista & Silva, 2004, p. 4).

2.2. The difficult integration of junior researchers in the labour market - Causes

The reasons for the unsuccessful passage of postgraduates dedicated to R&D activities to industry are varied and complex and they have been studied by several authors (Cotgrove, 1970; Blume, 1974; Cabral-Cardoso *et al.*, 2003; Hakala, 2009). As we will see, postgraduates, but also the institutions play a part in this problem of integration of young researchers in Portuguese industry.

2.2.1. Causes of the difficult integration of junior researchers in the labour market – The researcher's perspective

The "person-organisation fit" provides an interesting framework to examine the integration of young researchers in an organisation. As pointed out by Cabral-Cardoso (2001) and Cabral-Cardoso *et al.* (2003), individuals are usually attracted to organisations whose values are more compatible with their own, revealing preference for organisations that might more successfully satisfy their needs (Cabral-Cardoso *et al.*, 2003; Cabral-Cardoso, 2001).

As mentioned by Cabral-Cardoso (2001), "The academy is the reference against which respondents assess their preferences and value their options." (Cabral-Cardoso, 2001, p. 215). Though it is true that the idea of "academia" and "industry" as typical organisations corresponding to ideal types is just a simplification - being easy to find industry with academia characteristics and vice-versa (Cabral-Cardoso *et al.*, 2003) -, it is nevertheless true that academia and industry have different values and cultures (Cabral-Cardoso *et al.*, 2003; Lam, 2007).

The integration of postgraduates in industry could be more facilitated if there was a greater articulation between academia and industry, with a better balance between the supply and demand side of the labour market (Cabral-Cardoso *et al.*, 2003). However, as observed by Cabral-Cardoso *et al.* (2003), in Portugal, these two systems are still very apart. Besides a profound mutual unawareness, the authors also state that "when these two cultures meet, there is a process in which each one tries to make the other adopt its value system, which, frequently, leads to conflict situations" (Cabral-Cardoso *et al.*, 2003, p. 31).

As mentioned by Cabral-Cardoso (2001), “The different roles played in society by universities and business companies cannot explain by itself the difficult relationship between these two types of institutions. Disinterested production of knowledge, higher education, academic freedom and autonomy, peer assessment, long time horizon, publication, decision by consensus, individual work arrangements and structure by disciplines are some of the features of academic institutions.” (Cabral-Cardoso, 2001, p. 213). The same author also remarks that “In business organisations, despite of diversity of situations, all activities carried out must ultimately lead to improvements in financial performance and market share.” (Cabral-Cardoso, 2001, p. 213).

This reality was already perceived by Stephen Cotgrove (1970) when he observed that science is a social system with clearly defined values and norms that exercise a powerful influence on its members. He admits that “it is exposure to the ethos of pure science in the universities which is at least partly responsible for the preference for 'pure' research and a distaste for applied work.” (Cotgrove, 1970, p. 11).

In the case of postgraduates, their longer academic passage than graduates leads to a greater absorption and acceptance of the norms, work practices and values of the academia which might explain the greater adjustment difficulties that they anticipate in industry (Cabral-Cardoso *et al.*, 2003).

Nevertheless, not all postgraduates have the same adjustment difficulties in integrating in industry, for instance, it might depend on the levels of schooling and on the scientific fields (Cabral-Cardoso *et al.*, 2003). Namely, what Cabral-Cardoso *et al.* (2003) confirm with their study on young Portuguese postgraduates integration in industry is that engineers have less difficulties to integrate in industry, being more willing to apply their dissertation work to the applied field or grab a management position (Cabral-Cardoso *et al.*, 2003). Moreover, gender is also a factor in the greater or lesser difficulty to pursue an industrial career. According to Cabral-Cardoso (2001) and Zalevski & Swiszczowski (2009), more women than men cite barriers to integrate the business world, either as an employee or as an entrepreneur.

As observed in the study of Cabral-Cardoso *et al.* (2003), neither the PhD students nor the MSc students reject, in principle, the three career options that the authors refer, that are: academia, research and industry. Nonetheless, Portuguese postgraduates have some

pessimistic view about industry as a potential employer, where some fundamental questions may arise (Cabral-Cardoso *et al.*, 2003).

Besides being probably overqualified for most jobs in Portuguese industry, postgraduates fear that they might not be treated as scientists by companies, generally described as risk averse (Cabral-Cardoso, 2001). Additionally, industrial laboratories will tend to favour short-term projects oriented to profits rather than to work on long-term problems of fundamental interest, requiring no more than the use of existing knowledge to theoretically trivial problems (Blume, 1974). As Cabral-Cardoso (2001) remarks, "Unless companies commit themselves to innovation and science it is unlikely they manage to attract scientists who get committed to the organisation." (Cabral-Cardoso, 2001, p. 216).

2.2.2. Causes of the difficult integration of junior researchers in the labour market – The industry's perspective

The management of scientists in industry is very peculiar. As stated by Cotgrove (1970), "An essential feature of science is its communal nature - the existence of a 'scientific community' an 'invisible college' cutting across barriers of class, race, and nation. It is to this community that the scientist looks for judgement of his work (…) leading in some cases to painful tensions when his allegiance to science conflicts with loyalties to nation, family, or employer." (Cotgrove, 1970, pp. 1-2). The author then concludes that "Science for the dedicated scientist is more than an occupation; it is a way of life." (Cotgrove, 1970, p. 5). Therefore, the traditional industrial researcher deals not so much with an internal conflict but rather with a compromise, trying to ensure the advantages and recognition both from the scientific community and the organisation (Blume, 1974).

Although scientists may react in varying ways to actual career possibilities, even in the same organisation (Blume, 1974), generally speaking, the management of R&D professionals may be a real challenge for a company. In fact, when turning our attention to the industry's perspective on the reasons for the adjustment difficulties of postgraduates in industry, several aspects in the literature are currently referred to.

From the study conducted by Cabral-Cardoso *et al.* (2003), among Portuguese postgraduates and the industry, the latter demonstrates some doubts about the advantages of recruiting employees with a scientific profile. In a fast changing business world, where technologies are shifting and evolving continuously, the competencies valued by industry are flexibility, dynamism, versatility and managerial, commercial and multidisciplinary skills, the capacity to solve practical problems and to work in teams rather than some super-specialisation in a specific area (Cabral-Cardoso *et al.*, 2003; Melin & Janson, 2006; Thune, 2009).

These "soft skills", in opposition to "hard skills", that employers value, are lacking in most of the young scientists in several countries (Edwards & Smith, 2009). Industry does not look for the better scientists because most of the post-graduation degrees, like PhD degree, are irrelevant for most of the problems faced by industrial research (Cabral-Cardoso *et al.*, 2003). Even their scientific network, namely their academic connections, is not properly valued when it could really be a facilitation in the access to external knowledge and technology (Cabral-Cardoso *et al.*, 2003). Therefore, as pointed out by Cabral-Cardoso *et al.* (2003), "most of the companies does not value much the more common competencies of postgraduates" (Cabral-Cardoso *et al.*, 2003, p. 132).

Thus, it is not surprising that companies face more difficulties in managing such human resources. For example, the culture management and the reward system may need some adjustments, as the rewards valued by scientists are not organisational or solely monetary ones, preferring the recognition of their peers.

This is also true for the phases of recruitment and integration (Cabral-Cardoso *et al.*, 2003). As mentioned by Blume (1974) and Cabral-Cardoso *et al.* (2003), a process of "resocialisation" must take place. Blume (1974) refers to it as a process in which the norms and values acquired in university gradually appear as inappropriate to the new environment. The author remarks: "Many scientists thus begin to realize that they must consult superiors and act on their advice or instruction, that they must pay attention to administrative detail, and so on. The more thorough the initial socialization into scientific culture has been (roughly identifiable with different levels of education), the more difficult the resocialization." (Blume, 1974, p. 49).

As observed by Cabral-Cardoso *et al.* (2003), the process tries to make the individual and the organisation more compatible, with a greater commitment of the former regarding the latter (Cabral-Cardoso *et al.*, 2003). Actually, as stated by Blume (1974), "scientists have to be brought into a policy-making process, not simply left alone, in order to work most effectively" (Blume, 1974, p. 58). The mutual set of goals between the scientists and the superiors should bring a sense of challenge and interest in the work performed that is translated in good results in the work.

Another interesting fact mentioned by Cabral-Cardoso *et al.* (2003) is that most of the postgraduates recruited by industry, integrated an already formed team, though a considerable amount of them was recruited to start a new area or launch a new project (Cabral-Cardoso *et al.*, 2003). Thus, companies should try to attract the highly qualified human resources (Cabral-Cardoso, 2001), and understand the benefits that individuals with a different capacity in analysing problems, autonomy and initiative could bring to a company (Cabral-Cardoso *et al.*, 2003; Fiolhais, 2011).

2.2.3. Causes of the difficult integration of junior researchers in the labour market – The academia's perspective

According to many of the school-to-work literature (Harman, 2004; Edwards & Smith, 2009; Larson & Lockee, 2009; Hakala, 2009; Pitt *et al.*, 2010), besides internships and apprenticeships that enable students to work in authentic and complex real settings, there is a need to prepare students with diverse and transferable skills in order to facilitate the transition to the world of work.

Therefore universities have been challenged to adapt curricula, generally considered too narrow (Melin & Janson, 2006; Pitt *et al.*, 2010). Interdisciplinary competencies and soft skills would be easily transferable to a wide range of different employment contexts and environments (Cabral-Cardoso *et al.*, 2003; Harman, 2004). Melin & Janson (2006) consider that "students need to master a high level of knowledge of other disciplines in order to understand the latest developments in their own discipline." (Melin & Janson, 2006, p. 106). Management aspects, entrepreneurial, communicational or leadership skills are some of the new competencies that postgraduates are expected to develop in

order to be prepared to different contexts and to detach from all the competition (Melin & Janson, 2006).

Furthermore, job applicants should get information on cultural aspects prior to accepting employment in any firm (Cabral-Cardoso *et al.*, 2003; Larson & Lockee, 2009). According to Stewart & Knowles (2000), it is important that graduates are aware of opportunities and environmental conditions (Stewart & Knowles, 2000). Students should understand more fully the labour market in which they are entering (Stewart & Knowles, 2000).

The idea is to train professionals that can adapt to a range of employment destinations across academia, industry and the professions, avoiding over-specialisation (Pitt *et al.*, 2010). What is also very relevant is that the restructuring of Post-graduations programmes is not anymore an exclusive concern of academia, being permeable to external stakeholders, fomenting a new environment for university-industry collaboration (Pitt *et al.*, 2010).

2.3. The difficult integration of junior researchers in the labour market - Consequences

As pointed out above, Portuguese postgraduates tend to go to universities and non-profit R&D institutions in order to pursue their R&D careers (Perista & Silva, 2004). As Cabral-Cardoso *et al.* (2003) remark, "this is a segment of the labour market in which, clearly, the pressure is exercised on the supply side" (Cabral-Cardoso *et al.*, 2003, p. 179). Therefore, this surplus leads to saturation in the labour market of the traditional employers of postgraduates, and consequently some erosion of the working conditions (Cabral-Cardoso *et al.*, 2003).

With budget restrictions, universities only have few positions available (Cabral-Cardoso *et al.*, 2003). As a result, Portuguese universities almost only have, in employment terms, temporary solutions to offer to young researchers, namely successive grants (Cabral-Cardoso *et al.*, 2003; Perista & Silva, 2004; Fiolhais, 2011). As stated by Perista & Silva (2004), "there seems to be no doubt that doing scientific research is not an easy career pathway in a country like Portugal." (Perista & Silva, 2004, p. 25). In Portugal, the *Fundação para a Ciência e Tecnologia – FCT* (Foundation for Science

and Technology) is the main governmental instrument to fund the MSc, PhD grants or other advanced training grants, as well as other fixed-term employment contracts (these ones only for graduates). According to Perista & Silva (2004), "Scientific labour market in Portugal seems to be enlarging and opening to new realities, but it still shows rather small and concentrated, lacking of qualified human resources and offering limited prospects for career progression and well paid and secure positions." (Perista & Silva, 2004, p. 24).

In 2003, the *ABIC – Associação dos Bolseiros de Investigação Científica* (Scientific Research Grant Holders Association) was created in order to support the creation of better conditions for young scientists, namely in terms of employment conditions. The main problems concerning young Portuguese researchers and identified by ABIC are poor career perspectives, both in the private sector and in the public sector, poor social security benefits and poor research infrastructures (Perista & Silva, 2004). In fact, grant holders do not have a status of employee, so they are not covered by the usual social protections, while sometimes used as substitutes of employees, with the same duties but not the same rights (ABIC, 2008).

These precarious conditions for young scientists pursuing R&D activities are not only a Portuguese issue. Our review of literature detected that this problem appears in several other countries (Stephan & Levin, 1997; Harman, 2004; Lam, 2007; Hakala, 2009; Edwards & Smith, 2009; Edwards & Smith, 2010). For Edwards & Smith (2009), "'temporary' is becoming the norm" (Edwards & Smith, 2009, p. 28) and the same authors reinforce that "'new generation' academic scientists are increasingly becoming divided into two groups: a large group comprising those undertaking post doctoral research and temporary faculty positions because they cannot find tenured jobs; and a smaller group of those who do find a good tenured position, but struggle to fund their research because of their junior status" (Edwards & Smith, 2009, p. 28).

The problem is that these young scientists stuck in temporary positions are not so young anymore. As Melin & Janson (2006) remark, "They are often well into their 30s. The student lifestyle is, in part, stretched out and causes economical insecurity and problems regarding family formation." (Melin & Janson, 2006, p. 113). As a negative consequence, the authors wonder: "Not that there are real problems in attracting people

to the universities in general, but the question is who are attracted? The best, or the most persistent ones?" (Melin & Janson, 2006, p. 113).

For Edwards & Smith (2010), who refer to the condition as a "post doc treadmill", "This situation means that higher degree graduates are spending increasingly longer periods of time on temporary or short-term contracts linked to specific research projects and do not have the opportunity to build their profiles through engagement in long-running research and teaching." (Edwards & Smith, 2010, p. 26).

The problem that may incite dissatisfaction of the young scientists is seen as a sign of serious problems in present-day academia and that should be urgently addressed in order to guarantee that students receive the quality of experience they deserve (Harman, 2004; Hakala, 2009). As pointed out by Edwards & Smith (2010), the problem is that "the post-doctorate position is no longer serving its intended purpose: to provide a stepping-stone to a tenured position." (Edwards & Smith, 2010, p. 28).

What differentiates the Portuguese case of most other countries is that, in most countries, industry is a valid alternative, where working conditions, career prospects and high salaries are very attractive (Hakala, 2009; Edwards & Smith, 2009). The most talented researchers are leaving academia for industry, and in global terms, guarantying a growth in applied fields in detriment to more fundamental research (Hakala, 2009).

Furthermore, as mentioned by Edwards & Smith (2009), the issue gains in relevance when we take in consideration the progressive aging of the current faculty members and the need to substitute the retired (Edwards & Smith, 2009). As well summarised by the same authors, "there are problems with oversupply, but lack of quality; importance of research, but lack of career pathways and remuneration; and increasing demand, but seemingly decreasing incentives for students to follow a science career." (Edwards & Smith, 2009, p. 30).

There is a considerable number of scientists being hired on "soft money" in academic institutions, as termed by Stephan & Levin (1997) about the United States of America reality. These soft money positions only exist as long as the external funding that guarantee the payment of the grant or short-term contract of the researcher exists, guaranteeing non-secure and cheap labour conditions (Stephan & Levin, 1997).

Therefore, a kind of "Up or Out" situation seems to be spreading in the R&D management. For example, Stephan & Levin (1997) refer to the situation in the United States of America, where a young scientist, within a period of no more than seven years, need to establish a lab of his own or he will be forced to seek employment elsewhere (Stephan & Levin, 1997). In consequence, a typical R&D laboratory in the USA experiences a "substantial turnover among junior scientists" (Stephan & Levin, 1997).

2.3.1. The linked scientists

Besides the aspects referred to previously, new and emerging contexts of academia and industry collaboration are challenging traditional scientific careers and their management. Currently, in the fast moving industry technology and knowledge-intensive sectors of the economy, these changes are particularly reflected on the researchers' career structures and employment relationships (Lam, 2007).

The management of industrial Research & Development has evolved in the last decades. As mentioned by Lam (2005), "The dominant model of R&D organization has evolved from the technology-push model of the 1950s and 1960s to the market-pull model of the 1970s until the late 1980s, and an emerging network model of today in which firms use collaborative links and networks of scientists across organizational boundaries to support their innovation activities." (Lam, 2005, p. 242). Thus, in some scientific fields, such as engineering, life sciences and natural science fields, the relationship between university and industry is experiencing a profound shift. The traditional one way flow of knowledge is being substituted by reciprocal flows of knowledge but also of people (Lam, 2005).

According to Lam (2005), "This increased interchange takes place within a potent and enduring change in public science policy that seeks to promote closer science and business links." (Lam, 2005, p. 246). Following the same globalised trend, in Portugal, strategies to reinforce the network between academia, industry and government bodies are being implemented since 2008, namely through the COMPETE Programme and the creation of Competitive Poles and Clusters in strategic areas such as energy, transports, manufacturing, etc. (COMPETE Management Authority, 2011).

With the network organisation as a new mode of innovation, and the blurring of boundaries between science and business, the occupational roles and careers of R&D scientists have also co-evolved and been reshaped though still little is known about all the consequences (Lam, 2005; Lam, 2007).

A decisive role is ensured by doctoral students, or other young postgraduates, in this inter-institutional research collaboration (Lam, 2005; Lam, 2007; Boardman & Bozeman, 2007). There might be several types of organisational arrangements between a graduate student and industry and they can be classified as an employment contract as a resident scientist of the firm, a grant or scholarship partly funded by the industry during the scientist training or "non-contractual arrangements" in which the young scientist participates in a project but the contract is with the university or his supervisor (Thune, 2009).

The network organisation is leading, in Lam's opinion (2007), to new type arrangements in employment relationships. Universities provide the necessary structured and established careers to their scientists, allowing them to keep in contact with their own knowledge networks while they can engage in collaborative research projects (Lam, 2007). Therefore, this pool of human resources that Lam (2005) labels "linked scientists" are decisive to ensure the "capture and transfer of knowledge across organizational boundaries." (Lam, 2005, p. 267). According to the author, there are three categories of these mobile and hybrid scientists that are the "network nodes" and that allow the connection between university and the internal industry R&D (Lam, 2005). They are the "entrepreneurial professors", the postdoctoral researchers that the author refers to as the "Joint Human Capital" and the doctoral students (Lam, 2005).

The entrepreneurial professors participate fully in collaborative projects with industry but maintain fully their stable position at university. These professors are the focal points of firm' links to the universities, also attracting with their reputation top scientists in their teams (Lam, 2005). "All the network firms have developed their university partnerships through the personal contacts and deep engagement of such entrepreneurial professors in the collaborative relationships." (Lam, 2005, p. 268).

As for the postdoctoral researchers, they are affiliated to the university but work in the collaborative projects, being increasingly a large part of the temporary and flexible

labour market that the “linked scientists” constitute (Lam, 2005). As mentioned by Lam (2005), “These are usually young scientists located half-way between training and scientific employment who are employed for a fixed duration on industrial collaborative projects. For the firms, these researchers constitute a pool of flexible scientific labour and a repository of new knowledge that they can draw upon but without having to commit themselves to a period of employment of more than two to three years. For the universities, these funded positions enable them to offer temporary employment to their new PhDs while they build up their research record and wait for permanent positions in either the academia or industry.” (Lam, 2005, p. 269). This workforce can also constitute a “flexible academic workforce” that has little hope of staying in academia with an employment contract but that is addressing the temporary needs of universities, both entrepreneurial and academic (ensure lectures, etc.) (Hakala, 2009).

The third category corresponds to the doctoral students whose training is funded jointly by university and industry (Lam, 2007), developing the competencies necessary to what Lam (2005) calls “a new breed of hybrid scientists" (Lam, 2005). Hopefully, some of them may be recruited by the firms after graduation, as Lam (2005) concludes from her study that “firms tend to hire those who have interned with them. The employment of these students further strengthens the firms’ network ties with their academic partners.” (Lam, 2005, p. 270).

These linked scientists correspond to what Bailyn (1991) called “hybrid” career options, and Lam (2005) described as a “new breed of scientists” facilitating cooperation and exchange between academia and industry, two institutional spheres traditionally separated (Lam, 2005).

In Lam’s opinion (2005), this network organisation and the existence of these linked scientists could be called an “extended internal labour market” (EILM) that goes beyond the boundaries of the firm, turning them more open and fluid (Lam, 2005; Lam, 2007; Howells, 2008). Industry develops stable social frameworks in order to ensure knowledge and skills resourcing, that guarantee the production of knowledge commercially valuable. This enables firms to shape their future human resources, establish channels for reliable information about potential recruits and use the stable career system of universities in the case of professors (Lam, 2005). In the network

organisation, the career structures emerge with “less sticky employment relationships” (Lam, 2007).

According to Lam (2005), this overlapping internal labour market is “one particular form of institutional mechanism underpinning the network model of R&D organization.” (Lam, 2005, p. 272). Lam (2007) suggests that in some advanced research fields a “hybrid scientific labour market” is emerging and that “It draws our attention to the emergence of a hybrid space structured around the linked mobility of human resources that facilitates the interconnection of two different knowledge communities.” (Lam, 2007, p. 1013). This hybridism is characterised by the network flexibility of joining teams around projects and supporting knowledge creation, combined to the stable, institutional and independent career structures that provide long-term incentives (Lam, 2007).

As a result of these temporary arrangements and hybrid work roles, the scientists’ careers can become fragile and uncertain (Lam, 2005). As stated by Lam (2005), “Among the possible losers in this process are the “trapped” postdoctorates employed on “soft” money, and graduate students used as cheap scientific labourer in industry-university exchanges” (Lam, 2005, p. 273).

These structural changes in academia are leading to changes in the formation of academic identities that are subjectively interpreted (Hakala, 2009). Quoting Hakala (2009), “Moreover, senior academics are often unable to prepare the newcomers to an academic world which is very different from the one they entered in their youth. This means that the ideals and role models they offer are obsolete and even misguiding. The new generation of researchers is left on its own to figure out the meaning of their work and the orientation they should choose.” (Hakala, 2009, pp. 176-177). Thus, as concluded by the same author, “the attraction of a university career is not necessarily diminishing, but it is changing.” (Hakala, 2009, p. 177).

2.4. Managing researchers – Some human resource management specificities

Having reviewed the literature on scientific careers, an examination of the management of researchers is necessary for the background analysis of the empirical work.

As mentioned in the literature, R&D professionals have distinctive characteristics when compared to other human resources of the organisations (Kim & Cha, 2000; Cabral-Cardoso *et al.*, 2003). Their technical expertise, the commitment to the profession, the maintenance of collegial standards, but above all, the autonomy, flexibility and challenge crave, requires a distinct Human Resource Management (HRM) (Kim & Cha, 2000; Cabral-Cardoso *et al.*, 2003). Though the theme of appropriate career management system for industrial researchers has been much studied (Debackere *et al.*, 1997; Igbaria *et al.*, 1999; Bigliardi & Dormio, 2009; Petroni, 2000b), non-profit science organisations, on the other hand, have not dedicated much energy to career management (Mallon *et al.*, 2005) and the literature on the subject is scarce, if not inexistent.

As mentioned by Scaffidi & Berman (2011), "Curiously, higher education policy support for the career development of researchers in universities in the UK and US stands in stark contrast to the scholarly literature which has largely neglected the experiences of postdoctoral scholars in their immediate post PhD years. (…) In the absence of a robust literature, our knowledge of the postdoctoral experience is confined to surveys carried out by postdoctoral support professionals in universities and Medical Institutes, or by postdoctoral associations." (Scaffidi & Berman, 2011, p. 686).

Besides being sparse and usually focused on postdocs, the existing literature on career management of R&D workers in non-profit R&D organisations, namely in universities, tends to treat junior researchers issues, their current positions and employment outcomes as a student matter rather than a human resource management question.

Thus, several authors recommend educational or mentoring programmes for "students or scholars" (Galland *et al.*, 2008). Similarly, Akerlind (2005) refer to the term "trends" rather than human resource practices when alluding to suggestions made by grant holders about the need for annual appraisals on professional and personal development, formal career advice or training in transferable skills (Akerlind, 2005). The perception become clear with the citation of Galland *et al.* (2008) stating that "Almost all institutions have departments of human resources that provide developmental education for faculty and staff, but these educational opportunities usually are not designed to

address the specific needs of researchers, as described above, nor are they utilized widely by researchers." (Galland *et al.*, 2008, p. 55).

Nevertheless, some valuable recommendations for improving the management of junior researchers can be found in this literature. Specifically, the literature suggests qualitative support, training in transferable skills, such as communication, leadership and management skills, career development support and counselling (Akerlind, 2005; Galland *et al.*, 2008; Ghayur, 2008; Scaffidi & Berman, 2011), namely alternatives to academic and research-only careers (Akerlind, 2005) and networking (Akerlind, 2005; Scaffidi & Berman, 2011).

Meanwhile, in R&D intensive organisations, HRM strives to mobilise human capital as a productive and creative force (Préfontaine *et al.*, 1994). Thus, as in many companies in other sectors, HRM is growingly playing a strategic role and all of them must design their human resource functions in accordance to their business strategy, vision and values (Van der Linden & Parker, 1998).

Since the aim of this study is to assess the possibility of improving the management of young scientists, a glance at the literature in managing industrial R&D workers can be useful in order to collect some general recommendations applicable to all scientists.

For Petroni (2000a), "Nowadays, effective human resource management strategies in R&D organisations are specifically targeted at fostering innovation capabilities and creativity along four directions: human resource planning, performance appraisal, reward systems and career management." (Petroni, 2000a, p. 288).

Focusing on the latter, and as stated by Bigliardi & Dormio (2009), "a measure of career orientation enables an organization to find a match between organizational and individual needs and to restructure jobs accordingly. It also serves as a useful information base for individuals contemplating career changes, and for organizations seeking to help individuals plan their careers" (Bigliardi & Dormio, 2009, p. 10). Furthermore, it is a way to better understand the scientists' reactions to career development opportunities, according to changes in career aspirations and preferences (Igbaria *et al.*, 1999). As reinforced by the authors, "research has shown that compatibility between workers' desires and aspirations, and their job settings, produces

high levels of job satisfaction, career satisfaction, and organizational commitment, as well as a low intention to leave the organization" (Igbaria *et al.*, 1999, p. 31).

According to Aryee (1992), the research on careers is usually constituted of two main streams: the first, with a more psychological focus on the individual dimensions of career, like career aspirations, values, perceptions, and effective reactions to job experiences and the second, more a sociological perspective, focuses on the institutional framework, such as the sequence of jobs and positions (Aryee, 1992). As mentioned by the same author, career management is a dual responsibility that should be designed and monitored carefully by institutions, taking into account what skills and people they need, and proactively managed by the individuals (Aryee, 1992).

At the root of almost all contributions found on the topic (Bigliardi & Dormio, 2009; Igbaria *et al.*, 1999; Aryee, 1992; Petroni, 2000b), the concept of "career anchors" of Edgar H. Schein (1985) stands out. This conception refers to self-concepts of an individual about his perceived abilities, skills, values and motives and needs in a career. Based on these eight "career anchors", technical or functional competence, managerial competence, autonomy/independence, security/stability, sense of service/dedication, pure challenge, lifestyle integration and entrepreneurial creativity, the scientist will prefer a given career or position over another, gaining a "greater self-awareness of talents, motives, and abilities" (Bigliardi & Dormio, 2009, p. 9), and so the organisation should take it in consideration while managing researchers, such as better placement decisions (Schein, 1985).

According to Bigliardi & Dormio (2009), "The career anchor is significant because it influences career choices, affects decisions to move from one job to another, shapes what is being looked for in life, determines an individual's views of the future, influences the selection of specific occupations and work settings, and affects employees' reactions to their work experiences." (Bigliardi & Dormio, 2009, p. 10).

Thus, as stated by Igbaria *et al.* (1999), scientists may have "different values and pursue different types of careers" (Igbaria *et al.*, 1999, p. 31) though as mentioned by Aryee (1992), career behaviours do not always follow conscious and rational behaviours, and it could be a haphazard process responding to career opportunities (Aryee, 1992). Furthermore, as stated by Bigliardi & Dormio (2009), individuals may have more than

one anchor, but usually, one anchor dominates in the career decisions of the individual (Bigliardi & Dormio, 2009), and though the anchors may function as stabilising forces, they may evolve through occupational and life experiences (Petroni, 2000b).

The career anchor question leads to the person–environment fit and work adjustment, suggesting that organisations, namely human resource management, should take into account not only the organisational but also the individual interests and motives to "encourage productive career decision making" (Igbaria *et al.*, 1999). In order to guarantee one individual career success, there should be congruence between individuals' career values and the demands of the work context (Chen *et al.*, 2003), and individuals and organisations should be able to recognise "the variety of legitimate ways to run a scientific career" (Mallon *et al.*, 2005, p. 406). Mallon *et al.* (2005) remark that "In general, most people saw a reasonably limited role for the organisation in actively managing their career beyond the existence of pathways." (Mallon *et al.*, 2005, p. 404). This is reinforced by Bigliardi & Dormio (2009) when they state that "Traditional career theories are becoming outdated as the hierarchical pyramids on which they are based." (Bigliardi & Dormio, 2009, p. 9).

Organisations need to recognise the values of its employees and design appropriate career routes, opportunities and reward systems (Cabral-Cardoso *et al.*, 2003; Petroni, 2000b; Bigliardi & Dormio, 2009; Igbaria *et al.*, 1999; Mallon *et al.*, 2005; Chen *et al.*, 2003). Moreover, the career development system should be clear and widely communicated, namely the types of career available, and duly integrated in the business strategy (Aryee, 1992). Additionally, as mentioned by Petroni (2000b), "RD&E professionals should be introduced to the concept of career orientation and be encouraged to explore their values and aspirations and to recognize the importance of a match between career orientation and job setting." (Petroni, 2000b, p. 60).

In terms of careers, by referring to an "hybrid career system", Bailyn (1991) considers that a scientist should know his career anchor as it is crucial for satisfactory career progress, having the opportunity to get experience with diverse career paths in order to ensure self-understanding and guarantee a sense of satisfaction in his career route (Bailyn, 1991). Other authors consider that R&D professionals should be encouraged to diversify, avoiding overspecialisation that can lead to obsolescence (Blume, 1974).

In Petroni's opinion (2000b), R&D professionals should have the opportunity of getting feedback from their supervisors on an ongoing basis, discussing their needs and values and having a real possibility to establish a career route (Petroni, 2000b), knowing that it may change or evolve along the years and that the organisation will have to ensure flexible programmes and change job content to accommodate different employees (Igbaria *et al.*, 1999).

For Aryee (1992), individuals need to be proactive in the management of their careers, continuing education to maintain their technical currency, and in others cross-functional ones (Debackere *et al.*, 1997), but also ensuring their personal development (namely in soft skills) (Aryee, 1992). Furthermore, organisations should manage the human side as well as the technical side of R&D (Igbaria *et al.*, 1999) and the other spheres of the worker's life should be taken into account while designing the career programmes (Mallon *et al.*, 2005).

Organisations should also permit lateral career movement of staff members since this variety of experiences is likely to help individuals gain a clear and stable self-concept, benefiting the firm that can be able to determine the strengths and weaknesses of R&D professionals sooner, and thus know the positions for which they are best suited (Igbaria *et al.*, 1999). Only by guaranteeing the compatibility between career orientations and job settings, in different career stages, there will be job satisfaction and organisational commitment (Igbaria *et al.*, 1999; Chen *et al.*, 2003).

In the early stage of the R&D career, focus should be on training in order to continually reinforce the knowledge necessary for a good job performance (Chen *et al.*, 2003). Appropriate career development programmes should also be offered including the provision of on-the-job training and the implementation of professional development training (Chen *et al.*, 2003), as well as the design of appropriate rewards and motivational systems and initiatives for interpersonal relationship, counselling and guidance (Chen *et al.*, 2003).

According to Chen *et al.* (2003), each stage of a career has different needs. One way to ensure effective career development programmes and to boost job satisfaction is that R&D managers and human resource managers cooperate in an ongoing basis, trying to understand the needs of researchers and revise the programmes according to their needs

(Chen *et al.*, 2003). So, as mentioned by Kim & Cha (2000), HRM must go beyond the rank and salary level when managing R&D professionals. The authors even suggest different performance appraisal criteria and reward structures according to each career route (Kim & Cha, 2000).

As for the specific question of rewards, various authors stress the importance to adapt the reward system to the career route chosen (Petroni, 2000a; Kim & Cha, 2000; Ángel & Sánchez, 2009). Von Glinow (1988) considers that five key rewards can be categorised, and they are financial, prestige or social status, job content, career, and professional (Von Glinow, 1988). The prestige rewards help the worker earn the respect of other people in the organisation. The job content rewards motivate the worker with the "work itself" rather than with external outcomes of the job. The career rewards enhance personal career development opportunities and include namely promotion, job transfer and entrepreneurial opportunities. The professional rewards include the worker's professional abilities, giving him namely opportunities to present research outcomes to peer professionals.

According to Ángel & Sánchez (2009), apart from career development, job rotation and compensation, in R&D contexts, a special attention should be paid to the recruitment policy, the degree of delegation and managerial support, networks and multidisciplinary teams (Ángel & Sánchez, 2009). In the integration and socialisation part, and in order to help the newcomer, some information about the existing networks and sources of information in the organisation, as well the distribution of resources and the paths of access to them may be a good start (Bailyn, 1991).

The organisational culture is also an important aspect. The set of dominant values have major effects on employee morale and need to be adequate to the intrinsic values of the R&D professionals (Préfontaine *et al.*, 1994). Namely, the organisation must try to increase the scientist's organisational commitment by catering his intrinsic value at work (Chen *et al.*, 2003), through extensive socialisation and realistic job previews, and signalling the accepted and rewarded behaviours inside the organisation (Aryee, 1992).

According to Préfontaine *et al.* (1994), "Training is undoubtedly one of the most important mechanisms firms adopt to better integrate new employees and update their competencies and know-how." (Préfontaine *et al.*, 1994, p. 5). Training is even more

relevant in R&D institutions where there is a need of continuous update and upgrade in technical and scientific knowledge (Préfontaine *et al.*, 1994). As seen *supra* in our text, and as suggested by various authors (Edwards & Smith, 2009; Zalevski & Swiszczowski, 2009; Ángel & Sánchez, 2009), R&D professionals should also receive training in soft skills, combining personal, interpersonal and organisational skills, in order to improve the "work readiness", especially of the young and freshly graduated (Edwards & Smith, 2009).

Finally, R&D professionals are more attracted to flat organisations, with reduced hierarchical levels and bureaucratic tasks and to some degree of autonomy in order to pursue R&D activities (Cabral-Cardoso *et al.*, 2003).

Chapter 3. Methodological considerations

3.1. Research justification

From the literature review, we then conclude that, in Portugal, young scientists mainly develop their activities in public or non-profit organisations rather than in industry. As seen, the phenomenon can be explained by the researcher's natural tendency to prefer academia or non-profit organisations that are more in line with his values and guarantee him more autonomy and freedom. As for the industry, being predominantly small sized in Portugal, it lacks the understanding of the advantages in recruiting employees with a scientific profile, preferring more flexible workers, more adjusted to the company's culture. Finally, in some authors' opinion, even academia contributes to the problem by not properly preparing students with diverse and transferable skills in order to ease the transition to the labour market.

As a consequence of the young scientists' focus on public or non-profit organisations, some pressure on the job market happens and an erosion of the working conditions occurs. Scientists obtain limited prospects for career progression, trapped in temporary and insecure positions. Many become part of a network organisation between university or non-profit R&D institutions and industry. The latter benefit from R&D activity through collaborative research projects with the former and in which the young postgraduates and graduates are used as cheap scientific labour.

Since the future of these young scientists can be decisive to the future of science in Portugal, we believe it is important to understand if those young promising scientists are being properly managed, making sure that their post-graduation or exclusive dedication to scientific activity have the maximum return for them and overall for society. Thus, the aim of this study is to examine the current career paths of junior researchers in non-profit R&D organisations and to examine whether their needs or expectations can be answered by their host institutions.

The need for this better understanding had already been identified by some authors. As mentioned by Hakala (2009), there is an urgent need for studies that explore "the identities and socialization processes of junior researchers in different types of academic research environments and in different national contexts" (Hakala, 2009, p. 188). Chen *et al.* (2003) and Mallon *et al.* (2005) recommended further research on more

compatible career development programmes and the diverse dimensions of career needs should be done, namely broadening the study to new types of research institutions, and not just in industry (Chen *et al.*, 2003; Mallon *et al.*, 2005). Furthermore, Lam (Lam, 2005; Lam, 2007) considers that the effects of network organisation as a new mode of innovation on researchers careers are not so much analysed, thus future research on these effects and the consequent career arrangements is needed.

Essentially, this study intends to pursue the following specific objectives:

- Collect information about the careers of junior researchers in electrical engineering in non-profit R&D organisations, their prospects and needs;
- Examine the current support these young scientists are receiving from their host organisation;
- Uncover specific management practices, namely in the human resource area, that may be beneficial to young scientists beginning their career.

3.2. Research methodology

Once defined our research topic, an empirical work was settled in order to explore it (Silverman, 2000). Therefore, an appropriate methodology had to be found.

The choice of a useful methodology is critical, since as mentioned by Morse & Richards (2002), "It is the lens provided by a method that enables abstraction from data, the emergence and construction of theory about the data, and the linking of the results to the literature and other theories." (Morse & Richards, 2002, p. 59). By analysing the methodologies of the studies in our literature review and the references of several authors (Marshall & Rossman, 2006; Morse & Richards, 2002; Silverman, 1993), qualitative methodology was considered the more useful approach.

Qualitative research is, as stated by Marshall & Rossman (2006), a "research that delves in depth into complexities and process; research on little-known phenomena or innovative systems." (Marshall & Rossman, 2006, p. 53). Since not many academic studies about this research topic were produced, we therefore believe that it is the most appropriate methodology to use in order to explore new understandings (Morse & Richards, 2002).

Moreover, qualitative methodology is best suited for a study as ours in which the study focuses on individuals' lived experiences, where the context and the references of the participants are relevant (Marshall & Rossman, 2006). Through this methodology, we aim to explore and reveal junior researchers' understandings about their career needs and prospects, from their own points of view.

The strength of this qualitative study is to stress the importance of context and participant's frame of reference, gaining meanings that would be lost if the findings were to be reduced to numbers (Morse & Richards, 2002). As for the disadvantages of the methodology, they are mentioned in the Section 3.6 as well as the attempts to minimise them.

3.3. Sample selection and characterisation

Since one cannot study the universe, namely every junior researcher aspiration and experience in Portugal, an area of science and a sample of population had to be selected.

Due to time and distance constraints, our site selection was restricted, from its beginning, to the North of Portugal. Electrical engineering was the area of science chosen due to convenience reasons but also because of the recurrent and institutionalised collaboration between academia and industry in this area of science, through collaborative research projects in which several junior researchers participate, and therefore that may provide richer and more diverse experiences.

As for our sampling strategy, our first concern was to find a sample of junior researchers, with reasonable variation in the phenomenon and that would be fairly accessible (Marshall & Rossman, 2006). Initially, it was our intention to interview several junior researchers in electrical engineering from different non-profit R&D organisations in the North of Portugal, in order to capture an overall picture and the diverse realities. However, there was a risk that the different organisational environments and management practices could cloud the analysis and the comparison of the prospects and intentions of the young researchers. Therefore, and in order to avoid that kind of interference, a population from a single organisation and subject to the same management conditions was chosen.

Concerning the non-profit R&D organisation, a choice between university and an institution exclusively dedicated to R&D had to be done. The university option was discarded in favour of an institution exclusively dedicated to R&D for two reasons. The first one is that in what concerns R&D contracts and collaborative projects, these research centres are preferred to universities by researchers (Cabral-Cardoso *et al.*, 2003), thus potentially providing more varied types of R&D facilities and new combinations in public-private partnerships (Howells, 2008). The other reason is that in these R&D institutions, junior researchers have connections to the institution exclusively as R&D workers while at university, besides R&D workers they might also be students so there was a risk that their statements might be contaminated by this dual connection.

There are different types of R&D institutions exclusively dedicated to R&D. These research centres are usually considered very positive as they are a place where "problem focused research amenable to application" can be undertaken (Boardman, 2006). Boardman (2006) states that "(…) university research centres have been shown to provide numerous benefits. They aid industrial partners, if they have them, by way of increased patenting and research, enhanced access to students for potential hire, enhanced access to "upstream" modes of knowledge, and also by way of technological problem solving and competency building. Centres benefit the university scientists who affiliate with them as well, through increased opportunities for research, enhanced access to industrial research partners, enhanced access to resources (including funds, equipment and infrastructure, and collaborators), and also by offering an opportunity to "do good" for society." (Boardman, 2006, p. 3).

Generally, these types of hybrid organisations generate a permeable boundary between firms and universities, "it seeks to integrate the business and science systems within a single organization in order to facilitate knowledge exchange." (Lam, 2005, p. 267). According to Boardman (2006), these centres enable university scientists to "act as entrepreneurs and explore the commercial potential of their projects" and "act as consultants and "transfer agents" towards firms' representatives (Boardman, 2006). Inevitably, these new challenges constitute a new pressure on faculty members' lives demanding more diversified activities and consuming more time and energy. As mentioned by Boardman & Bozeman (2007), when organisations become more

complex, the lives of the actors within get more complex too, with additional roles for both of them (Boardman & Bozeman, 2007).

For all these reasons and due to its dimension and long-time outstanding reputation too, one specific non-profit and private R&D organisation, located in the North of Portugal was selected. With the status of Associate Laboratory, the institution acts as an interface between the academic world and industry. Its activities range from research and development to technology transfer, consulting and advanced training. With more than five hundred staff (at the time of the empirical work, though since then, it has increased), it was considered a large and accessible site where a sample could be found. For confidentiality purposes of the participants interviewed, the institution is referred to as "TECH1" in this study.

As for our population, and as in most other studies of this nature (Marshall & Rossman, 2006), the research first began with a convenience sampling, a non-probability sampling technique where participants were selected because of their proximity and accessibility, and therefore a good way of accessing the population. Afterwards, through snowball sampling, namely by asking to previous interviewees other suggestions of names, other cases of interest were identified.

Our sample was restricted to individuals, male or female, graduated in electrical engineering, at the time performing research in his/her field of expertise. Being researchers, most of them would be doctorate holders or doctoral students, but, since some career paths could be less academic in those types of R&D institutions, we decided that our sample would also include individuals that would be doing research while holding only a University Degree or a Master of Science. In order to guarantee a more representative sample, the author tried to guarantee interviewees from different areas of electrical engineering, with different status and link to the institution (grant, contract employment or faculty).

The age limit to be considered "young" or "junior" in this study, and consequently eligible for our sample purposes, was fixed to thirty-five years old. To determine this age, we considered the years necessary to conclude a doctorate and to be at an early stage of a R&D career. The decision about the age limit was supported namely by

Eurostat's Dataset "Doctorate holders by sex and age group" in the theme of "Science and Technology", whose first age group, in an ascending sort, was "Less than 35 years" (Eurostat, 2012), with the slight difference that, in our study, the age of thirty-five years was an inclusive age in the present sample. A brief characterisation of our sample is synthesised in Table 1.

Table 1 - Characterisation of the sample selection

Age	Sex	Qualifications	Ongoing Training
33	Male	MSc	PhD
30	Male	MSc	None
30	Male	MSc	None
27	Male	MSc	PhD
35	Male	PhD	None
27	Male	MSc	PhD
34	Male	MSc	PhD
35	Female	BSc	PhD
33	Male	MSc	PhD
31	Male	MSc	PhD
28	Male	BSc	PhD
32	Male	BSc	None
31	Male	BSc	PhD
26	Female	MSc	None
26	Male	MSc	None
26	Male	BSc	MSc
27	Male	MSc	None
28	Male	MSc	None
31	Male	PhD	None
35	Male	MSc	PhD
24	Male	MSc	PhD

3.4. Research technique

The semi-structured interview was found the most appropriate data collection technique (Morse & Richards, 2002). Semi-structured interviews are characterised by open-ended questions developed in advance and "arranged in a reasonably logical order, to cover the ground required. Usually, the interviewer will ask the same questions to all participants, although not necessarily in the same order, supplementing the main questions with either planned or unplanned probes." (Morse & Richards, 2002, p. 94). Suited to novice interviewers, such as the author, this technique offered the comfort of

preplanned questions, though maintaining the challenge of presenting the questions in ways that invited to detailed answers and let the interviewee get naturally and openly as possible to the themes (Morse & Richards, 2002; Quivy & Van Campenhoudt, 2005).

Following recommendations in the literature (Albarello *et al.*, 1995), several attempts to guarantee the quality of the data collected were undertaken. In each interview, the author introduced herself and the purpose of her study. Previous consent to audio-record was always asked, justifying its need with data analysis. Anonymity was guaranteed to each interviewee, and it was ensured that the institution name would also not be revealed in order to avoid any recognition of the researchers. Moreover, interviews took place in calm, reserved meeting rooms and at times were the interviewees would not feel rushed. All these efforts were done in order to establish a trust climate for the interviews and the minimisation of the interpersonal and social context.

Before the interviews, an interview guide was elaborated and it is presented in Appendix 1.

The first part inquired some personal information about the interviewee such as age, qualifications, the duration of his collaboration in the institution, his career path since his graduation. The collection of this information served the purpose of a smooth introduction in the interview and the posterior characterisation of our sample.

In the second part of the interview, questions related to human resource management aspects and the R&D career management specificities were asked, namely about recruitment/selection, integration/welcoming, culture, training/development, career management, performance management, compensation and phasing out. These areas were mentioned in the literature as areas in which the management of R&D professionals had some specific aspects involved. The objective of this part was to inquire the perceptions interviewees had about their career path and prospects. Moreover, the other purpose was also to verify if the interviewees had some awareness about human resource practices and if they were applied to them.

Finally, one important purpose was to detect needs felt by the interviewees that could be fulfilled by changes in the human resource management.

The third and last part of the guide asked more global and open questions about the scientific career in Portugal, the role of R&D institutions in the economy and science

and the role of the human resource department in these institutions. The aim of this part was to gain some distance and abstraction on the subject globally and therefore to uncover more personal inferences and foster parallel developments on the subject from the interviewees.

The first interview worked as a test to valid the running of the interview. The duration and rigid following of the questions in the first interview showed a need of some adjustment of the novice interviewer. Benefiting from the gradual experience, in other interviews, some fluidity and flexibility were gained. Thus, each interview was different, questions asked in different order, or not asked; therefore, other questions, not mentioned in the guide, were also enquired, following the natural flow of the conversation.

Portuguese language was chosen to conduct the interviews, since it is the native language of all participants and, thus, the communication of deeper thoughts, feelings and beliefs would be easier than in a foreign language.

At the beginning of each interview, the interviewees were informed of a pre-seen duration of fifteen to twenty minutes, but always with the possibility that it could take longer according to the interest of the interviewee. The average duration of the collected interviews was thirty-one minutes and fifty-five seconds.

Twenty-one interviews were conducted to nineteen male researchers and two female researchers, from July to November of 2011. The imposing number of men versus women in our sample reflects the greater number of the former in the R&D institution itself, and, overall, in the science field of electrical engineering.

At an early design, only twenty interviews were planned. In fact, indicators of saturation were looked up at the end of the twentieth interview, showing the replication of data and the verification of facts by several participants, giving confidence that adequate data had been obtained and the collecting process could stop (Morse & Richards, 2002). However, the opportunity to interview a junior researcher simultaneously collaborator in the R&D institution and member of an association of grant-holding researchers supporting better conditions for young scientists, was seen as an additional interview worth to be included in the present study.

As for the storage of the information, only two audio-copies of the collected interviews remain, stored in a CD-ROM and in the author's computer. In preparation to a systematic analysis, the six hundred sixty-three minutes of interviews were transcribed. The transcriptions are identified by numbers, and the names of the interviewees were erased for anonymity reasons, being replaced in the present study as Interview 1, Interview 2, Interview 3, etc. Since names (companies and individuals), places and events were contained in the transcriptions, being easily connected or identified, the author decided not to attach the two hundred ninety-eight pages of transcriptions to the present research work.

3.5. The content analysis

According to Quivy & Van Campenhoudt (2005), "In social research, the interview method is always associated to a method of content analysis." (Quivy & Van Campenhoudt, 2005, p. 195). As an unobtrusive technique, it allows the analysis of "relatively unstructured data in view of the meanings, symbolic qualities, and expressive contents they have and of the communicative roles they play in the lives of the data' sources" (Krippendorff, 2004, p. 44).

Therefore, once the text of the interviews was transcribed, the analysis process started through an immersion in the data, by several readings (Albarello *et al.*, 1995). And since systematic, informed and verifiable inferences had to be drawn from the text, the coding technique was chosen to analyse the text.

According to Ole Holsti (1969), "There is no "best" method of coding which can be applied to all research questions." (Holsti, 1969, p. 94). Coding is the strategic process that transforms and aggregates diffuse and messy data into organised units which permit precise description, analysis and comparison of relevant content characteristics (Holsti, 1969; Krippendorff, 2004; Morse & Richards, 2002).

In this study, diverse types of coding were used simultaneously. Morse & Richards (2002) consider three kinds of coding: "The first is the storage of information, sometimes termed descriptive coding. The second is coding in order to gather material together by topic. And third is the coding used when the goal is the development of

concepts (analytic coding)." (Morse & Richards, 2002, p. 112). In the present study, coding became more analytic as the coding for categories went on.

"Coding generate categories." (Morse & Richards, 2002, p. 132). A category is a concept through which a reality existing in the collected data can be nominated. As mentioned by Ole Holsti (1969), "categories should reflect the purposes of the research, be exhaustive, be mutually exclusive, independent and be derived from a single classification principle." (Holsti, 1969, p. 95).

In this study, the starting point for the initial coding was based on the topics of the interview and the related literature read earlier, avoiding any incorporated assumption or "fishing expedition" (Holsti, 1969; King, 1998; Krippendorff, 2004; Marshall & Rossman, 2006). A previous test on the two first interviews was made in order to valid the set of categories. Since the coding hypotheses were confirmed, the set of categories was applied to the rest of the data corpus (Silverman, 2000).

As recommended in the literature (Albarello *et al.*, 1995; King, 1998; Morse & Richards, 2002), the process of development of categories stopped when new information only confirmed the existing one, leading to a level of saturation of information and that no section of the text clearly relevant to the research remained non coded. As stated by Morse & Richards (2002), "It is saturation that provides the researcher with certainty and confidence that the analysis is strong and the conclusions will be right." (Morse & Richards, 2002, p. 174).

As suggested by some authors (King, 1998; Morse & Richards, 2002), codes were organised hierarchically, with groups of similar codes together, conceptualised as a treelike structure. First, content analysis started through coding interviews contents in the following categories: "recruitment", "welcoming/integration", "culture", "autonomy", "time schedule", "training", "competencies/added-values", "career orientation", "career", "performance evaluation", "compensation", "other supports", "networking", "phasing out", "the scientific career in Portugal", "the role of interface institutions" and "the role of human resource department".

However, during the analysis of the data and the writing of the dissertation, some categories were modified and evolved furthermore. The final structure gives special relevance to "career management" category - enclosing parts of the former category

"career orientation", and the category "careers", "the scientific career in Portugal"– and to a new category referring to "motivational and reward system" which merged and rearranged the former categories "autonomy", "time schedule", "competencies/added-values", "compensation", "other supports" and "networking".

According to Nigel King (1998) and Marshall & Rossman (2006), this approach is in between the content analysis and other standardised strategies where all codes are predetermined and grounded theory or other immersion strategies where no codes are defined *a priori* and categories rely mostly on the researcher interpretations (King, 1998; Marshall & Rossman, 2006). Regarding disadvantages, Nigel King (1998) mentions the lack of substantial literature on the technique, compared to others such as grounded theory or discourse analysis, which can leave novice researcher with a lack of guidance leading to too simplistic analysis to allow any in-depth interpretation, merely allowing a description of the data, or, on the contrary, results too complex to allow any analysis (King, 1998)

3.6. Criteria of soundness

According to the literature review (King, 1998; Morse & Richards, 2002), reliability and validity are determined differently in qualitative research than in quantitative work, although determining them must remain the qualitative researcher's goal.

In simple words, "reliability requires that the same results would be obtained if the study were replicated, and validity requires that the results accurately reflect the phenomenon studied." (Morse & Richards, 2002, p. 167). In this research, following the recommendations of Morse & Richards (2002) for qualitative researchers, the concepts of reliability and validity were replaced by the aspects of "truth value" that are the "credibility" of the inquiry, the "applicability" which is the transferability of the results and the "consistency" that is the dependability of the results (Lincoln & Guba, 1985 *in* Morse & Richards, 2002).

In order to ensure the credibility of this study and to demonstrate the appropriate elaboration of the inquiry, every decision in the research work is described, justified and documented in the present dissertation. Namely, the preparation of a sampling design that reduced data to manageable proportions, the operational definition of consistent

categories, the identification of boundaries and limitations of the study, the choices about the research design and the theoretical framework were all efforts made in that sense.

As for the transferability of results, or the possibility of replication of the study, again, our attempt is to describe as thoroughly as possible our research in order to allow others, with this information, to try to replicate the study in other circumstances and another population in spite of the fact that reality is never fixed and unchanging (Morse & Richards, 2002) so results may, in fact, vary and, this study being exploratory, it aims at searching for new ideas and solutions rather than generalisations.

Finally, as for the dependability of the results, which tries to capture the traditional concept of objectivity, our attempt was to implement strategies that tried to limit any bias in interpretation. As it is well known, in qualitative inquiries, data is made in a collaborative and ongoing process, negotiated through the interaction of the participants and the study researcher (Krippendorff, 2004; Morse & Richards, 2002). Furthermore, the fact that the area field was familiar to the author, it could bring the disadvantage of some "insider's taken-for-granted assumptions" that might have interfered in the research (Morse & Richards, 2002). In order to minimise theses interferences, diverse strategies were undertaken.

First of all, at the moment of the collection of data, the author made efforts to ensure that her mandate was clear to the participants, namely who she was, what was studied and what was going to be done with it (Albarello *et al.*, 1995).

Secondly, when examining data, there was a clear conscience that the data collected corresponded not to actual or neutral events but to representations or reports of events formulated and that would have to be interpreted in their context (Morse & Richards, 2002). Any analysis was grounded in the previous literature while checking the data and examining possible explanations (Marshall & Rossman, 2006). Additionally, constant comparative method was undertaken in order to test out provisional findings inside one single case, between cases, or by actively seeking and addressing possible deviant cases that would strengthen the research (Silverman, 2000).

Finally, one other limit of our study is related to the nature of transcribing and translating, since they contain inherent judgements and interpretations of the study researcher.

Following recommendations in the literature (Marshall & Rossman, 2006), a scrupulous transcription of the twenty-one interviews was performed, including every word spoken, every change in the discourse, every silence (marked by suspension points). However, due to the lack of experience of the author, when analysing the data, no second-degree interpretations were made about silences, exclamations or hesitations, considering as data material only the ideas conveyed clearly by the meaning of words. There is a conscience that this option might have limited in some ways the depth of the analysis but it was seen as the most prudent step in order to limit the possible interference and judgement of the author.

As for the translating issue, in order to render the more accurate meaning, some words or idiomatic expressions from Portuguese language were transcribed and between brackets (Marshall & Rossman, 2006).

Chapter 4. Findings and Discussion

In this Findings and Discussion Chapter[2], we present the main findings collected on the careers of the junior researchers in electrical engineering that we interviewed, namely in order to assess their career needs, challenges and prospects. Subsequently, based on the findings, this chapter suggests some specific human resource management practices in order to support them in the beginning of their careers.

4.1. Junior researchers' perceptions of their careers

4.1.1. Clear career orientations

Our first attempt through this research was to collect sufficient information about our interviewees in order to have a clear picture of their current professional situation and to confirm if the different characteristics found in our literature review were also verified in our sample.

The first point identified is that interviewees have a dominant career orientation that was decisive in their choice in entering the scientific career. As seen in the literature review, researchers' career choices are influenced by their career anchors or career orientations. From our responses, most of the interviewees know their career orientation, with a clear presence in our sample of orientations towards academia, industry and pure research. Some interviewees also refer to entrepreneurship.

> *"Many people end up arriving with an orientation about their future. They already know what they want; they want a research career and/or lecturing." Interview 3*

> *"I think that here academia isn't much separated, so it's more or less what I want. Like it happens in many countries, most of researchers are university professors or they are students." Interview 10*

Nevertheless, many of them show flexibility, in principle, in following other career options, namely when confronted to the difficult labour market or as their career anchors evolve with their life experiences.

[2] According to Chris Hart (2009), when the research is executed through interviews, the chapter of findings, its analysis and discussion can be merged in the same chapter. Thus, this chapter intends to present the main findings of the research, as well as analyse and discuss them (Hart, 2009).

"I don't know, possibly… I see myself as a researcher, exactly, now moving maybe more to another study area, project management, project coordination." Interview 1

"It's like this: my first idea would be to go to industry. That was before I arrived here. Right now, as I see that, here, it is not just academic, it also has a business orientation, I'm a bit in doubt… Well, it will depend on how things go." Interview 15

For many of the junior researchers interviewed, entering the research world was more the result of an opportunity to work in an environment between the academic world and industry, a first step in the labour market.

"It wasn't exactly, it's not like I took right at the beginning the option of an academic career, it was a first step. And the option came up later; later I started to think better, about the future and thinking that, in fact, maybe it is the path to follow. So, it was more the contrary, first I saw myself in the scientific career and then I thought that maybe it was a good path." Interview 13

Many junior researchers saw themselves first as researchers and only later realised that it could be a desirable path. The host institution is a place where they can still feel the values of academia, to which they are well acquainted, and pursue a research career that they could not follow if they would have gone to industry.

"But, let's say, the opportunity to go to TECH1 as a grant holder came up, and already with the perspective of starting the PhD the following year, and so I thought it was better to follow that way. Because, if I would have gone to a company, I would never have reached the career that I imagined I would have liked to follow." Interview 19

Many interviewees would like to pursue a career in academia, being a faculty and doing research as a complementary activity. However, as seen in our literature review, the opportunities for doctorates or PhD students to work in academia are rarefying, making it difficult for junior researchers to find career opportunities.

"I still have one foot in academia, I like it a lot, lecturing, etc. But I have no guaranties on that aspect, that is, I don't have guaranties of having… of being employed in a more definitive way. Right now, I am under a contract and so, I can't put all my eggs there, isn't it." Interview 7

For the researchers who have not abandoned the idea of pursuing a career in academia, research is an activity that they have to maintain, thus this activity is a way to keep close to the path they initially wanted. For others, research is a valuable alternative that might keep them in a more academic environment.

> *"If it was at a personal level, I think that, maybe, it would be more academic, on one hand. On the other hand, right now, the availabilities are very scarce in that type… in academia, and the type of things that are already asked in academia, they are discouraging..." Interview 20*

> *"So, the idea of being simultaneously doing research and lecturing pleased me, the typical university professor. But it's just that, lately, lately in the last two-three years, things worsened in the lecturing field, and so, now I am seeing… I am directing all my efforts to research." Interview 19*

Hence, we can conclude that the junior researchers interviewed have a clear notion of what their career orientation is, mainly varying between academia, research and industry. In all the cases, the passage through their current R&D experience is valued as an appropriate step in their career, may it be as a transitory or complementary activity to a lecturing activity, a way of getting acquainted to the research activity as a future and exclusive path or as a *curriculum* valorisation before moving to industry. As we will see further ahead, this clear notion is a valuable aspect that should be used in improving the management of their careers.

4.1.2. The PhD degree dilemma

From our research, a dilemma that might have relevant implications in future career decisions was identified. The decision of continuing their studies for a PhD is a difficult decision that many Portuguese junior researchers have to take. If junior researchers do not choose to do a PhD, their careers in academia will be compromised. However, due to the rare opportunities available in academia, they might have to renounce to academia afterwards and turn to industry, having spent several years getting a degree and a super-specialisation not valued by industry and arrive to the labour market overqualified and "aged".

"Well, initially, I didn't even intend to start a PhD (laughs). Because… for several motives. My vision of a PhD was exactly this, that it is… training mostly oriented to an academic path, and… and it wasn't my vision of my future. I imagined that I would be here for some years and then I will pass to a company, or… (…) And my dilemma is: I start from zero and waste everything that I have done until now or I invest in a PhD and I deepen what I have done? And after reflecting, harm for harm, I'm not that young anymore, let's do the PhD." Interview 9

"Yes, because, what I see too, I already considered many times… obviously when I got back here again, the proposal that they made me was: "Why don't you start a PhD?". But, the question is that I have thirty-three years, that's why I say my case is special, so thirty-three years, doing the PhD in four, if things go well, I am thirty-seven. That psychological boundary in the labour market, when I would leave, I would practically…" Interview 12

This dilemma, either already solved or still being faced is found in almost all interviewees and is very important in management terms. Junior researchers tend to have difficulties in taking this decision since they themselves have difficulties in seeing their future, due to uncertain work relations or the intense and competitive research environment.

"Actually, one of the reasons I stayed so much time at TECH1 is that this has always been an indecision for me. Because, in fact, research is an area where there are a lot of very valuable people, it's a very competitive area, it's complicated, someone may take the chance of getting a PhD and doesn't… and then have no opportunities. (…) So, in fact, I don't know what it will bring me… I mean, it will bring me some value, obviously, of course it brings value but afterwards, I don't know, nothing is sure anymore, that is, it's not such a sure career as going to a company, and okay, you know what to expect." Interview 17

Besides the lack of alternatives, junior researchers feel that by choosing to pursue PhD studies, they may become too old for a career or environmental shift once it may become desirable or inevitable.

"If I don't do it, I think that my continuation in this environment will be more fragile, because at the end, while a PhD closes doors in the industry, here, I think it is the

contrary, I think it opens them, in order to give lectures and everything else." Interview 18

"However, I think that really the career isn't much praised and above all, PhDs, if I look at for example the industry, the relationship with industry, there are few institutions, unless multinationals, that value really a PhD, isn't it." Interview 1

In the "regular cycle of concerns" of junior researchers (Akerlind, 2005), this aspect is one of great relevance. Thus, management should take into account this dilemma in the career management and counselling process of junior researchers.

4.1.3. The "less sticky employment relationships"

Dedicated for some years to a R&D activity, we search for the interviewees' perceptions about the research career in general. Many interviewees do not believe that there is actually a scientific career in Portugal outside a temporary or complementary activity.

"There is no such thing as scientific career. You can make a career in research, until the point where it ends. In other words… It's like doing a career as a singer, until you sell records, from the moment you stop selling, then you are no more a singer." Interview 4

"You speak of scientific career, if I am going to speak of a transitory component, transitory, that is, you are a scientist but then you go work to a company, or in parallel, in which you are a scientist but also a professor. But here there's not so much the concept of a researcher career." Interview 20

This scepticism about the research career can be explained by the fact that research is done almost exclusively in academia, as a complementary activity for university professors or a temporary activity for postgraduate students.

"But I don't know if in Portugal there is a defined research career. I think there might be a university professor career, and connected to it, there is a research career." Interview 2

As seen in the literature review, the early stage of a research career is characterised by a succession of transitory positions offering limited prospects for career progression.

> *"Yes, I didn't take long to figure out what could be the path, that is, in conclusion, grant holder, well you finish your MSc, the framing of my work was very good to do the MSc, but then, there isn't much to do here, the option is to get a PhD or else… or you can exploit commercially what you are doing, isn't it, and the fact of being integrated in a technology transfer process would be good too. But that's it, excepting this, there is not much choice." Interview 17*

> *"I think that the career of researcher in Portugal goes a lot through that scheme of: to have a grant, and the grant stops and maybe that person can go on with it if she will do a MSc. And afterwards, the MSc also ends, if there is nothing else, then we will go try the PhD. You just… (…) Sometimes, I use to say that we are postponing what is inevitable, that is arriving to a point there is nothing else…" Interview 4*

In many cases, the temporary research positions correspond to successive grants funded by public organisations or funded on "soft money", in Portugal as in other countries. For many researchers, there is a subversion of the primary goal of grants which should be advanced training, being often used to finance R&D or some specific activity.

> *"Actually, how are things abroad… From what I see abroad, they are not much better. But I think that here the main problem is how to drain the PhDs and this drain can't be only with the R&D institutes, faculties, universities. Industry will have to start absorbing and that's where there is the main problem. But, once again, I don't think it's just here I think there are more countries with this problem, I think it's a general problem." Interview 5*

> *"Ok, I am going to say something that is kind of bothersome but that is true, and that happens, that is: the grants, I think I am not giving any novelty, grants are being frequently a subversion of what they should be. The grant shouldn't be… it can serve to finance an activity of service providing, of a consultancy, or a work to a project. In other words, the grant should finance, supposedly, training as a PhD, like a… I think that there is a subv… and I think that in institutions like TECH1, probably this is being used in a more regulated form maybe, I don't know other cases, maybe it's much worse." Interview 12*

Recalling Melin & Janson (2006), the ones who stay in R&D may not be the best but the more persistent, due to the general discouragement with the existing types of employment bonds.

> *"The scientific career? Hmm… I think that it is complicated. This question of the bonds I think is essential. Really, to try that researchers stay connected through grants… There are people who accept, who continue but I think that it shouldn't be this way and, really, it is limiting a lot. And people, either they go abroad, or they give up the research career, or then, they try the professor career. And of course, being a professor, you always maintain a connection to an institute. You hear talking, you here sayings and you know that they are not hiring. And so, it becomes difficult, it isn't through the professor career, or a hired research career, it becomes difficult a research career here in Portugal, at least in these institutes." Interview 11*

As found in the literature review, the question of the precarious bonds in scientific research leads junior researchers to continue a student lifestyle while aging. These "less sticky employment relationships" (Lam, 2007) make them face problems with family formation and economic instability.

> *"No, I think it isn't easy, it isn't easy and it's kind of a bit discouraging. Normally, people that are in research, I'm not talking about me, but there are people that are in research and they are very good, they are very intelligent, and sometimes, they see themselves in a situation that isn't agreeable for them which is to be a grant holder. To be grant holder is nice, I mean, it isn't nice but it is acceptable when you are younger, but when you start to have other commitments and everything, and that you have to go to the bank ask for a loan, it's something that don't… Ok, and in fact, the scientific career in Portugal, I don't know how it is in other countries, but I think it's not very different. In fact, you need a lot of effort and a lot of work to get to… you need maybe… to make it in research, it's more than a regular work that someone has in a company." Interview 17*

The junior researchers interviewed showed great disappointment for remaining in a kind of limbo for so many years. Bearing in mind this uncertainty, many choose to delay their career decisions, specifically focusing on their PhD study or waiting for some new opportunities.

"Well, since the PhD is kind of a sword of Damocles hanging over my head, I, honestly, don't even think, I don't lose much of my time thinking about what will be the future. (…) So thinking about the future is to think in two or three years from now, more or less." Interview 13

"Well, I am currently in the PhD, I still have four years in front, and even I can't anticipate." Interview 9

In sum, we found that junior researchers have a more or less clear career orientation. However, and due to the shrinking research labour market they face some career dilemmas namely the decision to pursue their doctoral studies. In the end, they usually postpone their career plans for several years, with significant professional and personal implications.

Taking into account these findings, management can break this cycle by implementing some simple measures with no significant increase in costs but with a positive impact in the situation of young researchers, while benefiting the organisation itself.

4.2. The need for a strategy and long-term planning

When asked about their work relations with their current host institution, many refer to the difficulty of having another type of work relation than grants, namely employment contracts. However, junior researchers do not hold their host institution responsible, blaming instead the type of activity or the system in itself.

"Now, we need to think how this is sustainable. Because, in fact, it would be good, me being in the shoes of the person without rights that can't get sick. I… I can say: "Eih no, I think so, that people should have a lot of rights and they could I don't know what" but someone has to pay for it. And in companies, people know… what people do is converted immediately in money or… there is a strategy for what the person is doing at the moment will be converted in money some time later. And here it doesn't, here what we are doing, we don't know if and when it will be converted in money. So, paying this is very complicated." Interview 8

"Yes, the issue of stability is relevant, obviously, but I think that it doesn't depend of my institution. I think that the question of the contract, to have an employment

contract, it doesn't depend of the institution. (…) Because I know that the institution, TECH1 doesn't have the possibility of keeping the research that it has today, giving an employment contract to everybody. That is obvious. It's not up to the institution. If TECH 1 wants to give an employment contract to everybody, I mean… first there is the "figure" of research grant holder, and the funds that are given to TECH1 are given this way, TECH1 doesn't have another possibility." Interview 21

Hence, if employment contracts and more tenured positions are a solution that host institution cannot provide to their junior researchers, other positive changes could be brought in that would improve career aspects and the daily management of these researchers.

Many interviewees agree that if their host institution had a well-defined strategy, a long-term vision for these human resources and planned ahead their possible paths in the institution, it would contribute to minimise the uncertainty associated with the lack of career prospects.

"But, in that aspect, if there was a long-term planning of what are the possibilities that they will offer, so could we plan more easily." Interview 13

"But above all, to have a well-defined strategy and at long-term, I think it is often not clear in this type of institutions." Interview 1

"I think that what is missing is a long-term strategy… a long-term vision in management or I don't know, at the higher strategic level of the country." Interview 4

Usually, junior researchers do not know what they will be doing the following year, as the projects in which they participate and that fund their grants have a short duration. Likewise, they know little about new projects under negotiation that may fund new career opportunities in the institution.

"What is lacking is a framework at the root, someone… For example, here a research grant, someone who gets it, and starts working, he has no clue what to expect next. And what should be necessary is: John Doe gets a research grant, the perspectives are these: if he does well, he can progress to here; with the years passing by, if he still does well, this can happen. What happens nowadays is not this,

they give him the grant, the grant has a specific period and at the end of this time, it closes." Interview 9

"Sometimes, I am more or less secure about my work, at least until my PhD is concluded, but I notice that some people live here with the worry of "what is going to happen to me next year?". So, there are people who would like to keep in research but since they don't know what is going to happen at the end of the grant, what they will do is: they will be searching in industry or somewhere else in order to have some guarantee." Interview 21

As a result, many junior researchers live in a permanent uncertainty, searching for some alternatives in case their grants do not get renewed. The recommendation is that the institution should develop long-term projects that would provide work to the young scientists for several years giving them some sense of stability.

"Another possibility is, somehow, there should be some information provided to us, a plan in a much longer term by TECH1 saying: "Right now, we have these projects, we plan to have these ones afterwards, so, in principle, you can continue working in this area or you will have to change to that area, in x or y years, etc." That could be a possibility." Interview 13

Therefore, our conclusion is that if it is not possible in the short-term to avoid the "post doc treadmill" (Edwards & Smith, 2010), in which young researchers cannot all have permanent and secure work relations, at least the institutions should improve their management practices. For example, by providing junior researchers with an opportunity to work in long-running research projects that would bring a positive change in their professional and personal lives.

4.3. The importance of communication

Associated to a better planning, there is also a need for better communication between the researcher and his management. Besides a better communication of the long-term strategy of the institution and the research group, allowing the researcher to have more control about his future, a regular communication and feedback would also be very positive in the opinion of junior researchers.

"I already had some conversations with the Unit director but very superficial ones, very superficial. And I confess that it is one of the things that bothers me because, once again, the feeling that I have is that even them don't know, even them can't anticipate the needs of the Unit." Interview 9

"It isn't clear, no…. There is a lack of transparency, not because of dishonesty but because of a lack of information." Interview 13

Through communication, a sense of transparency would emerge, allowing junior researchers to know what the host institution has to offer and what the expectations are. Communication could improve the relation between junior researchers and the institution, contributing to the alignment of the objectives of both parties.

"This, exactly, this is something that is missing maybe. People orienting themselves… Well, it is the first time that I am thinking about it, I don't know if the institution has to have this role of orienting people. I think there should be a clear relationship, between people and the institution, but the orientation… (…) No, it doesn't happen. But it is missing. At least, in order for the institution to know what it can expect from us and so that we can know what to expect from the institution. It would be very important in the relationship with the institution." Interview 21

A better fit between the individual interests and expectations of junior researchers and the organisational prospects could already be a great improvement in the lives and careers of junior researchers, as the literature recommends (Igbaria *et al.*, 1999). Only by the definition of realistic job previews and opportunities can junior researchers be able to prepare themselves to their future challenges, being more pro-active about it and there may be a match between needs of the person and the ones of the institution, as suggested in the literature (Bigliardi & Dormio, 2009).

4.4. The career planning

4.4.1. A specific career guidance

To provide some sense of long-term planning and open communication about the possibilities of development of their careers in the institution would be a great step to

support junior researchers. Some management practices could be adopted in order to help young researchers to plan careers, even if in another institution.

> *"Now, I think that it is very important that an institution has a career plan. Which is that we can know: ok, you are here, you can have this path, you can have another one, and be perfectly clear for people who enter, choose and direct themselves. However, they could change their perspective. Now, I think that the distance between the institution and the people ends up weakening both parts." Interview 21*

Junior researchers share the idea that many will not be able to pursue a career in their current host institution, and therefore they are unlikely to be retained. But the institution could help them get better prepared to face other challenges.

> *"Yes, for example in terms of career management, it would be interesting. I am not saying that, I mean, TECH1 has a clear philosophy that everybody knows, and I am not claiming anything, it's not, ok, grant holders, there is no career evolution in here, right. It's very rare. So, but I think that it would be important that TECH1 would have a more active career management, that it would try to orient people either this way or the other. We all know that we won't stay here forever." Interview 17*

Young scientists should be introduced to career orientation and encouraged to explore their values and aspirations and recognise the importance of a match between their aspirations and the job they have or want to pursue (Petroni, 2000b). As seen in the literature, they are left alone to sort out their problems since the conditions and role models are changing and the former researchers cannot show them the way since they have stable careers as faculty members or employment contracts as researchers (Hakala, 2009). Therefore, there is a need for new and different approaches to the career management of these junior researchers, from both the researchers and the host institutions.

> *"Hmmm… there is something that can, that can be made in this sense. I don't know if it's TECH1 mission to do it, but it's like that. There are a lot of people at TECH1 but it is temporarily, most of them. It is known, right? How many of us are going to stay and make a career at TECH1? Very few. How many will be hired? Very few. Isn't it? Now, there are more, and such, but because there are funds to encourage it,*

etc. One day it will stop, who knows, right? So, very few are going to make a career… typically, TECH1 is a place of passage for most of us. Ok? This said, since I am thirty-four and I'm still around and someday – I don't think so but – let's imagine that I already have difficulty in going somewhere. The human resource department can make some work, preparing the change, the exit of people from here when they finish their PhD and the placement in some companies of some recognition." Interview 7

This framework leads to a career management very distinct from the traditional one. The aim is not to retain the human resources but rather to prepare them to leave. In order to achieve this, the institution should create and widely communicate a variety of career routes, most of them leading to a new phase outside the institution, and personal development programmes (Aryee, 1992), with on-job-training, appropriate rewards and motivational systems, counselling and guidance, as recommended in the literature (Chen *et al.*, 2003), though in a logic of "prepare and launch" rather than retain. Thus, the career support activity, currently approached in a *ad-hoc* way should give place to a more structured career support that would not orient junior researchers exclusively to lecturing and research-only careers but also to other career routes and work environments (Akerlind, 2005).

4.4.2 The strategic network

Another idea that junior researchers propose is related to the active cooperation of their host institution with academia and industry that could foster interchanges and provide career opportunities to junior researchers, although outside its natural boundaries.

"Because, I don't know, for example, if there is a project… let's imagine there is a project that lasts two years, and that a person obtains a grant for that project which is for a company that hired that project to TECH1. At the end of the two years, what is... the grant ends and the person goes away. Now, nothing provides TECH1, knowing that this company at the end of the two years could be interested in hiring this person, so this interest could materialise. I already was in a project where the company said that the people… that it would have liked to have the possibility to hire the people who worked in that project. I think that this, TECH1 doesn't lose

anything, on the contrary, and, ok, this type of things is interesting, but perhaps, I don't know if it is possible. And it should be associated to careers, there should be people in charge for this." Interview 6

Thus, additionally to the work experience in the network, the host institution could work as a reference to the labour market and help them by the means of its wide networking in getting opportunities to pursue their careers, opening doors, both with its partners in industry and in academia.

"What it seems is that TECH1 opens doors to the contact to industry but it doesn't open doors to jobs in this industry. There might have exceptions. (…) I think that, I don't know if anyone does the management of its Unit in this paradigm, but I think that most of the directors will want to keep, at least, an essential nucleus of people in the unit. To do so, they have two alternatives, either they give a contract and a remuneration, a remuneration level that is attractive, that will allow people to have what is called a normal life and at the same time, a type of work that is attractive. Or then, they open doors in another place. What I have seen at TECH1, is that sadly, at least in the unit, and I can only talk for myself, neither one nor the other took place." Interview 9

It is interesting to note that the junior researchers interviewed are themselves craving for the existence of an "extended internal labour market" mentioned by Lam (2005, 2007) and Howells (2008) in the literature review, a pool of flexible scientific labour where industry could be recruiting already trained young workers for some short period of time in industrial collaborative projects.

"I think that it will be very positive above all because it is not certain that someone who gets out now from faculty and that will be a grant holder for one or two years, I am not talking in the cases of PhD students because, there, their perspectives are different but, someone that is here, (…), it is not guaranteed that maybe with the training that is acquired here, that sometimes is very specific to the projects that are being developed, it is not guaranteed that it will be an added-value in the labour market. Maybe it would be good if there was a work, maybe it would be a very good idea. Because, it ends up promoting the institution inside the companies and, I don't

know, some companies already know TECH1 and there are a lot of companies throughout the country that still have an idea…" Interview 12

Recovering Lam's ideas (2005), these linked scientists could also strengthen the network ties between academia and industry, reinforcing the inter-institutional research collaboration, so important for Portuguese economy.

"Another thing that could exist is an attitude of TECH1 of… I don't know, collectively, find a set of job opportunities in academia, that is, kind of a job fair, actually it's not really TECH1 duty but more of the faculty, of having there a central point, the faculty or the university, of having a central point of access where all the job opportunities in the faculty at this time, the future perspectives, etc. but it's more the faculty duty than TECH1. But even TECH1 could do something in this sense, TECH1 has more power than me by myself." Interview 13

"And then, if the grant holder or researcher, that is the student, would have interest in going to industry, or to the market, to the real world, the supervisor could be the right person to launch him and to establish the contacts. And there are projects in which the grant holder or the researcher, himself, is directly connected to the client, and here the bridge is more direct." Interview 4

Through the professional network developed by entrepreneurial professors, supervisors and the overall institution, junior researchers feel they could get more future career opportunities than just by themselves. Thus, they suggest that, associated to a clear career route definition, their host institution should have a more pro-active policy in helping them getting better career opportunities, and compensate them for the lack of job stability.

4.5. An appropriate rewards and motivational system

As pointed out above, the junior researchers interviewed consider that their host institution could balance the lack of employment contracts or other benefits with some long-term planning, improved communication, a specific career guidance and strategic networking.

Furthermore, from the data collected, other suggestions were also identified by junior researchers as possible aspects that management should take into account and could foster in order to motivate them. As recommended in the literature (Chen *et al.*, 2003), specific rewards and motivational systems should be designed and, with no additional costs, improve the professional and personal lives of these junior researchers, while providing indirect benefits for the hosts institutions.

4.5.1. Monetary rewards

In monetary terms, all interviewees are unanimous considering that this aspect is an important component.

> *"The most important is money, let's not be hypocrite, it doesn't have to be much but the grand holder level is generally low, quite low even for the average level, for the average cost of life." Interview 9*

For youngest researchers, the money issue is not too bad, having the idea that for their age and level of experience, they would not be earning much more if they had chosen another career path, namely in industry.

> *"For someone like me, without experience in the area, I would be hardly paid so well. Of course, the commissions here are different; here they don't have the usual characteristics." Interview 14*

However, as the junior researchers grow older, and still maintain themselves as grant holders, the dissatisfaction rises. Again, they do not hold directly responsible their host institution but rather the government for lacking to update their grants for more than a decade, leading to an impoverishment of the researchers in a context of increasing cost of life.

> *"Ok, there is a critic I have to say but it is about the fact that grants are not updated for at least ten years, but this a problem of the country not of TECH1. (…) I understand that it can be a problem but I think it is a problem of the research community, which is grants are not updated for more than ten years, more and less, I think it is since 2002-2003, and so it is easy to understand that people lost purchasing power or quality of life with 980 that you earn today, that you earned ten*

years ago when, in fact, the cost of living increased a lot, so people are really earning much lesser. So, this is one aspect." Interview 19

"Money can be important, but I think that… I think that at TECH1 you have to strengthen what we trade for the money. (…) If there are no conditions to better compensate financially, because I believe there are no conditions, then the other aspect need to be worked out. The aspect is to remember people that they did the good choice. With some regularity; because, sometimes, people forget. When they have to go to the credit card to pay the TV and say "Damn, but my friend bought it and paid cash." Isn't it? And then, on those times, a person has to… Fifteen days before, there must have been news saying "John Doe did this". I think that… I am saying this but I think that TECH1 does things in that sense, I'm not saying it is all or nothing… (…) They can reinforce it." Interview 7

The literature review tells us that monetary rewards are not the only reward system valued by researchers (Cabral-Cardoso *et al.*, 2003). When referring to this aspect, our interviewees immediately reinforce this idea by mentioning several other compensating and motivating aspects in research that junior researchers value and that their management should foster. In the following paragraphs, some of these aspects are highlighted.

4.5.2. Recognition

Junior researchers value the opportunity of getting recognition, from both their peers and management in the institution, their peers in the scientific community and even from society.

"That's something else that I think, recognition, I think, is essential. That is: if I work in one project, in the case of a European project in which I worked, and there are project meetings, and the person works six months and there is a meeting, and then he doesn't go: that cuts the performance in half." Interview 6

"I think that both things are important because… well, the part of being valued by your peers is important to create some reputation in the community. (…) Here, internally, I think recognition is important most of all for people to feel motivated,

and to feel that they are doing work and they are excited doing interesting work, and then, around them, their colleagues or their supervisors don't value it, I think it is bad." Interview 19

"About recognition, I have noticed that outside the world of research, people don't really understand what a research grant is. "Ah, it's not really work, isn't it?" It's a bit the general idea." Interview 16

Associated to this topic of exposure and communication to the broad scientific community, there is the aspect of travelling and other benefits. For some managers, it is seen as a possible reward, instead of salary, but the opinions on this topic are divided.

"I don't know, I didn't know Europe like I know it nowadays, precisely because I had the opportunity to travel." Interview 19

"Travelling is the part that… it's funny, it's nice to travel, but in itself, it isn't as glamorous as someone from the outside may think. It is a lot of work, the trips are business trips, so you don't go for sightseeing. First sightseeing alone, and to take a stroll with the bags on your back, it isn't much fun." Interview 13

"Ok, many times, travels were considered, sometimes, as a way of compensation, but really I wouldn't consider it that way… (…) The Professor, in that case the Coordinator, saw travelling as a possibility for people… or at least, he would try to convince us that it was a way of, not valorisation, but to reward the effort". Interview 1

Besides the individual recognition, junior researchers also value the recognition of their host institutions since it can be a powerful introductory card for the labour market. If the brand is strong, the possibility of establishing connections for its researchers is very valuable.

"The institutions help a lot because they are always a good reference in the external world and when it is visible that they support some situation, it values the project and the work. Mainly when a young fellow like me arrives at a bank, or some other institution, and presents his project, they believe more in the project when there are institutions behind it too." Interview 2

"I don't know, I think that TECH1 has its advantages. In first place, because it is an institution, maybe, with more recognition than the faculty itself, although the University is one of its associated. Then, it has this relationship with industry…" Interview 21

"An institute like TECH1, which from my point of view has a good image in society, and in the business world, I think it is positive you, in your curriculum, let's say like that, to have a passage through TECH1. Without a doubt." Interview 4

Hence, while managing these human resources, the host institution should try to foster opportunities for its junior researchers to get recognition of their scientific community, namely by presenting their results in conferences and in journals, and guarantee an internal recognition of their work by their peer and management. Additionally, the institution's brand and network at national and international level are crucial in order to reinforce the future employability of its human resources.

4.5.3. Time flexibility

One of the most relevant, if not the most relevant aspect that young researchers refer to and value in all interviews is the time flexibility that the research activity provides them.

"One of the things I like is the time schedule flexibility in itself, it's a way too, it's a contribution that is given to me. It allows me to contribute or have time for myself to do other things that I like, at personal level, that in another institution or in industry I will have to answer completely… (…) The hours are important. I think that time to live is important, more than money. (…) I think that, I have this idea that, even if it is a conceptual detail, much of the compensation given to the workers, in this case not the workers but the ones who work, is in terms of time." Interview 21

"Because, on one hand, it gives us freedom to solve our personal issues, and on the other hand, actually I'm not that kind of people, but there are some people who prefer to work at night or at the end of the afternoon, and they can manage their time schedule that way, because there are some people who arrive at four o'clock, and then do their office hours, and I think it's nice." Interview 17

Though the host institution in question does not have a completely flexible time schedule, with some core-time to respect, nevertheless, the possibility to adapt their schedule to their needs, not having to justify lateness and being able to compensate later is by far one of the aspect that researchers most praised.

> *"No, I think that on that aspect, we are really well. Because I think we can do, let's say in quotes, the time schedule that we want. (…) So, I spend more time here than the ones I am required to. But ok, because I want, I have work to do." Interview 11*

> *"I think I can't complain about that because I already have abused a lot of the flexibility. About time schedules, no one ever told me anything. (…) And I mean, when there are meetings and stuff like that, I come, isn't it. But if it's not trouble, it's handy to arrive after the hour. Because I will do the hours, and it's always more than the required, and for me it's the same, it's just that I don't have to be worried with the fact that I have to be there before 10:30." Interview 18*

Therefore, it is, no doubt, one of the aspects that management has to preserve and explore more in order to motivate and compensate these specific human resources. In fact, through this flexibility, junior researchers have more time to explore other personal aspects that may balance their lack of employment security.

4.5.4. Challenging Activity

One of the reasons that the literature attributes to the limited attraction of researchers towards industry is the lack of a challenging work, namely with some autonomy and flexibility and having to respond to some technocrats focused on profits. In our interviews, challenging activity was mentioned as an important point to take into account.

> *"I think that the added-values are: the variety of research subjects and themes that we explore and that in real world has no comparison. (…) Here, monotony, we don't… it doesn't exist. So, it is an added-value. Then, the fact that we are in the front line of development and innovation, because this, in the industry world, it is very difficult." Interview 4*

"Ok, I think that here, I would say that the greatest advantage was, for example, to be close to very good people, people very competent, and to see how they work, and get familiar with the scientific process, which is a different process and perhaps not usual in companies, which maybe just do things, if at the end things are done, great." Interview 17

The sense of challenge and of thinking things much ahead than the rest of the society is often highlighted as well as the unique possibility to work with very bright and interesting colleagues or managers.

"In terms of motivation, it's above all… it's nice to the ego to know that, sometimes, you can do nice things. (…) This idea of being always thinking about the future and not about the present, it's what is fascinating." Interview 19

As mentioned, researchers value autonomy and flexibility. Though in some work groups, it is granted almost from the beginning, in other groups, it seems like it has to be earned.

"Yes, there are the project general goals and those have to be accomplished, but I had had some liberty, even a lot, to find the tools with which the objectives are fulfilled." Interview 16

"Well, nowadays, I have all the autonomy but I know that it is an exception and that I earned it through my work and by showing autonomy, because without autonomy, there is nothing. So, someone who just sticks to do his assignment, fulfilling the assignment, he will never have autonomy. He has to start taking chances, doing other things outside the assignment and show that he is capable. (…) More autonomy and the possibility to grow. Give him responsibility. If the person is not capable of, ok, that's fine; but if the person is capable and he is willing to, it should be given to him, which is good for his bosses that stop to have to do a lot and it is good for the people because they become more motivated and they stay here well although they are not earning a lot." Interview 6

This aspect of autonomy and growing responsibility is an aspect that management has to take into account and start to value. Since the junior researcher does not have much stability and job secure conditions, it is important that he does not get confined to the

same and repeated activity during all his stay in the institution since it will have poor relevance for his personal and professional development.

4.5.5. The completion of a degree

Besides the possibility of working in cutting edge areas and gain experience, for the ones willing to use their research time doing a MSc or a PhD, the completion of the degree while putting knowledge in practice in research projects is of a great value.

> *"I think that TECH1, particularly for people under thirty years, not so much for people of my age, but in that phase in which they end their graduation, until thirty years, it must be faced as an added-value in terms of training. It is still a bit of an academic environment, but you already have contact with companies. Thus, you combine the best of two worlds." Interview 9*

> *"Ok, right now, what is compensating my effort, of course money has its relevance, but my effort right now is in accordance with what I will get, that is my PhD degree. It's the degree in itself; it's not even the knowledge anymore, since I feel I already learned what I have to learn. Now, I just have to put it out there and show the world, essentially, what I have learned." Interview 8*

It seems that the completion of a degree is the only motivational aspect that the host institution waves at its junior researchers to attract them.

> *"I think that… I understand too why, normally, obviously what the people at TECH1 suggest, it's not just to be here for four years at a zero cost, I get that too, it is to use these four years to do a training, or in other words to use the time we are here to have a training… ok, a higher education training." Interview 12*

However, as seen in our findings, there are other relevant aspects that may be considered as valid motivational or rewarding instrument in managing the junior researchers' careers. Since a secure work relation with great benefits cannot be provided to all of them, at least, the guarantee of the best return for the years they dedicate to research should be ensured, namely through the motivational and rewarding aspects mentioned in this section.

4.6. The support of other human resource practices

In the previous sections of this chapter, the value of the implementation of a career management as well as a new motivational and rewarding system were pointed out as positive improvements instead of the mere hosting of junior researchers funded by grants or other temporary bonds.

However, the findings collected in this study provided other valuable suggestions that may complete the ones already presented. Thus, and providing an holistic approach to the subject, this section aims to present some recommendations in other human resource practices, such as recruitment, welcoming, integration in the culture, training, performance management and phasing out.

4.6.1. Recruitment

As seen previously, many of the interviewees have a clear idea of their career orientation, however, they seem to know little about the environment they are entering in, when leaving their university. Most of the young researchers interviewed barely knew their actual host institution or research path when they were in their graduation studies. In a general way, only in the last years of their graduation course would students hear about scientific activities.

> *"Thus, already during my training in the faculty, I heard about TECH1, I had Professors from there. I didn't really know what was going on inside and I had a different idea of the one I have now. I thought it was something unreachable, everything very… very top, very top-secret and I even thought that… well, maybe by ignorance, but it was the idea that I had. Later, then, I applied to the grant, I got it, then, I came to see that things are actually not like that, that the environment is… agreeable." Interview 4*

> *"I think I never had heard in PhDs or anything of scientific institutions, such as TECH1." Interview 5*

> *"I guess I didn't have a clear idea of what was the work here before I actually arrived here." Interview 17*

Usually, the first contacts come from Professors and the final project of their graduation course. It is their first acquaintance with scientific institutions. After that first contact, commonly, freshly or soon to be graduated are invited to apply to some grant calls by their own Professors. For the freshly graduated, it is a choice that allows working with a manager that they know, in an environment not too much different from university and even have a glance to more professional scientific activity.

> *"Hmm, yes, I did the final project of my graduation here too, but at that time, it was, I don't know, in the last year of graduation, or the year before, that I heard about TECH1. (…) I never heard about TECH1 out of the circle of colleagues and professors." Interview 11*

> *"There is already a mutual acquaintance, either from the student about his professor, or from the professor to his student and his competences. Also, in part, in some cases, even of some characteristics of his personality – persistence, stubbornness, if the student raises too many questions, if he doesn't get things at the first time, that is, knowledge that people have. Since he is the one to do recruitment, and often, being them the ones who bring the students, because of their proximity with the faculty, this recruitment process is extremely simple, facilitated, since one interview would add little." Interview 3*

From these statements, one can conclude that young researchers often start their research career in a mix of not really knowing what a professional scientific activity is, barely knowing their host institution and what a scientific career is or can be. Therefore, some efforts should be made to prepare them sooner in their studies to the idea of scientific career.

> *"Yes… I think that… it is important to build an image towards the academic community, in this case, students, because students are the ones that in the future will be grant holders, isn't it? It's like the assembly line, it is in the faculty, in order to later feed the scheme. Therefore, I think it is important to have a presentation, the building of an image in the academic community." Interview 4*

> *"There is not a policy of recruiting sooner and establish partnerships with other cities abroad, because they go abroad, they come in (...) but someone that identifies itself with, that actually stood out in subject x, y or z, that would be contacted and*

integrated sooner in institutions of that type, and it will allow evolutions, with some limitations, due to time-schedules more limited but that will allow evolution and, in a way, bond them to the institution because it will prepare them and integrate them in one culture, sooner." Interview 1

Stewart & Knowles (2000) mentioned the importance for young researchers to know the labour market they are entering in, knowing the kind of jobs that are available. From our findings, we can also conclude that it would be important for management to inform sooner the students in order to allow the latter to have real expectations about the research career and therefore guarantee that the ones opting for it are fitted to it.

4.6.2. Welcoming

Being introduced to the host institution during the short period of the realisation of the final project of the graduation, and such, as students, no proper introduction to the institution is done then. Unfortunately, once they come back to the institution, now as grant holders, the idea that they already were collaborators of the institution leads to the situation in which no proper introduction is ever done, therefore no real fitting in takes place.

"Since I started in the final project of my course, and I didn't know what to do in the future, it was all temporary. And then, I stayed, and so I didn't feel because I never thought too that I will stay, I never thought, at that time, that I would enter to do a PhD, and of course, if it was now, I would have liked, knowing what I know now, to have entered and get introduced to… maybe, the ideal would have to get introduced better, right from the beginning, every nook and cranny in the house. But, ok, I got acquainted gradually ("fui conhecendo"), it was like that." Interview 11

"After, from the point of view of preparation, for everything that was coming, there was not much preparation. It was like: arrive and watch. The preparation was more like, observation and execution, to be watching ("ir vendo")." Interview 1

"There is a little that thing that is to throw a little the person in the water and see to which point she can swim. That is good because it helps people to understand that

they need to disentangle themselves ("ser desenrascadas"), and that it is going to happen anywhere." Interview 3

Even for those who had never been in the institution before, they do not really know what to expect. As the institution grows bigger, the need to integrate more efficiently young newcomers should be a priority. Some mention an introduction to some people of the work groups with whom they will work more closely, but there is never a holistic introduction to the research unit, or to the institution, like the support services, facilities, etc.

"The first contacts were… They gave me a resumed view about everything that was done there, who were the people and they welcomed me well. Yes. But I think that, in the end, it depends a lot on the grant holders or students to search to know more, because it has a lot to do with people's personalities too. There are people who arrive to their workplace, go to have lunch alone, arrive to the work place, leave, and the contact is minimal. Now, there are others who go have some coffee, play football, go out on week-end, and everything, and then it allows you to better know the rest of the work group. But it is up to the person ("vai das pessoas"). Interview 4

The lack of commitment to well done welcoming and integration may lead to less integrated and committed researchers. Préfontaine *et al.* (1994) and Van der Linden & Parker (1998) mentioned the importance of mobilisation of the R&D human resources, namely by aligning them with the vision, values and strategy of the institution.

"Nothing, nothing. I mean, there was a supervisor that was in charge for the work, but it was not the person in charge to introduce us in the Unit. There was no one. For example, myself, only at the end of… only at the end of several months I discovered that there was… - a fridge I knew – but... What did I discovered that was there and that I didn't knew? ... Ok, I didn't know the password to print, only few months later I discovered that. There were series of things that I didn't know. There was a welcoming guide but no one told me that it is was a welcoming guide." Interview 6

"If they could do a better work, I think it is always possible. (…) I don't know, maybe this part of initial introduction of people to the institution, to explain in an

organisations' chart what each part does, specifically what is the role of the researcher, rights and duties, etc." Interview 13

Although these young researchers may not all remain in the institution, some will, and they will not be properly integrated in order to align with the goals of the institution. As for the ones who will leave, they will have lost an opportunity to get acquainted and share a culture of excellence that might have been useful in the future, and for the institution, it will have lost the opportunity to cause a good and positive impression in a former human resource that by integrating another institution, rather academic or industrial, might become a valuable partner.

4.6.3. Integration in the culture

Strongly connected to a welcoming programme and the establishment of a more effective motivational system, lies a good integration in the culture of the organisation. Values such as teamwork, vital to the effectiveness of the institution, and a good work environment should be fostered by the host institution.

"I think that the old idea that people have of each researcher in his corner, is not true anymore. The research work is teamwork. (…) Hmmm. I mean, for students, of course, the relationship between university and its student is much more individual. He is there and he can, he can… learn whatever he wants to learn, work wherever he wants to work. If he wants to contribute with something to university, he contributes if he doesn't want, he doesn't contribute. But here no, we are required to contribute a little for the institution, and that is good. That's why it is an institution, and that collective construction is also important." Interview 21

"I am not forced to work in things that I don't care at all and put up with clients, and with directors or bosses, and people who say: "Eh, you arrived at 9h10 when you should have arrived at 9h00." That kind of bad atmosphere, and people… people who work here, they are not thinking: "This one is earning more that one". No, the effort of people here is rewarded in other ways. Money, here, doesn't abound for anybody. And as such, there is an atmosphere; it ends up being better, more relaxed. Then, nobody tells me what to wear, how I… well, there's a set of things, almost a freedom that I wouldn't have if I worked anywhere else." Interview 8

Apart from integrating its young human resources, the host institution should also make sure that the required equipment and facilities are available to foster communication and the free share of ideas.

> *"Here, you easily have access to certain equipment." Interview 10*

> *"If I am always here and I get here and grab a paper, I need to get up and take a walk, and that detail of getting up and taking a walk is missing here. Because if I get up, I don't have anywhere to go. What happens frequently is that you have leisure areas, couches, whatever, where people can go and be relaxed. And then you have boards spread. Here, when we want to talk about something, we need to reserve a meeting room, but it is so formal that what will happen is that we will only get to that trouble if necessary. (…) Because, sometimes, it is when you go stretching your legs that ideas come out." Interview 20*

Thus, it is important for the host institution to socialise and integrate the young human resources and share a mutual set of goals. The institution should take actions of "resocialising" them (Blume, 1974) in a more hybrid environment, between academia and industry, and prepare them to different work environments. Moreover, apart from fully integrated and aligned human resources with its goals, the organisation will also benefit from their increased motivation and creativity.

4.6.4. Training

On the training subject, there is a dominant point of view from the interviewees. According to this view, in technical terms there is no need for them to get training in their technical and professional fields from their host institution since their additional studies were sufficient. In particular, PhD graduates consider that, in their advanced level, they are able to keep up with new technologies without requiring formal training.

> *"No, no, I can't say I need it. Of course, there are always subjects that you don't know, but this, with the knowledge evolving so fast, it is difficult. I have the means to look for, I think that it is the most important." Interview 21*

> *"I can do it, I think I can do it because you reach a level in which the basic knowledge is already acquired, I will say, and then with that knowledge we can*

understand things that we don't know but that we can learn quickly, or in a quick or easy way, with the know-how that we have. So, I guess, I think it is possible. It is possible to acquire the necessary knowledge in order to do more research, supervise people." Interview 19

The only exceptions pointed out are some programming or computing programmes that junior researchers feel they would gain from attending a formal training course in one of these areas.

"I always disentangle myself ("desenrasco-me"), watching and so on, I never had training with a beginning and an end, with a logical continuum, presenting the strong points, it has been more a question of consulting, I even checked the official book, but it was always by myself, there was never a real training. And sometimes, I miss it; without doubt it would be helpful here, because I wanted to learn new things, sometimes there are basic things that I don't know how to use. And maybe, if I had done training with a beginning and an end, I had been through that. So, it would be handy, even now." Interview 18

When asked about training or at least some on-the-job experience in other technical areas, many consider, on the contrary, that their super-specialisation was a great advantage. However, few others would prefer to enhance their future work opportunities by acquiring competencies in other areas.

"Personally, I would like to have more tentacles, so to speak, to have more alternatives. It can be from the type of employment, the type of offers that will exist, isn't it, sometimes to know only about one area, only about one specific thing, is an added-value, other times it isn't, because it means that you don't know about nothing else." Interview 9

"I think that the only motivation I see for me is that, if I want to work in a totally opposite area, that chance should be granted because I proved on the other one that I was capable of, and all that. Because beyond this, I only see money as the sole motivation. If this is cut off, if someone works five years in one area, and then he has to continue working in that and they won't let him go to another area, the person loses motivation if there isn't money involved." Interview 6

In our literature review, some authors recommended that R&D workers should seek diversification rather than overspecialisation in order to avoid obsolescence (Blume, 1974). Host institutions should encourage junior researchers willing to diversify their technical expertise, namely by announcing internally vacancies in other areas or creating multidisciplinary teams in some projects. These initiatives could give them new and valuable competences or at least reinforce their self-understanding (Bailyn, 1991).

However, the opinion of the interviewees about the non-technical competences is quite different. Confirming the perspective mentioned in the literature review that scientists lack some "work readiness" (Edwards & Smith, 2009), junior researchers feel the need of more competencies and skills in the so called "soft skills".

> *"In fact, with the entrance in PhD, it's an essential competency. It doesn't make sense for people to have a very specific training, invest, and then to have gaps in other areas." Interview 9*

> *"Sometimes, I think that this training is necessary. The person has a great training in technical terms, but then it fails a bit in this area" Interview 12*

> *"A PhD has several components. One of them is to be focused on your thesis, in the theme that we are studying, but we can't close ourselves in a phone cabin and forget about the world because it is completely wrong. First because, later, we won't be able to fit what we have done in the thesis with what is around it, that is an important aspect, it is to know in what world we are in, everything that encompasses our PhD work context and the surrounding aspects." Interview 19*

The most referred areas are communicational (presentations, foreign languages), managerial and entrepreneurial skills. As seen in the literature review, those are competences valued by industry since they provide human resources with flexibility, managerial and multidisciplinary skills, expanding their horizons to other areas of the organisation.

> *"In terms of soft skills, as it is usually said, maybe one thing or another, would be helpful. Sometimes, presentations would be helpful." Interview 18*

> *"The question of presentations is another one, something that we need to invest in. One of the biggest problems of researchers is the presentations they do; they usually*

suffer of two problems: they are too technical, and no one understands, talking to the general public is something they can't do, or they have too much text, making them absolutely unpalatable, no one can gain interest in it. I think that it is something that any researcher should be forced to do, a course on presentations to audiences in order to know what to do, how to communicate and all the stuff. And entrepreneurship too, if here our goal is to be an interface institution, people should want to know how a company thinks." Interview 6

The entrepreneurial competence is a specific competence that R&D workers are usually pushed to acquire. In a country like Portugal, where the economy is mainly made of medium and small sized companies working in poor added-value areas, the government wishes to see young scientists starting new companies in technological and high added-value areas, boosting the economy and at the same time, increasing career opportunities for young scientists (Fontes, 2003). As seen in our findings, some researchers are willing to get acquainted, at least, to this idea of becoming self-entrepreneur. It is, thus, a competence that their host institution should also support.

Further recommendations on training were made, namely on how the communication and satisfaction of existing training needs should be managed.

"No, there was a thing that ended at TECH1; before there were reports on training needs, that were mandatory by law – I think, it stopped to be and so it stopped being done – which is bad because, I thought, I didn't know that it was mandatory by law and I thought that they were elaborated because it was important that people would say what were their difficulties, but after all no, it was just mandatory by law. Well, it was important for supervisors and for Unit Coordinators to know if the people were aware of their difficulties, what their difficulties were, and what training needs they had. And when that reports stopped, that need stop to exist." Interview 6

Training should be integrated in a development programme for each individual in which their current and future training needs are addressed, taking into account their career orientations and career prospects in different work environments.

Though the funding of such diverse training may be a problem, junior researchers themselves suggest mentoring or, at least, internal workshops where some member with experience on the subject could share his experience and good practices with the

youngest. The same could apply to the administrative services of the host institution, specialised in accounting, controlling, legal matters, human resource management, etc. and that could share a common knowledge, fulfilling training needs, and even present and explain some internal procedures, thus reinforcing the integration of these human resources in the organisation.

> *"I understand that funds are much reduced and ok, they need to be optimised because investment is made through them. But I think that, here inside, several people could… that have knowledge, and could share it, not in a formal way "Eh! Great course about this or that!" but a workshop, information session, I think it would make sense." Interview 4*

> *"Maybe, there could be some kind of introduction to those matters, something short because it isn't something transcendental neither. But it could be something of one day duration, a short training that will say: "Ok, TECH1 works like that, if you want to do a budget, you do like that, using those tools". Interview 19*

Thus, by using existing resources, the institution could make available to junior researchers valuable training programmes that could help them to be more productive in the day-to-day operations but that could also provide them with valuable competences for the future.

4.6.5. Performance appraisal and management feedback

Similarly to the individual development and training, in terms of performance assessment, junior researchers rarely have feedback from their management in a clear and structured way. They usually do not know the parameters evaluated nor are they informed in advance of the evaluation meeting in order to have some time to prepare for it.

> *"No, they tell me what they liked, what they didn't like, it is all very spoken, in terms of points they considered in the appraisal. (…) Well, it is usually a surprise. Nobody told me about appraisal, at least that I remember. I was completely taken by surprise." Interview 18*

"Transparent, no way! I don't know the parameters. (…) Yes, it could be something more transparent, at least there could be a set of parameters so that we can know under what parameters we are being evaluated, and know specifically, in a detailed appraisal, what is good and what should be improved. That will be, actually, interesting." Interview 13

Thus, a recommendation is made for a different performance appraisal, integrated in the personal development plan already suggested, diagnosing new expectations and needs for new training, both from the researcher and the management.

Furthermore, management training should not be exclusive to junior researchers but also to the management. Usually, they are the "entrepreneurial professors" mentioned by Lam (2005) that need to work on their communicational, managerial and leadership skills.

"Everybody is different. Personally, I think there are people who are professors, and they will always be professors, and it's a mistake to let them manage because they will manage like a professor. And, so, in these cases, clearly, they should put a manager." Interview 7

"There's everything. There are people who are too much controlling, others who are too "laissez-faire, laissez-passer", and in a general way, I think that the evaluation is positive. I think that there is less preparation to deal with the abuse because, in spite of everything, most people who pass here end up complying. And there is less experience to deal with the ones who don't comply than the contrary." Interview 9

"I don't really like the vision of the responsible as the only person who is orientating; I think it comes from both sides. That is, if we want to have a relationship of proximity, I think that this is the best way." Interview 21

In the literature review, Petroni (2000b) recommended that R&D workers should receive feedback from their managers, in an ongoing basis, in order to keep their motivation. As seen in our findings, this is particularly relevant in a non-profit R&D organisation where more freedom is given to managers and researchers. The former are usually the main representative of the host institution to junior researchers, if not sometimes the only one, thus it is important that they have the appropriate skills to manage and support their human resources. Hence, the host institution needs to train the

managers, often great experts in technical fields but sometimes lacking soft skills, so that both the institution and the junior researchers get the most of their collaboration.

4.6.6. Phasing out

The phasing out section is a very sensitive topic since the departure of many junior researchers from their host institution is taken for granted in most cases. And that is the reason why a specific career management, preparing them to this step, should be implemented.

We note that, in spite of the precarious bonds and sometimes bad management, many researchers would like to stay and continue their activity in their host institution.

> *"Yes, on my side, there is availability. If there was an opportunity, great, I wouldn't mind! But from my side, there would have availability." Interview 13*

> *"It's what I would like, if I finished my PhD today, I would like to stay here under certain circumstances. (…) If they wouldn't exist, no… I would go abroad. It's to keep working in research and go abroad." Interview 6*

> *"The problem is that, something that limits at front is the issue of the type of bond that we have, as researchers, with the institutes. And, truth be told, a bond like grant holder isn't a bond that people want all their lives, obviously. And right now, I am a grant holder. Of course there are chances, or they have been appearing here and there, of employment contracts, but they are very rare. Very few and very rare. And so, if such hypothesis should appear or come up, yes, it would be a hypothesis that I would put on the table and that I would like." Interview 11*

Therefore, many junior researchers would like to pursue their research activity in their current host institution, either full time or as a complementary activity to a lecturing position. For few others, industry is a preferred route or even entrepreneurship, creating their own businesses.

What all have in common is the dedication, for several years, to a research activity in a host institution, combined with the pursuit of some postgraduate studies or with grants or temporary employment contracts. Thus, junior researchers and management should work in order to guarantee that they receive the most of this mutual collaboration.

The institution should benefit from having, for several years, motivated and creative human resources that share its values and goals and, thus, work efficiently in order to attain them. After leaving the institution, these former human resources can become a possible partner, regardless of them being integrated in industry or academia.

As for management, it should change in order to understand what are the needs and career prospects of its junior researchers and thus providing them with the necessary preparation and support in order to successfully pursue their careers elsewhere.

4.6.7. The role of the human resource department

As complementary considerations, some insights on the perceptions of junior researchers about the human resource department of the non-profit R&D organisation are also presented.

From the answers, we see that many do not feel much support from the human resource department, and have to sort out their problems dealing with their managers and R&D group.

> *"I think that the human resource department in an institution like this one err for being far from the human resource. It is very distant. He talks with the head of department and the head of department often doesn't know of the researcher's need, and that is, many times, the researcher can't talk with his boss for some… because he is afraid, or because he is ashamed, or etc." Interview 2*

> *"Now, apart from this, I don't have a great accompaniment, I don't feel anything. No, no. That is, to be here or in the faculty, in this aspect, it ends up being the same. I enter here and leave and I don't feel." Interview 11*

> *"I think I never dealt directly with the human resource department (laughs), truth be told." Interview 14*

As for the importance it should have, many interviewees just do not see the relevance of it.

> *"The idea of a human resource department in a climate where there is so much freedom, this informality in the relationship with the grant holder, I feel comfortable*

at TECH1 to speak to a Director, to speak to my colleagues, I am perfectly at ease. And I like this informality. (…) If there is this relationship, I don't miss a human resource department. If it exists, I think it is a bad sign. The organisation which needs a human resource department I think it is a bad sign. (…) (Laughs) No, but I have this idea that things manage almost by themselves, when there is this climate. If there is a climate of contribution of every one and if there is a climate of management that is at people level." Interview 21

Others feel there is a need for a global management in the human resource area. First, it would make sure that all the R&D groups in the institution are consistently managed, sharing the same HRM policies and practices. On the other hand, some refer to the need for a more active human resource department, strategic in managerial terms, rather than confined to an administrative role.

"And I think there are completely different policies and it is hard for someone to work in the same floor that other unit and see that there are people with employment contracts, they also have a lot of work, and we have a lot of work but we don't have an employment contract. And it is in the same institution and that don't feel right. There are different human resource policies between units, and very asymmetric." Interview 6

"I mean, there is a human resource department that takes care of the more operative things, of the vacation bonus, of health insurances, but from the point of view of a set of… I mean, now with age and learning, there are a set of different areas in human resource that are neglected. From performance appraisal, rewarding the merit, understand very well how it…, what are the appraisal criteria, the best career management, the welcoming and integration in the culture, the vision itself of… to keep the culture in the company itself." Interview 1

Thus, we conclude that, although in the literature, many authors recommend a strategic and well-designed human resource management for industrial R&D workers (Petroni, 2000b; Chen *et al.*, 2003), the reference to the management of researchers in less stable careers, namely in non-profit organisations, in the literature is almost nonexistent and it is not clearly perceived as a gap by many researchers interviewed.

However, if career routes and personal development programmes are to be designed in order to better support junior researchers, and a more pro-active management of these transitory human resources is to be implemented in a non-profit R&D organisation, there should be changes in the role of its human resource department. Namely, this department should, provide preparation, support and specialised feedback to management and to junior researchers, in the several human resource areas and processes in operation in the organisation, in order to help them successfully benefit from their mutual collaboration.

Chapter 5. Conclusions

5.1. Main findings of the research and recommendations for policy or practice

The aim of this research was to investigate the careers of junior researchers in the scientific area of electrical engineering and examine whether junior researchers were spending increasingly longer periods of time on temporary or short-term positions with poor career perspectives. If so, our aim was to identify what could their host institution do for them and to suggest some management practices, namely in the human resource area that could help them in their careers.

In order to achieve this purpose, a literature review about the early stage of scientific careers in Portugal was conducted in order to better understand the reasons for the surplus of young researchers in public and non-profit R&D organisations and the growing deterioration in working conditions. In terms of methodology, we moved away from the organisational analysis and proposed to explore what junior researchers themselves felt about their career prospects and inquire them about day-to-day management practices, namely in the human resource areas. As seen in the literature, few attempts to analyse research management from the human resource view were done in non-profit organisations. The effort was also to collect suggestions for industrial researchers in the literature and inquire junior researchers in non-profit organisations about it.

First of all, our research found that junior researchers in electrical engineering are sceptic about their R&D career prospects. They feel that career progression is limited to a succession of transitory solutions, transforming the early stage of their scientific career in a temporary or complementary activity. Nevertheless, junior researchers value their present R&D experience as an appropriate first step in their career: if they decide to go for a lecturing career, the research activity is highly valued; if they intend to dedicate themselves in the future to a research activity, they already are in the right track; and if they choose the industry, this experience can be a precious *curriculum* element.

Junior researchers interviewed have a more or less clear view of their career orientations, mainly towards academia, research or industry. For many of them, the research option at the early stage of their career was the result of an opportunity at the

end of graduation and only gradually did they start to think themselves as researchers and possibly do a career of it.

This study detected a “PhD dilemma” that junior researchers face while waiting for uncertain future opportunities. They frequently have to take a decision about continuing their studies while doing a R&D activity, namely a PhD. If they decide not to do a PhD, their careers in academia or research may be compromised; on the other hand, due to the lack of opportunities, they might have to renounce to academia subsequently and turn to industry, having spent several years getting a super-specialisation not valued by industry and arrive in the labour market too “aged” and overqualified.

Due to uncertain prospects in their careers and the possibility to stay in R&D, many choose to delay their career decisions, leaving them for years in uncertainty, compromising their future, the establishment of a family, etc. Our research shows that junior researchers do not hold their host institution responsible for this type of work relation, but consider it rather the result of wrong science policies and blame the government for it. Many of the interviewees understand that, in the short-term, it is not possible for all young researchers to have a permanent and secure work relation with their host institution. However, they do have many suggestions for management in order to help them have better working conditions and improve their future.

Thus, another contribution of this study is the evidence provided showing that there is a need for the management of junior researchers in non-profit organisations and academia. Junior researchers need to be considered and managed as human resources, although transitory ones, and not just hosted as students. Furthermore, the human resource management has to be different from the one recommended in literature for industrial researchers. Rather than working in order to develop and retain them, the goal has to be developing these transitional human resources and prepare them to leave for their future career steps.

First of all, junior researchers ask for a clear and long-term strategy of their institution and working group in particular. A long-term planning, namely through the participation in long-running research projects, would bring a greater sense of professional and personal stability to junior researchers.

Associated to it, a need for better communication between the researcher and the management is identified in this study. The need is felt to communicate the strategy and long-term planning and to foster a better fit between the individual's expectations and the organisational possibilities.

As it occurs with industrial researchers, young scientists in non-profit organisations need to be more pro-active and explore their values and aspirations in order to identify their career orientations (Petroni, 2000b). As for management, there is a need for a definition of realistic job previews as well as opportunities and their communication to junior researchers so that a match between the needs of the person and of the institution can occur, as recommended in the literature (Bigliardi & Dormio, 2009).

Additionally, the institution should create and widely communicate a variety of career routes, even if outside the institution, and design personal development programmes (Aryee, 1992), with on-job-training, appropriate rewards and motivational systems and interpersonal counselling and guidance (Chen *et al.*, 2003).

Besides the efforts of helping define career orientations and career routes, the host institution should provide career opportunities to junior researchers. Taking advantage of its network and active collaboration with academia and industry, the host institution could recommend its transitional human resources to other institutions, inform them about work opportunities. The effort would be positive for all the actors in the network. It would grant a new career opportunity to the junior researcher that wishes to stay working in research; for the new employer, it would have the guarantee of a trained and recommended worker. For the host institution, a satisfied former human resource would become a gatekeeper in a strategic partner, possibly fostering new collaborative activities.

As mentioned in our findings, this confirms the ideas of Lam (2005, 2007) and Howells (2008) theory on the "extended internal labour market" and how this latter is inclined to a greater expansion in the electrical engineering in Portugal. A pool of flexible scientific labour, trained by academia or research centres, involved during their training years in cutting edge projects with industry and with the possibility that later on, industry would recruit them. They are the new type of scientists - the linked scientists (Lam, 2005) -

that can reinforce the inter-institutional research collaboration, so important for the economy.

Implementing better planning, communication, career guidance and networking, non-profit R&D institutions would start to manage its transitional human resources rather than just hosting them, and provide appropriate rewards and a motivational system, as recommended in the literature on industrial researchers (Chen *et al.*, 2003). From the data collected, some suggestions are identified as possible aspects that management could foster in order to motivate and compensate junior researchers without excessive burden for the host institution.

The monetary incentive is mentioned by junior researchers. However, like the type of work relation, they consider that it hardly depends on their host institution. Moreover, in the interviewees' opinions, other compensating and motivating aspects should be fostered by host institutions, being valued and found useful by junior researchers.

First, recognition of their work has to be given by their host institution, either from their peers and managers in the institution, by their national and international scientific peers or from society. In order to obtain external recognition, junior researchers value the opportunity to go abroad and present their work, in conferences or project meetings. Furthermore, the institution should develop a strong brand and a solid networking, at national and international level, in order to reinforce the personal value of its human resources and helping them accessing new career opportunities.

One of the most relevant, if not the most significant aspect, that young researchers refer to and value in all interviews is the time flexibility that the research activity provides them. Even with some fixed core-time, the possibility to adapt their schedule to their needs, having more time to explore other personal aspects that may balance their lack of employment security is highly praised by junior researchers. Therefore, it is, without doubt, one of the aspects that management has to preserve and explore in order to motivate and compensate these specific human resources.

One other aspect valued is the challenging work, the opportunity to work in cutting edge areas, looking for the future rather than the present. In order to ensure relevance for their personal development, junior researchers prefer not to get confined to the same

and repeated activity during their stay in the institution and rather participate in multidisciplinary teams. Junior researchers also value autonomy, flexibility, growing responsibility and the possibility to work with very bright and interesting colleagues or managers.

Finally, junior researchers praise the possibility of getting a university degree while working in research projects. This seems to be the only aspect that the host institution usually waves at its junior researchers as a motivational aspect to enter the research career.

Since the findings collected provided other valuable suggestions that may complete the ones already presented, this research also propose some recommendations in other human resource practices, such as recruitment, welcoming, integration in the culture, training, performance management and phasing out.

First of all, junior researchers should have a previous idea of the labour market they pretend to enter in, as recommended in the literature (Stewart & Knowles, 2000). Based in our findings, the host institution should inform and present research activity to university students so that they have more real expectations about the research career and therefore guarantee that the ones choosing to do so actually fit in.

Once recruited, the need to integrate newcomers should be a priority. Besides an introduction to the work group, there is a need for a holistic introduction to the institution, like the support services, facilities, etc. Although all these young researchers may not remain in the institution, some will, and if not duly integrated, they will not align with the goals of the institution. As for the ones who will leave the institution, it is relevant that they get acquainted and share a culture of excellence that may be of great utility in their future. For the institution, it will be the opportunity to cause a good and positive impression in researchers that may become a future client or partner, by integrating another institution, either academic or industrial.

Linked to this question of integration in the culture of the organisation, teamwork, vital to the good functioning of the institution, or a good work environment should be fostered by the host institution since they are also valued by young researchers.

Moreover, the host institution should also provide advanced equipment for the research purpose and facilities that foster communication, creativity and free share of ideas.

Host institutions should encourage junior researchers willing to diversify their technical areas, namely by informing them about internal vacancies in other areas or creating multidisciplinary teams in some projects. Besides, the possibility to work in projects with industry allows them to get acquainted to other possible career environments that may be of great utility in the future.

Confirming the perceptions denoted in the literature review that scientists lack some "work readiness" (Edwards & Smith, 2009), junior researchers feel the need of more competences and skills in the so called "soft skills". The most referred areas are communicational (presentations, foreign languages), managerial and entrepreneurial skills. As seen in the literature review, those are competences valued by industry since they provide human resources with flexibility and multidisciplinary skills, expanding their horizons to other areas of the organisation. Some researchers are willing to, at least, get acquainted to this idea of becoming self-entrepreneur, as another possibility for their future. It is, thus, a competence that the host institution should also support.

Training should be integrated in a development programme for each individual where his current training needs and future ones would be addressed, taking into account his career orientation and possible future career routes in different work environments. Though the funding of such diverse training may be a problem, junior researchers themselves suggest mentoring or, at least, internal workshops where some researcher with experience on the subject could share his experience and good practices with the youngest.

Some junior researchers interviewed ask for a performance appraisal integrated in a personal development plan, identifying training needs and the expectations both from the researcher and management. Furthermore, the institution needs to better prepare its managers, often great experts in technical fields but sometimes lacking some preparation in soft skills, so that both the institution and the junior researchers get the most of their collaboration.

Lastly, since junior researchers mostly deal with their manager and their close R&D group, we suggest that the human resource area should have a more important role.

Namely, if career routes and personal development programmes are to be designed in order to better support junior researchers, and a more pro-active management of these transitory human resources is to be implemented in non-profit R&D organisations, changes in the role of their human resource departments should occur. They should namely provide preparation, support and specialised feedback to management but also to junior researchers themselves, in the several human resource areas and processes in operation in the organisations, in order to help both of them to successfully benefit from their mutual collaboration, currently and in the future.

These recommendations would benefit both the junior researchers and their host institutions, without increasing the costs for the latter but rather changing management policies. The final purpose is to host a valuable human resource funded by grants or other temporary bonds and to properly manage him and help him, his future and the future of all the society, in the end.

5.2. Study limitations and further research

First of all, as mentioned in our methodology chapter, our research technique can be seen as a limitation in our study. The interviewer might have inhibited or unconsciously induced some types of answers in her interviews. Moreover, interviews limit the possibility of statistical generalisations that a quantitative technique would have permitted, with larger sample of the population.

Furthermore, the present study scope is limited to the scientific area of electrical engineering. It is, thus, unrepresentative of the needs and challenges faced by junior researchers of other scientific areas. In other scientific areas, the collaboration between academia and R&D research centres and industry may be rarer, creating barriers and new challenges for junior researchers uncovered in this study. No doubt, it would be very interesting to study the needs of junior researchers in other scientific areas, giving continuity to recommendations in the literature about the need for further research on more compatible career development programmes and the diverse dimensions of career needs in new types of research institutions (Chen *et al.*, 2003; Mallon *et al.*, 2005).

Likewise, it would be interesting to confirm if the same needs and challenges are faced by junior researchers in other types of non-profit R&D organisations. As previously

mentioned, the choice of interviewing researchers from the same institution was made in order to prevent variation of management practices. It should now be interesting to compare with populations of other institutions.

Similarly, to study other stages of the research career in Portugal could help to better understand other career routes, opportunities, and help researchers in their career management.

Finally, the suggestions collected in our study that a possible “extended internal labour market”, like mentioned by Lam (Lam, 2005; Lam, 2007), in the electrical engineering area may exist in Portugal between academia, some R&D institutions and industry should be an interesting new aspect to study, namely its implications in the career prospects of R&D workers.

Appendix 1 – Interview guide

Enquadramento do Estudo

Estrutura e Duração da Entrevista

Pedido de Autorização para Gravação e Garantia de Confidencialidade

I. Enquadramento

Nome

Idade

Estado Civil

Formação Académica (Graus académicos e respetivas datas)

Vínculo com a Instituição

Antiguidade na Instituição

Percurso Profissional

II. Gestão de Pessoas em Instituições de I&D de interface – Potenciação das carreiras dos Jovens Investigadores

a) Recrutamento/Seleção

Como se facilitou ou se pode facilitar ainda mais a passagem para a vida ativa, nomeadamente a investigação?

b) Integração/Acolhimento

O que foi feito e o que poderia ter sido feito?

Sentiu alguma diferença da universidade para a instituição?

c) Cultura

O que foi preparado divulgado e o que poderia ser melhorado?

Conhecimento dos comportamentos valorizados, para quem vai a lealdade (organização ou pares?), autonomia, descentralização

d) Formação/Desenvolvimento

Que competências, técnicas ou comportamentais, considera mais necessárias para trabalhar em investigação?

A Instituição apoia a contínua formação nas suas áreas de especialização ou até em novas áreas?

Como considera que a entidade poderia apoiar mais os colaboradores nessa área?

e) Gestão de Carreiras

Sabe que tipos de carreiras existem na Instituição de I&D?

Há planeamento de carreira?

Tem perspetivas reais de carreira na Instituição?

A perspetiva de carreira motiva-o?

Papel do Superior: feedback (contínuo) e preparação para gerir pessoas.

Sabe qual é a sua orientação de carreira?

A Instituição possibilita experiências em diversos tipos de carreiras? Tem possibilidade de movimentos laterais de carreira?

O que pode ser melhorado?

f) Gestão de Desempenho

A avaliação de Desempenho é indiferenciada para todos os investigadores?

Como acha que poderia ser melhorado o processo?

g) Compensação

Os tipos de compensações são indiferenciados para todos os investigadores? Se sim, são essencialmente monetárias?

Que outros tipos de compensações considera que deveriam ser atribuídos aos jovens investigadores?

h) Phasing Out

Pensa que, no futuro, manter-se-á nesta mesma Instituição?

Que perspetivas de carreira tem?

Vê-se a trabalhar na Indústria?

Que vantagens de se estar neste tipo de instituição de interface *(networking, novas competências valorizadas pelos futuros empregadores, experiência, contacto com cultura híbrida, etc.)*?

Alguma desvantagem?

III. Considerações finais sobre (o que é e como se poderia melhorar):

- A carreira científica em Portugal (*focar nos jovens*)

- O papel das instituições de I&D de interface

- O papel do departamento de RH nessas instituições

Tem algum comentário adicional?

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