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AERONAUTICAL KNOWLEDGE MANAGEMENT IN AIR FORCE

A GESTÃO DO CONHECIMENTO AERONÁUTICO NA FORÇA AÉREA

Nuno Rafael Quirino Martins
Major
Master of Human Resource Management
Lecturer at Academia da Força Aérea
Almada, Portugal
nuno.quirino.martins@gmail.com

Abstract

Human Resource Management is an extremely challenging activity because it manages an organization's most important asset: its people. The challenge is greater when the target of the organisation is the knowledge that these people hold, as managing this asset ensures the quality, availability and up-to-dateness of that knowledge.

The Portuguese Air Force operates highly advanced assets, which require specific knowledge. Turnover and mobility in the military may occur without service overlap and represent unchecked losses of valuable knowledge that the Air Force has not been able to safeguard against.

Based on case studies conducted at Boeing, NASA and the USAF, on interviews, and on the Knowman report, a plan of action was devised that looked at the institution's strategic alignment to propose an architecture and determine how knowledge management can be integrated into the Air Force information management structure.

Our findings revealed that a knowledge management programme for aeronautical and military knowledge is viable and that it will validate the conditions that already exist in the Air Force and fill in the gaps between it and its global counterparts. The programme can help minimise the loss in knowledge by suggesting more appropriate ways to manage Air Force resources in the fulfilment of its Mission.

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Keywords: Knowledge Management Cycle; Air Force; Information Management; Human Resources Management; Management of Aeronautical-Military Knowledge; Knowledge Management Programme.

Resumo

A Gestão de Recursos Humanos é uma atividade desafiante porque gere o ativo mais importante da organização: as pessoas. O desafio aumenta quando o objetivo está focado no conhecimento que essas pessoas transportam, pois a gestão deste ativo permite garantir a sua qualidade, disponibilidade e atualidade.

A Força Aérea Portuguesa opera meios extremamente evoluídos que exigem conhecimento muito exclusivo. As saídas dos quadros e a mobilidade que caracterizam a carreira militar podem ocorrer sem que haja sobreposição de serviço, representando purgas incontroladas de conhecimento valioso que a organização não tem sabido acautelar.

Com base em estudos de caso da Boeing, NASA e USAF, em entrevistas e no relatório da Knowman, foi construído um plano de ação, que atendeu ao alinhamento estratégico da instituição, propôs uma arquitetura e definiu a integração da gestão do conhecimento na estrutura da gestão da informação da Força Aérea.

Os resultados revelam que é viável implementar um programa de gestão do conhecimento aeronáutico-militar, conferindo sentido às condições que a Força Aérea já apresenta e preenchendo a lacuna que existia entre os seus pares globais. Este programa pode mitigar a perda de conhecimento, sugerindo uma gestão dos recursos mais adequada no cumprimento da Missão da Força Aérea.

Palavras-chave: Ciclo de Gestão do Conhecimento, Força Aérea, Gestão da Informação, Gestão de Recursos Humanos, Gestão do Conhecimento Aeronáutico-Militar, Programa de Gestão do Conhecimento.

Introduction

Knowledge Management (KM) was introduced in the corporate world in the 1980s as a means to select critical information that could give organisations a competitive advantage. Today, knowledge is considered a key asset for organisations, and as it (partially) resides in the minds of its employees, the practice is often associated with Human Resource Management (HRM). Because knowledge is shaped by an individual's experience, the challenge posed by KM lies in orchestrating an environment where employees are encouraged to share that knowledge so that can be included on the organisational body of knowledge and help minimise the impact of employee outflows.

The aeronautical industry is one of the most complex industries of the global age, in that it develops a final product with distinctive characteristics. The field of military aviation is even

more exclusive, as it involves the operation and management of highly advanced weapons systems and a Mission that distinguishes it from other institutions. The Portuguese Air Force (FA) is the flagship of the national aeronautical sphere for the quantity, diversity, longevity and sophistication of the aircraft that constitute its operational assets.

The FA's Human Resources (HR) combine a unique body of knowledge which contributes to the military defence of the Republic (MDN, 2009, p.6429). However, the organisation is facing a serious problem due to the outflow of military personnel, as 4,756 of its employees left the force since 2010[1] and another 5,172[2] were transferred from 2010 to 2015. Both situations may occur without the overlap of duties to safeguard 'handover of service', resulting in irreversible losses in aeronautical knowledge.

In light of the above, it should be noted that the FA is at a high risk of losing core assets because it has failed to implement measures to preserve organisational knowledge, unlike the following top companies in the aeronautical industry: Boeing; National Aeronautics and Space Administration (NASA); and the United States Air Force (USAF). This gap can be addressed by implementing a Knowledge Management Programme (KMP) in the FA that continue some separate informal initiatives already undertaken. In light of the problem presented above, we propose to study the issue of 'Aeronautical Knowledge Management in the Air Force'.

The object of study of this research is the retention and sharing aeronautical knowledge in the FA, and thus we will not address the issues of types of knowledge, piloting procedures and navigation procedures, and technological structures. This research aims to identify guidelines to help minimise the loss of aeronautical knowledge in the FA by preparing a KMP that: takes into account the strategic alignment of the FA; presents a global KM architecture suited to the FA; and enables the integration of KM into the FA structure.

This study will be conducted according to the methodology suggested by Quivy and Campenhoudt (2005), and the main **Research Question** was defined in the first stage: *How will implementing Aeronautical Knowledge Management help minimise the loss of knowledge caused by the outflow of Air Force personnel?*

This question led to the following Subsidiary Questions (SQ):

SQ1 – *To what extent is the Air Force aligned with the critical factors for the successful implementation of knowledge management?*

SQ2 – *What is the best suited knowledge management programme architecture to minimise the loss of knowledge?*

SQ3 – *How can knowledge management be integrated into the existing information management structures?*

The second stage consisted in conducting a literature survey and exploratory interviews with four people: Colonel José Pacheco (then the Deputy Director of Personnel); Major

[1] Data from the Directorate of Personnel on 7 November 2016.

[2] Idem.

José Marques (author of the individual research project 'Criação de um repositório digital institucional' ['Creation of an institutional digital repository']; Ana Neves (general director at Knowman); and Professor Maria João Santos (head of the Master's programme in HRM at the Instituto Superior de Economia e Gestão [Lisbon School of Economics and Management]).

The **Hypotheses** (H) that guided this research are:

H1 – *The Air Force is favourably aligned with the critical factors of KM implementation.*

H2 – *The architecture of the KM programme must favour knowledge sharing and knowledge retention.*

H3 – *KM can be integrated into the Information Management structure as an autonomous, independent activity.*

The hypotheses were tested using two observation techniques: semi-structured interviews with seven members serving in the FA (subjected to content analysis); and secondary data collected from the Knowman report (2013) on KM in Portuguese companies.

This research paper has been divided into four chapters. The first chapter presents the theoretical framework of this research, with special emphasis on the KM cycle. The second chapter contains cases studies conducted on Boeing, NASA and the USAF. The third chapter features an analysis of the state-of-the-art of KM in the FA. Finally, the fourth chapter provides an analysis of empirical data which will allow us to test the hypotheses and answer the research question that guided this research. The conclusion will outline this paper's contribution to knowledge.

1. Knowledge Management

"The goal is to break down barriers and transform industrial-era organizational structures into an information and knowledge-based enterprise."

United States Strategic Command (2009)

Today, modern society no longer relies on natural resources and physical assets to grow, but on intellectual capital, which means that knowledge has become the key organisational resource for projects and smart decision making (Silva and Neves, 2004).

Knowledge is created and shared between individual and collective minds and stems from experience and learning, and it can be described as the final product of a metamorphosis that begins with 'data' (discrete and objective facts on events stripped of their importance and relevance), evolves into 'information' (organised, relevant data that can be used by task doers and decision makers), and culminates with 'knowledge' (a more encompassing term which implies understanding the information). When refined by experience and prudence, knowledge can be elevated to the higher status of 'wisdom' or, when it refers to in-depth knowledge on a single subject, of 'expertise' (Curado and Bontis, 2011).

Knowledge is applied information that is both relevant and is partially based on experience (Fard and Selseleh, 2010), and it can be divided into two types:

- Explicit (codified), when it refers to competencies that are observable and that can be easily measured and shared (for example, processes and models);

- Implicit (tacit), when knowledge is gathered through experience, perspectives and values (for example, know-how, judgements and impressions). This kind of knowledge is the hardest to document and share, as it resides in the minds of employees and in informal social relationships (Martin, 2005; Lungu, 2013).

KM is a process that combines the design and implementation of tools, systems, structures, and cultures, creating value and improving decision making and performance in organisations by fostering the creation, sharing and use of knowledge (Noe, 2008; Schreiner, 2013), and, according to Santos (2013), it also 'allows companies to leverage their innovation capacity'. There have been three generations of KM (Anand and Singh, 2011): the 1st generation (1990-96) focused on the principles and concepts; the 2nd generation (1996-2002) was based on artificial intelligence and on the practical applications of KM; and the 3rd generation (2002 to the present day) focuses on the relationship between knowledge and action.

According to Nonaka and Takeuchi (1995), the forerunners of KM, the real competitive edge of KM lies is translating the tacit knowledge that resides in the minds of employees into organisational knowledge.

a. Cycle

The knowledge life cycle is the organisation of a set of stages through which information becomes a valuable strategic asset. Based on proposals by different authors, we were able to build a matrix that describes the path that knowledge travels in an organisation and to identify four phases (Bergeron, 2003; CEN, 2004; Nonaka and Takeuchi, 1995; Wiig, 1993):

- **Capture**. This phase consists of knowledge acquisition and is represented as a spiral that successively converts tacit knowledge into explicit knowledge in an endless continuum that requires direct contact with the experts holding that tacit knowledge. This phase is particularly important when organisations adopt incentive policies to reward creativity and experimentation.
- **Codification**. This phase comprises the activities related with organising and formatting knowledge in compliance with organisational norms and taxonomies. 'Encrypting' knowledge protects intellectual property rights, preventing competitors from discovering it.
- **Exploitation**. This phase enables the sharing and use of knowledge by specific individuals in an organisation (for economic, functional or security reasons). Once this knowledge has been used, it is then 'memorised' by the organisation and can be (re)used in institutional archives, such as manuals, databases, repositories, patents, frequently asked questions systems, Yellow Pages, etc.

- **Review**. In this phase, knowledge is assessed and then archived or eliminated by enhancing value creating assets, or those with strong potential, and by removing 'toxic assets' that represent costs for the organisation, or assets with limited future value that could be replaced by outsourcing.

b. Critical factors

Critical factors are a limited number of factors shaped by an organisation, which can jeopardise the potential success of the KM activity if they are not complied with. Following the idea put forward by Wong (2005), we have selected three factors that will allow us to assess military aeronautical knowledge.

- **Culture**. Organisational culture is a set of perceptions and ideals shared by the members of an organisation that set it apart from other companies (Noe, 2008). Some sub-factors allow us to categorise the culture of organisations according to their 'knowledge awareness' (CEN, 2004):
  - Traditional organisations with low knowledge awareness - limited dissemination of information; numerous management levels; rule-based; formal structures; risk-averse; knowledge retention; and low emotional intelligence;
  - Modern organisations with high knowledge awareness - scaled dissemination of information; few management levels; principle-based; informal structures; capable of some risk-taking; open policy; sharing and use of knowledge.
- **Leadership**. Leadership is the ability to direct, motivate and inspire a group to increase their commitment to KM (Pukkila, 2009). Commitment is crucial to the success of KM, and, because it is driven by internal motivations and external incentives, an organisation's leadership style will determine whether the implementation of the project will be supported or hindered. KM requires leaders who make sharing a top priority and ultimately consider a policy of 'compulsory sharing' acceptable (Prevou, 2011, p. 10).
- **Technology**. Technology encompasses a set of physical or virtual operating systems that enable an organisation to computerise some of the practices and theoretical procedures of KM. Technology is widely seen as a support element, which may weaken its status as a critical factor; however, the dependence of KM practices on computer technology is substantial, as it: centralises the knowledge repository and the KM portals to link information systems together; creates an environment that facilitates the gathering and presentation of internal and external knowledge; and seeks and shares information, allowing knowledge to be instantly reused.

2. Military Aeronautical Knowledge Management

Aeronautical KM is implemented at the institutional level by Boeing (aeronautical industry), NASA (aerospace industry) and the USAF (military aeronautics). Although the 'business' conducted by these three world-renowned organisations may seem rather distant in terms of size/volume when compared to the reality of the FA, there are common aspects to these four organisations, such as the need for aeronautical KM, valuable knowledge, and outflow of HR. The three organisations under analysis were chosen because the goal is to bring the FA KM into line with the top aeronautical companies.

a. Aeronautical knowledge: Boeing and NASA

'Like all large, knowledge-intensive organizations, NASA faces continuous challenges identifying, capturing, and sharing what it knows effectively'.

Ed Hoffman, CKO at NASA (2012)

Boeing is a north-American company founded in 1916, and its main activity is building commercial and military aircraft, satellites, weaponry and electronic and defence systems. As of May 2004, the company employed over 169,000 people in 65 countries. The company's vision is 'people working together as a global enterprise for aerospace industry leadership' and its strategic goals are: 'sharing best practices, technologies and productivity improvements; leadership development; and valuing ethics and compliance' (Boeing, 2014).

In 2013, Boeing's HR Department found that 19% of its workforce was eligible to retire, and that by 2018 that percentage would rise to a hefty 40%, which was aggravated by the fact that in 2007, 80% of knowledge resided 'only' in the minds of employees. It was a delicate situation because Boeing has a highly technical workforce dealing with aircraft with exceptionally long product life cycles (Arkell, 2007; Bridges, 2010).

The company adopted a KM strategy with the following aims: retaining the knowledge of exiting employees; sharing knowledge, best practices and lessons learned across the company; preventing employees from 'reinventing the wheel' and repeating past mistakes; and accelerating innovation. To ensure that all employees participated in KM, Boeing implemented an incentives plan to reward the most committed employees, which included certificates and recognition awards.

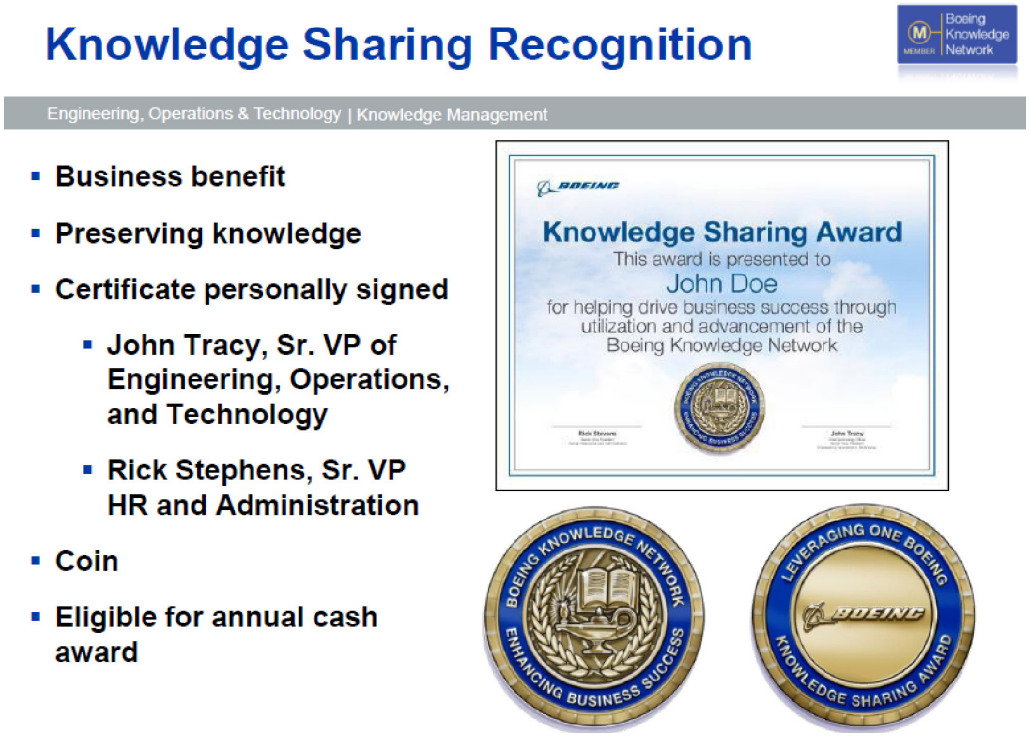

Figure 1 – A Boeing recognition award

Source: Briges, 2010.

Boeing's KMP is represented by the 'wheel of knowledge', which summarises the stages of organisational KM:

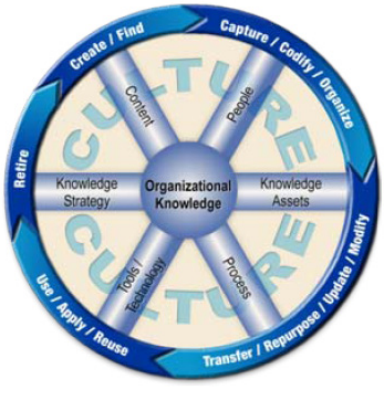

Figure 2 – Boeing Wheel of Knowledge

Source: Briges, 2010.

This model merges knowledge with learning to create a continuous life cycle. This encourages the creation or discovery of new knowledge as a positive response to the selective retirement of useless knowledge, ensuring that more information is available in repositories. Organisational knowledge and culture are the 'heart' of a system composed of processes, tools, methods and techniques designed to identify, capture, apply, retire and create knowledge throughout its life cycle.

For Boeing, a KM programme must focus on the knowledge capture and knowledge sharing phases, as they are the most critical and valuable for the enterprise (Arkell, 2007).

NASA is a north-American government agency created in 1958, which employs about 18,000 people, and the company vision is 'to reach for new heights and reveal the unknown for the benefit of humankind'.

According to the Chief Knowledge Officer of NASA (Hoffman, 2012), more than half of the company's workforce is eligible for retirement at that time, and there was a strong possibility that most 'senior' employees would leave the Agency from 2012 to 2016. NASA's answer to the challenges of KM was the NASA Knowledge Management Team created in 2002. The team elaborated a Strategic Plan based on Information and Communications Technology (ICT) which focused on sharing employee knowledge rather than facilitating its capture.

Over the years, the Agency identified three strategic KM goals (Holcomb et al, 2002): to sustain NASA's knowledge across missions and generations by identifying and capturing the information that exists across the Agency; to help employees find, organise and share existing knowledge; to increase collaboration and to facilitate knowledge creation and the sharing of lessons learned by developing techniques, tools and venues.

NASA called its KMP the *Knowledge Management Roadmap*, which attempts to integrate KM procedures without interfering with pre-existing work processes and without adding new functions, concepts or tools. This 'smooth' integration is represented by the phases of the KM cycle (Sharing, Integration, Capture and Modelling), which are distributed chronologically depending on needs and context. The KM practices programme implemented by NASA since 2002 can be represented by the following diagram:

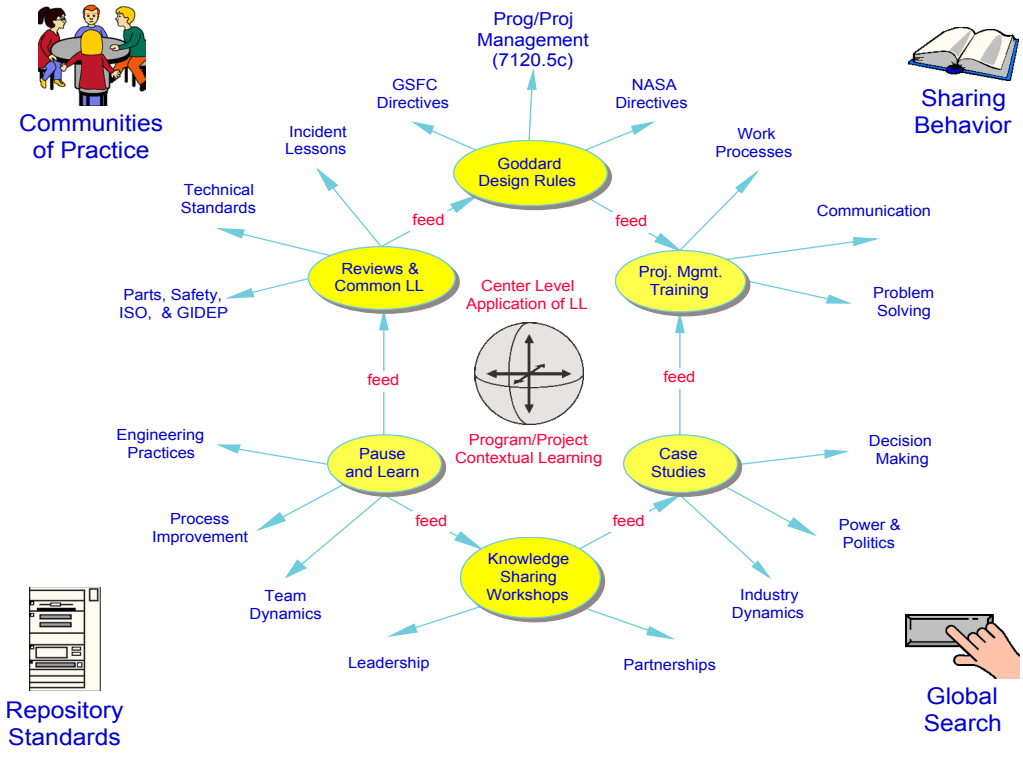

Figure 3 – NASA's KM practices programme

Source: Holcomb et al, 2002.

The programme is based on 'lessons learned' and combines four capabilities: Knowledge repositories; Global search; Communities of practice; and Sharing behaviour.

b. Military Knowledge: the USAF

> *"The goal of military knowledge transfer is very simple: Find those that have military experience and knowledge of value and transfer it as rapidly and easily as possible to those who need it."*
>
> Dalton (2010)

The USAF is the military aeronautical branch of the US, which employs about 333,000 active military personnel and about 5,500 aircraft. Its Mission is to 'fly, fight and win... in air, space and cyberspace' and its vision is 'Global Vigilance, Global Reach and Global Power'. Its values are 'integrity first; service before self; and excellence in all we do' (USAF, 2013).

Much like the two organisations we addressed above, the USAF is facing an HR outflow problem, especially as the force will be reduced by 25,000 airmen until 2017 (Svan, 2013).

The USAF developed a KM solution that takes into account the knowledge required by a warfighter, and acknowledges that all airmen must have access to relevant data, information and knowledge/expertise in the right place, at the right time, safe from interception and presented in a simple format for sustained superiority (USAF, 2008).

The USAF considers that 'boundary-less knowledge sharing is synonymous with Air Force culture' and acknowledges that airmen must be aware of the benefits of knowledge sharing and of the need to integrate it into their work routines, and this led to a training programme (e-learning) being implemented on the capabilities and potential of KM, which is administered across the institution (Bartczak et al, 2010; USAF, 2008; USSC, 2009).

The USAF approved the *Air Force Smart Operations for the 21st Century* programme to capitalise on using knowledge from other organisations and disciplines to improve processes within the Air Force (USAF, 2008). The effectiveness of this strategy depends on the Knowledge-Centric Operations approach, which focuses on managing warfighter know-how, constantly adapting the knowledge available to the needs of the battlefield.

In addition to this, Air Force Policy Directive (AFPD) 33-3 establishes the framework that allows the USAF to create, use and preserve information to achieve its strategic goals and fulfil its missions, and to ensure that all Air Force personnel has on-demand access to the knowledge available, accelerating 'machine-to-human' and 'machine-to-machine' interactions (USAF, 2006, p.2).

In order to respond to the urgent needs of Information Management (IM) and Knowledge Management (KM), the USAF introduced Knowledge Operations Management as a military speciality, a role which not only functions as a CKO but also develops manuals to regulate data storage.

KM is crucial to the fulfilment of the USAF mission, and, in that spirit, the Knowledge Management Centre of Excellence was inaugurated to develop and manage the Air Force Knowledge Now (AFKN) application. Also known as Community of Communities, the AFKN application launched in 2002 is a web-based environment organised into thousands of Communities of Practice (with a total of about 300,000 users) featuring e-learning techniques, connecting 'those who know' to those who need information through a set of practices (USAF, 2013; Tucker, 2010). The USAF recommends knowledge sharing and access to knowledge (through repositories), as shown in the figure below:

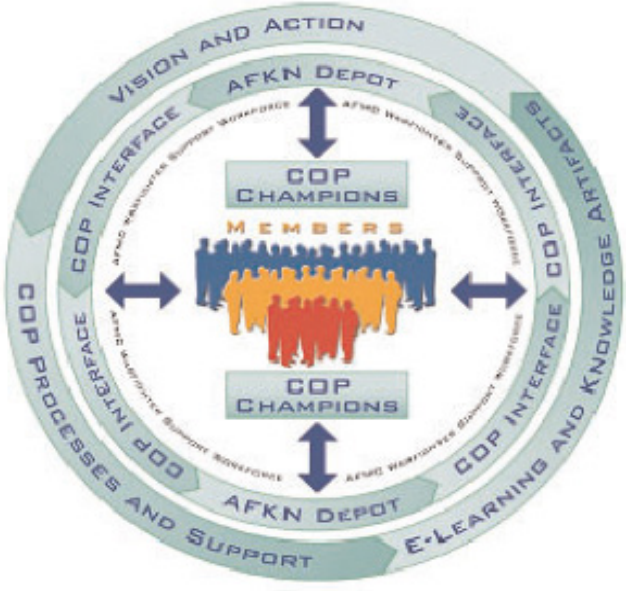

Figure 4 – The USAF KM cycle

Source: Tucker, 2010.

'What we cannot allow is that new arrivals erase what has already been done and start over, as if it were the first time'.

Páscoa (2013)

3. Assessment of the Portuguese Air Force

a. Organisation

The FA Mission is to readily and actively participate in the main areas of national interest by cooperating with other entities in the defence of the Republic. The FA vision is supported by the value of its people, and the principles which guide their actions are: loyalty, integrity, competence and excellence (CEMFA, 2013). The FA goal of most relevance to this research is that of 'promoting the ongoing improvement of the FA performance through the efficient management of its human resources', which includes the operational objectives 'managing HR in an efficient manner; valuing human potential; and ensuring the development of strategy, knowledge, and management of change'.

Much like the three aeronautical organisations analysed above, the FA is facing structural difficulties related to the loss of knowledge caused by the exit of 4,756 airmen since 2010, which was aggravated by the transfer of another 5,172 (in an organisation with 5,958 service members) from 2010 to 2015 [3].

[3] Data from the Directorate of Personnel on 7 November 2016.

Considering that the outflow of military personnel can occur without the guarantee of 'handover of service' to newcomers, instead of sharing tacit knowledge, which is refined by experience, there is a risk that the organisation may discard it as if it were organisational waste.

b. Knowledge Management Audit

The FA has developed separate institutional initiatives to guarantee the retention and sharing of knowledge, such as: coordination meetings, of which minutes are kept; internal portals and intranet; internal manuals; issuance in the *Ordens*; *Mais Alto* journal; scientific journal of the Air Force Academy (AFA); 'FAP on line'; operational procedures (especially flight-related procedures); website; Facebook; Twitter; etc. Most of these practices resemble instruments of institutional communication and are not managed in an integrated manner, nor are they included in any of the established procedures of the FA policy, which leads us to conclude that an effective KM is not in place in the organisation.

There are other factors which contribute to the implementation of a KMP, from an organisational perspective. The life cycle of military aircraft is extremely long (the Alouette III has been in use since 1962; the C-130H, since 1977; and the P3, since 1988) and the exclusive knowledge consolidated over years of experienced is not managed, which makes it difficult to share it with newcomers. It should be noted that in terms of IT, the conditions have been created to allow any member of the military access to the portals and platforms on a computer terminal anywhere in the world.

In August 2011, the Air Force issued *Regulamento da Força Aérea 391-1* (RFA) [Air Force Regulation 391-1] to regulate the Gestão da Informação da Força Aérea (GIFA) [Air Force Information Management], defining an organisational structure to ensure that informational resources are used effectively and efficiently, and to preserve and identify information that is perpetually valuable for the organisation by combining the functional aspects (content) and the systemic aspects (technology) in a single body. This version of the RFA is an excellent basis for the implementation of KM in the FA.

With regard to 'information stakeholders', the *RFA 391-1* introduced the position of Chief Information Officer (the person who manages the IT processes and is in charge of the projects related to Information), as well as the positions of: Information Director; Functional Area Information Administrator; Functional Area Information Deputy; and Information Delegate.

Finally, a proposal for a teaching, training and qualification directive was presented in April 2013, which mentions the implementation of the 'collaborative' concept (DIVREC, 2013), stating that the FA will provide the conditions for the creation of collaborative and cooperative practices through which all military personnel will participate in their own learning process, building their own knowledge; should that knowledge have organisational value, it will then be managed by the GIFA.

This brief assessment allowed us to conclude that it is necessary to create a KM system to aggregate the practices of the different areas, and that some conditions needed to integrate this new HRM practice have already been met.

4. Plan of action

> 'Among the organisational factors that can act as main roadblocks to a Knowledge Management Programme, one of the most important is organisational culture.'
>
> Santos (2013)

a. Methodology

In the observation phase, secondary data were collected based on the Knowman report (2013), seven semi-directed research interviews were conducted, and a comparison map of the responses was elaborated to make it easier to identify points of convergence and divergence by conducting a content analysis. The following people were interviews were interviewed:

- The Director of Personnel, Major General José Mata, as the person in charge of global HR management in the FA;
- The SubCEMFA and Information Director, Major General Manuel Martins, as the person in charge of GIFA;
- The Head of Public Relations of the Air Force, Colonel Rui Roque, as the person in charge of dissemination and of selecting internal and external information channels.
- The Head of the Analysis and Methods Department of the Operations Division, then Lieutenant Colonel Carlos Páscoa, as the person in charge of planning the FA Effort Regime, and the author of the PhD dissertation*Organizational and Design Engineering of the Operational and Support Dimensions of an Organization: The Portuguese Air Force Case Study*", someone with vast experience in the teaching and training areas;
- The Head of the Information Systems Department of the Communications and Information Systems Division (DIVCSI), Lieutenant Colonel Ana Telha, as the person in charge of implementation and development policies for the new IS;
- The Head of the Information Technologies Department of the Communications and Information Systems Direction (DCSI), Lieutenant Colonel José Gorgulho, as the person in charge of managing and developing the IT assets of the FA, someone with experience in creating Information Systems to support decision-making;
- The Deputy for personnel planning of the Personnel Department of the Resource Division (DIVREC), Major Paulo Simões, as a 'disseminator' of FA e-learning content, someone with training experience, and the person in charge of developing teaching platforms in collaborative environments.

Table 1 shows the model of analysis used in this paper, which comprises the hypotheses, concepts and their dimensions and indicators:

Table I - Model of analysis

Hypotheses	Concepts	Dimensions	Indicators
H1:The Air Force is favourably aligned with the critical factors of KM implementation.	Critical factors	Culture	Knowledge awareness level
			Compatible with FAP values
			Formal or informal collaborative transfer
			Sharing or rentention-based management
		Leadership	Change-driving or change-resistant
			Integrating or destructuring
			Orientation towards voluntary or compulsory sharing
		Technology	Centralising or decentralising the knowledge repository/ knowledge portal
			Facilitating capture/presentation or reusing knowledge
			Degree of importance
H2:The architecture of the KM programme must favour knowledge sharing and knowledge retention	Programme architecture	Strategy	Focus on knowledge retention (Boeing model)
			Primacy of sharing over capture (NASA model)
			Guarantee of simple, useful and available information (USAF model)
		Life cycle	Capture of new knowledge
			Codification into the organizational taxonomy
			Exploitation to disseminate knowledge across the organisation
			Review to separate valuable assets from toxic assets
		Practices	Video records and presentation in classroom lessons
			Transfer of knowledge by retired senior officers
			Repositories or databases
			Billateral collaborative techniques
			Review of actions and lessons learned
			Fostering sharing and individual contributions

Hypotheses	Concepts	Dimensions	Indicators
H3:KM can be integrated into the Information Management structure as an autonomous, independent activity	Information Management	Structure	Horizontal relationship: integration or separation
			Vertical relationship: level of dependence
		Positions	Creation of the "Knowledge and Information Director" position
			Creation of the 'Administrator' and 'Deputy for Knowledge' positions
		Competencies	Desirable competencies for 'knowledge workers'
			Body of autonomous Knowledge Management competencies

Source: Prepared by author.

As the model of analysis shows, the 'Critical factors' concept was divided into three dimensions: Culture, which combines knowledge awareness, values, knowledge transfer and stance on sharing: Leadership, which aggregates some aspects of the senior ranks' stance on change and on the way knowledge is shared; and Technology, which gathers some aspects of the centralisation of the knowledge portal, its usefulness and degree of importance. The 'Programme architecture' concept was divided into three dimensions: Strategy, which combines the stances of Boeing, NASA and the USAF; Cycle, which aggregates the capture, codification, exploitation and review phases; and Practices, which gathers the sharing activities used in the aeronautical industry. The 'Information Management' concept was divided into three dimensions: Structure, which combines the relationship between KM and IM; Positions, which aggregates the creation of new functions that integrate the 'knowledge' component; and Competencies, which gathers some aspects of the expertise needed for KM.

b. Alignment of the Air Force

For Santos (2013), 'the success of the implementation of a KM programme depends on the establishment of proper links between the organisational context and the KM programme'. Thus, examining how the FA aligns with the critical factors 'culture', 'leadership' and 'technology' will allow us to ascertain if the organisation currently meets the requirements to implement a KMP.

With regard to the 'culture' factor and to the sub-factors that allow us to categorise the culture of an organisation, the FA is a 'Traditional organisation, with low knowledge awareness' (CEN, 2004). However, knowledge awareness is what has allowed the FA to adapt to transformations and changes (Martins, 2013). This is further reinforced by the Knowman report (2013), which states that 62% of organisations seek to 'reap greater and better benefits from existing knowledge'.

We have discovered that the FA values (loyalty, integrity, competence and excellence) are the key to doing more with less, or to doing more, faster, because the knowledge of how things are done is already there, rooted on past achievements, which means that they align with the principles of KM. For Telha (2013), KM promotes the FA values, especially 'excellence', by leveraging resource management, decision-making and the improvement of the final product.

We have found that the method of knowledge transfer most used in the FA is the informal method, in the form of a 'semantics shared by all' (Páscoa, 2013), suggesting that the organisation meets the conditions for the kind of 'collaborative sharing' that is also used in KM. ICTs promote the informal transfer of information by providing useful information for decision-making to complement formal modes of transfer.

This study found that the FA does not have an established culture of sharing, and that, on the contrary, knowledge is retained in the minds of its people. This creates difficulties when service members have to be rotated, as it can easily lead to the notion of 'irreplaceable' personnel. In addition to this, the FA culture does not foster knowledge sharing, which on the one hand makes its members less likely to divulge what they know, and on the other discourages them from 'working outside their unit's perimeter because we do not have all the knowledge we need' (Gorgulho, 2013). However, most interviewees acknowledged that the current trend is a slow but steady change towards a culture of sharing.

As for the 'leadership' factor, all interviewees considered the strategic apex of the FA to be a driver of change which plays an integrating role in today's climate of uncertainty. This stance by the chain of command suggests that the climate is now optimal for the integration of KM in the FA because leaders tend to adopt new projects when the narrative they are presented with has compelling arguments. The FA leadership should not force its members to share their knowledge, but should instead encourage voluntary sharing as the responsibility of all military personnel by employing 'evangelisation' processes that convey the advantages and importance of KM to the organisation.

The Knowman report (2013) concludes that 47% of organisations state that their global strategies include KM, which shows that today's strategic leaders are concerned with achieving the type of alignment examined in this paper.

With regard to the 'technology' factor, the most appropriate approach to KM is the centralisation of the repository/information portal, as this will enable faster decision-making and the systematisation and integration of knowledge, albeit in different forms for each area of work. However, centralisation does not only require structured knowledge, and it can be

presented in a non-structured manner, much like Google, Twitter and Facebook (Gorgulho, 2013).

As for the usefulness of the IT platform, it is considered important but not as essential as culture, so it should only serve as a facilitator. However, the 'information system is the new centre of gravity and the FA has yet to recognise this' (Páscoa, 2013), which points to the urgency of setting up redundancies (records kept in physical documents) to safeguard organisational knowledge, something that KM can provide.

In military aviation, the technological footprint is a constant cause for concern, and the emphasis on this factor is 'naturally high, as it results from an organisational culture that is highly technological when compared to that of the other branches' (Mata, 2013). However, it should be noted that while 'technology is capable of achieving whatever one wishes, it must always serve the objectives of the organisation, and its business processes must align with the technology architecture and the application architecture (Gorgulho, 2013).

In the face of these data, we believe that we have enough information at this time to assess the first hypothesis. In light of the above, we can confirm **H1** - *The Air Force is favourably aligned with the critical factors of KM implementation*. Thus, we are now able to answer **SQ1** - *To what extent is the Air Force aligned with the critical factors for the successful implementation of knowledge management?*

The conclusions presented so far allow us to state that the FA is currently aligned, in descending order of priority, with the factors 'leadership' (as a driving force for change, with an integrating role), 'technology' (tendency towards the centralisation of the knowledge portal) and 'culture' (the weaker element due to low knowledge awareness and retention-based management, which is nevertheless compatible with the values of the FA and is identified with collaborative transfer), which means that conditions for KM implementation are likely to be met.

c. Knowledge Management Architecture in the Air Force

The KMP should: be designed according to a KM strategic orientation that will guide all subsequent actions; be supported by a life cycle that defines how knowledge will be treated; be sustained by a set of practices.

With regard to 'strategy', the Knowman report (2013) states that 62% of surveyed organisations do not have a KM strategy and do not include KM in the global strategy, in a discouraging outlook for the success of KM in Portugal. The FA includes knowledge development in its operational objectives, another reason why it is important to define a KM strategy for the FA. Some of the FA HR hold exclusive knowledge that is difficult to share, so this strategy should focus on retaining knowledge in the organisation (Boeing vision), as this is the only way to fill in the gaps left by personnel outflows.

The strategy should also invest in interpersonal sharing, as NASA does by inviting employees to expose their knowledge free from commercial pressures. The FA must begin

capitalising on informal sharing and on the aeronautical knowledge that flows out of the organisation (Gorgulho, 2013). While sharing is essential, it will only add value to an organisation if it is in line with the culture and maturity of that organisation (Páscoa, 2013).

The USAF's KM model provides simple, useful and available knowledge, and is one of the strategies best suited to the FA, as it most closely resemblesPortugal's response capability needs and the security issues associated with military knowledge. It should be noted that the USAF includes the concept of KM in its leadership definition, which clearly shows the organisation's stance.

As for the knowledge life 'cycle', the statements made by the interviewees suggest that the FA should adopt the following four stages: 'Capture' of explicit and tacit knowledge, which focuses on encouraging sharing and on teaching sharing in training schools; 'Codification', which is fundamental to feed the organisational glossary; 'Exploration', especially by rewarding individuals who take the risk of sharing, and taking steps towards implementing a 'search engine' system (access to information regardless of structure); and 'Review' to separate permanent knowledge from outdated knowledge and to validate new or enhanced knowledge and feed it back into the cycle.

With regard to the practices that would 'ideally' be included on the FA portfolio, our research found that 'video recording' has the advantage of conveying knowledge to people who do not attend training actions, and that it can use Youtube,'broadening its potential as a solid research channel' (Gorgulho, 2013). The transfer of knowledge by 'retired senior officers' is well accepted, albeit subject to rigorous selection (Martins, 2013; Telha, 2013). This solution would successfully dissociate important issues from the past featured in the *Museu do Ar* or in the FA's *Arquivo Histórico*, but it would require a change of mindset in the organisation and in exiting members.

'Repositories or databases' are considered crucial for a KMP, and it is essential that they remain disciplined and up-to-date to prevent information overflow. As long as provisions are made to keep information secure, 'bilateral collaborative techniques' are regarded as 'absolutely crucial' practices and some are already being developed in the FA, such as custom collaboration portals and communities of practice for work groups.

As for 'review of actions and lessons-learned', military personnel who perform operational duties are 'formatted for this way of working, unlike other members of the military' (Roque, 2013), and thus constitute a valid practical example of 'learning from mistakes and from successes' from which a check-list of organisational procedures can be drawn (Telha, 2013). Finally, with regard to 'sharing and individual contribution' of knowledge that is not directly related to the Mission, interviewees stated that it increases motivation in military personnel, enabling the FA to receive new knowledge, but also that it is a waste of time and resources.

According to the Knowman report (2013) these are the tools/activities used by more than half of the companies analysed: Best practices databases; Knowledge-sharing meetings; Intranet or corporate portal; Chat-rooms and instant messaging; Online collaborative

platforms. The most 'innovative' practices are used sparingly: Practice communities/Learning networks; Wiki; Micro-blogging; and internal Social bookmarking.

In the face of these data, we believe that we have enough information at this time to assess the second hypothesis. The above allows us to confirm **H2** - *The architecture of the KM programme must favour knowledge sharing and knowledge retention* and answer **SQ2** - *What is the best suited knowledge management programme architecture to minimise the loss of knowledge?*

The KMP architecture should provide a strategy that combines knowledge sharing between military personnel, as Boeing and NASA have done, with available, useful and simple knowledge that can be used by any service member who might need it, as in the USAF. The cycle that drives the KM activity should include phases to capture, codify, exploit (special emphasis must be given to this stage) and review knowledge. Practices should be diversified so that all military personnel will be encouraged to share their knowledge, both in the form of innovative virtual activities (collaborative techniques) and in the form of traditional attendance-based sessions (lessons learned).

d. Integration of Knowledge Management in the Air Force

Implementing a KMP in the FA implies following a set of rules to guarantee success, and we will now examine how KM may be integrated into the organisation.

We have found that KM may be introduced into the structure of the FA by integrating it in (rather than separating it from) the structure already approved for the GIFA under its new designation, Gestão do Conhecimento e da Informação da Força Aérea (GCIFA) [Air Force Knowledge and Information Management]. Efforts should concentrate on 'adding a layer of knowledge to the provisions of *RFA 391-1*' (Páscoa, 2013) to take advantage of the existing structure in the most rational way. According to the Knowman report (2013), KM either functions as a part of the Direction or as an independent department.

Conceptually, it is widely accepted that knowledge should rank higher than information, so the structure should reflect this hierarchy. A 'Director of Management and Information' position should be created to perform this new higher management role in the FA by 'redesigning the former Information Director position', as 'the conditions have not yet been met to create a Knowledge Director position' (Páscoa, 2013; Simões, 2013). Suggested middle management positions include an 'Administrator' and a 'Knowledge Deputy' (as well as a Knowledge Representative), which are different from the current GIFA positions, so that the two domains can remain independent. The Knowman report (2013) states that 47% of the organisations analysed have people in charge of KM.

It was found that the desired competencies are no different than those required for GIFA, and that knowledge workers should be able to gather and convey information through the available channels. These individuals should be imbued with the values, vision and Mission of the FA, so that they may function as 'railway operators who select the most relevant lines of knowledge for the collective body that requires it, at the right time' (Roque, 2013). These

individuals (if they are engaged in the activity full-time) could be known as 'content curators' who, after a critical reading of the information entering the organisation, manage that information by assigning it value and meaning (Simões, 2013).

The KM body of competencies should be exclusive (rather than shared with GIFA's) and should provide: a critical and interpreted analysis of useful intelligence pertinent to commanders; predicting future scenarios with a high degree of certainty (for example, ten-year career forecasts) based on given variables; developing mechanisms and methodologies to selectively capture and share knowledge. The Knowman report (2013) lists the main competencies exclusive to KM: facilitating knowledge transfer initiatives; identifying sources of information and knowledge; managing the KM strategy; and publishing content.

In the face of these data, we believe that we have enough information at this time to assess the third hypothesis. The above allows us to confirm **H3** - *KM can be integrated into the Information Management structure as an autonomous, independent activity*. We can now answer **SQ3** - *How can knowledge management be integrated into the existing information management structures?*

KM can be integrated in the GIFA structure through a layer dedicated to knowledge, although conceptually it should rank higher than information. The new higher management positions required by this new layer will be redesigned based on existing ones, while middle management positions will be created from scratch. The competencies required for these positions in the new layer must be compatible with those required for the GIFA positions, although the body of competencies (job description) should be different to ensure the exclusivity of both domains of knowledge.

After testing the hypotheses, we can now answer the **research question** that guided this research: *How will implementing Aeronautical Knowledge Management help minimise the loss of knowledge caused by the outflow of Air Force personnel?*

The losses in knowledge caused by the outflow of Air Force personnel can be minimised by approving a KMP that takes the following into account:

- Alignment between the organisation and the critical factors of KM (culture, leadership and technology) at any given time;
- An architecture that provides a KM strategy to foster the retention, sharing and availability of knowledge in a simple format, a full knowledge life cycle (capture, exploitation and review) and a variety of practices that involve all military personnel;
- The possibility of implementing KM as a part of the existing Information Management structure, with some common positions and competency requirements, although maintaining its conceptual superiority and the autonomy of the body of competencies that support its exclusivity.

Based on the contributions of this research and to complement the answer to the RQ, we have proposed an orientation for the implementation of a KMP in the FA, summarised in Figure 5.

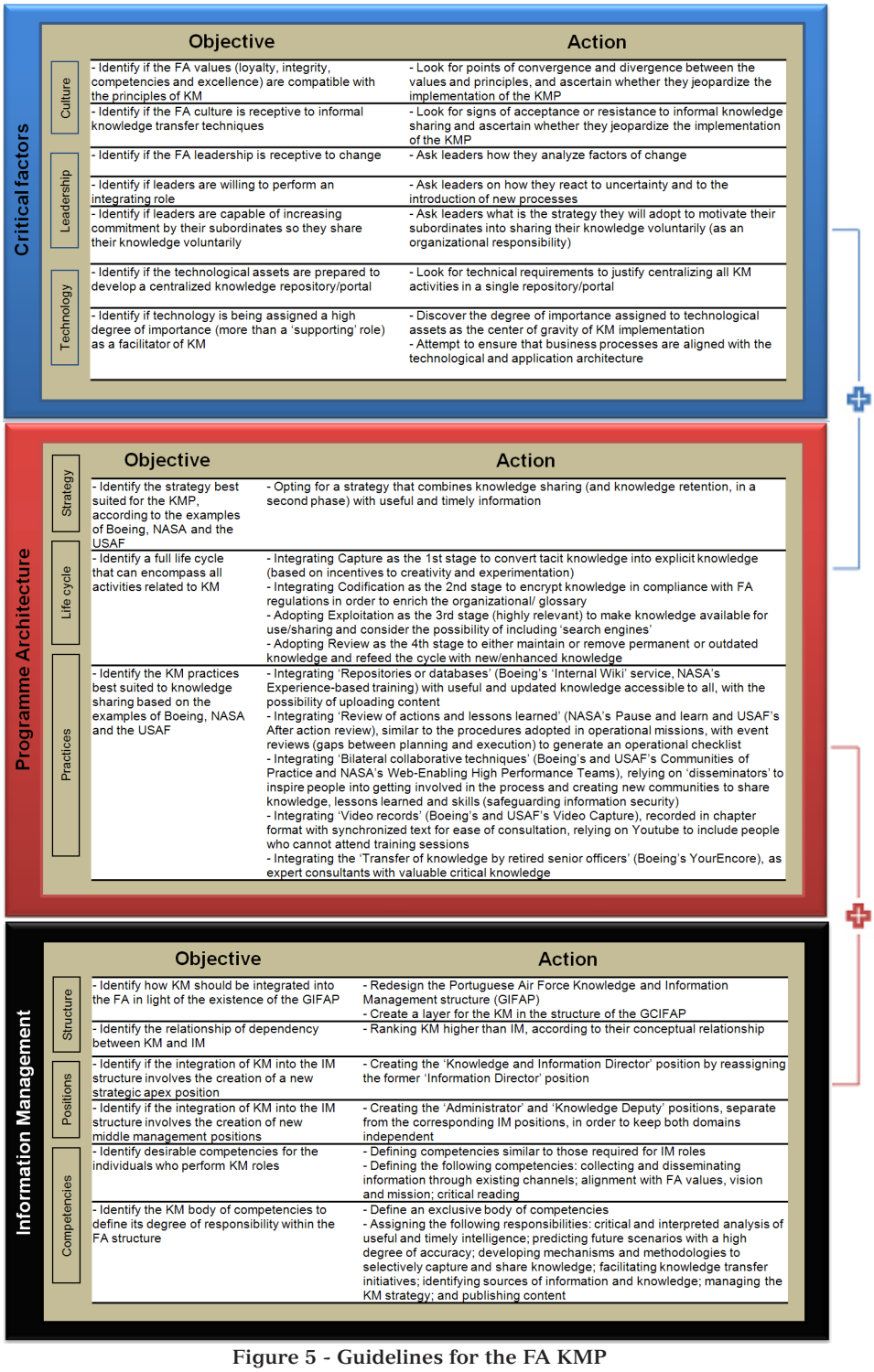

Figure 5 - Guidelines for the FA KMP

Source: Prepared by author

Conclusion

This research paper intended to identify a set of guidelines to enable the implementation of a KMP that can help minimise the loss of knowledge caused by the outflow of military personnel. Like other enterprises in the field of aeronautics, the FA deals with extremely valuable knowledge with unique characteristics in the Portuguese context, which makes it a key asset for the fulfilment of the FA Mission, suggesting that it should be kept within the organisation.

HR outflows result in uncontrolled losses in the knowledge that resides only in the minds of employees and are an opportunity for organisations to make the strategic decision of developing a KMP to minimise those losses, as Boeing, NASA or the USAF have done. In the case of the FA, 4,756 individuals left the organisation since 2010 and another 5,172 were transferred from 2010 to 2015, with the aggravating factor that both situations can occur without the overlap of duties to safeguard the informal 'handover of service', leading to alarming losses in knowledge. Unlike benchmark organisations in the sector, the FA does not safeguard the preservation of organisational knowledge at the institutional level, and that knowledge leaves the organisation along with exiting military personnel.

In order to solve this problem, we formulated the following research question: *How will implementing Aeronautical Knowledge Management help minimise the loss of knowledge caused by the outflow of Air Force personnel?*

To answer this question, we have developed this research according to Quivy and Campenhoudt's Methodology for Research in Social Sciences.

In the first chapter, we contextualised KM, the core concept of this research, as well as its importance in leveraging innovation and its fundamental role in the treatment of tacit knowledge. We presented a proposal for a knowledge life cycle in four phases (capture, codification, exploitation and review) based on the combination of the theories analysed. Finally, we defined the critical factors for the implementation of KM, such as culture, leadership and technology.

In the second chapter, we prepared a case study of three world-renowned aeronautical organisations that use KM in order to select the strategies, practices and perspectives best suited to the FA. The most relevant are: the Boeing strategy, which emphasises the retention of knowledge and sharing of best practices; the NASA KMP, which focuses on the instant sharing of knowledge accumulated over the years so that it may be included in repositories and elicit new captures; the perspective of the USAF, which provides all military personnel with relevant knowledge in the right place/at the right time in a simple format.

In the third chapter, we prepared an assessment of the FA, focusing on the aspects that could affect the implementation of a KMP, which revealed that the organisation is receptive to the concept because it combines: a vision supported by the value of its people; values compatible with KM; 'strategic' objectives that provide efficient HR management and 'operational' objectives that emphasise human potential and guarantee knowledge

development. Other factors that contribute to the creation of a KMP have been identified, such as: various institutional initiatives; weapons systems with long life cycles that require specialised, exclusive knowledge; the IT system capabilities; and the GIFA structure under development since 2011. A KMP was found to be beneficial to the fulfilment of the FA Mission, as well as to minimise the difficulties caused by the outflow of military personnel.

Finally, in the last chapter, we reflected on the methodology and on the empirical aspects. Regarding the research strategy, in addition to a literature survey, we conducted four exploratory interviews with military and civilian individuals, the results of which helped us formulate a model of analysis composed of three concepts: 'Critical factors', which we subdivided into Culture, Leadership and Technology; 'Program architecture', which we subdivided into Strategy, Cycle and Practices; and 'Information Management', which we subdivided into Structure, Positions and Competencies. The hypotheses formulated to answer the Subsidiary Questions that resulted from the Research Question completed the model of analysis.

To gather empirical data, we used a combination of observation techniques that comprised seven semi-directed interviews with FA personnel in charge of integrating KM into the organization and an analysis of secondary data from the Knowman report. These data allowed us to test the hypotheses and answer the research question. We then examined the FA's alignment in relation to the KM 'critical factors' and the data obtained allowed us to confirm **Hypothesis 1** - *The Air Force is favourably aligned with the critical factors of KM implementation* - and answer **Subsidiary Question 1** - *To what extent is the Air Force aligned with the critical factors for the successful implementation of knowledge management?*

The FA currently aligns with the critical factors, especially with 'leadership' as an integrating, change-driving element, with 'technology' in the tendency to centralise the knowledge portal, and with a 'culture' that is compatible with FA values and that has been identified with the collaborative type of knowledge transmission.

Regarding the KMP 'architecture' best suited to the FA, the data obtained allowed us to confirm **Hypothesis 2** - *The architecture of the KM programme must favour knowledge sharing and knowledge retention* and answer **Subsidiary Question 2** - *What is the best suited knowledge management programme architecture to minimise the loss of knowledge*?

The KMP architecture must provide a strategy that prioritises knowledge retention and knowledge sharing among military personnel, as well as ensuring that knowledge is available in a useful, simple format. The knowledge life cycle should include phases to capture, codify, exploit (special emphasis must be given to this stage) and review knowledge. The KMP should include a variety of practices by combining innovative and traditional approaches so that all military personnel can be encouraged to share their knowledge.

Finally, the data obtained on the relationship between IM and KM allowed us to confirm **Hypothesis 3** - *KM can be integrated into the Information Management structure as an autonomous, independent activity* and answer **Subsidiary Question 3** - *How can knowledge management be integrated into the existing information management structures?*

KM can be integrated in the GIFA structure through a layer dedicated to knowledge, although conceptually it should rank higher than information. New positions should be created for this new layer (higher management positions will be redesigned and middle management positions will be created from scratch), and the competency requirements must be compatible with GIFA's, with the exception of the body of competencies, which should be independent to ensure that both domains remain exclusive.

After testing the hypotheses, we were able to answer the **research question**. Minimising the problem identified will require the implementation of a KMP that takes into account the alignment between the organisation and the critical factors of KM. The programme architecture should provide a KM strategy oriented towards the retention, sharing and availability of simple knowledge in a full life cycle, combining practices that foster knowledge sharing. Finally, the KMP must ensure that KM can be integrated in the GIFA structure by creating a layer of knowledge that should rank conceptually higher than information, should have an autonomous body of competencies, should allow the sharing of top positions and whose competencies should be compatible with those required for the GIFA positions.

After the research was completed, we were able to present some contributions towards knowledge. On the one hand, this research filled a gap discovered during the literature survey, which is the scarcity of studies in this area, and could be the basis for future reflections on the issue. On the other hand, it could also contribute to KM, which has been gaining traction in the FA, namely by identifying ongoing strategies and practices in top global organisations and by surveying the theoretical integration of the knowledge life cycle.

This research is important for the DIVCSI, as the KMP identifies guidelines to update IM policies and integrate KM in the Division's structure. It is also relevant for the Personnel Direction (DP), as it enables a more agile management of transfers by reducing the overlap time of military personnel being transferred or on the verge of exiting the FA.

This research also proved to be important for the FA in a wider sense, as implementing a KMP that makes useful knowledge available when needed through different channels could result in changes to work methods that span the Institution's hierarchical levels. Should the top of the decision-making ranks choose to integrate KM in its management activities, the FA will be aligned with the HRM practices of outstanding aeronautical organisations and may become a benchmark for other sectors.

Finally, it should be emphasised that the problem of losses in knowledge is extremely serious for an Institution that manages and operates complex systems, and that the solutions presented here could substantially minimise those losses, although this would require structural changes within the organisation.

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