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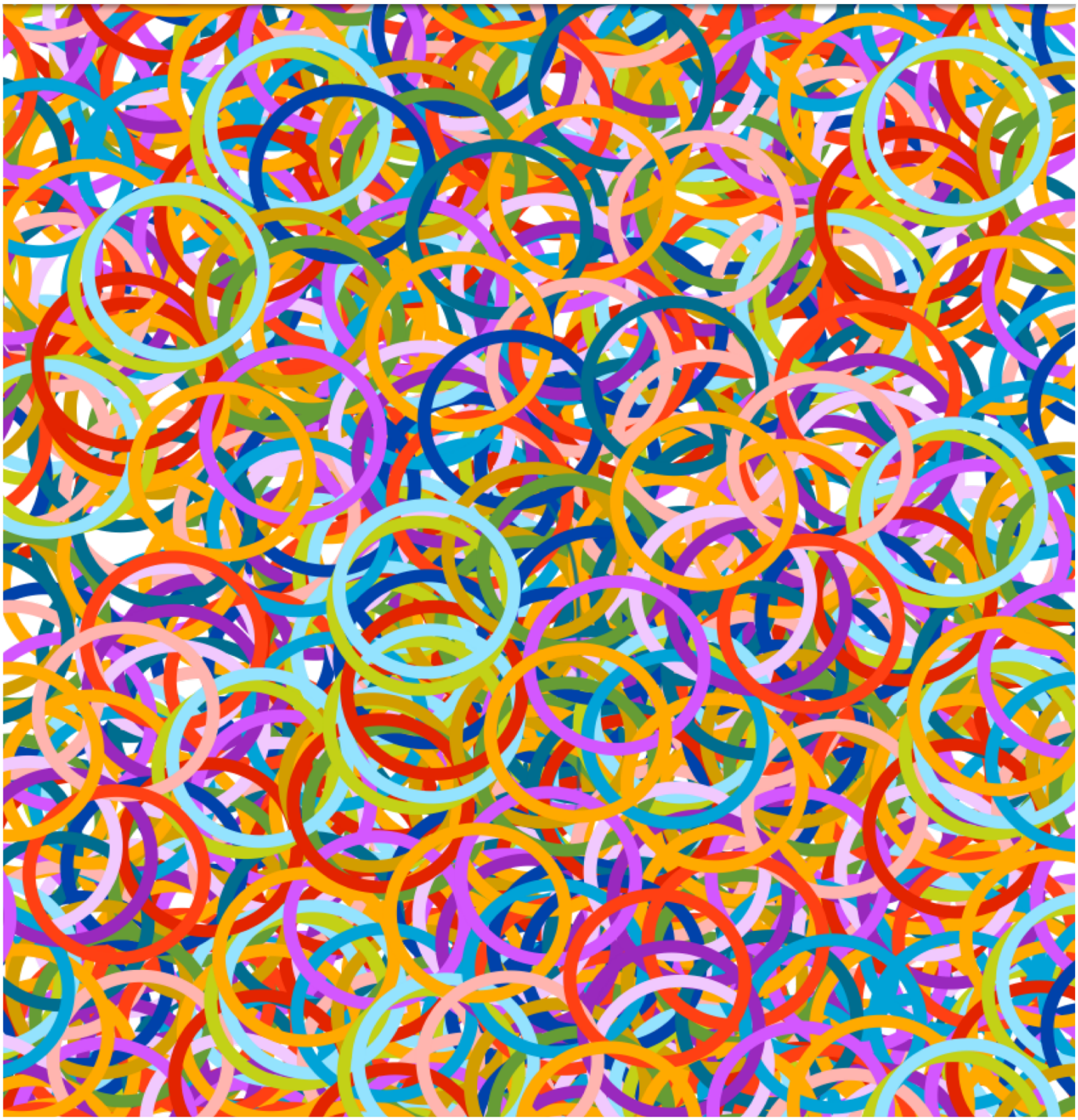

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*Editorial*

# The Tourist and the Traveller: Embracing the Paradoxes of Innovation

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Have you ever been a tourist or a traveller? How did you plan that? What experiences did you collect? Ask a tourist and they will tell you that it is all about maximising time and money – see as many things as possible, take a picture and move on. Ask a traveller and they will tell you all about the hidden secrets of the land, how they felt when they met "that person" and how the experience has changed their worldview. So, question for the budding globe trotter is – what would you rather have – efficient quick wins or productive shifts in mindset? Maybe the plan is to have both at the same time and if so, you share similar sentiments to those who are either contemplating or already are on the journey of innovation. Yes, innovation is a journey in which destinations are often temporary. Where, journey is that of collecting knowledge and learning from experiences and destinations are the 'photo-opportunities', the time to sharpen up, go-to-market and get smarter. Destinations are temporary as the quest to get to the 'next best thing' keeps the senses active. Scholars in innovation call this the circular path of innovation: research-development-commercialisation-feedback-reflection (and repeat).

The latest research on environmental sensitivity suggests that the stronger the ability to perceive and process external stimuli, the more the affinity towards exploration and prosocial behaviour (Pluess, 2015). Paradoxically, being more sensitive to the environment, psychologically results in overstimulation and hence burnout (Homberg, Schubert, Asan & Aron, 2016). As environments become global, competitive and complex, many structural, psychological and strategic processes influence the decisions and behaviour of actors on the journey of innovation. Firstly, the realisation that innovating requires looking beyond economics and second that it is packed full of paradoxes. For instance, quality vs cost, convergence vs divergence, exploration vs exploitation, profit vs social responsibility and control vs freedom, to name a few. These paradoxes are "contradictory yet interrelated elements" (Lewis, 2000, p.760) – value-creating on one hand and value-contracting on the other. The innovation literature has recognised and reviewed several of these as tensions in transaction cost economics or relational exchanges in creativity (for insights see Sheremata, 2000; Smith & Tushman, 2005; Gebert, Boerner & Kearney, 2010). If one is looking for practical examples, look at Xerox for what happens when one does not travel with time,

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look at 3M for what happens when one actively looks for social interactions, especially when feeling lost. Notice how by embracing paradoxes IBM rose from the ashes of near bankruptcy and how the Coca-Cola combined the branding vs taste paradox to consistently beat its near rival Pepsi, despite Pepsi's success at taste test challenges.

Lewis (2000) posits that paradoxes are "cognitively and socially constructed" (p.761), grounded in the difference, distance and identity frameworks (DeFillippi, Grabher & Jones, 2007). Pragmatically, they address the issues of feelings, demands, power, interests, perceptions, intentions and behaviour in practice. For example, on one hand it may feel good to discover as many new places as possible but the approach can also constrain integration and learning. On the other hand, staying in one place in search of that enlightening moment means many other opportunities may pass by! Apparently, embracing co-existence of opposing forces when under time pressure has higher probability of success in the endeavour (Sheremata, 2000). So, is that what one should do?

For starters, managers need to recognise the paradoxes in the context of their environment. Extant research suggests they can be broadly categorised into tensions related to boundary, relationships and organising (Jarvenpaa & Wernick, 2011). Here boundary refers to organisational dimension (i.e. inflow vs outflow of knowledge) as well as temporal dimension (i.e. present vs future) (Eisenhardt, 2000). For instance, Jarvenpaa and Wernick (2011) found that in Finland boundary tensions tend to be centred more on the input rather than output. That is to say on one hand innovators are driven by demand and internal value creation while on the other hand institutions such as the European Union promote open innovation, long-term project legitimacy and academic novelty. For managers, this means balancing current resources with future needs and industry-focus with publication potential (Jarvenpaa & Wernick, 2011). The category of relationships refer to the social aspect – who and how of interactions and exchanges in innovation process. This category of paradoxes captures spatial homogeneity vs heterogeneity across ecological, power and identity dimension as well as cognitive cohesiveness vs diversity across knowledge and experience contexts (Antons & Piller, 2015; Dahlander & Gann, 2010). Interestingly, while homogeneity is preferred, more so in terms of past experiences than identity, it also leads to conformity and reduced innovativeness (Jarvenpaa & Wernick, 2011). Cohesion thus can be argued to be better in the later stages of development and commercialisation and diversity in the earlier research stage of innovation. Organising for innovation then is about promoting and managing innovation, with motivated self-presentation and self-determination on one hand and controlled routines on the other (Dougherty, 2006). From a managerial perspective, organising brings about tensions of closed vs open innovation – should we embrace collaborative participation to scan and develop knowledge or should we focus on creating intrinsic economic value through intellectual property protection? While the collaboration may access larger pool of knowledge, it may also compromise competitive advantage in the future.

Important to note is that trying to alienate these tensions in practice or research is counterproductive, for they are inter-related, vary in intensity across innovation stages and are nested within internal and external exchanges (Jarvenpaa & Wernick, 2011). A polarised focus on tensions tends to shift the actor's perspectives away from simultaneity, encouraging the tendency to choose or trade-offs the seemingly opposing

truths (Ford & Backoff, 1988; Jarvenpaa & Wernick, 2011). Falling into the contingency-oriented thinking leads one to believe that there must be a right and a wrong and that they must choose one – the mythical fixed pie (Bazerman, 1998). So when one focuses on resolving the paradoxical tension, they allocate resources to one pole or the other, rather than embracing the power of plurality (Smith & Tushman, 2005). What this editorial is aiming to project is that paradoxes are a norm and it is best to be a tourist and a traveller simultaneously (hope you are still following the analogy!). Activating the plurality of tensions encourages balancing of paradoxes through holistic discovery, diagnosis, selection, reinforcement and self-correcting actions (Lewis, 2000). The latter requiring effective processes of managing cognitive conflicts of past experiences vs future thinking, perceptions vs behaviours, often requiring higher levels of collaboration, coordination and knowledge transfer across actors (Gibson & Birkinshaw, 2004; Lubatkin, Simsek, Ling, & Veiga, 2006, also see Bloodgood & Chae, 2010 for transcendence of thinking). When firms embrace paradoxical tensions by moving between poles whilst paying attention to momentum, methods and performance, they enhance their ability to cope (Bloodgood & Chae, 2010). Innovating managers should accept the paradoxes, activate them at appropriate stages and constructively reinforce productive cycles (Poole & Van de Ven, 1989) – beyond transactional agency-thinking and towards integrated intentional rationality. In other words, be a tourist and maximise that photo opportunity but develop an itinerary that allows room to experience the environment beyond the camera's lens. For practitioners, this means embracing the global trends of innovation, but avoiding 'pilotitis' (Khan & Joseph, 2013). It means leveraging the structural foundations of the innovation processes (i.e. routines, hierarchy) in the organisation and simultaneously organising flexible project-based teams and partnerships to turn the 'exotic sand' into a 'practical pearl' (Khan & Joseph, 2013).

It is now well known that innovation starts in the minds of those tasked to bring it to life. This process involves a shift in mindset to reframe, reimagine and reconfigure research, development and commercialisation of products and services. Eventually, individuals, teams and firms often find their own way of dealing with paradoxical dissonance, but it starts with recognition and integration of tensions. A traveller may indeed have to be a tourist at times or else it defeats the entire premise of being a "traveller". It is not triumph or fiasco, rather triumph and fiasco. Managerial focus needs to be on what can be learnt from triumph and fiasco alike. Paradoxically, the less managers chase innovation success, the more likely they are to realise creativity and collaborative growth.

Innovatively Yours,

Anne-Laure Mention, João José Pinto Ferreira, Marko Torkkeli
Editors

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# Beneficial AI: the next battlefield

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*Letter from Academia*

When planting our human print in a new technology-driven world we should ask, remembering Neil Armstrong in 1969, "after many small steps for AI researchers, will it result in a giant leap in the unknown for mankind?" An "Artificial Intelligence-first" world is being preached all over the media by many responsible players in economic and scientific communities. This letter states our belief in AI potentialities, including its major and decisive role in computer science and engineering, while warning against the current hyping of its near future. Although quite excited by several recent interesting revelations about the future of AI, we here argue in favor of a more cautious interpretation of the current and future AI-based systems potential outreach. We also include some personal perspectives on simple remedies to preventing recognized possible dangers. We advocate a set of practices and principles that may prevent the development of AI-based systems prone to be misused. Accountable "Data curators", appropriate Software Engineering specification methods, the inclusion, when needed, of the "human in the loop", software agents with emotion-like states might be important factors leading to more secure AI-based systems. Moreover, to inseminate ART in Artificial Intelligence, ART standing for Accountability, Responsibility and Transparency, becomes also mandatory for trustworthy AI-based systems. This letter is an abbreviation of a more substantial article to be published in IJCA journal.

**Keywords.** Artificial Intelligence, Beneficial AI

## 1 AI has an history

Scientific paradigm changes and relevant outcomes of civilization derive from intelligence at work. How can we improve and enlarge those benefits, through artificial intelligence (AI) based systems, without being fully replaced both on the job market and, most important, as final decision-makers?

AI has evolved, during the last five decades, starting with a very classical approach grounded on mathematics and psychology then followed by more romantic times in which almost everything was said to be possible for a computer to solve.

Intelligence, although somewhat difficult to formally define, can be recognized as having many facets including problem solving, learning, recognizing and classifying patterns, building analogies, surviving by adaptation, language understanding, creativity and many others.

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It has been proved that it is not too difficult to build systems and algorithms that incorporate some kind of intelligence (although far from encompassing all the possible facets) whenever it is realized that "Most, if not all known facets of intelligence can be formulated as goal driven or, more generally, as maximizing some utility function" (Hutter, 2005).

After a more pragmatic attitude that lead AI researchers to develop Knowledge Based Systems in which transparency and explain-ability were mandatory for the sake of real applications, the new trend became a call back to the fundamentals in which learning, adaptation, cooperation and autonomy became corner stones of more sophisticated intelligent systems.

It was not very long ago that a rupture in the traditional step by step AI systems development happened and, together with euphoria, new warnings reached the scientific community about the future potential dangers of possible misuse of AI algorithms and systems.

This rupture happened since "Big Data" started to become available everywhere, "The Internet of Things" started to grow (the so-called "outernet") and new algorithms like those related with "Deep Learning" concept, lead to striking applications with huge economic and social impact. Reflecting upon such an impact is no longer a kind of an unnecessary distraction, "like worrying about overpopulation of Mars" in the words of Andrew Ng, quoted in (Das, 2017).

The class of algorithms usually referred as Deep Learning mostly rely on the artificial neural networks (connectionist) paradigm. Connectionist-based methods approach has the big advantage of avoiding the knowledge acquisition bottleneck since the proposed model is directly built from observations with very little human intervention. The disadvantage that comes together is that those systems mostly result in a kind of black boxes.

There are however a plethora of different approaches that AI researchers have followed in the past which are responsible for relevant AI based systems application. In "The Master Algorithm: The ultimate Learning Machine that will remake our world" (Domingos, 2015), the author identifies five AI and machine learning "tribes" that currently exist: the symbolists, connectionists, evolutionaries, Bayesians and "analogizers".

Although applying very different paradigms and coming from different schools, the objective is always the same: To develop machine intelligence.

AI has been repeatedly over-hyped in the past, even by some of the founders. As a consequence, so called "AI winters(s)" hit the field decreasing the potential impact of AI realizations. Nevertheless, for more than ten years ago, well known researchers like R. Brooks, a critic of GOFAI (Good Old Fashion AI) have opposed the idea that AI failed and warned that AI would be around us every day (reproduced in (Wess, 2014)). And he is indeed right!

This letter has in mind to challenge readers in the sense that, together with the recognition of the very relevant achievements AI has already reached, we should reflect upon the current excitement of its potentiality and future social impact. And doing so, it also warns against a new age of intensive overselling that raises huge expectations on AI-based systems without discussing their inherent dangers.

## 2 Can Artificial General Intelligence be dangerous?

Corroborating Brooks statement, AI-based systems have been around and useful in many different relevant, although narrow, domains. For example, they have been used to make specific medical diagnoses, to allow companies to build up consumer profiles, for satellites to be intelligently controlled, for search engines to do page ranking, for computers to intelligently filter spam. Recommender System such as those used by Amazon and Netflix are welcome. And we feel proud of amazing accomplishments of AI programs like those used by Deep Blue and AlphaGo, at least for the prestige. And who will deny the real importance of using "mentalistic" Agent architectures to represent investors in the stock exchange or, even better, to automatically recognize when skin steins are carcinogenic?

Moreover, Machine Learning (ML) algorithms are working together with a multitude of other algorithms in order to get solutions to complex situations. Siemens Healthineers and IBM Watson Health are tackling population health together. Through the combination of the clinical expertise of Siemens and cognitive computing sophistication of IBM Watson Health, it is already possible to make critical healthcare data meaningful.

Those kind of synergies are also responsible for the impact of AI systems in many domains, and sometimes also more controversial as it is the case of the self-driving car or those NSA algorithms that may decide if you are a potential terrorist or not...

Because most AI-based systems, in some way, reason and interact, we are often tempted to compare them to humans. We sometimes forget there are limitations that still make a great difference.

While humans are good at parallel processing (patterns recognition) and slower at sequential processing (classical reasoning), computers have only recently mastered the former in narrow fields and have always been superfast in the latter. We also can say that "`Just as submarines do not swim, machines solve problems and accomplish tasks in their own way." (Gerbert, Justus & Hecker 2017)

Moreover, according to some scientists and opinion-makers, we could expect that Super-intelligence or General Intelligence, would give artificial systems the property of consciousness, making the boundary between humans and machines, in many decisive aspects, fuzzy.

Artificial General Intelligence can be seen as an intermediate stage between what we have now, a kind of Artificial Specialized Intelligence that is very performant in restricted domains, and a conceivable future Super-intelligence that might endow artificial systems with the capability to exceed human performance in many, if not all, the relevant domains, possibly including leadership.

Some authors (Oliveira, 2017) are now putting the following question: Is the human brain the only system that can host a mind? If digital minds come into existence, and the referred author states that it is difficult to argue that they will not, we have to face all the legal and ethical implications of such a possibility.

It is argued that current hardware development rate, regarding miniaturization and integration, makes us believe that in a few years it will be possible to replicate the number of synapses happening at the brain level. I believe that reasoning patterns of

high level of abstraction as well as structured knowledge are not always directly emerging exclusively from those simple operations. It is however worthwhile to prepare ourselves for this future possibility. Legislation and ethical principles should guide a harmonious development of either some kind of "digital minds" or even hybrid minds.

It is not yet the case that we foresee the possibility of humans becoming obsolete in too many situations, but it is the right time to clearly state that real Beneficial AI must be developed in such a way that humans and machines cooperate to solve complex problems together and, in doing so, possibly learn from each other.

More than having intelligent entities, robots, systems, computers, machines, programs, replacing humans everywhere, we need to develop processes, methods and regulations leading to a harmonious coexistence of both for humankind beneficial.

This ultimate goal justifies that we must pay attention to present signs that point to possible dangers in some future research directions of AI, leveraged by a plethora of books and scholarly opinions over-hyping the current and future role of AI.

Although I must express a few warns, I still am a real enthusiastic of the scientific development of the Artificial Intelligence field and stand for a firm position defending the crucial importance of the field.

Security and privacy, data integrity, distributed and parallel computation, software engineering development methods and many other computer science topics should have in mind the needs of intelligence-based systems.

Although this can be prone to controversy, Computer Science and Informatics should thus be seen as contributing to the broader field of Artificial Intelligence. An Artificial Intelligence confined by ethical principles for research, development and deployment.

## 3 AI realizations and "The Master Algorithm" Claims

"The Master Algorithm" (Domingos, 2015) is a remarkable book that makes us exercise our critical opinion without denying both the beauty and the dangers of its main message. "*Our goal is to figure out the simplest program we can write such that it will continue to write itself by reading data, without limit, until it knows everything there is to know*."

To be able "*to know everything*", or to make people think that "it knows everything", could be in itself potentially dangerous, but things still change for the worse when the same author also claims that "*Machine learning is remaking science, technology, business, politics, and war ...*", (Domingos, 2015) showing the relevance of it.

Although this last claim may be accepted as partially true, it also reveals a well–known tendency to oversell a specific research topic, trying to ignore that, often, Machine Learning (ML) algorithms work together with a multitude of other different tools in order to get things done.

Artificial Intelligence should be neither glorified nor blamed in isolation for the important outcomes to appear soon.

It is true that ML algorithms look like artifacts that produce new artifacts. In some way,

a "Master Algorithm" would be a powerful and absolute General-purpose learner, a kind of "Holy Grail" which, in reality, I believe will be very difficult to find.

If it exists, the Master Algorithm, seen as a combination of current ML algorithms working over big data, "*can derive all knowledge in the world - past, present, and future - from data*". Inventing it would be one of the greatest advances in the history of science. It would be, as the author names it, the "*ultimate learning machine*", (Domingos, 2015).

However, it definitively seems to me that, up to now, those algorithms work over data that, although collected in large amounts, have a relatively simple or already known structure. You do not need much extra knowledge to build up a theory that explains those extracted patterns. This is not the case whenever big data has to be first recognized and then extracted from many image-based sources (video, pictures, MRI- Magnetic Resonance Images) in which recognizing what is relevant in data also becomes a crucial issue. Apriori knowledge to guide the system focus of attention on different dynamic and noisy situations becomes of utmost importance for collecting and interpreting data.

Without our explicit consent, there are also large data brokers that collect, analyze and sell to others all the harvested details about consumers' online activities for marketing purposes.

It may even be the case that, who knows, whenever you decide to act differently from what was expected, when you are upset with your past choices and decide to do it radically differently, it may happen that you will become suspect to someone or some organization, seen as a disruptive person, half a way to become a potential terrorist...

Are current AI algorithms ready to derive all possible and needed knowledge from any kind of data sets? Of course not. You may supply hundreds of thousands of medical cases about, let us say, different cancer types, but if you miss a few tenths of cases regarding very specific situations, they will always remain invisible to the inferred algorithms.

Sundar Pichai, chief executive of Google and an AI enthusiast assures that "*Google is going to be AI first*". Very recently he even stated that "*In an AI-first world, we are rethinking all our products*," (see The New York Times, May 18, 2017).

Although he is confident that AI will make available a general tool designed for general purposes in general contexts, he also adds, and I fully agree, that "*for the moment, at least, the greatest danger is that the information we're feeding them* [AI-enhanced assistants] *is biased in the first place*" (Lewis-Kraus, 2016).

Reliable Data Curators become then necessary to guarantee that the recorded past is not adulterated and remains trustworthy.

Chaining and mixing existent different machine learning principles, may not be enough to solve the overall learning problem. Even if we accept the inherent power of data, it might take more than collected observations to directly induce natural selection "*as Darwin did*" (Domingos, 2015).

Is it just a matter of observing data? I do not believe it is only that.

There are specific abilities that some minds (and brains also) have developed, and others did not, to extract from, as well as apply to, the same data, in some identified contexts, more sophisticated knowledge than other minds. And, perhaps, there are many different capabilities that need to be developed in the future that, even the most

gifted minds and brains cannot yet imagine.

We should also be cautious about the scope of AI and ML. In the same book it is stated that "*The Master Algorithm would provide a unifying view of all of science and potentially lead to a new theory of everything.*" (Domingos, 2015).

I recall that a Theory of Everything is sought because quantum physics only deals with the very small, Einstein's general relativity theory deals with the very big and we are looking for a unique theory that works everywhere.

However, physicists do not think that the Theory of Everything will come out of a kind of combination of the previous two theories mentioned before. They are still looking for something radically new. The same will happen, in my humble opinion, with the so-called "Master Algorithm" and it is an over simplification to believe that it (like a kind of "master key") will come precisely out of the ML algorithms that we already know now.

I am not as radical as those who state that "*big data is not the new oil; it's the new snake oil*" (worth of mouth). But, nevertheless, I would be more cautious in targeting the possible goals of current ML algorithms working over big data as the "*ultimate learning machine*".

## 4 "Artificial General Intelligence" and consciousness

Learning is becoming the hard kernel of AI, enabling more sophisticated and general-purpose AI-based systems capabilities. Artificial General Intelligence can be seen as fostering the property of consciousness. This property can also be translated as self-awareness or even capability of feeling (sentience).

John Searle, in his book "Minds, Brains, and Programs" (Searle, 1980), clearly states that. "A program cannot give a computer a mind, understanding or consciousness regardless its intelligence."

The main argument he used, the well-known Chinese room, seems more like a paradox which, like the Zeno paradox, contradicts observed events. This is the opinion of Jean E. Tardy, who in the book "Meca sapien blueprint" (Tardy, 2015) argues that Machine consciousness is feasible and can be an emergent property. Is it not the case that a movie is made of a large amount of static frames?

"Consciousness is equal to that specific capability also called sentience [capable of feeling] and self-awareness" (Tardy, 2015). As a definition it does not help much. Is awareness the acknowledgment of Self? How to define the Self?

Even if we admit, and I could, that it might be possible that some simple type of "consciousness" will emerge from very complex interactions of more primitive forms of intelligence included in AI-based Systems, we cannot assure that such a complexity will be reached with current "in silico" hardware systems.

Moreover, the possibility either to download a mind or to make it evolve from a simpler digital mind, and, here, I agree with the ideas expressed in "The Digital Mind" (Oliveira, 2017), would need an non existing reverse engineering capability of the brain or, for the latter alternative a kind of real body, plenty of sophisticated sensors, which is not yet available today.

However, to replicate "in silico" what exists "in vivo" in the biological brain seems to be, for now, out of our grasp as far as we can preview based on scientific grounds.

## 5 Mind the dangers

It is obvious that there are potential applications in which data gathering, data mining and Machine Learning algorithms outcome become not at all crystal clear and may lead to conclusions backing some kind of artificially justified dominance in many different aspects.

Taking the AI researchers' role, we should be mainly concerned with establishing a set of practices and principles that may prevent the development of AI-based programs and systems prone to be misused for the bad of humanity. And the first major concern is privacy.

Many data mining algorithms rely in analyzing sensitive personal data including individual identification, photos, genetic and medical records or even brain signals.

We must enforce and support all the efforts trying to ensure that individual privacy will always be guaranteed and are not just feeding someone else's commercial interests.

Are we over-reacting? Should we really be afraid of some potential future AI-based systems? Haven't we always known how to deal with similar possible threats? Naïve answers to these threats can be: "remove the plug", use a "kill switch", use a "cage" (virtual machine), but current learning algorithms and data dispersion in the cloud make this kind of possibilities innocuous.

We have then to recognize that the problem is real and we, as researchers and developers, we need to take actions to reinforce AI-based systems security well beyond simplistic solutions. Individual privacy should not be for sale, specially by others.

## 6 The Human in The Loop

Developing Autonomous Software Agents taught me that it is always mandatory to include the human in the control loop. We have done that in different contexts like Airlines Operations Control (A. J. M. Castro, Rocha, and Oliveira 2014) and, also, to manage critical damages when ships are under severe conditions. One can never forget the intrinsic responsibilities assigned to humans (here, commanders and officers in the first place) in charge.

To make this possible in a transparent way, developers need to take human-machine interactions into consideration from the initial design steps. Therefore, appropriate systems specification methods, of AOSE- Agent Oriented Software Engineering kind, (Zambonelli, Jennings & Wooldridge, 2003) (Castro & Oliveira, 2008), become crucial in guaranteeing that we can trust the system.

Despite a good specifications practice, is it a definitive answer to AI and ML potential dangers to include the human in the loop? It might not be. We should not forget that Drones can fly autonomously and despite being monitored by humans, we should not be sure of the drone's goodness in many different situations...

## 7 Is Rationality mandatory?

The recent western economic crisis made many economists to believe that it is wrong to build strategies upon computer-based models in which agents are believed to always act rationally. Real intelligent agents, in order to be included in economic models, should be aware of more emotion-based decision-making capabilities that go beyond strict economic rationality represented by what the 2017 Nobel prize in Economics calls "Econs" (Thaler, 2016).

In a different scientific domain, back in 1997, I published a short paper about "Robots as responsible Agents" (Oliveira, 1997). My naïve approach, twenty years ago, was that the then novel cognitive software agents architecture based on "mentalistic" concepts like "Beliefs", "Desires" and "Intentions" (BDI) could bring a positive influence in the designing of more self-aware robots controlled by those BDI software agents.

It was only about five years later that I realized that one important and decisive component of human-like reasoning is deeply related with emotions and could be helpful for intelligent AI-based systems.

Some, like John Searle (Searle, 2011), arguing, through an article in the Wall Street Journal, against real intelligence of IBM Watson, the program that brilliantly won the "Jeopardy" competition against humans, sarcastically said that the referred sophisticated program did not become happy after winning.

I, nevertheless, believe that it would not be very difficult to program Watson or other AI based system in such a way that, after winning the game, it would reach an "emotional state" similar to happiness. Not regarding the external signs of happiness, which would be too easy to implement, but in which concerns the internal reasoning capability changes, along with its way of acting and memorizing for a certain period of time, until that emotional state gradually declines.

Past experiences, in different scenarios and with different meanings, can be mapped to kind of primitive emotions (fear, anxiety, ...) intensity, through accumulator-like variables.

Including these "emotion-like" states in the reasoning loop, makes it more difficult to take decisions that possibly lead to bad results in terms of causing harm or some kind of pain to the agent or its environment. This implies that artificial and intelligent decision-making may benefit in taking into consideration these more human-like influential factors, like emotion states, in order to become more human friendly and compatible.

## 8 Ethical issues

I believe we do not want to see the boundaries between the individual self and artificial systems to dissolve. Are we ready to accept what the author of "The Master Algorithm" book said in a TEDX Talk: "the question what means to be human will no longer have an answer. But maybe it never did."? (in "Next 100 years of your life" (Domingos, 2016)).

Are we going to leave AI plus IoT (The Internet of Things), plus ML, to create some

kind of future dystopia? Or will we be able to circumscribe the potential dangers and fortunately live with the obvious advantages of this new technology?

It seems that there is now a main concern of AI main players (from researchers to the big high-tech companies) leading to the searching for ethical laws that could prevent situations like those happening during the industrial revolution or even in those decades immediately after the development of nuclear energy.

To make the scenario still more strange, it may also be the case that a super-intelligence might not be perceptible as such. It could even be in the so-called "Technium", a huge network of computers.

That is why so many people are now contributing to the discussion on how to guide AI research development in such a way that, whatever results we will get in the future they will point to a beneficial AI age.

We, thus, stick in line with the 23 Asilomar principles pushing AI research towards the creation of, not undirected intelligence, but beneficial intelligence instead (Conference, 2017).

We are also aware of the efforts made by M. Delvaux, at the European Parliament, about the possibility to give intelligent robots a limited "e-personality", that could be comparable with what already happens with "Corporate personalities", a legal status which enables to sue or to be sued in court.

However, if we have learned something from the past about law, it is that it does not change as fast as technology does. We will have to wait a long time before relevant legal system changes will occur.

We prefer here to emphasize that we should enforce decisive principles to be applied to AI systems, like those brought from good Corporate Governance and that V. Dignum (Dignum, 2017) also advocates: To inseminate ART in Artificial Intelligence. Here, ART standing for Accountability, Responsibility and Transparency.

There is a need to know, in all circumstances, who is to blame whenever an AI based system's misconduct is noticed, the typical example being the situation of a self-driving car accident harming humans.

Hardware builders, software developers, licensor authorities, car owner, or the car itself? In fact all of them should be accountable.

Moreover, AI researchers and developers should take the responsibility to create models and algorithms to enable AI systems to take decisions, in such a way that they can justify them according to rational and logic principles. This is not the case with current deep learning based mechanisms.

It is also evident that, if algorithms are not transparent enough when making relevant decisions on our behalf, we cannot judge where the responsibility lies and how can we argue against the quality of those decisions.

## 9 Just to conclude

Stuart Russell, the well-known AI scientist drafted and became the first signatory of an open letter calling for researchers to look beyond the goal of merely making artificial

intelligence more powerful. "*We recommend expanded research aimed at ensuring that increasingly capable AI systems are robust and beneficial*" (Russel, 2017).

Although some consider a myth that AI will either turn evil or conscious, we believe it is time to recognize the actual worry that AI is more and more turning competent and, simultaneously, there is a possibility that its goals become misaligned with well-formed human goals.

We remain excited about all the potential benefits of possible Super-intelligent either agents, systems, networks alone, or in cooperation with humans, and their respective relevant impact in the future human society. Meanwhile we believe that current glorification of AI is not proportional to the reality.

That impact may still be decades away.

Nevertheless, the scientific community in general and the AI community in particular, should be proud of launching all the interrogations that have to be made about the potential impact of AI in the future.

The promoted symposium dedicated to the social and economic impacts of artificial intelligence in the next 10 years (AI Now), by the previous White House Administration, was a very relevant forum for discussing social, inequality, ethics, labor and health domains in which AI is raising pressing questions.

According to Kate Crawford and Meredith Whittaker (Crawford & Whittaker, 2016), an uncomfortable truth has been revealed "*there are no agreed-upon methods to assess the human effects and longitudinal impacts of AI as it is applied across social systems. This knowledge gap is widening as the use of AI is proliferating, which heightens the risk of serious unintended consequences.*"

It is also possible that spontaneous generation of synergistic control systems that will be no longer accessible to human control is nothing but another myth. But we should never forget that any algorithm can be as biased as the data they draw on. As simple as that.

Even if we look at the present, we are not willing to replicate what happened with Microsoft Corporation Chatbot Tay that began to post offensive tweets, forcing Microsoft to shut down the service about 16 hours after its launch. In some specific scenarios, 16 hours could be too late ...

In conclusion, I would like to emphasize this letter main message. It is at least smart to start worrying about how to enforce human beneficial AI by using human intelligence to direct AI research in the benefit of humankind. We hope that, also in the future, ethical concerns will remain behind the law.

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# Success Rates in Horizon 2020

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*Letter from Industry*

Horizon 2020 is the name of the European Union's research and innovation programme. In the first three years of the programme (2014-2016) over 100,000 proposals were received. 10,456 proposals were selected for funding. This success rate (11%) sounds very low and can discourage researchers from applying to the programme. This article argues that this success rate is not a reliable indicator for researchers. This article will show that a more realistic success rate is 29%. In one sub-programme (Energy) a success rate of 47% was measured. The message from this paper is that the chances of success in Horizon 2020 depends on two main criteria: a) having an excellent scientific idea; and b) having a thorough understanding of the evaluation process.

**Keywords**. Horizon 2020, Success Rate, Evaluation Process.

## 1 Introduction

Horizon 2020 has a budget of €77 billion and this will be allocated to successful proposals approved in the period 2014 to 2020. The programme is divided into many sub-programmes. The most famous of these is the European Research Council (ERC) that supports fundamental research. Another well known programme is the Marie Curie Actions that supports PhD and Post Doctoral training. Details of all the different programmes can be found on the Horizon 2020 official website. ( http://ec.europa.eu/programmes/horizon2020/h2020-sections ). Other sub-programmes include research into health, food, energy, transport, security, and social sciences and humanities.

Every year 'calls for proposals' are published for each of these individual sub-programmes. Researchers submit proposals (individually and as part of consortia). The proposals are evaluated by independent evaluators. Successful proposers are invited to prepare legal agreement with the European Commission.

In 2017 a 'mid-term evaluation' of Horizon 2020 was undertaken to report on the progress of Horizon 2020 in the first three years (2014-2016). Arguments presented in this paper are also based on data used from this official report.

Every year the European Commission published a report on the progress of the programme entitled the 'Annual Monitoring Report'. Data used in this paper is from the most recent Annual Monitoring Report (2015).

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## 2 The Evaluation Process in Horizon 2020

Before discussing success rates it is important to understand the evaluation processes used in Horizon 2020. The evaluation process varies between the different programmes. In this paper a general evaluation process is described. When a proposal arrives in Brussels it is first checked by a Commission official against 'eligibility' criteria. 'Eligible' means that the forms were filled in properly. A proposal based on a very weak scientific idea can be classified as 'eligible' if the forms are filled in properly and the basic rules are met.

When the European Commission quotes 'success rates' they are based on these 'eligible proposals'. Clearly this is not a good denominator.

The 'eligible' proposals are then sent to independent scientific evaluators. The evaluators read the proposals individually. In some progammes the evaluators meet (Consensus meeting) and in other cases they simply send their evaluation scores to the relevant administrative body in Brussels. A final score is agreed based on the evaluators individual scores. A 'threshold' is set to define 'low quality proposals'. For example, in some programmes the maximum score is 15 and a threshold is set at 10. Any proposal scoring below 10 is considered low quality and automatically elimated. Scoring below 10 is a very low score. These proposals should be classified as 'low quality proposals'. If research organisations had effective quality control procedures, these proposals would never have been submitted.

In the case of the ERC Programme the maximum score is 8 and a threshold of 4 is set. This threshold is sub-divided i.e. a threshold of 2/4 for the researcher and a threshold of 2/4 for the idea.

Following this evaluation a list of 'high quality proposals' is compiled. The final selection of successful proposals is based on these high quality proposals. This is a far better denominator to use when calculating the success rates

## 3 Success Rates in Horizon 2020 (2014-2016)

| | |
|---|---|
| Total number of proposals received (2014-2016) | = >104,000 |
| Total number of 'eligible proposals' | = 102,076 |
| (This means that over 2000 proposals did not fill in the forms properly) | |
| Proposals below threshold (low quality proposals) | = 56,444 |
| | **(55.3% of eligible proposals)** |
| High Quality Proposals (above threshold) | = 45,632 |
| Proposals selected for funding | = 11,108 |
| | |
| **Reported Success rate (funded/eligible)** | **= 10.88% (11,108/102,076)** |
| **Real Success rate(funded/high quality proposals)** | **= 24.34% (11,108/45,632)** |

This overall success rate of 24.34% is a far more encouraging number for researchers thinking about submitting proposals.

**ERC Starting Grants (2014-2016)**

*Source: European Commission (EC) Mid-Term Review of Horizon 2020 (Table 8 and 9)*

The ERC Starting grant is one of the most prestigious grants for the career development of young researchers. Proposals are submitted by individual researchers.

The maximum score that reviewers can award ERC proposals is 8 (4 for the researcher, 4 for the research idea). Proposals below the threshold (with a score < 4 ) in ERC are given a Grade C. Any researcher receiving a grade C is not allowed to resubmit a proposal to ERC for two years.

| | |
|---|---|
| Total number of ERC Starting grant proposals received (2014-20160) | = 8947 |
| Proposals below the threshold (Grade C) | = 6120 **(68.4% of eligible proposals)** |
| High Quality Proposals (above threshold) | = 2827 |
| Proposals funded | = 950 |
| Reported Success rate (funded/eligible) | **= 10.6%** (950/**8947**) |
| **Real Success rate(funded/high quality proposals)** | **= 33.6 % (950/2827)** |

This success rate (33.6%) is very encouraging for young researchers planning a career in science.

## 4 Success Rates Horizon 2020 (2015)

The Annual Monitoring Report (2015) provides far more detailed data on individual programmes. It is the most recent Annual Monitoring Report available at the time of writing this article.

| | |
|---|---|
| Total number of proposals received in 2015 | = 42,535 |
| Proposals below threshold (low quality proposals) | **= 22,511 (53% of eligible proposals)** |
| High Quality Proposals (above threshold) | = 20,024 |
| Proposals selected for funding | = 4,565 |
| Reported Success rate (funded/eligible) | = 10.7% (4565/42535) |
| **Real Success rate(funded/high quality proposals)** | **= 22.8% (4565/20024)** |

ERC Statistics for 2015

| | |
|---|---|
| Total number of ERC proposals received in 2015 | = 10,019 |
| **Proposals below the threshold (Grade C)** | **= 6083 (61% of eligible proposals!!)** |
| High Quality Proposals (above threshold) | = 3936 |
| Proposals funded | = 1327 |
| Reported Success rate (funded/eligible) | = 13.3% (1327/10019) |
| **Real Success rate(funded/high quality proposals)** | **= 33.7% (1327/3936)** |

**SME Instrument (2015) (Page 122)**

An SME Instrument is a special grant for Small and Medium Sized Enterprises (SME). Companies submit proposals individually (no mandatory partners required).

| | |
|---|---|
| Total number of proposals received in 2015 | = 11008 |
| **Proposals below the threshold** | **= 8378 (76% of eligible proposals)** |
| | (Here the threshold is < 13/15 for Phase I grants) |
| High Quality Proposals (above threshold) | = 2630 |
| Proposals funded | = 714 |
| Reported Success rate (funded/eligible) | = 6.5% (714/11008) |
| **Real Success rate (funded/high quality proposals)** | **= 28.2% (714/2630)** |

For companies considering a proposal for an SME instrument a thorough understanding of the evaluation process and the evaluation criteria is essential.

**Table 1.** Summary of Real Success Rates in the individual programmes in 2015 (SME Instrument Proposals are excluded from the different programmes)

| Programme | Number of Proposals | Below Threshold | High Quality Proposals | Funded Proposals | Real Success Rates |
|---|---|---|---|---|---|
| Health (page 132) | 1212 | 75% | 318 | 94 | 29.5% |
| Energy (page 145) | 839 | 71% | 243 | 114 | 47% |
| Food ( page 138) | 358 | 36% | 228 | 62 | 27% |
| Transport (page 153) | 702 | 33% | 467 | 167 | 35% |
| Climate (page 160) | 648 | 48% | 335 | 79 | 23.5% |
| Security (page 172) | 463 | 45% | 252 | 39 | 15.4% |

# 5 Conclusions

## 5.1 Message for the European Commission

Why does the European Commission continue to quote success rates based on 'eligible' proposals? This number is meaningless. Success rates should be calculated as a percentage of 'High Quality Proposals' – those that score above the threshold. This is how 2015 results should be reported:

"In 2015 a total of 42,535 proposals were submitted to Horizon 2020. After evaluation by independent experts, 22,511 (53%) were classified as 'low quality proposals'. From the remaining 'High Quality Proposals' (20,024) a total of 4,565 proposals were accepted for funding. This represents a 22.8% success rate."

## 5.2 Message for Research Organisations

Research Organisations must take a share of the responsibility for the large numbers of low quality proposals submitted. Quality control procedures such as screening and

proposal clinics, should identify weak proposals – before any considerable effort can be wasted on their preparation. This should be a core activity of Research Support Offices.

### 5.3 Messages for Researchers

Researchers must bear in mind the words of the Greek statesman and orator Pericles (450BC) "Having knowledge but lacking the power to express it clearly is no better than never having any ideas at all."

In a lecture you tell or express the idea. In a competitive proposal you have to sell the idea to the evaluators.

It is essential to understand how different types of evaluators think and how decisions are made in the evaluation process. There are two ways to learn this – attend training courses or (better) become an evaluator.

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# Creating High-performing Innovation Teams

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**Abstract:** This research suggests a conceptual process of how to create high-performing innovation teams to meet the market's need of faster ways of conducting innovation work. The CIT-process (Creating high-performing Innovation Teams) is a five-step-process systematically developed to meet organizational-, team-, and individual perspectives. On a holistic level, this research contributes to prior research by bringing research on innovation teams *and* high-performing teams together to become a pre-stage to established group dynamic processes and innovation processes. Practical implications and future research are suggested.

**Keywords:** High-performing, Innovation team, Group process, Teamwork, Multi-functional, X-functional, Product development.

## 1 Introduction

This research is based on the need for innovation teams with the ability to conduct agile innovation work within established companies. These teams are needed for two reasons: first, innovation is a key driver of economic growth and social development, that is, from national innovation systems to the underpinning regional growth strategies, and for organizational performance and competitiveness (Clark, 2012). To stay competitive, organizations must both continuously innovate their products (including services, processes, organizations, systems, etc.) to accommodate the rapidly changing environment (Brennan & Dooley, 2005; Dobni, 2006; Tidd & Bessant, 2013) and carefully manage their innovation processes (Dooley et al., 2000), and research shows that product life cycles have become shorter over time (Barczak et al., 2009); second, teams as such have for centuries contributed positively to work on innovation (e.g. Frostenson, 1997; Zuidema & Kleiner, 1994), and several classifications of these teams have emerged over time: for example, "multifunctional innovation teams," "X-functional innovation teams" and "new product development teams" (NPD teams). Each has numerous positive effects based on the teams' performance: for example, decreased time to market (Highsmith, 2009), increased job satisfaction, reduced job stress, less time pressure (Cordero et al., 1998; McGreevy, 2006b), improved quality and productivity (McGreevy, 2006a), higher quality produced in a shorter time (Edmondson & Nembhard, 2009). These teams enable knowledge sharing, the development of trust and the ability to overcome organizational barriers (Horth & Vehar, 2012; Love & Roper, 2008).

Innovation processes have also developed over time, from stage gates into cyclic innovation processes based on collaboration and iteration. Companies have to interact with customers, co-suppliers and both internal and external service providers to, for

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example, explore technological opportunities, build customer knowledge and networks, and co-develop with customers and partners to understand, visualize, and deliver value propositions (e.g. Berkhout et al., 2006; Narasimhalu, 2005; Smith et al., 2012; Tidd & Bessant, 2013). Even though innovation processes are visualized over several steps or phases, the operational work can be divided in two phases. The early innovation phase centers on the ideas in focus (i.e. creative processes), while the later phase focuses on implementation (i.e. developing and marketing processes) (Amabile et al., 1996; Eschenbächer et al., 2011). Another practical approach to executing innovation work is to fail fast: that is, to make mistakes early and to try not to avoid failure. Instead, the idea is to fall forward, to learn from mistakes (Adkins, 2010; Tahirsylaj, 2012). Due to the level of abstractness in innovation work, methods of envisioning innovation processes act as knowledge agents, in terms of "knowledge integrators" and "knowledge brokers," to support innovation (Bertola & Teixeira, 2003).

However, creativity and innovation processes are complex, and they depend on individual and group efforts from a divergence and convergence perspective (Backström et al., 2011; Haner, 2005). The complexity of innovation teams is also pointed out by Johnsson (2014), who claims that newly formed innovation teams hardly can handle all the complex work that they have to conduct without a proper set up when being created; that is, a newly formed innovation team needs to know, for example, how the innovation processes work, how to be creative when identifying new opportunities, how to execute practical innovation work, and how handle the group dynamic process.

In sum, there is a need to increase the speed of innovation work for organizations to stay competitive and to adapt to rapidly changing markets; innovation teams have proven to be a successful way of approaching innovation, as they generate great results; and well-researched innovation processes and practical tools exist for these teams. If the innovation team is successful, it will become a part of, and contribute to, increased innovation efficiency and thus become a high-performing innovation team. Still, what about organizations that are inexperienced in innovation work? Again, the innovation team is at the heart of this question, since it is supposed to conduct the practical work although the members of the organization may not be aware the complexity implied in innovation. As such, this research focuses on the deliberate creation of high-performance innovation teams.

## 2 Literature review and research gap

This section demonstrates a timeline of relevant research connected to the creation of high-performing innovation teams to demonstrate where and how the research focus has developed over time, closing with a clarification of the research gap and the research question that has guided the present study.

### 2.1 High-performing innovation teams

Research on groups and teams has been conducted for a long time, but the focus has rather been on groups or teams that have conducted innovation work or on innovation as a result of team work. Farris (1972) revealed that the setting of members in scientific

groups effected performance of innovation. The group members within study were conducting R&D work, but they separated their work in a collegial way over three stages—a suggestion stage, a proposal stage and a solution stage—to get input and support technical and administrative matters, for example. Farris found that highly innovative groups used supervisors to evolve original ideas rather than for the contribution of original ideas, and groups with influence on supervision were best for problem solving. Farris also suggested that the supervisor does not necessarily have to be innovative, which may in fact decrease the group's innovation performance, but the supervisor should offer support by encouraging the group to think through their technical problems and by playing an active part in the group, seeking original ideas from outside the group to spare the group from wasting energy on information collection but not imposing ideas on them.

In the 1980s, self-directed work groups (SDWG) were developed as a result of a buzzword of the day, "employee empowerment," and they had various names, for example "self-managed teams," "high-performance teams," "super-teams" or "cross-functional teams" (Zuidema & Kleiner, 1994). The teams consisted of three to 30 employees, but most often included six to 10 employees, and the idea was that groups were created to manage themselves to work on a specific work task. They were intended to have more flexible structures, to be cost effective, to overcome built-in bureaucracy, to speed up product innovation, to cut through hierarchical decision-making procedures and to respond quickly to changes in work conditions. The teams were considered X-functional, meaning that they would bring employees together from different departments to solve problems, for example with product development teams concentrated on innovation and development of cycles for new products. The benefits of this setting according to the team members were that they improved team involvement, morale and the sense of ownership of the team's goal, but mistrust of managers, conflicts between team members and stress syndromes caused from lack of familiarity with new situations were common. Management thought that improved quality, productivity and morale were the best outcomes. The conditions for successful SWDGs were that top management needed to believe in the approach and that the manager of the team should act like a coach or facilitator to develop consensus in the team. However, that required not only an overall change in attitude, but also trust building, the overcoming of fear-factors and appropriate training in new tools for employees and management.

In general, high-performing work teams were claimed, through the lens of the big five criteria, to be perform best when based on personal diversity (Neuman et al., 1999). In Neuman et al.'s study, the teams, which consisted of four people, were trained in all functions within the department, and the personalities traits of agreeableness, conscientiousness, and openness to experience were valid predictors of effectiveness, and team members with the traits of extroversion and emotional stability also improved performance. Furthermore, Neuman et al. suggests that the team members in a highly innovative team would need additional traits, such as creativity.

One way to create innovation teams is suggested by McDonough (2000): he proposes four factors that increase success for cross-functional teams; first, cooperation, that is, the importance of setting a common goal that every member understands; second, commitment, relating to the members' duty to achieve the goal and the fact that the

members' skills, confidence, and willingness to commit themselves all contribute to making the project successful; third, ownership, that is, the desire to make change, which goes beyond commitment and requires a need for empowerment, climate, and goal setting early in project; fourth, respect, which is built on the feeling of trust, with which the members can interact honestly with each other, and thereby make cooperation possible.

In a study regarding NPD and the integration of other departments within the development work, Gomes et al. (2003) comes to the conclusion that early integration with marketing in the NPD process is beneficial. The higher the degree of interaction between R&D and marketing in the stages of budgeting, planning and scheduling, the more collaborative the behaviors and attitudes of the people involved in NPD projects, which may aid in overcoming internal differences and other built-in barriers.

Pearce and Ensley (2004) suggest that the impact of shared vision on the innovation process is one of the main antecedents of effective team innovation, where they created teams based on managers or internal customers selected from interviews and questionnaires within a company. All participants were given at least 20 hours of training before the work began. The conclusion of the study was that a shared vision contributes highly to innovation efficiency. In addition, team potency, teamwork behavior, altruistic behavior, and courtesy behavior all increased within the study.

West et al. (2004) suggests that an innovative team could be developed within an organization in 12 steps. The first step is to identify the task, followed by identifying external demands, selecting the team members with a focus on skills and diversity, securing organizational rewards, creating a learning and development climate, fostering an atmosphere of innovation, establishing norms of innovation, encouraging reflexivity in teams (i.e. making them stop working for a while to reflect on the situation), ensuring that the team leader's style is appropriate, managing conflict constructively and aiming to bridge and coordinate competencies.

McGreevy (2006a; 2006b) offers a best practice for creating teams. From a practical point of view, he claims that one should start with gathering information on what teamwork is and how it effects the organization, followed by ensuring that top management is committed to the teamwork approach and that middle management is on the same track. The following steps plan for change of the culture and management structure, selecting team members based on applicability and willingness to develop the team. Furthermore, the team members should have management's approval and support to participate in the team, and they should be selected on an X-functional basis.

In a longitudinal study between 2006–2010, an external innovation driver had positive effects on both the innovation project and the knowledge of innovation management within the participating innovation teams, according to Johnsson et al. (2010). The teams were created on a multifunctional basis, but the activities slowly decreased and completely stopped shortly after the project in two out of three participating companies due to lack of knowledge regarding innovation management.

Innovation steering groups (IS groups) were created by Hallgren (2009), who organized multifunctional IS groups that consisted of seven employees from "all levels," although top management was excluded to avoid their influence on the teams' decisions. The set

up was that top management ensured their commitment to the IS group, then Hallgren taught the IS group to manage innovation by "learning by doing," and encouraged the rest of the company to be involved in the innovation project. The results of the innovation project were positive, overall, and the main reasons for positive results were attributed to the external innovation driver (Hallgren himself) and his stimulation of high involvement levels among the employees, accomplished by having group members choose an incremental idea by themselves. However, the IS groups lacked performance due to lack of innovation-related knowledge. In a 2009–2011 longitude study on the ability of innovation teams to increase innovation-related knowledge through seminars, inspired by IS groups in accordance with Hallgren (2009), it was found that employees inexperienced with innovation had problems with innovation-related vocabulary, and innovation-related knowledge gaps caused problems not only for the teams but on the managerial level as well (Karlsson et al., 2010). Although the innovation teams had positive effects in terms of learning, there was mistrust of managers, conflicts between team members and stress from lack of familiarity with new situations (Johnsson & Karlsson, 2011a).

Hülsheger et al.'s (2009) review of innovation team antecedents has identified two classes of antecedents as important to an innovation teams and their performance; team input and process variables and methodological moderator variables. The most influential factor for innovation was goal interdependence, and regarding team diversity it was found that job-related diversity was more important than personal diversity. Job-related diversity was slightly positive for innovation and had greater impact on performance than personal background. In fact, personal diversity showed a slightly negative relationship to innovation. Leadership was demonstrated to play an important role in organizing the potential for job-relevant diversity, that is, to stir up innovation by informing team members according to their different kinds of knowledge, skills, and capabilities, and helping them to value and use their different viewpoints to engage in elaboration and integration of opposing viewpoints. The team's size may effect the performance in two ways, as found by Hülsheger et al. (2009): if a team becomes too large it will suffer from social loafing, but if a large team has relevant knowledge, skills and abilities, it can handle difficult tasks, which may be the case for innovation projects. Team processes including vision, external communication, innovation support, task orientation, and internal communication have a strong correlation with innovation, meaning that managers and team leaders should strive to support these determinants by showing commitment and engagement. To foster innovation in the workplace, internal and external communication is especially important.

Barczak et al. (2009) conducted a study on NPD practices in order to identify what differentiates the best companies from the rest when portfolios are increasingly incremental and cycle times drop dramatically. They conclude that innovation processes are inherent to every company, but the best companies spend more effort on market research, engineering, R&D, technology and team support. The suggested areas in which a company can improve its work are idea management, where formal processes are recommended; NPD project leadership and training; support of organizational mechanisms and processes in place for managing collaborations with other firms; the enabling of individuals with multiple functions to work together as a

team; and support for team leaders from functional and senior managers.

Employee-driven innovation (EDI) is a result of the insight that human capital within a company has become increasingly important (Kesting & Ulhöj, 2010). The concept of EDI is based on the assumption that employees at all levels have unrevealed capabilities for innovation and that these underutilized resources can be recognized and exploited to benefit both the organization and the employee. One major positive effect from EDI is that the employees' feel more motivated to work, but even though it was found that innovations can emerge in any department, from the shop floor to management, the team members´ inexperience in decision making and bias hinders them from taking action in a project and thinking outside their ordinary routines. A similar concept to EDI is employees-driven innovation in a regular team (EDIT), developed by Kristiansen and Bloch-Poulsen (2010). The difference is that under this concept the team members could be anyone in the organization, regardless of educational background or current employment, a circumstance confirmed in practice by Kleinknecht (1987). Another difference from EDI was the researchers assisted the teams and their members, but instead of cooperating, the team members actively looked for shortcomings and pitfalls, questioning project agendas, complaining over long meetings about work overload and expressing skepticism. The researchers tried to solve these problems in separate meetings, where project planning was conducted.

Nakata and Im (2010) stress the question of whether cross-functional integration in NPD teams improves new product performance, and if that is the case, what the ways of strengthening this integration are. Their findings indicate that by letting high-tech companies assess the results of teams with divergent functions, cross-functional integration generates greater customer satisfaction, technological advancement and overall performance. They found that internal factors such as social cohesion and superordinate identity, and external factors such as market-oriented reward system, formalization of planning, and managerial encouragement to take risks are positively related with integration in NPD teams.

The only article identified within this literature review that addresses the creation of high-performing innovation teams is an academic course for teaching technological entrepreneurs how agile teamwork is conducted (Marion et al., 2012). The course is aimed at students who want to learn how to enter the market quickly with limited resources. The course includes the creation of multifunctional teams, where technical engineers work together with industrial design students. The program follows a structure where teams are created based on Meyer Briggs' personality trait classification, where type of engineer, background and experience determine to what team students will belong. The students have no influence on this grouping process, and 5–7 members typically form a team. A project manager is designated, and the team gets their scope to work on. The team has weekly meetings to review project deliverables and team progress, course work and assignments. At the end of the course, the team presents a concept, prototype, and technology to a panel of industry experts and investors. Two main success factors are identified within this course: first, the engineering and visualization students cooperate; second, the students use a very experimental approach.

Recent research from Im et al. (2013) combines the two parts of innovation work, that is, creativity and implementation, as defined by Amabile et al. (1996), to explore the antecedents and consequences of creativity in product innovation teams. They conclude that antecedents to product innovation teams, that is, cross-functional teams, are social cohesion of both on internal- and external dynamics, as they have positive impacts on both new products and marketing programs. Internal dynamics, on the other hand, are defined as the emotional factors: to know one another, to be aware of the same kinds of opportunities, to have access to the same kinds of resources, and to share the same kinds of perceptions. The external dynamics are the organizational design and structure. Similar to prior research, Im et al. (2013) emphasize top management support and encouragement in establishing the meaningfulness of the innovation work and taking risks, but one of the key management tasks is to remove communication barriers to avoid conflicts, and when it comes to development teams, it is suggested that a kick-off may be important in building team identity.

Recent research from Johnsson (2014) suggests the innovation team model (ITM), where the complexity of the innovation team and its context are demonstrated to better understand the situation of a newly formed innovation team before innovation work has begun. The difference from the prior research on innovation teams is that ITM focuses on the highly complex situation that an innovation team, with inexperienced team members, will meet when its members start conducting its innovation work, that is, the management of innovation-related knowledge and associated knowledge gaps, innovation-related information flow and innovation awareness. In accord with prior research, the innovation team is created on the understanding that multifunctional teams perform better than individuals. One of the team members is suggested to be a convener to distribute the leadership to the other team members. The suggested steps in ITM are that the convener carefully choses the other team members based on their skills and personality.

### 2.2 The research gap

The literature affirms that teams have positive effects for companies' product development. Furthermore, multifunctional teams are more efficient than other teams, and the literature highlights an interest in what kinds of team members an innovation team should consist of. There is also a clear research focus on what factors are antecedent to successful innovation work within companies. Recently, creating innovation teams where employees from all levels within a company can contribute to innovation work has come into focus, and even though this team composition has met with positive results, obvious problems have also arisen in the teams. Problems identified in the present research on innovation teams (IS groups and EDITs) are mistrust of managers, conflicts between members and stress (Johnsson & Karlsson, 2011a; Kristiansen & Bloch-Poulsen, 2010 Johnsson & Karlsson, 2011a;). These problems are interesting, since they were observed already in work on SWDGs in the 1980s (Zuidema & Kleiner, 1994). Other recent problems related to innovation teams include that team members complain over long meetings about work overload and express skepticism (Kristiansen & Bloch-Poulsen, 2010). Even though research clearly shows that the team leader should know about the group process (Adkins, 2010, Hallgren, 2009; West et al., 2004), there have been problems related to group dynamics

causing the innovation project to struggle, that is, wasting valuable time and energy. One reason for such struggle might be that there is no time to create these kinds of teams in a proper way (Edmondson, 2012), but when reviewing the structured ways of creating innovation teams, there is a lack of focus on how to prevent the problems that arise in the development of the group.

It has been shown that multifunctional teams are more effective for NPD (e.g. Nakata & Im, 2010), and it is stated that the work cycle in innovation work has been dramatically shortened (Barczak et al., 2009), but lack of innovation-related knowledge result in poor performance (Hallgren, 2009; Johnsson et al. 2010; Kesting & Ulhöj, 2010).

Prior research into methodologies for how to create high-performing innovation teams to conduct innovation work in organizations has not yet been identified, nor methodologies for how to create innovation teams. However, McDonough (2000) and West et al. (2004) both suggest how to develop innovative teams, and McGreevy (2006a; 2006b) how to develop teams that perform. Marion et al. (2012) focus on how to create innovative student teams within engineering education. Johnsson (2014) is the only one who focuses on the complexity of innovation work and has developed a model that demonstrates the creation of innovation teams in a few steps within an organization. Still, they do not explicitly focus on how to ensure that the teams become high-performing innovation teams, but rather teams with potential innovation outcomes.

The literature suggests that research has come closer to the core of the creation of high-performing innovation teams, but there is still no explicit process demonstrating in how to do so. Prior research focused either on innovation teams *or* on high-performing teams, not putting these aspects together to create high-performing innovation teams. Another problem identified within the literature review is that groups and teams seems to be confused as being the same, but they are not, according to Wheelan (2013). It takes approximately six to eight months of teamwork for a group to become a high-performing team. However, only 15% reach that level, and as many as 80–90% of teams have performance problems within the emergence process. The problem is even greater for teams based on diverse members, which makes the creation of high-performing innovation teams a delicate task to fulfil, since innovation itself is highly complex.

To help to bridge the research gap, this research focuses on the pre-stage of innovation teams' emergence process, that is, on generating knowledge of how to create innovation teams so that they can enter the high-performing phase from the beginning.

### 2.3 Research question

Based on the introduction and problem identification, a research question emerged to guide this research: What would a conceptual process that demonstrates how to create a high-performing innovation teams look like?

The aim of this research is to generate new knowledge, to be demonstrated as a conceptual process, of how to create, step-by-step, high-performing innovation teams that waste neither time nor energy on conflicts or other non-valuable actions.

# 3 Research methodology and findings

## 3.1 Research methodology

This research is inspired by the Design Research Methodology (DRM) approach (Blessing & Chakrabarti, 2009), and the work has been conducted according to the first three stages of the DRM model: the research clarification, in which the research problem is defined and a research question is stated, followed by a descriptive study in which understanding is provided and developed within the prescriptive study stage into a process describing how to create high-performing innovation teams. The final descriptive study in the DRM model is not a part of this research (i.e. to evaluate the outcome of the suggested process), but presents a step to be taken in research.

This research was conducted systematically, where the first step was to explore prior research on high-performing innovation teams to understand the research area and the academic problem, partly through database research and partly as snowballing from relevant articles. Keywords such as "innovation team," "high-performing," "team," "group," "group members" and "how groups emerge and develop" were used when searching for relevant research. The database search engine Summon was used within this research, which cuts through multidisciplinary databases relevant for this research and is used in scholarly research worldwide. The literature was systemized and analyzed in the light of demonstrated methodologies concerning how to create innovation teams and whether they focused on group development problems. The conclusion was that prior research focused on either innovation teams or on high-performing teams; that is, the focus was mainly on the performance of teams' work, where innovation was a plausible output; creating a climate to stimulate innovation where teams and teamwork were highly supported ingredients; and the team members in terms of personalities and skills to perform as effectively as possible that could generate innovative output. However, research did not focus on creating high-performing innovation teams specifically, even though researchers agree on the need for faster ways to conduct innovation work.

As the research gap was clarified, a literature study was conducted to gather relevant data covering the organizational, team, and individual aspects of innovation, including team creation, group dynamics and psychology, and change management. To collect data for the theoretical framework, the database search engine Summon was used, which covers relevant research of this topic.

Finally, a conceptual process for creating high-performing innovation teams was developed and demonstrated step by step. In doing so, the data was first organized in organization, team and individual perspectives, and then it was clustered into themes by searching for patterns and connections relevant when creating innovation team (Boyatzis, 1998). This analysis yielded three main areas: management, including top management and middle management; team leadership; and team members; The second step was to identify phases, specific factors, processes and sub-processes relating to each other within the identified themes, which were used to develop a structure of a new process and theory (Blessing & Chakrabarti, 2009; Boyatzis, 1998; Langely, 1999). This strategy resulted in a five-step process, the creating high-performing innovation teams (CIT) process, that on a conceptual basis demonstrates

how to create high-performing innovation teams. The development of the CIT-process accorded with current innovation processes (e.g. Andersson, 1996; Johnsson, 2009; Tidd & Bessant, 2013) subject for discussion with stakeholders, such as researchers, practitioners, small-and-medium enterprises (SMEs) and large industrial companies, to get feedback on its academic relevance and potential for both future research and practical application.

### 3.2 Findings

Based on the findings, a process in five steps emerged when aiming to create high-performing innovation teams. The approach of the CIT-process is to be similar to a guideline or a hands-on tool, as suggested by Dobni (2006), where the purpose is to ease organizations' efforts to create innovation teams that do not suffer from group-emergence-related problems or innovation-related knowledge problems.

**Creating high-performing innovation teams, the CIT-process.**

- Secure commitment from management, including top management.
- Identify an innovation team convener.
- Prepare (prime) the convener.
- Gather innovation team members.
- Kick-off innovation project.

*Securing top managements' commitment*

First, secure commitment from management, including top management. This step is crucial if one wants the planned innovation work to be official; otherwise one can skip this step and create an "under-the-radar innovation team" that conducts skunk work. However, as research claims that companies need to become more innovative in their approach, it is worth the effort to align management with the mindset of agile innovation work. In this first step, management needs information on how the innovation work will be conducted by the innovation teams, that is, step-by-step explanation of the CIT-process. One hurdle to pass in this initial step is to convince top management and management that unknown factors are a part of the usual innovation work to handle, and another hurdle may be to see innovation work as investment instead of risk. Depending on how innovationally mature the organization is (i.e., where they are on the industrial to post-industrial scale), the time for top management to see the benefits of high-performing innovation teams may vary, and one should not be surprised if it takes months to come to an agreement to set up a pilot project. Some argue that pilots are used to dismiss a new idea or process later on, but others actually use pilots for real evaluation and improvement. To gain the feeling of ownership and control at the management level, they can point out strategically important directions to work on, which also helps the creation of high-performing innovation team, as it is subsequently much easier to find appropriate team members;

*Identifying an innovation team convener*

Second, identify an innovation team convener. Management, together with the facilitator if needed, selects the convener. This second step is related to team leadership, but the convener is not to lead the team but to ensure that the innovation team is leading itself. If the convener can contribute to the innovation work, this contribution is a bonus,

but it is not crucial for the selection. It is more important that the convener has the ability to see the benefit of the innovation organization work in the same way as management and has the ability to steer an innovation project to the goal together with the prospective team members. The convener's role is to create a small organization that is built on convergence and divergence, in which the members can feel that they become one unit and share leadership as a team. There is no project manager in the high-performing innovation team; all the prospective team members will be experts within their area, and they will with that development lead any part of the innovation project that relates to their expertise. Together, the team will take united ownership and management responsibility for the progress. The main task for the convener is to focus on the working environment and ensure the team works together on a consensus basis, helping and supporting each other in the shifting and challenging innovation work. In this work, as with the previous work, patience is important. It takes time to find the right person and time to secure this person's manager's support for participating in the high-performing innovation team. One can assume that at least 10% working time is needed, and in some parts of the innovation project even more time is needed.

*Preparing the convener*

Third, prepare or prime the convener. As soon as the convener is identified and has accepted the challenge of creating the planned high-performing innovation team, the previous work conducted with top management and management to build confidence in the forthcoming innovation work starts over again with the convener in focus. The purpose of priming the convener is to prepare that person for group process problems and cyclic innovation processes and to feel secure when the innovation project suddenly finds a new way towards the goal, which is not yet fully decided. Another task that the convener must prepare for is the challenges of transferring the method of conducting innovation work in an autonomous innovation team, where shared leadership is the key. Here, the facilitator can support with in-depth knowledge concerning how to think when choosing team members based on multifunctionality, how to conduct agile innovation work with guidelines and tools for the different steps in the innovation process, and how to communicate the need for individuals' responsibility and the importance of commitment. In sum, the convener has only an innovation direction to aim for, and based on that the convener starts to think of possible team members, how to conduct a kick-off and how to get the group to become a team instantly. In this part of the priming, it is important to focus on building the convener's self-confidence, since the more input the convener gets, the more complex the situation is to master.

*Gather team members*

Fourth, gather innovation team members. This step is one of the most critical, as one of the ground rules is that the high-performing innovation team is built on team members' trust in each other, trust in the sense that, for example, agreed upon work is executed and completed in time and that the commitment one feels in the beginning something new does not fade away. Therefore, the convener must carefully choose team members that fit the purpose, and the convener should not be surprised if this selection takes one or two months to accomplish. One reason for this timeline is that if a person is invited and accepts the invitation, that person should not be terminated from team. Here, the previous process of explaining the overall methodology is a now the convener's tool when inviting team members to be the core of the high-performing

innovation team. As mentioned, a high-performing innovation team is based on multifunctionality, where at least one member should have connection to the organization's market. The other members' functions depend on the innovation project, but in total the team is preferably no bigger than four to six core members, including the convener. When searching for team members, the convener should define what core competences could be essential to the innovation project and choose to invite members in accordance with those competencies. It is essential to identify key people within these specific areas who want to participate and are open to new ways of working, since these key people are trusted, they have self-confidence, they have established networks and can easily connect to new networks when needed, and they can find help with specific tasks in the innovation project. Two critical aspects regarding time must be considered when selecting the key people: first, the key person must have available time to work in the innovation team, that is, real time available, not "I-can-get-it-done-somehow-time"; second, the key person's manager must approve that the invited person can work in the innovation project. Both of these aspects present problems later on if not addressed in a serious way during selection of the team members. Otherwise, the effect may be that the innovation project starts, but suddenly no one is doing the practical work. The high-performing innovation team is not supposed to do all the work by themselves, but to involve colleagues on temporary basis that conduct specific tasks along the innovation project. So, the required work time is about 10% for each member, but the situation for the team members will be the same as for the convener, that is, there will be occasions where less or more time is needed.

*Kick-off*

Fifth is the innovation project kick-off, the final step in preparation and the first step in the practical innovation work. The kick-off is the occasion on which the high-performing innovation team is officially created and initiated. Again, the overall methodology is explained to the team members, including the expected problems, from group emergence to how agile innovation work is conducted. This overview demonstrates that there will be tough situations to handle, but also that they have already been considered. The team members may not have met each other before, which is one challenge to handle; therefore, the team starts by establishing ground rules, expectations and a goal for the innovation project. Here, the facilitator can help by supporting with in-depth knowledge of group dynamics and with team-building exercises to provide the first hands-on tools to get the practical innovation work going. By this work, the team members are primed in a similar way as the convener, manager and top management; that is, the methodologies for why the innovation team has been created as it is have been approved at all levels and by the individuals concerned. With this preparation, the innovation team may be ready to start in a high-performing mode without waste of time and energy. A high-performing innovation team may have been created.

# 4 Discussion and conclusion

## 4.1 Discussion

*Creating high-performing innovation teams, the CIT-process*

As demonstrated above, the suggested CIT-process is step-by-step process that begins with the top management's approval and ends with a kick-off. Below, the CIT-process is discussed from a theoretical perspective.

The CIT-process starts with approval from top management (Dobni, 2006; McGreevy, 2006b) or management that can make the decision to create a high-performing innovation team. This first step requires patience, as top management might need several months to adopt a new mind-set, or because the wanted commitment may be easily changed out of mistrust (Johnsson & Karlsson, 2011b), delaying the CIT-process. In accordance with Backström et al. (2011), the organization itself must be mature enough to embrace new ways of working, or this moment is easily mired in a catch-22 based on the uncertainty connected to innovation work. To set up a project team to conduct an ordinary project is far different from creating a team to produce innovative results because the context is much more complex in terms of, for example, acquired innovation-related knowledge (Johnsson, 2014). The creation of a high-performing innovation team equals change; that is, the organization has to change to some degree to be able to conduct innovation work in a new way, and the new innovation team needs back-up and support from its management (Gamatese & Hallowell, 2011; Hayton, 2003; Hayton & Kelly, 2006; Kihlbom, 2005; Ribiero-Soriano & Urbano, 2010; Un et al., 2010; West et al., 2003) and needs space and empowerment (Ahmed, 1998; Backström et al., 2011; 1998, Brown, 2005, West et al., 2004) to become high-performing.

Top management should ensure that innovation projects get necessary support from all levels in an organization, that structured methodologies and systems are set and that middle management at all levels is committed to the use of teamwork (Ahmed, 1998; West et al., 2004). Another task for the management, in general, is to encourage risk taking (West et al., 2004) and learning from mistakes rather than establishing blame (Aagard & Gertsen, 2011).

Even though empowerment and autonomy are required for successful teamwork, it is also suggested that management provide a newly formed innovation team with direction for the innovation work (Hallgren, 2009, Tidd & Bessant, 2013). However, the innovation team must feel free to conduct the innovation work in a way that is not too structured.

Except for the commitment of top management and middle management at all levels, team leadership has a central role in the high-performing innovation team. Prior research has shown that an innovation team leader must be well experienced with group processes and able to encourage team members to mature into a cohesive unit (Hallgren, 2009; West el al, 2004), and that involving inexperienced employees in innovation work is good for innovation in an overall and long term perspective (Bessant, 2003; Xu et al., 2006). Despite that, innovation teams created in that way have demonstrated group development related problems and innovation-related knowledge problems (Hallgren, 2009; Johnsson, 2011; Johnsson et al., 2010; Kesting & Ulhöj, 2010; Kristiansen & Bloch-Poulsen, 2010). External innovation drivers have been successful for innovation project performance (Johnsson et al., 2010; Hallgren, 2009), but the learning components are not thus fulfilled to enable the innovation teams to work on their own. To address these problems, the CIT-process suggests that the innovation team leader or innovation team manager be replaced for an innovation team

convener. The person suitable to become a convener understands the importance of group processes (Hallgren, 2009; West et al., 2004) and plans for shared leadership (Adams, 1996, Backström et al., 2011, Trott, 2012). The convener should also have the ability to understand and set up an innovation teamwork environment (Johnsson, 2014) where the team members are motivated and self-confident (West et al., 2004), not feeling the threat of exclusion from the team (Wheelan, 2013), and the convener must for example participate, support the team and allow team members to make own decisions (Backström et al., 2011; Byrne et al., 2009; West et al., 2004), striving to help the members freely contribute to innovation (Dobni, 2006; Hallgren, 2009; Pearson, 2002; Xu et al., 2006). The convener understands the positive and critical effects of a broad representation of functions (Kelly, 2005). From an organizational perspective, the innovation convener also has support from innovative organization theory in the way that modern highly innovative organizations are built upon consensus and shared leadership (Laloux, 2014).

To avoid the group process problems demonstrated by, for example, Tuckmann and Jensen (1977) and Wheelan (2013) and experienced in prior research, the main idea of the CIT-process is to aim for shared leadership early, when planning for the creation of a high-performing innovation team. Accordingly, the convener should be educated in innovation management in general, in the basics of innovation teams, in how to select team members and to get commitment from their managers, in group dynamics and in how to manage the innovation model in practice. However, the convener must also be supported by his or her managers and be allowed the time to use a "learning-by-doing" approach (Hallgren, 2009; Johnsson et al., 2010) to overcome problems (O'Reily & Pfeffer, 2000; von Hippel & Tyre, 1995). This approach allows conveners to acquire their own understanding of aims and visions (Kihlbom, 2005).

The preparation and education should be provided by a person with experience from all these areas (Hallgren, 2009; Johnsson, 2014; Johnsson et al., 2010; Nanda & Singh, 2009), and the suggestion within the CIT-process is that this person act like a facilitator to the convener and the innovation team until they are able to manage by themselves; that is, innovation work differs from ordinary work activities in that innovation work has the purpose of contributing to something new. Innovation models have been well described in several schematic models in recent decades (Andersson, 1996; Baxter, 2002; Johnsson, 2009; Michanek & Breiler, 2004; Ottosson, 1999 Tidd & Bessant, 2009) and further described for professionals (Adair, 2004; Utterback et al., 2006; Johansson, 2005; Johnsson, 2009; Kelly, 2001; King & Anderson, 2002). However, the literature has not handled the potential to release untapped innovation capacity from ordinary employees' work activities, and this is where the facilitator is suggested to support the convener and the innovation team with practical advice (Hallgren, 2009; Johnsson et al., 2010) in accordance with a blended-learning approach.

The first assignment of the convener is to identify the team members and their managers to get approval to spend time on the innovation work (Hallgren, 2009). When selecting members, the big five criteria are important to keep in mind, that is, to have members that are, for example, organized, reliable, ambitious, hardworking, helpful, cooperative, sociable, enthusiastic, optimistic, calm, stable, curious, imaginative, broad-minded, and sophisticated. Furthermore, the people should be receptive to new influences and new

knowledge and enjoy working together in a team. LePine et al. (2011), who have conducted research based on the big five developed by Barrick and Mount (1991), come to the conclusion that the selection of team members must be taken seriously, as one person who does not satisfy these criteria can have a negative effect on the work of the entire team, eventually ruining the project (LePine et al., 2011). If the innovation team feels that the performance is not improving because of a certain person or certain people, a natural reaction is to try to exclude any counter-productive person from the team. Instead, however, the innovation team should focus on helping that person to increase the team's effectiveness (LePine et al., 2011; Wheelan, 2009).

The potential members' participation by free will is of importance (Hallgren, 2009; Hoegl et al., 2003; Nerkar et al., 1996; Xu et al., 2006), and Hallgren (2009) suggests that the idea to be developed should be the attractant for the team members, but one problem to be aware of is that most employees do not participate because of a perceived lack of time, resources and knowledge (Kesting & Ulhöj, 2010). It is also important that the ideas follow or align with the overall strategy of the organization. Prior research has shown that small teams are more effective than larger teams, where the suggested number of members is three to eight, but the best-performing teams are of three to six members (Dew & Hearn, 2009; Wheelan, 2009). Within the CIT-process, I suggest that a team is ready to launch an innovation project when the convener has gathered another two or three members to participate in the innovation team, as long as they cover or have access to market, suppliers and distribution (Andersson, 1999; Johnsson, 2009; Tidd and Bessant, 2013) and leave a few places to be used for temporary members. More than six members would probably cause social loafing (Aronson, 1999; Clark, 2003; Dew & Hearn, 2009; Wheelan, 2009). Members of the team should have characteristics selected according to the big five, except for extroversion, since homogeneity on this characteristic allows a team to avoid conflicts regarding leader roles, according to LePine et al. (2011). However, the CIT-process follows the research of innovation models (Andersson, 1996; Baxter, 2002; Johnsson, 2009; Michanek & Breiler, 2004; Ottosson, 1999; Tidd & Bessant, 2009, 2013) where both an external and an internal perspective are important. By "external perspective" I mean active connections with, for example, end users, customers and suppliers, and by "internal perspective" I mean connections with other departments and an internal network containing relevant competences. The CIT-process also builds on shared leadership (Backström et al., 2011, Trott, 2012) why I believe that extroversion is a positive character for all members of the innovation team.

The innovation team should be multifunctional, so divergence and convergence should work as attractors of the members (Lubaktin et al., 2001). Divergence in, for example, skills and knowledge is positive for the dynamic of the group. It prevents group thinking, which in many cases produces incorrect decisions early in projects, and divergences in a network are also positive, as they make it easier to find relevant competences when needed (Isaksen & Ekvall, 2010; Olsson et al., 2010).

Following LePine et al. (2011), the innovation team members should be open to learning new methodologies, but as the members are in a process of divergence and convergence, the individuals need to have reached readiness for learning (Billett, 2001; Ellström et al., 2007). The process of achieving learning readiness is dependent on the individuals and upon the organizational wish to engage in a certain of work (Ellström

et al. 2007), in this case, innovation work. This eagerness relates to the ability to be aware of innovation affordances, that is, opportunities to innovate in everyday work or other situations. Norman (1999) claims that affordances are available everywhere at all times but must be detected. Affordances can be visible or perceived in a physical product or be invisible in a situation, for example, at a workplace, in the supermarket while shopping, in contact with a supplier or at a meeting with the innovation team. The ability to achieve innovation readiness in order to detect affordances requires practice, which is why the convener has to identify members open to learning related skills.

As claimed above, innovation is about change. In the case of innovation, change is most often connected to shifts in established work routines. In the same way, as it is suggested to prepare the convener to establish a good start, the CIT-process recommends that the entire innovation team start with a kick-off where the members can unite and start their development process (Amabile et al., 1996). Actually, in the CIT-process the group development process starts when the convener invites the team members to join the team and prepares them for the project in its entirety. This preparation eases the start up, as the members can become familiar with one another before the kick-off (Edmondson, 2012; Nanda & Singh, 2009). At the kick-off, the main focus is to establish a team formation based on the unique situation of the innovation team (Olsson, 2010; Wheelan, 2013), meaning that they should set the agenda, establish goals, and find ways to start work and to communicate, meet and relate to each other; the most important thing is that all members actively agree on what they decide upon (Adkins, 2010; Backström, 2011). The role of the convener at the kick-off is to build trust and establish commitment (Johnsson & Karlsson, 2011b, Lubaktin, 2001), which could be achieved by being honest about limitations and uncertainties, ensuring there are no hidden agendas, acknowledging ideas, and creating space for communication without filtering information between management and members. Another important element of the kick-off is to be explicit in the group dynamic process problems that might appear and how to handle them. Every member is thus prepared for what might come, making future situations easier to anticipate, handle and sort out (Wheelan, 2013). To support the convener at the kick-off, the facilitator plays the important role of preparing the team in the same way the convener was prepared (Hallgren, 2009; Kihlbom, 2005; Nanda & Singh, 2009).

Time is required for involved people to develop their own understandings of what is happening and what will come (Kihlbom, 2005), to emerge as a team and to develop order parameters (Backström & Olson, 2010). Once in a while, it can be valuable to remind top managers that the team members need time both to understand innovation work and to develop the team, especially as research shows that even, for example, top management needs around six months to understand the background necessary to start a shift towards an innovative organization (Karlsson et al., 2010), and six to eight months are needed to develop a high-performing team (Wheelan, 2013). Learning begins in the individual, continuing as group learning, performed via a dialog and discussions between the individuals. The final step is a system thinking that is shared by all concerned (Kihlbom, 2005). When interpreting this thinking in terms of the CIT-process, one can see the introduction of the top mangers, other managers, the convener and the gathering of team members as individual learning. The group learning starts at

the kick-off, and system thinking is achieved when all members reach the critical level of understanding.

*CIT-process as a pre-stage to group processes*

As suggested in the previous section, the CIT-process is a step-by-step process that starts at the level of top management and ends with a kick-off. When looking at the CIT-process from that perspective, it could be seen as a pre-stage to established group dynamic processes as the group starts with a formative stage and hopefully reaches a team stage (Buijs, 2007; Tuckmann & Jensen, 1977), or preferably a high-performing stage (Wheelan, 2013). Even though time is needed to prime and prepare the involved people, which may take months of work, one benefit is that this time effects only the convener, that is, one person and not the entire team of four to six people. Another benefit is that there commitment from the team members is secured at the kick-off, and they can start forming norms and discussing plausible issues that may cause conflicts from the very first day of the innovation project. That prepares the team for possible problems that may occur in the forthcoming work, thus saving both time and energy.

### 4.2 Conclusion

The CIT-process is a conceptual process that presents a step-by-step guide and structure to create high-performing innovation teams. It is developed from established research in relevant areas. On a theoretical level, the CIT-process provides guidance to organizations that aim for increased efficiency when developing new products (services, processes, etc.) as it may reduce time and energy for an innovation team to become high-performing.

The message of the suggested CIT-process is that one should not hope for an innovation team to reach the high-performing stage immediately nor to focus on tools to rescue innovation teams already struggling. Instead, one should carefully plan and prepare for a high-performing innovation team to be created in the first place. This planning is be accomplished by addressing both plausible group process problems and challenging uncertainty in innovation work, by priming and preparing involved people from top management to individual team members, by aiming for shared leadership when involving the convener and team members all the way to kick-off and, furthermore, by securing support from an experienced innovation facilitator that can, when needed, remind the convener and team members of the group-development challenges and planned uncertainty along the innovation project.

### 4.3 Contribution to prior research

This research contributes to prior research in several ways. On a holistic level, it contributes to group dynamic processes by suggesting a pre-stage to already established theories of innovation processes (e.g. Johnsson, 2009; Narasimhalu, 2005; Smith et al., 2012; Tidd & Bessant, 2013). However, to be more specific, there are four main contributions to highlight. First, prior research has focused on either innovation teams or high-performing teams (Adkins, 2010; McDonough, 2000; McGreevy; 2006a; 2006b; West et al., 2004). This research contributes by joining these two branches together, resulting in a conceptual methodology for how to create not just *any* innovation teams, but high-performing innovation teams. Second, prior research has

suggested that an innovation team consists of the team leader or an innovation driver to ensure that progress is achieved. The consequences are that the innovation teams suffer from lack of innovation-related knowledge. This research contributes by suggesting a setup based on an innovative organizational structure, where the innovation team leads itself based on shared leadership among the innovation team's members (Adams, 1996, Backström et al., 2011, Trott, 2012). Third, prior research conducted on innovation teams has revealed problems connected to performance caused by lack of innovation-related knowledge. This research contributes by suggesting a convener, and a facilitator if needed, to ensure that the innovation-related knowledge is provided to the team members. The facilitator ensures that management at all relevant levels is provided with adequate innovation-related knowledge. Fourth, prior research conducted on innovation teams has demonstrated problems connected to group emergence problems (Hallgren, 2009; Kesting & Ulhöj, 2010; Kristiansen & Bloch-Poulsen, 2010). Much research on innovation teams and group development has been conducted, but not focusing on the conditions for the creation of high-performing innovation teams, as this research has done (Buijs, 2007; Tuckmann & Jensen, 1977; Wheelan, 2013). This research contributes suggestions for how to prevent the initially most problematic and challenging stages a newly formed innovation team confronts. The key element here is to enter the high-performing stage faster and more easily than before, where the suggested method is to secure the innovation project by ensuring commitment from all levels of the company, to carefully choose a convener, to invite team members that ensure their buy-in and to provide an understanding of the group dynamic process.

### 4.4 Practical application

The contention of the CIT-process is that an innovation team's success can be planned for in advance with proper preparation for a high-performing innovation team already on the drawing table. When focusing on providing solutions to already-known group process problems before the innovation team is gathered, as described above, the team has the potential to skip or minimize the initial challenges of the group process and start in the team, or even better, in the high-performing phase. Such efficiency would probably save much time, money, energy and effort for all involved people and parties.

Businesses and innovation leaders may adopt this knowledge and suggest new ways of starting an innovation project within an organization, and the approach may be used to educate customers or clients on how to prepare an organization to become more agile, responding quickly with new ideas to meet the present market conditions. The practical contribution of this research would be to speed up innovation work and thus contribute to increased innovation efficiency concerning the total time for development, the implementation and the magnitude of the innovation, as stated by Pearce and Ensley (2004).

## 5 Limitations of the study and suggestions for future research

The suggested CIT-process is based on a theoretical framework, systematically developed to meet organizations increasing needs for faster ways of conducting

innovation work. Although it is based on relevant research and best practices regarding, for example, innovation teams and group dynamic processes, there are limitations to be considered. One should notice that the CIT-process is a conceptual process and needs to be evaluated. Further, the CIT-process is designed to be applicable to organizations such as, for example, SMEs or large companies aiming to develop a more agile way of conducting innovation work. Another limitation is that it requires a knowledgeable person who can introduce it to an organization before it is adopted, as some elements of the CIT-process require a high level of innovation-related knowledge.

Suggestions for future research are to create case studies through which the CIT-process could be studied. The research focus would for example, concern how a facilitator effects the innovation team, the innovation team's development process and the team's performance. Measurable indicators would be to measure cost, time and intangible results and values from innovation projects, and to compare those results to how the company usually plans and conducts similar innovation projects. Of course, a study regarding whether an innovation team created in accordance with the CIT-process would be high-performing or not is highly recommended.

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# The emergence of financial innovation and its governance - a historical literature review

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**Abstract.** This paper reviews the literature from diverse disciplines in order to trace historically, the emergence of financial innovation and its governance. It starts with a charting of the occurrence of financial innovations throughout history, followed by a chronological mapping of the introduction of mechanisms to govern these innovations. It then discusses findings from the review in order to shed light on the extent to which financial innovation governance approaches used throughout history were sufficiently robust to ensure the emergence of responsible financial innovation. Findings show changing drivers of financial innovation across history with no evidence of specific governance mechanisms for the process of financial innovation itself. What exists are mechanisms for governance of the financial sector, in the form of legal frameworks, policies and self-regulatory mechanisms that place emphasis on regulation of the products of financial innovation after these have been developed and implemented. The paper is concluded with a brief discussion on implications for theory.

**Keywords:** Financial innovation, Innovation governance, Regulation, Self-regulation, Responsible innovation.

## 1 Introduction

Following the financial crisis of 2007/2008 the assumption that innovation contributes positively to finance and welfare has been challenged (Sánchez, 2010; Corsi, et al., 2016; Fostel & Geanakoplos, 2016), and the balance of risks and benefits of financial innovation to society questioned (James, 2015; Beck et al., 2016). Financial innovation has received various criticisms from the media, the public, policy makers and top economists in society (Litan, 2010). Thus actors (e.g. Armstrong et al., 2012, Asante et al., 2014) have become interested in finding ways to preserve the benefits of financial innovation, while at the same time limiting the impacts and risks of financial innovations that have the potential to be harmful. This begs the question of how financial innovation occurs, how it is governed, and how adequate current mechanisms, including regulation, for governing financial innovations are in predicting and managing their wider impacts before they occur; questions that this study hopes to address. Answers to these questions could shed light on the context within which innovators in the financial sector must understand and frame any conceptualisation of responsible financial innovation.

Allen and Gale (1997), Goetzmann and Rouwenhorst (2005) and Allen and Yago (2010) argue in favor of a studying financial innovation from a historical perspective

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when they discuss at length major financial innovations that have occured in history in their research publications. While these are useful, they do not consider how these innovations have been governed through history. Such an activity allows for comparison between when specific financial innovations occurred and when mechanisms were introduced to govern them. Further, comparisons of this nature can be considered useful because according to Hu (2015), some theories associated with financial innovation, for example decoupling, can have implications for information-based governance mechanisms. Therefore, this paper seeks to take the works of Allen and Gale (1997), Goetzmann and Rouwenhorst (2005) and Allen and Yago (2010) a step further. I describe the emergence of financial innovation and its governance. Specifically, the paper charts the emergence of financial innovations and associated governance throughout history and compares the two in order to assess whether innovation management and governance approaches used throughout history have been sufficiently robust to ensure the responsible emergence of financial innovation. Further the paper highlights lessons that can be learnt from the review with regard to the motivation, drivers and types of financial innovation.

## 2 Research Methodology

A review of the literature (Bhatt and Bhatt, 1994; Brundage, 2013; Salevouris and Furay, 2015; Marius and Page, 2015) suggests three activities are crucial in the historical review process; collecting data, verifying its authenticity and organising, analysing and writing it out. Regarding data collection, these authors highlight primary and secondary data as the main sources which historical researchers can use; and acknowledge that access to primary data could be limited, in which case use of secondary data sources only is justified. To this end, the study uses mainly data from secondary sources.

The main approach of this study is to juxtapose a review of the literature on the emergence of major financial innovations in history and their governance. To identify the articles to be used for the study, research was conducted from secondary sources of data including journal articles, books, encyclopedias and newspapers. The search for relevant material started in bibliographic databases (JSTOR, Emerald and EBSCO) using key words such as “financial innovation”, “innovation in financial services” “history of financial innovation” and “governance of financial innovation”. This yielded a large number of articles which allowed for the identification of innovations considered significant in the financial services industry, but with limited details about the event. Further, the search on governance of financial innovation returned fewer relevant articles. Therefore, for each major innovation identified, a more targeted search was conducted in the bibliographic databases stated above, and in a few cases on the Web to find relevant material that shed light on when, where, why and by whom the first form of the financial innovation emerged, what type of governance mechanism existed to govern the innovation, when and why that mechanism was introduced.

Salevouris and Furay (2015) argue that there is no hard and fast rule in selecting literature to be used for historical writings. However, he suggests a number of things that could be useful to consider including how up-to-date the literature is, whether the

source references of the literature is substantive and whether the work is respected by other researchers in the field. These guidelines as well as others such as relevance to topic, acceptance by fellow researchers and influential strength (i.e. the extent to which the author of selected literature has influence on the advancement of knowledge in the field of study) suggested by Karayiannis (1998) were employed in choosing literature used for the study. Where possible, scholarly secondary sources were used; and for relevant events identified, multiple data sources were reviewed to ensure authenticity and reliability of information.

The study used both the narrative and analytical modes of historical writing suggested by Marius and Page (2015). The narrative method was used at the beginning of the paper to help readers appreciate the financial innovation and governance story; with a chronological ordering of events in a way that allowed for the kind of comparison the researcher wanted to do in terms of timing (i.e. when an innovation was introduced and when some mechanism was put in place to govern it). The analytical method was also applied mainly to the discussion section of the paper to allow the researcher tease out arguments regarding motivations, types and processes of financial innovation and its governance overtime.

# 3 Emergence of financial innovation

## 3.1 Definition of financial innovation

A review of the literature on financial innovation reveals that most researchers (e.g. Llewellyn, 1992; White, 1997; Tufano, 2003; Mishra, 2008; Sánchez, 2010; Delimatsis, 2011; Gubler, 2011; Lerner and Tufano, 2011) define financial innovation as the creation and popularisation of new financial products, processes, markets and institutions. Nevertheless, Mention and Torkkeli (2012; 2014) argue that this definition is narrow thus suggesting a more holistic view of financial innovation which not only acknowledges changes in offerings, and modifications in structures, processes, practices and distribution channels, by financial institutions, but also emphasizes the need for these to lead to some measurable economic or intangible impact on society. For the purpose of this study, I take the definition of Mention and Torkkeli (2012; 2014) and that of others mentioned above a step further and define financial innovation as "*a process, carried out by any institution, that involves the creation, promotion and adoption of new (including both incremental and radical) products, platforms, processes or enabling technologies that introduce new ways or changes to the way a financial activity is carried out*" (Khraisha and Arthur, forthcoming). With this definition, we argue in another paper (Khraisha and Arthur, forthcoming) that financial innovation transcends innovations in the financial instruments category and can come from non-financial institutions; and these are important characteristics which should be captured in its definition.

## 3.2 Core financial products

Serving as a hub for financial innovation, Mesopotamian civilisation played an important role in the development of financial innovation in early history (Figure 1). During those early civilisations, societies were normally run as gift economies,

coupled with the practice of the barter trade system. While some individuals gave valuable goods to family and friends for free, without any formal agreements for immediate or future rewards, others traded by exchanging their goods for other goods perceived to be of equivalent value. Thus as far back as 3000BCE, the concept of commodity money was coined and this allowed individuals to purchase goods and services using commodities, such as gold, precious metals and cowry shells, which were perceived to have great value. This ability to trade led to the development of the most primitive form of financial arrangements, personal loans, typically compensated with interest (Allen and Gale, 1994; Wyman, 2012) which made the "intertemporal transfer of value through time", a key foundation for finance, possible (Goetzmann and Rouwenhorst, 2005, p.4). Over time, more sophisticated financial arrangements sprang up; and banking firms were developed in the Mesopotamian Valley leading to the creation of the first two financial instruments, bank deposits and bankers' acceptances (Allen and Gale, 1994; Allen and Yago, 2010). A few centuries later (i.e. between 1700 and 1100 BCE), early forms of annuities were recorded to have been traded in Egypt (Wyman, 2012).

Like loans, the development of cuneiform records, which is an example of a contingency claim in Mesopotamian civilisation, presents another important principle in finance; "the ability to contract on future chance outcomes" (Goetzmann and Rouwenhorst, 2005, p.5). This reflects the fact that as individuals transferred the ownership of their monies to the future though financial arrangements, they also exposed themselves to risks derived from uncertainty in the future. As a result, both lenders and borrowers could purchase contingency claims by entering into another financial agreement requiring one party to make a payment depending on the outcome of some event (Goetzmann and Rouwenhorst, 2005). These systems had their own limitations, as transactions under the barter system for example could only take place if a trader could find someone who wanted what he or she had to offer and had what he or she wanted; a situation normally referred to as the "double coincidence of wants". Thus there was a need for a medium of exchange to make trade easy and early forms of metal money began to emerge by 1000BCE in China. Between 700 and 600 BCE, modern coins were introduced as a way of standardizing money and facilitating trade in Lydia and Western Turkey (Allen and Yago, 2010; Wyman, 2012). This made it easy for market participants to trade their contractual claims to third parties. For example lenders faced with unexpected events leading to a sudden need for cash could sell their loan contract for coins. Goetzmann and Rouwenhorst (2005) call this the "negotiability" feature of finance and argue that true negotiability was developed in China with the introduction of paper money in the eleventh century. Similarly, Allen and Yago (2010) point out that the development of state-backed paper money in 1024 made finance easier. However, financial arrangements returned to a primitive state during the Dark Ages and bank deposits and acceptances faded out of the system (Allen and Gale, 1994).

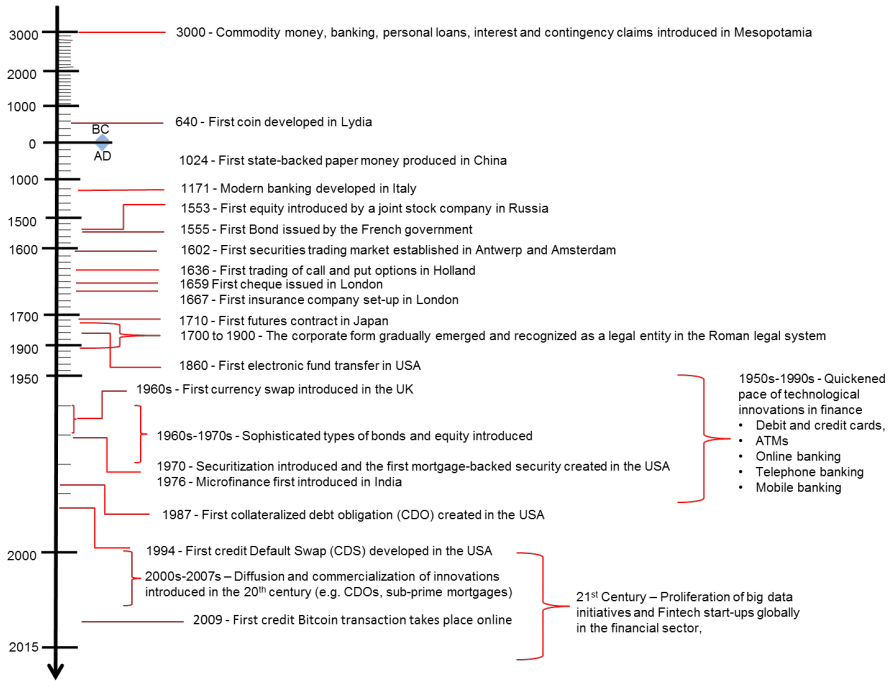


**Fig. 1.** A historical rise of financial innovation (Adapted from Allen and Gale, 1994, Goetzmann and Rouwenhorst, 2005, Sengupta and Aubuchon, 2008, Allen and Yago, 2010, Davies, 2010, Sudhakara, 2012, Wyman, 2012, Murdock, 2014, Malvey et al., 2013 and Reid and Harrigan, 2013)

Between the twelfth and thirteenth centuries, when commercial practices of the city states in northern Italy emerged and became sophisticated, society saw a re-emergence of bank deposits and acceptances in the form of modern banking; and its use spread widely as trade and commerce grew in Europe (Allen and Gale, 1994). Furthermore, the rapid development in trade and commerce during this period led to prosperity and consequently a desire to create more wealth; and capitalism, "a system based on individual investments in the production of marketable goods, slowly replaced the traditional ways of meeting the material needs of a society" (Appleby, 2010, p.3). Capitalism was characterized by private ownership, entrepreneurial control, free competition and the formation of joint stock companies among other things (Hodgson et al., 2001). Thus there was a motivation to create new financial products that met the needs of capitalists. By the sixteenth century, two new financial instruments were introduced to facilitate this; bonds and equities (Allen and Gale, 1994). While the first equity was issued by a joint stock company in Russia in 1553, the first bond was issued by the French government in 1555 (Allen and Gale, 1994). Gradually the use of equities and bonds became widespread. In addition to governments, companies also began to issue bonds, and also developed various types of securities such as convertibles and preferred stock to meet the needs of investors. At the same time, the first cheque was introduced in 1659 in London as trade continued among financial institutions in continental Europe (Davies, 2010). By the

seventeenth century, the total amount owed to both firms and government had grown larger; and this necessitated secondary trading and a better organisation of how financial markets worked. In 1611, the first securities trading market was opened in Antwerp and Amsterdam (Allen and Gale, 1994). Furthermore, "the development of organized secondary markets for securities led to sophisticated trading practices which in turn spurred financial innovations" in the area of financial risk management in the 17th and 18th centuries (Allen and Gale, 1994, p.13). By the end of the 18th century, innovation of quite sophisticated and complex financial products and services had occurred: and this happened in quite a short space of time.

Between the nineteenth and twentieth century, the Roman legal system developed "a form of de facto depersonalized business entity" (Abatino et al., 2011, p.1) which recognized the corporation as a legal entity, "with right of ownership and the capacity to contract with others" (Goetzmann and Rouwenhorst, 2005, p.13). This concept of the corporate form is seen by Goetzmann and Rouwenhorst (2005) as a financial innovation in itself as it changed to a great extent practices in the financial sector. With this new system, business activities were no longer personal, as managing partners and shareholders held a limited liability in the company. That is to say "no matter how large the loss incurred by a company, its shareholders would be liable for no more than the value of their initial investment" (Goetzmann and Rouwenhorst, 2005, p.14). With the invention of the corporate form, coupled with repeal of the Bubble Act (an act which made it illegal to form a company without a charter (Allen and Gale, 1994)) due to developments in canal and railway construction and falling security values (in Britain), financial activity increased, leading to the development of even more sophisticated types of bonds and equity. Similarly, the USA's increasing need for capital due to civil war and expansions in railway construction led to creation of different types of financial securities (Allen and Gale, 1994). Some of these were income bonds, commercial paper, warrants and commodity futures exchanges (Allen and Gale, 1994). Further, the first electronic fund transfer was recorded in a transaction by Western Union in the USA (Sudhakara, 2012).

After the Great Depression and the Second World War, financial instruments in common use remained relatively stable. However, between the 1960s and the 1970s, the pace of innovation quickened tremendously (due to changes in the underlying technologies of finance (e.g. data processing and telecommunications), deregulation, changes in the economic environment (i.e. higher and more variable inflation and interest rates) and the desire of many to circumvent regulation (White, 1997); with most of the innovations being a further development of some of the traditional instruments discussed above. Tufano (2003, p.7) argues that this is a "normal pattern of financial innovation where a security is created, but then modified (and improved) slightly by each successive bank that offers it to its clients". For example, firms introduced floating rate notes, zero coupon bonds, synthetics and poison pill securities, all of which are types of bonds or equity with different features (Allen and Gale, 1994). Important financial innovations such as currency swaps developed in the 1960s by UK banks as a way to avoid UK exchange controls (Allen and Gale, 1994) and securitized loans created in 1970 under the auspices of the US' Government National Mortgage Association (GNMA) were introduced.

The advancement of technology in finance accelerated greatly, leading to the development of several process-related innovations such as debit and credit cards, automated teller machines (ATMs) and online/telephone banking systems between 1950 and 1980 (Batiz-Lazo, 2011). During this period, microfinance was also introduced by the Grameen Bank in 1976 (Sengupta and Aubuchon, 2008). Within a short time, the concept of securitisation, a process whereby cumbersome, illiquid financial contracts (e.g. the Russian government bond fund which made available loan-backed bonds of Russian government debt to smaller investors in Holland in the nineteenth century) are converted into liquid instruments of smaller denomination that could be traded on a capital market (Goetzmann and Rouwenhorst, 2005) had been extended to other assets (e.g. homes, cars, credit card receivables etc.). This led to the creation of more complex and sophisticated asset-backed securities (ABSs) in the twentieth century. The collateralised debt obligation (CDO), first created in 1987 in the USA (Stefani, 2010) is one of such ABSs; and this has since been classified as 'toxic' (Longstaff and Myers, 2009) and is seen as a major contributor to the recent financial crisis (Gubler, 2011). Unfortunately, there is limited information on innovations that emerged after the year 2000. However, the literature suggests that between the years 2000 and 2007, the financial sector witnessed a rapid diffusion and commercialisation of innovations developed earlier in the mid to late 20th century such as CDOs and subprime mortgages (Arestis and Karakitsos, 2009; Dwyer, 2012; Murdock, 2012). Further, other major innovations witnessed in the 21st century includes company specific big data initiatives in the financial sector (Malvey et al., 2013), financial service technologies (FinTech) startups (Zavolokina et al., 2016), and the virtual currency, Bitcoin, first traded in 2009 (Reid and Harrigan, 2013).

### 3.3 Managing financial risk and uncertainty

The emergence of innovations to support risk assessment and pricing in finance dates back to 2500BC, in the context of good transport insurance (in Babylonia) around the same time when core financial products were introduced (Wyman, 2012). However, the proliferation of innovations to support the management of financial risk and uncertainty largely occurred in the 17th and 18th centuries in response to increasing sophistication in financial practices (Allen and Gale, 1994). During this period, the first insurance company was established in London in 1667 (Allen and Yago, 2010) to protect investors from the risks and uncertainties arising from the introduction of more complex innovations into the financial system. Further, society witnessed the introduction of innovations such as the call and put options (introduced in 1636 in Holland (Sinclair, 2010)), the futures contract developed by the Japanese in 1710 (Reszat, 1997; Wyman, 2012), the mutual fund created by the Dutch in 1773 (Wyman, 2012) and check clearing houses developed in London in 1774 (Wyman, 2012). While options and futures gave investors protection from fluctuating prices (Smithson, 1998), mutual funds (if managed properly) made it possible for investors to reduce investment risk (through diversification) (Hu et al., 2014) and clearing houses (e.g. counter party clearing houses) helped reduce default risk by netting offsetting transactions (Mehra, 2010; Duffie and Zhu, 2011). Similarly, the creation of the credit default swap (CDS), created in the mid-1990s (Kolb and Overdahl, 2009) in the USA, made it possible for financial institutions to insure against third party

defaults. CDSs have been identified to have contributed to the 2008/09 financial crisis and to the sovereign debt crisis in the Eurozone (Dunbar and Martinuzzi, 2012). In the case of the 2008/2009 financial crises, Adam and Guettler (2015) argue that the destruction was not caused only by the design of the innovation, but also by how it was governed; that is the use of teams to manage the fund slowed down decision making processes at a time when market conditions were changing rapidly.

### 3.4 Summary

Financial innovation has existed since the civilisation of man; however the pace of financial innovation quickened in the first half of the 17th century, and then again in the 20th century. Although some financial innovations in history are novel (e.g. technological innovations like the ATM) and have changed how the industry works, most innovations, especially in the 20th and 21st century have been further developments of already existing products and service. Therefore the process of creating new and/or improved, products and services appears to have been largely incremental as levels of competition in the industry have increased; and these innovations have been driven by factors that are both internal and external to the innovating organization. Complexity, which derives from reconfiguration in a globalized, socio-technical context, seems to characterize the financial innovation process, causing high risks and uncertainty. This historical review creates a background against which the financial innovation governance landscape can be explored.

## 4 Emergence of financial innovation governance

### 4.1 Financial regulation

The history of governance in financial innovation is evidenced in practices such as the, social and political organisation, called the polis, developed in the eighth century BC by the Greeks to respond to market conditions and limit the effect of the market on society ((Redfield, 1986), regulatory problems resulting from forgery and counterfeiting in the financial system faced by first Roman and then Byzantine States in the Middle Ages (Levi, 1987), competition identified in early civilisation among national authorities in order to subject financial actors to their needs and demands (Germain, 2010) and activities of barter markets centuries ago (Gilligan, 1993).These suggest that governance of financial innovation extends back many centuries, with usury laws being the oldest form of regulation (Benmelech and Moskowitz, 2010). Introduced in 454BCE (Bolles, 1837), usury laws governed aspects of some of the earliest financial innovations (e.g. banking) by putting in place restrictions on the interest that could be charged by bankers; and punishments for offenders. This was to avoid extortion and protect consumers from the negative impact of the lending system. By the 14th century, governance of previous innovations in finance became a part of existing legal frameworks as the UK introduced clauses to govern financial activity in her common law. These legal policies did not govern the innovation process itself but mainly governed financial activity and the products of innovation after they had been introduced. Thus financial traders were prosecuted for several

offences, including engrossing (buying goods to sell in the future at a higher price), forestalling (raising the price of goods by holding up supplies) and regrating (buying goods in any market in order to raise price and selling it at a later date in the same place) (Gilligan, 1993). These practices continued until centuries later (i.e. the 16th and 17th century), when the need arose for the introduction of more prudential forms of regulation due to increasing complexity in financial products/services. In 1668, the first central bank was set-up in Sweden to oversee the issuance and circulation of currency in the economy (Allen and Yago, 2010). Gilligan (1993) suggests that government's increasing demand for short term borrowing coupled with the need for joint stock companies to fund growth into new markets led to an increase in marketing of stocks, fraud and manipulation of the market. Thus in 1697, the Act to Restrain the Number and Practice of Brokers and Stock Jobbers was passed. This, the first securities trading legislation (perceived as being restrictive, preventive and punitive), was a piece of process innovation in itself, as it sought to limit the number of brokers and the commissions paid to them; and to ensure that all brokers were licensed and transactions carried out were recorded (Gilligan, 1993).

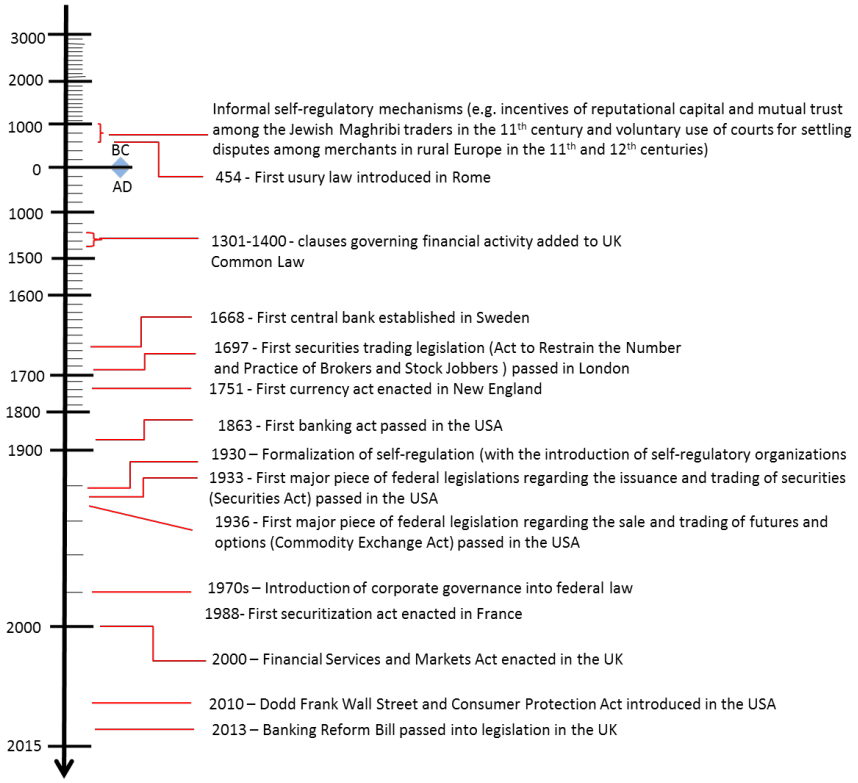


**Fig. 1**. Historical rise of governance structures for financial innovation (Adapted from Redfield, 1986, Allen and Yago, 2010, Archarya et al., 2010, Germain, 2010, Omarova, 2010, Komai and Richardson, 2011, Cheffins, 2013, Her Royal Majesty's Treasury and Javid, 2013)

The 18th, 19th and 20th centuries saw the emergence of more policies to govern financial activity in several countries. In New England for example the Currency Act was introduced in 1751; this act declared paper currency a legal tender (Allen, 2009) and provided further guidance on the issue and circulation of money. Similarly, the US Government in 1791 chartered First Bank of the United States to manage the financial needs of the federal government, credit and coinage of the nation; following which the country witnessed in 1863 the passing of the National Currency Act (Komai and Richardson, 2011). In 1873 in Massachusetts, the first standard insurance regulation (for fire) which focused on licensing and reserve requirements (among others) was passed; although the industry had governed themselves prior to this through insurance boards (the first of which was set up in 1855 in New Hampshire) (Meier, 1988). This was followed by the introduction of the first Banking Act (sometimes referred to as the Glass-Steagall Act) in 1933 in the USA which sought to regulate the activities of banks; provisions included the separation of investment from commercial banking (Garten, 1997; Russell, 2008), restrictions on private banking activities and the use of bank credit and requirements for banks to have temporary insurance for deposits (Preston, 1933). In 1929, the USA witnessed the collapse of the New York Stock Exchange i.e. a sudden decline in stock prices (e.g. a fall of 24% for the Dow Jones over a period of two days and a total decline of 37% by the end of November 1929) due to excessive speculation (among other things) which caused distress to the financial system (Mishkin and White, 2002). This led to the introduction of the first major piece of federal legislation (in the USA) governing the issuance, sale and trading of securities as well as futures and options respectively (i.e. the Securities Act in 1933 and the Commodity Exchange Act in 1936) (Germain, 2010; Komai and Richardson, 2011). In 1988, securitisation was introduced into French law as a way of governing securitisation reconfiguration of financial assets (Baums, 1994).

The use of legislation in governing the financial sector worked well until the late 1970s and early 1980s when advancements in technology and communication caused financial institutions to innovate and find ways around existing regulation (Ingham and Thompson, 1993). This, among other things, led to a series of de-regulation initiatives mainly focused on the removal or lessening of interest rate ceilings and the management of competition among banks (e.g. the introduction of the Competition and Credit Control Act of 1971 in the UK, the Depository Institutions Deregulation and Monetary Control (DIDMC) Act of 1980 in the USA, Report of the Campbell Committee of 1982 in Australia and the 1974-75 liberalisation practices in Japan) (Adhikary, 1992). Since the 1980s, the financial sector in various countries has experienced periods of regulation and de-regulation leading to the introduction of new acts and the amendment or repeal of existing acts (Adhikary, 1992; Sherman, 2009). In the USA for example, acts such as the Garn-St. German Depository Institutions Act of 1982 (which allowed commercial lending among savings and loans institutions), the Financial Institutions Reform and Recovery Act of 1989 (which strengthened regulatory mechanisms for governing thrifts), the Gram-Leah Bliley Act of 1999 (which repealed the Glass-Steagall Act of 1933) (Sherman, 2009) and the Dodd-Frank Wall Street Reform and Consumer Protection Act of 2010 (which reforms the financial regulatory environment (in response to the 2007-2008 financial crisis) with a view to improving financial stability and protecting consumers)

(Acharya et al., 2010) among others were introduced. Similarly, acts such as the Banking Act of 1979 and 1987, the Financial Services Act of 1986 and the Financial Services and Market Acts of 2000 have emerged in the UK in an attempt to consolidate financial services regulation, improve financial stability and protect consumers (Radcliffe et al., 1994; McConnachie, 2009; Davies et al., 2010). More recently, the concept of separating investment and commercial banking activities (as in the case of Glass-Steagall mentioned above) has been proposed by the Independent Commission on Banking set up by the UK government (following a series of irregularities e.g. LIBOR scandal) to make recommendations on banking regulation; and UK financial regulators have, following a bill put through to parliament, recently in 2013 passed this into legislation (Edmonds, 2013) under the Banking Reform Bill (Her Royal Majesty's Treasury and Javid, 2013).

Germain (2010) suggests that financial governance went through several changes; and finally gained prominence in the 19th and 20th centuries. In these centuries, it was possible to see establishment of international governance systems operating through a set of linked world markets mainly based in London and central banks across Europe, Latin America and Asia (Brown, 1940; Williams, 1963; Germain, 2010). This led to "a new 'sectoralisation' of financial governance in which different parts of the financial system became subject to specific, often statutorily independent, regulatory agencies" (Germain, 2010: 31). In the USA for example Securities and Exchange Commission (SEC) was set up to oversee stock exchange regulation (Germain, 2010). Nevertheless, the financial sector saw a move towards internationally agreed regulatory practices with the deepening of networking relationships (through international conferences and organisations/committee e.g. League of Nations) among financial institutions in the 19th century (Germain, 2010); the collapse of the Bretton Woods fixed rate system (i.e. a system where exchange rates were determined by pegging foreign currencies to the US dollar) in 1971(Verdier, 2013) and the introduction of the Basel Accord (a consensus among 12 countries to impose upon their international banks a set of minimum capital standards (Van Roy, 2008)) in 1988 (Davies et al., 2010) among others. With the creation of the 'new international financial architecture' (NIFA) (which was a reaction to major financial crisis that took place in emerging markets such as Mexico in 1994, East Asia in 1997-8 and Argentina in 2001) (Eichengreen, 1999; Kenen, 2001) in recent years, it can be said that the scope of international financial regulation is broadening to include non-western countries.

### 4.2 Financial self-regulation

Greif (1989) suggests that the history of financial self-regulation dates back to the 11th century where Jewish Maghribi traders in Baghdad used structures built around incentives of reputational capital and mutual trust to facilitate trade. This was followed by the voluntary enforcement of courts for settling disputes among merchants in rural Europe in the 11th and 12th centuries (Benson 1989; Benson 1994). The 19th century saw the introduction of self-regulation in the financial securities sector, although evidence of how this worked is limited (Centre for Financial Market Integrity, 2007). The use of this system of governance continued to increase until the 1930s when the SEC formalized self-regulation and statutorily

established various self-regulatory organisations (SROs) in the USA (e.g. Financial Industry Regulatory Authority (FINRA) and national stock exchange) (Centre for Financial Market Integrity, 2007; Omarova, 2010). By the 1970s, financial malpractices among US corporations led to an increased interest in internal governance (by the SEC) and consequently the introduction of concepts of corporate governance (i.e. "a system by which companies are directed and controlled" (Governance, 1992, p.15)) into federal law (Cheffins, 2013). This term gained prominence in the 1990s with the introduction of the UK's Cadbury Report (Erturk et al., 2004; Cheffins, 2013) and has since been a mechanism used both internally and externally to govern organisations (O'Sullivan and Diacon, 1999; Weir et al., 2002; Hu, 2015). Siepel and Nightingale (2014) suggest that such corporate governance mechanisms could vary from country to country; in their study where they focus on the UK and the US, they argue that practices within the US create a broader scope for 'managerial agency' (for example when it comes to issues such as shareholder rights) when compared to the UK. This is an important point to note as they further argue that such differences in agency is positively correlated with managerial risk taking where those with greater agency have the potential to take higher risks (Siepel and Nightingale, 2014).

The 21st century saw the emergence of several open innovation initiatives within the financial services industry (Schueffel and Vadana, 2015). While innovation in traditional settings were initiated by and managed solely within a specific organisation, open innovation encouraged co-creation among multiple stakeholders such as customers, suppliers, consultants, educational institutions and research labs. Therefore, innovation contexts changed considerably; thus encouraging changes in innovation governance mechanisms. In this open innovation setting, governance mechanisms included internal processes, rules of collaboration, new service or product development frameworks that are repetitive, corporate culture initiatives, evaluation methods, and communication and collaboration technologies that fostered flexibility; all of which were managed by stakeholders, specifically, top management within the corporate governance framework (Schueffel and Vadana, 2015). Within the context of financial self-regulation, it is important to note the emerging use of decentralized forms of governance. A typical example of this is evidenced in the virtual currency, Bitcoin, which depends on the efforts of multiple people such as software engineers, users, currency exchanges and regulators in the setting and enforcement of rules. Bitcoin encourages the use of governance rules embedded in the design of the product rather than the use of an intermediary or central authority (Rainer et al., 2015). Therefore, its rules include features in the system's underlying software that encourage transparency by making transactions traceable and available to all in the Bitcoin network, fosters anonymisation of user identity and money flows through encryption and pooling of transactions and allows users to control the pace of commercialisation of the virtual currency by correctly solving mathematical puzzles in order to validate transactions (Rainer et al., 2015). Although such self-regulatory mechanisms are unique and appear robust, Rainer et al. (2015) suggest the possibility of lapses in the use of self-regulatory mechanisms such as these; thus arguing in favor of supporting them with financial regulation for aspects of the virtual currency (e.g. consumer protection).

### 4.3 Summary

While until recently there is no evidence of specific governance mechanisms for the process of financial innovation itself, governance of the financial sector, in the form of legal frameworks, policies and self-regulatory mechanisms, dates back many years in history. These governing systems mainly focus on financial activity, using internal and external structures and placing emphasis on the regulation of the products of financial innovation after these had been developed and implemented, sometimes many decades or even centuries after this had occurred. Throughout history, governance systems of the financial sector have continued to be restrictive, evolving from being a national activity using a consolidated system to an international activity organized on a sectorial basis. This trend is however changing and society is witnessing a centralization of financial sector governance and an increased focus on financial stability and consumer protection in terms of objectives. I now proceed to discuss lessons learnt in history with regard to the emergence and governance of financial innovation.

## 5 Discussion

### 5.1 Motivations for and drivers of financial innovation

It can be argued that the introduction of money, interests, personal loans, banking firms, contingency claims and all the products associated with lending during Mesopotamian civilisation were introduced as demand increased for these products. This suggests that financial innovation started out as a need - based activity to support trade and enterprise; where financial products, services, and institutions were developed because the need for the product/service already existed, or was created by the innovators. Nevertheless, other factors such as technological advancement, civilisation and consequently the changing needs of man contributed to the continuous improvement of original innovations. Unlike practices in Mesopotamian civilisation (where financial innovations were introduced to profit from trade and enterprise), capitalism introduced a system where money itself became the commodity and profit from trading money rather than non-financial products and services gained emphasis i.e. a move from money as a facilitating agent to money as a tradable commodity that generates profit in itself. This was because society saw massive developments in terms of ownership of private property and means of production among governments and owners of large corporations and financial intermediaries. According to Ferguson (2008) the desire for governments to provide for and support their wars was a major driver of financial innovation in this era. In the cases of Germany, Russia and Austria for example, the countries suffered bad currency collapses and hyperinflation resulting from huge debt mountains they couldn't honour as a result of wars; hence the need to develop various financial instruments to raise additional capital. In the case of large corporations financial innovation was driven by the desire to increase profits; and the case of the Medici and Rothschild brothers who, by actively participating in the evolution of banking, made tremendous financial gains for themselves and their families is a good example

(Ferguson, 2008). Therefore, the introduction of market economies, various types of financial institutions, stock exchanges, options, futures, forwards and swaps can be said to have been stimulated by the desire to increase wealth while minimizing the risks associated; thereby supporting arguments by Laeven et al. (2015) that financial innovation is the output of decision making processes by profit maximizing individuals. Nonetheless, it is also clear, as can be seen from the repeal of the Bubble Act and the introduction of the corporate form, that some of the developments in financial innovation during this stage were a result of changes in the regulatory environment.

With regard to financial innovation in the 21st century, there seems to be a slight change in motivations and drivers. This is because most of the financial innovations that have taken place within this period have been minor variations of already existing products, services and institutions. In a paper exploring the perceptions of banks' senior managers and management consultants on the factors stimulating and constraining the adoption of new technology in financial intermediaries in the UK, Batiz-Lazo and Woldesenbet (2006) found that innovation in banking is largely a process of incremental change that modifies both banks' internal and external environments. Thus Graham and Dodd (1934) identify 258 financial securities; all of which are bonds, shares and warrants with slight differences in characteristics and risks. To this end, it might be suggested that in the 21st century, the vast majority of financial innovations are driven by competition where financial institutions need to differentiate their products by providing options and flexibility in order to survive, thrive and win. Further it could be argued in line with Su and Si (2015) that financial innovations in the 21st century were also made possible due to the existence of national contexts that promoted economic freedom. However, there is limited data to allow for an investigation into whether there are any performance aspiration effects. In conclusion, it can be argued that the main drivers of financial innovation are found to have evolved from need to profit and competition. However it is worth noting that none of these factors have worked alone. Allen and Gale (1994) show that financial innovations were also stimulated by social, cultural and political factors.

### 5.2 Types of financial innovation

From the historical review above, it can be argued that financial innovation can generally be grouped under four main headings; 1) Products 2) Platforms, 3) Processes and 4) Enablers. These four categories are not mutually exclusive and could be intertwined in many respects (see Table 1).

**Table1.** Typology of financial innovation based on historical review

| PRODUCTS | PLATFORMS | PROCESSES | ENABLERS |
|---|---|---|---|
| **Cash Instruments** | Commercial Banks | Automated Teller Machines (ATM) | **Financial Theory** |
| Savings Accounts | Investment Banks | Online, Telephone and Mobile Banking | Econometrics |
| Checking Accounts | Central Banks | Consumer Online Stock Trading | Portfolio Theory |
| Money Market Accounts | Fractional Reserve Banking | Point of Sale Terminals | Efficient Markets Theory |
| Certificates of Deposits | Mutual Funds | Debit and Credit Cards | Capital Asset Pricing Model |
| Interbank Deposits | Clearing Houses | Improvements in Financial Management and Reporting Practices | Black-Scholes Merton Model |
| **Debt and Equity Instruments** | Stock Exchanges | New Customer Service Processes within Financial Institutions | Risk Adjusted Return on Capital |
| Loans | High Frequency and Algorithmic Trading Platforms | Monitoring | Duration Analysis |
| Notes | Secondary Mortgage Markets | Diversification | Sensitivity Analysis |
| Bills | Venture Capital Firms | Relationship Banking | Value At Risk |
| Bonds | Hedge Funds | Private Banking | Expected Shortfall |
| Stocks | Blockchain Technology | Wealth Management | Financial Technology |
| Microfinance products | FinTech Startups | Risk Management Procedures | Software and Information Technology |
| Private equity | Asset Management Funds | Non-Bank Credit Intermediation | Computational Power of Computers |
| **Derivative Instruments** | Exchange Traded Funds | Crowd Funding | Data Collection and Telecommunication |
| Forwards | Pension Funds | Risk Culture | Regulatory Innovations |
| Future | Mobile Network Operators | Risk Sharing Techniques | Limited Liability |
| Options | Finance Companies | Securitization | Capital Adequacy Requirements |
| Warrants | | Syndication | Deposit Insurance |
| Swaps | | Loan Trading | Ongoing Research and Development in Finance |
| Credit Default Swaps | | Trade Finance | Financial Indices |
| Mortgage-Backed Securities | | Islamic Finance | |
| Collateralized Debt Obligations | | | |
| Insurance and reinsurance products | | | |

Product financial innovations as those innovations that serve as tools for carrying out financial transactions. These include a wide range of cash, debt, equity and derivative

instruments as well as insurance and reinsurance products. While cash instruments comprise certificates of deposits, interbank deposits and savings, checking, money market and time deposit accounts, debt and equity instruments include loans, notes, bills, bonds and stocks and vary depending on characteristics such as risks and payoffs involved and how payments are to be made among parties. On the other hand, derivative instruments consist of forwards, futures, options, warrants and swaps that vary based on the type of underlying asset, the market in which they trade and the payoffs while insurance and re-insurance products include packages introduced to help individuals and firms pool and diversify risks. Platform financial innovations are defined as those innovations that provide a place for financial activity to take place. They are institutional in nature and include, but are not limited to, banks, financial markets, clearing houses, Blockchain and Fintech start-ups that normally emerge to improve the efficient use of, and create opportunities for using, product innovations. Process financial innovations are those innovations that involve the creation of new ways or the introduction of changes in how a financial activity is carried out and delivered. This includes significant changes in techniques, equipment and/or software used in distributing securities, processing transactions, or pricing transactions. They relate not only to radical (often technology based) innovations (such as Automated Teller Machines (ATMs), online banking, electronic trading and securitisation among others) that transformed the financial sector but also to incremental innovations carried out by organisations to improve how things work; what Mention and Torkelli (2012, p. 11) describe as "modifications to internal structures and processes, managerial practices, new ways of interacting with customers and distribution channels" within financial service firms. An example of this regards the use of e-transparency initiatives by financial institutions to facilitate financial reporting and information dissemination as required by law (Railiene, 2015).

Innovations within the final category (i.e. the enablers) are defined as those innovations that facilitate advancements in the other three categories. Enabling financial innovations are not per se the end of financial markets, in the sense that they are not the final product to be sold and exchanged. However, they have led not only to the creation of new financial products, platforms and processes but also new ways of using already existing financial innovations. The importance of enablers as a class of financial innovations derives from the fact that financial innovations have shown to follow what Carlota Perez called 'Technological Revolutions'. Each technological revolution brings about new enabling technologies that trigger the development of new financial innovations (Perez, 2003). Therefore, they deserve to be acknowledged in the financial innovation typology. The most notable financial enablers are the proliferation of sophisticated mathematical models (e.g. Louis Bachelier's theory of speculation, Markowitz mean variance of portfolio selection model, the Capital Asset Pricing Model (CAPM), the Black-Scholes (1973) model for options pricing and the Gaussian copula model for probability distribution which has become central to modern finance (particularly investments and capital markets) in the last two decades (Merton, 1995b). These models played a significant role in the advancement of innovations within the derivatives, risk management, asset management, diversification, investment banking and corporate banking industries.

### 5.3 Process of financial innovation and associated stakeholders

According to the review above, financial innovation appears to have occurred within a process of idea generation to launch with limited understanding of what happens between these two end points, among internal and external stakeholders and associated lead times; thereby suggesting the use of an unstructured approach to innovation. Although some financial innovations in history are novel and have changed how the industry works, most innovations, especially in the 20th and 21st century have been further developments of already existing products and services. Thus ideas generated at the conception stage of the innovation process have evolved from radical, 'do different' strategies to smaller, incremental changes. For instance, while financial innovations in early civilisation (money, early forms of bonds, stocks and exchanges), were found to have caused a dramatic effect on the nature and scope of financial activity, recent innovations, especially in the derivatives and securities sector, follow Merton's innovation spiral principle i.e. a situation where the creation, of one financial product leads to the creation of a new financial product (Merton, 1992). This process is made possible, for example, due to the interaction between financial intermediaries and markets and the effect of cost reduction they benefit from innovation; as products created by financial intermediaries get standardized, new trading markets are created and this in turn leads to the creation of new financial products as financial intermediaries further trade in these new markets (Merton, 1995a). Therefore, recombination, incremental adaptation and increasing complexity are identified as key features of the financial innovation process. This involves both internal and external stakeholders including corporate institutions, governments and individuals who interact and collaborate with each other; thus suggesting an element of co-innovation (Lee et al., 2012) within the innovation process.

### 5.4 Process of and mechanisms for financial innovation governance

Findings from the review show that there are few accounts of specific mechanisms for the governance of financial innovation itself. What exists is governance of the financial sector which focuses on ensuring law and order in financial activity rather than (Germain, 2010) rather than the development of financial innovations from inception to commercialisation (Asante et al., 2014); and these are predominantly monitored and enforced using legal codes. Nevertheless, if issuance, as used to describe the various legislations above, refer to circulation, then it can be argued that although no evidence of specific regulations for the creation of financial innovation exists, some legal frameworks have been put in place to govern its popularisation; but these were imposed sometime after the innovation had occurred and become embedded in practice. Further, Bettzüge and Hens (2001) argue some financial innovations do not become standard instruments of financial trade since they disappear as quickly as they emerge. For example the financial innovation process in early civilisation saw the introduction and disappearance of several products, with some re-appearing at a later date in slightly altered form (Allen and Gale, 1994). Thus there could have been informal mechanisms in place to govern the financial innovation process (i.e. amend those innovations or withdraw them from the system); although evidence of this is limited due to lack of information.

It is visible from the discussions above that financial sector governance is most often reactive rather than forward looking (Pol, 2009; Germain, 2010; Pacces, 2010); normally occurred in response to a crisis (Cox, 2008; Helleiner and Pagliari, 2010); and comprising extensive government involvement (Helleiner, 1994; Eichengreen, 1996) (e.g. as central banks were thought to be incapable of regulating the financial system after the 1929-1931 financial crisis (Germain, 2010)). These suggest that financial sector governance (both financial regulation and financial self-regulation) lags financial innovation itself (Owen et al., 2009) and an attempt to address the impacts of an innovation is normally based on hindsight and not foresight. Thus although major legislations (under financial regulation) were in place to govern basic financial products/services by the 1980s, a series of amendments of these (in the form of several acts after this period were necessary in order to address issues brought to the forefront by various financial crises and scandals (Gilligan, 1993). This has resulted in an increased focus on maintaining financial stability and protecting consumers in terms of the objectives of financial sector governance.

## 6 Conclusions and contributions

I am left with the impression that the current state of knowledge of financial innovation and its governance is very limited. While studies in the field have engaged in discourses centered primarily on the "back-end" of the innovation process (e.g. the diffusion of innovation, the characteristics of adopters, and the impact of innovation on firm profitability) (Frame and White, 2004), this paper has contributed to calls by these authors to develop a more comprehensive understanding of financial innovation and its governance. My point of departure for the study was to make the argument that an understanding of how financial innovations have occurred and been governed could shed more light on the topic. Although a review of the literature show that some of the historical mapping of financial innovation exists (e.g. Allen and Gale, 1994, Allen and Yago, 2010), none combines this with aspects of their governance, regulatory or otherwise and a comparison of the two is necessary to enable researchers understand the extent to which governance mechanisms used in the past are robust to ensure the responsible emergence of financial innovations.

Findings from this review show that there is huge diversity within the financial innovation landscape with innovations spanning a myriad of activities. These are normally driven by factors such as need, profit and competition which have changed overtime. The innovation process per the review is also identified to be largely unstructured. Nevertheless, this may be more of an information void rather than a management void that may need to be addressed by more open and transparent articulation of internal innovation management approaches by stakeholders to the public. The review also suggests the financial innovation process to be characterized by multiple stakeholder involvement, recombination, incremental adaptation and increasing complexity.

It is important to note that findings from the review brings to bare the lack of specific governance mechanisms for the development and commercialisation of financial innovation. What existed was legislations targeted at the governance of financial activity in the sector with the introduction of legislations lagging the development and

implementation of financial innovations themselves. Thus I could conclude that approaches to governing financial innovation throughout history were insufficiently robust to support the responsible emergence of financial innovations in society; hence the proliferation of financial crises and scandals in the financial innovation and governance narrative.

## 7 Limitations and Areas for Further Research

This review paper has sought to investigate the extent to which mechanisms for governing major financial innovations through history are robust in supporting their responsible emergence in society. Nevertheless, it is important to note that the use of timing of governance in relation to when innovation was introduced is only one way of measuring robustness; thus posing a major limitation to the study. In other studies (Asante et al., 2014; Arthur, 2017), I suggest use of the dimensions of responsible innovation being developed in the literature as another approach to measuring robustness of governance mechanisms. Therefore further studies that relate the innovation governance processes and mechanisms identified in this study to dimensions such as anticipation, reflection, deliberation and responsiveness suggested by Owen et al. (2013) would be beneficial. Further, validation of the features of financial innovation deduced from the review through empirical study within institutions across a wide range of sub-sectors in financial services is necessary if we are to consider the feasibility of a general theory on responsible financial innovation. Additionally, it is important for use to investigate whether financial sector governance subsumes financial innovation governance in a satisfactory way as findings from the review also indicates that legislation could play an indirect (contextual) role in the framing of innovation trajectories

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# Innovation intermediaries in service industry: the role of consultancies

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**Abstract.** Much of the existing literature on innovation intermediaries is focused on manufacturing, and limited scientific knowledge has been developed about the role of intermediaries in services. This paper aims to expand and test an existing framework on the roles and functions of intermediaries in services, focusing specifically on consultancies. Furthermore, it is investigated to what extent services and manufacturing are perceived as different clients, and what represents the added-value of consultancies. Using a case study approach, consultancies´ activities are analysed and compared within services and manufacturing contexts. Findings indicate that while consultancies do not consider manufacturing companies different from service companies, during the collaboration process several differences do exist in terms of their role in these two types of companies, mainly due to different degrees of development of the corresponding innovation strategies and to different perspectives regarding the use of technology.

**Keywords.** Consultancies, innovation intermediaries, service innovation, technological and non-technological innovation.

## 1 Introduction

According to Howells (2006), intermediaries act as agents or brokers in innovation, which emphasizes their brokering role (brokering-based definition). Dalziel (2010) proposes an alternative definition, focusing on the intermediaries´ purpose, describing them as organizations or groups within organizations that work to enable innovation (purpose-based definition).

There is a great diversity of innovation intermediaries, namely technology brokers, university liaison departments, regional technology centres, innovation agencies, cross-national networks. Consultancies are included in this group, due to their extensive services, and their flexibility in modes of operation and interaction (Bessant & Rush, 1995). In an open innovation model, consultancies are considered to play an important role as source of ideas and knowledge (Tether and Tajar, 2008).

Innovation intermediaries strengthen the innovative capacity of companies, industries, regions and nations. They reduce the gap between internal and external knowledge, decrease the time to access know-how and market, increasing the firm´s innovation efficiency (Dalziel, 2010; Gassman et al., 2011).

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Most of the existing studies on innovation intermediaries are focused on primary and secondary sectors (namely agriculture and manufacturing), yet little is known about the role and significance of innovation intermediaries in the service industry. The growing importance of the service industry as well as its specificities underpins the importance of contributions to the current understanding of service innovation (den Hertog et al, 2010; Tether, 2005; Tether and Tajar, 2008).

Pinto et al (2016) introduced a conceptual framework focused on the role of intermediaries within service innovation, which is a useful contribution to that literature gap. In that work, consultancies emerged as key innovation intermediaries in the service industry, together with universities, due to their flexibility in modes of operation and interaction.

However, there were two key limitations of the conceptual framework developed by those authors. First, the framework had not been tested empirically. Second, the framework had been developed to be used in services, yet it was important to ensure that the specificities of services had been properly addressed.

These limitations lead to a future research path that is followed in this paper, namely the empirical testing of the proposed framework, using consultancies whose clients belong to service and manufacturing sectors, in order to perform the comparison and specificities related to services included in the framework.

Our main research questions are:

- To what extent consultancies perceive [innovation in] service (companies) as different from [innovation in] manufacturing (companies)?
- How do consultancies support the innovation processes of service industry?
- What is the added-value of consultancies to the innovation processes of service industry?

In line with the research questions and knowing that the framework had not been tested empirically, a qualitative methodology was adopted, namely a multiple case study, where compared cases are consultancy companies acting in service and manufacturing sectors.

In order to present the research undertaken, the paper is structured as follows. Section two includes a synthetic review of the existing literature on innovation intermediaries, with a specific focus on consultancies, which includes the framework proposed by Pinto et al (2016). Section three is dedicated to the methodological planning of the case study research. In the fourth section, results are presented, drawing on six analysis dimensions. Section five concludes the work and highlights the research contributions and section six asserts limitations of the study and future research directions.

# 2 Innovation Intermediaries

## 2.1 Functions

Innovation is critical to ensure the survival and growth of businesses. Knowledge is not consistently distributed among the market players, and companies have to move beyond their borders to manage innovation (Chesbrough, 2006). In an open innovation model, innovation intermediaries, as specialist entities, arise to provide information, access and funding to enable transactions to occur between parties (Chesbrough, 2006).

Intermediaries in innovation can be traced back to the "middlemen" in the agricultural, wool and textile industries of 16th, 17th and 18th century Britain. These middlemen had commercial functions and disseminated technical knowledge (Howells, 2006). Intermediaries have gained importance ever since and, currently, their functions are extensive and vary from one organization to another. With the rise of the Open Innovation concept, innovation intermediaries received a wider, more recognized role. Intermediaries work directly with their clients on a one-to-one basis, seeking for lasting collaborations, but are increasingly involved in more complex relationships in the context of innovation networks (Howells, 2006).

Intermediaries may act as architects of collective exploration and creation of knowledge in the fuzzy front end of innovation, where technologies, knowledge, market and network of relevant actors are not known or do not yet exist (Agogué, 2013).

In what concerns the functions of innovation intermediaries, Howells´ (2006) contribution highlights the following functions: Foresight and diagnostics; Scanning and information processing; Knowledge processing and combination/recombination; Gate keeping and brokering; Testing and validation; Accreditation; Validation and regulation; Protecting the results; Commercialization; and Evaluation of outcomes.

In Howells' (2006) perspective, innovation intermediaries support new technology development by their clients, working as a brokering agents between two or more parties (Klerkx and Leeuwis, 2008; Dalziel, 2010).

Pinto et al (2016) proposed a new tool for service industry, arguing that Howells´ (2006) framework was limited to technological innovations, and could not be directly applied to service industry, due to services peculiarities[1]. According to the OECD (2005), innovation in services can differ substantially from many manufacturing-oriented sectors. It is often less formally organized, more incremental in nature and less technological.

Therefore, in contrast with Howells' (2006) framework, Pinto et al (2016) identified 12 functions of innovation intermediaries which may apply to service industries (see Table 1).

[1] A service provision is about organizing a solution, placing a package of capabilities and competences (human, technological, organizational) at the disposal of a client (Gadrey et al, 1995), and services are often characterized by its intangibility, inseparability, variability, and perishability.

**Table 1.** Functions of innovation intermediaries proposed by Pinto et al (2016): Critical analysis

| Function | Comments |
|---|---|
| 1. Analysis and definition of innovation needs | Pinto et al (2016) ´s model, drawing on an enlarged view of innovation, proposes a more holistic diagnostic, beyond technology, as well as the identification of the user needs and trends alongside with the analysis of the technological options. In Howells´ model the foresight and diagnostic are essentially related with technology forecasting and technology road mapping. |
| 2. Identification of user needs and major trends | |
| 3. Signalization of technological options | |
| 4. Conceptualization of new service offerings | This approach proposes a wider role for the intermediaries, as a result of an enlarged understanding of the innovation concept, which includes technological (product and process) and non-technological (organizational and marketing) innovations. The support of intermediaries in the development of marketing and organizational innovations is placed alongside with their support in the conceptualization of product (service or goods) innovations. |
| 5. Conceptualization of new organizational methods | |
| 6. Conceptualization of new marketing strategies | |
| 7. Identification of potential partners | The brokering function, associated with matchmaking and brokering collaborative deals for the intermediary´s client, which is crucial in Howells´ proposal since innovation is mostly associated with new technologies, appears somewhat redefined in this new framework. An intermediary in services supports the identification of the client´s potential innovation partners, which can be suppliers and knowledge centres but also other players such as clients and competitors. |
| 8. Testing and scaling | The testing and scaling of innovations gain new dimensions in this model, challenging the intermediary´s competences. Tangible products can be tried out in a laboratory while the peculiar nature of services makes almost impossible to test them there. Services are also difficult to reproduce consistently and exactly, what jeopardizes the introduction of standardized services on a large-scale. |
| 9. Selection and training of specialised workforce | People are of utmost importance in services. Consequently, the selection and training of human resources is critical. Services are a result of co-production, involving the provider and the client. The service staff, namely frontline staff, has a major role in “customer education”, drives customer satisfaction and loyalty, and influences the company´s productivity. |
| 10. Protection of innovation assets | The protection of innovations in services is more challenging due to the difficulty of using tools such as patents. Service companies favour other forms of intellectual protection (IP), namely trademarks and trade secrets, what demands a wide approach to IP issues. |

| Function | Comments |
|---|---|
| 11. Accreditation / certification | Unlike product certification, the certification of services is a relatively recent activity and there are some problems in implementing it because there are still insufficient standards covering most services. Another difficulty faced in the implementation of service certification has to do with the fact that some standards do not establish measurable criteria from which quality of service should not be accepted. These standards are developed for a set of similar services and only establish guidelines on the indicators that should be evaluated. |
| 12. Investment appraisal | The evaluation of innovation investments as well as the funding opportunities is an important function of intermediaries that can gains new specificities in services due to the soft nature of service innovations. |

This framework, drawing on Howells´ proposal, envisages a wider role for the innovation intermediaries, suggesting some new and renewed functions that result from a more enlarged understanding of the innovation concept (Author, 2016). In this sense, it advanced a synthesized approach to innovation in services, emphasizing features of innovation that have been overlooked in studies taking a technology-focused manufacturing approach to innovation.

### 2.2 Consultancies

Consultancies can be classified as KIBS - Knowledge-Intensive Business Services (Lemus-Aguilar et al, 2015). KIBS industries are private companies or organizations, relying heavily on professional knowledge i.e. knowledge or expertise related to a specific (technical) discipline or (technical) functional domain, and supplying intermediate products and services that are knowledge-based.

KIBS are seen to act as facilitators - when supporting a client in its innovation process, but not creating nor transferring innovation from others; carriers - when transferring existing innovations; sources – when triggering and developing innovations in the client; and also as co-producers of innovation - working closely and interactively with the client, in a two-way learning process (Muller and Doloreux, 2009; Winch and Courtney, 2007; Den Hertog et al, 2010; Miles et al, 1995; Bilderbeek and Den Hertog, 1998). According to Klerkx and Leeuwis, (2008), the intermediaries that have a broker role as their core function are facilitators of innovation while those also develop non-third-party activities are either sources or carriers of innovation.

KIBS are fundamental partners of SMEs, as their innovation capacities depend strongly on the access to external informational resources (Muller and Zenker, 2001). Among external knowledge providers, KIBS, and specially consultancies, are service firms´ (with the exception of technical service firms) favoured partners as they are more easily reached than other knowledge providers (Authors, 2016; Tether and Tajar, 2008). Significant knowledge is produced in the science-base and spread to ‘end-user’ companies by consultancies (Tether and Tajar, 2008).

## 3 Methodology

We adopt an exploratory research design, more specifically a multiple case study approach (Yin, 2003, Eisenhardt, 1989), which allows a more profound understanding of consultancies´ involvement in the innovation processes of their clients, when their portfolio included both services and manufacturing companies. The geographical focus was Portugal, a country with many consultancy companies, which was also compatible with logistical and financial restraints of the research team.

Case selection followed a specific procedure. There were a large number of consultancies operating in Portugal, yet only a small number of those companies had as main organizational purpose to enable innovation. We reached to Portuguese innovation experts in order to identify compatible cases and 20 companies were shortlisted.

From this group, four companies were selected based on their relevance (type of services, type of clients, size) and accessibility (see Table 2). All offered a significant diversity of services to clients belonging to both manufacturing and service industries, and promoted themselves as "*innovation enablers*". Note that the names of the consultancies have been withheld due to confidentiality reasons.

**Table 2.** Cases overview

| Name | Size (number of employees) | Main Clients | Age (years) | Main Markets |
|---|---|---|---|---|
| Case 1 | 89 | Banking, Retail, Tourism, Manufacturing Industry | 6 | Portugal, Spain, UK, Italy, and Angola |
| Case 2 | 75 | Biotechnology, Pharmaceutical, ICT, Moulds, Food & Beverages | 21 | Portugal, Spain, P. R. China, Singapore, and USA |
| Case 3 | 40 | ICT, Manufacturing Industry, Logistics | 22 | Portugal and Mozambique |
| Case 4 | 3 | Retail, Manufacturing Industry | 7 | Portugal |

*Source: Own formulation*

Empirical data sources were collected from interviews with CEOs or innovation department managers, as they were responsible for defining the mission and strategy of the company/department, and had a broader perspective over company activities.

The data collection took place between January and March of 2016. The four interviews, of about 90 minutes each, followed semi-structured, open-ended guidelines and were oriented around three main blocks: Business Model, Collaboration Process and Value Added (see Fig.1 and Appendix 1).

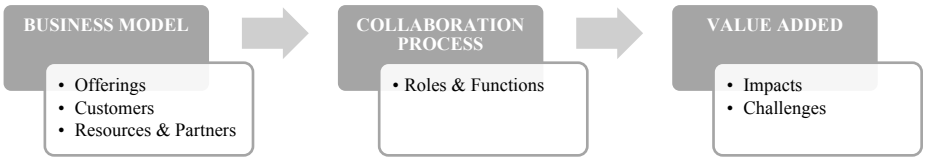


**Fig. 1.** Components analysed in the interviews

We asked managers to describe their business model (namely their services, types of clients, main resources, and partnerships[2]), the collaboration process with clients (main roles and functions), and immediate impacts on clients and challenges faced, concerning services and manufacturing clients.

Other sources of evidence were explored such as internal documents provided by the consultancies, information from websites and media (press and social media) as well as direct observation.

Data analysis followed a content analysis approach, with initial coding developed based on the components analysed in the interview, allowing, as well, the identification of new categories (Yin, 2003). After the initial coding all categories were double-checked for consistency and categories have been reviewed.

# 4 Multiple Case Studies: Results

## 4.1 Cases presentation

### Case 1

Case 1 is a company/firm focused on consulting and management training, more specifically on scientific methodologies widely accepted to boost clients´ competitiveness. It has a research centre that develops scientific knowledge, relying on academic partnerships, and has a training academy.

Its team has high academic qualifications (PhD and post-graduate courses in management, professional and international certifications of reference) and specific expertise in the fields of construction, energy, health, telecommunications, retail, and services industry.

Initially, the company was focused on project management services. Nowadays, the company is organized in five main service areas: Innovation management (innovation assessments, and opportunities identification); Benefits management (evaluation of projects); Business analysis (identification of gaps, development of strategies and management tools); Project management; Dynamic capabilities (identification of gaps, advisory, and development and implementation of leadership and talent management programs).

[2] In order to further detail the Business Model component, Canvas model is used (Osterwalder and Pigneur, 2010) for three areas which are key to consultants´ intermediation activities (offerings, customers and infrastructure).

### Case 2

Case 2 is part of a wider group with subsidiaries in other markets. Its consultants are from different nationalities and have different professional and academic backgrounds.

It provides services in three areas: consulting, R&D, and training. The company focuses its activities in the area of innovation (innovation management, competence development, internationalization), science and technology (technology transfer, R&D), and territorial development (regional and sustainable development). The market differentiation relies on its specific expertise in the areas of science and technology.

Its main clients are private companies, professional and business associations, scientific and technological institutions, public administration entities, and international organizations (e.g. European Commission, World Bank).

### Case 3

Case 3 offers consultancy services to business companies and business associations. Its main clients are companies from the information technologies industry and from the manufacturing industry. It has a subsidiary located in Africa.

It presents a technological profile, due to professional and academic background of its CEO. At the time of the research, it was diversifying its services to non-technological areas to satisfy clients´ increasing needs, in areas such as internationalization and marketing.

The company differentiation lies in technological areas. It identifies the source of a specific technology which satisfies a customer need, and supports its transfer to the client.

Its team is separated into two distinct groups: the first one is composed by a group of engineers (fields of physics, industrial management, information technologies and biotechnology); the second one, a much more eclectic group, has academic background in economy, management, marketing, accounting, international relations.

Case 3 services are in the fields of Business management – services regarding projects of expansion, investment and fiscal optimization; Strategy and development – services to support company strategic decision making; Research & technological development – technical consultancy in the areas of information technologies, electronic, health, manufacturing and new materials; Certifications (quality, environment innovation, social responsibility); Project management – technical, administrative and financial management of ongoing investment projects.

### Case 4

Case 4 is a consulting and training company in the areas of business strategy and innovation management. It works alongside its clients to provide tailor made solutions for each organization, fostering the development of its clients´ innovative capacities. The company relies on a net of external consultants, for consulting or training services, with specific expertise in different fields. Its clients´ portfolio is composed mainly by local companies, which belong to manufacturing industry (namely fashion) and retail industries. Around half of its clients belong to service industry.

Case 4 supports the company's innovation processes through consulting services. Under this remit, it offers business diagnosis and specific audits (marketing area), marketing strategic plans and studies. It typically acts at strategic level, focusing in the

diagnostic and strategy definition. It provides information regarding market trends and best practices as well as technological options and main players in the industry (companies, research centres, universities, suppliers …). It also can offer strategic advice regarding the definition of new products and processes. The operationalization of the strategic plan can be done by the company, eventually with the support of other players, which can be recommended by Case 4.

Additionally, Case 4 promotes customized training programs and also thematic workshops, emphasizing the development of new competencies that will allow participants to respond in a creative and quick manner to the changing business environment. It positions as the link between academia and business, focusing on the transmission of state of the art knowledge along with evidence of best practices.

### 4.2 Results

#### Business Model: Offerings

The consultancies provide services in the areas of information and access to other players in the innovation system independently of the clients´ industries. None of the four consultancies considers being a specialist in innovation funding, even though one of the companies of the Case 2´s Group provides business support in the area of venture capital. Case 2 and Case 3 prepare companies´ applications to EU funded programs in the area of innovation, R&D and fiscal incentives.

Case 1´s value proposition is based on the transmission of scientific knowledge to enhance its clients´ innovation process. Its expertise is supported by best practices and procedures, namely the ROI Methodology, BABOK Guide, PMBOK Guide and HCI (Human Capital Institute). It has a research centre and a training academy, to foster knowledge creation and transmission.

Case 2 CEO highlights: "*We are a knowledge management company, with an emphasis on science and technology areas, which aims to manage projects that foster innovation. We boost the connectedness of the innovation system, functioning as an interface between private companies, universities and other knowledge centres, and national and international public organizations*". It has a large network of contacts, which continually and proactively increases. Case 2 also helps private companies to structuring their innovations activities, identifying and defining processes and procedures, and creating innovation centres or groups, in order to enhance their innovation outputs.

Case 3 value proposition relies on providing information and access to players (namely the universities) on the innovation system. Depending on the type/dimension of client, Case 3 can help clients to articulate its innovation needs and search for the technology among the possible sources and make the matchmaking or, instead, Case 3 can just locate the technology and do the matchmaking. Case 3 CEO states: "*We are perceived as a trustworthy intermediary in ICT industries*".

Case 4 provides services in the areas of consultancy and training. It supports the client innovation processes acting at diagnostic and strategic reflection level as wells as at the innovation implementation level. The consultancy works closely with the universities and research centres, to keep track regarding the state-of-the-art research, which "*(…) allows us to have a strong reputation as a reliable information provider*", states Case 4

CEO. Case 4 is specialized in non-technological innovation, especially in the areas of marketing.

**Business Model: Customers**

All four consultancies provide services to manufacturing and service companies. They claim they do not do market segmentation according to the client´s industry (services or manufacturing) as they consider service and manufacturing companies' needs to be similar.

Case 1 points out that traditionally innovation services were requested essentially by manufacturing companies, as a result of the (reduced) dimension and (not complex) organizational structure of service companies. Nowadays, things are different, and service industry gained significant importance. Case 1 manager refers that *"service companies became interested in innovation topics more recently and, today, both service and manufacturing companies are key clients".* Likewise, Case 2 refers that both type of clients are equally important. Its CEO comments "*We do not target any special industry. Our clients belong to different industries, such as agro-food, pharmaceuticals, biotechnology, (…)".*

There is some industry specialization in the case of Case 3 and Case 4. Case 3's main targets are ICT and manufacturing companies, mainly as a result of its CEO's academic and professional background. Case 3 acknowledges that these industries offer (more) cross-selling opportunities, what makes them more interesting clients. The consultancy is specialized in technological innovation. The main clients of Case 4 belong to retail and fashion industries, even though the consultancy mentions that all industries have innovation needs, and are potential clients. Case 4 considers that its location influences the type of clients, as companies usually look for local suppliers. "Our headquarters are located in the North of Portugal; our main clients are companies from the local clusters, namely from fashion cluster".

The consultancies point out that the main interlocutors of service and manufacturing companies are usually different. Due to its dimension and structure, typically service companies do not have an R&D department, and usually marketing departments lead the innovation process. In the case of manufacturing, some companies have an R&D department or the interaction is done with production department.

Most part of the consultancies considers the needs of service companies to be somewhat different from manufacturing. For Case 1, *"Manufacturing companies are concentrated on the obsolescence of their products, efficiency of their production processes and on their next products while service companies' main concern is market differentiation".* Case 2 enhances that the manufacturing companies, when compared to service companies, have larger dimensions and resources. They define specific innovation strategies, with dedicated resources, and are more concerned with internationalization issues. Collaboration with manufacturing companies endures longer. Nevertheless, Case 2 CEO points out *"The needs of manufacturing and services are quite similar".*

Case 3 claims that manufacturing companies have a larger spectrum of needs than service companies. They need a holistic support, including several areas such as product development, products and processes accreditation, definition and implementation of organizational and marketing strategies. This allows Case 3 to have long-term relationships with manufacturing clients. From this perspective, services are

not considered an interesting client, since they only ensure occasional sales, from time to time. Case 3 CEO highlights: *"We seek to select industries where we can do effective cross-selling, to sell different products to satisfy diverse needs. And this is not possible in service industry".*

For Case 4, usually, manufacturing companies have a "technological strategy" and define a technological roadmap, namely regarding the sources of technology (internal or external); whereas service industry strategy values non-technological areas.

Regarding technology, Case 4 states that, on one hand, the needs of manufacturing companies are usually quite distinct, as they have a wide range of distinct products. On the other hand, Case 4 CEO points out: *"Services do not consider technology so strategically, and their technological needs are mainly related with service delivery and client interface. Moreover, the technological solutions that these companies look for are very identical".*

The four consultancies typically provide services directly to their clients on a one-to-one basis (dyadic relationships), and on a 'one-to-one-to-one' basis (triadic relationships). Services such as diagnosis, definition of marketing and organizational strategies, and investment appraisal are provided without the intervention of third parties; the identification of trends and technologies, and the definition of new products can combine the intervention of other entities. Case 2 and Case 3 highlight that consultancies can also be involved in more complex relationships, namely in the case of mobilizing projects, aiming to develop new technologies. In this particular case, consultancies support the creation and management of innovation networks composed by companies and knowledge centres.

**Business Model: Resources & Partners**

All consultancies agree that their staff and organizational knowledge are their most valuable assets. Partnerships, namely with universities and other knowledge centres, are also considered fundamental to fulfil the consultancies´ mission.

Case 1 created its own research unit that develops knowledge and science, namely through academic partnerships, and it has a training academy. Case 1 managers have a strong liaison to universities, and they combine professional experience with academic experience.

Case 2 establishes partnerships with entities in science and technology system in different markets, namely with knowledge centres and business innovation centres (living labs, incubators, clusters) as well as with public organizations in the areas of innovation support and funding.

Case 3 has a partnership with a global network of internationalization consultancies, which provides business support services in accessing international markets to Case 3´s clients. The consulting work in the target market is carried out by local consultancies. They also have other partnerships with consultancies specialized in venture capital, financial issues accountings, and management software. As regards technological issues, they have strong liaisons with knowledge and research centres.

Case 4 pursues a close connection with knowledge centres, especially the universities. The universities develop state-of-the-art research, and Case 4 aims to diffuse this important knowledge through businesses to boost their innovation processes.

Consultancies value human resources with different academic and professional backgrounds to ensure a high-quality service. The staff recruitment and training is considered critical to increase the organizational knowledge.

The organizational structure of the four consultancies is not aligned with their clients´ industry (services or manufacturing). Collaborators´ expertise in specific industries is welcomed by the consultancies.

Case 1 is internally organized in five main areas along the innovation value-chain, namely: innovation management, benefits management, business analysis, project management and dynamic capabilities. Each area has its own specific group of collaborators, and there are consultants with specific industry expertise. Case 1 CEO comments *"Our innovation services are industry agnostic, even though it we consider important to create teams with collaborators with specific expertise within the client´s industry"*. And he adds *"We do not have an organizational structure aligned by clients´ industry; there are only departments with complementary activities, who satisfy clients´ needs independently of the industry"*.

The Case 2 team is composed by highly qualified professionals, with valuable knowledge in various fields, namely agro-industrial industry, environment & energies, biotechnology, health, ITC, industrial technology, transport & mobility and tourism. Case 2 CEO comments: *"Our team is made of individuals from various nationalities, with different backgrounds, skills and expertise, which collaborate in different offices nationally and internationally, and allow us to maintain a stable presence in strategic locations"*. The collaborators are involved in different projects, according to their expertise.

Case 3 is structured in two differentiated teams: there is a team working the R&D, composed mainly by engineers, working at product or process engineering level; there is another team, which integrates collaborators with diverse qualifications, that acts in the areas of business management strategy and development, certifications and project management.

Case 4´s structure is much reduced and it relies, when necessary, on external specialists. The CEO clarifies *"We do not consider important to have dedicated teams to manufacturing and services, however, when working with a client, we seek for involving external partners with specific industry expertise"*.

### Collaboration Process: Roles & Functions

All consultancies see themselves as innovation facilitators, providing support to their clients in order to improve their innovation outputs. They identify knowledge gaps, search for information and knowledge, and identify opportunities. Case 3 CEO points out *"Consultancies are mostly carriers of knowledge; they are not producers"*.

Two of the consultancies stress its brokering role, acting as a bridge between the users and the sources of knowledge, such as other private companies, universities and other entities from the S&T system, and international organizations. They also consider being carriers of innovation, supporting the knowledge transfer. Case 2 claims to be a unique catalyst for connections among scientific and technological institutions, companies, business associations and clusters, public and private national organizations, and international institutions. Case 3 points out its bridging role between ICT companies and centres of knowledge what, according to its CEO *"(…) makes us a unique provider*

*in this area (…)".* Case 3 offers integrated and customized services: defining clients´ needs, identifying possible sources of technologies, and supporting the technology transfer process. Case 3 considers that the universities are important sources of knowledge regarding technological innovation. In the case of small clients, Case 3 acts as a carrier of innovation, identifying the source of knowledge and being responsible for the technology transfer; in the case of medium-large companies, Case 3 just identifies the source of the technology (broker function), following the client´s requirements.

The two other consultancies (Case 1 and Case 4) do not emphasize the brokering role, pointing out that they just act as bridges when specifically requested by clients. Case 4 manager points out that *"When it is possible, if the target player makes part of our network, we facilitate the contact".*

The majority of the consultancies' do not see themselves as sources or co-producers of innovation, as they mainly operate as interfaces, providing information and/or access to relevant players in the market. Case 2 CEO states *"We do not produce innovation together with our clients. We mostly work as an interface between private and public companies, universities, research centres and international organizations".* The exception is Case 4, which claims to be a co-producer of innovation, as it works together with the client, searching and defining innovative solutions in partnership. It helps its clients to design and implement (new) services, to (re)adjust organizational structure and to (re)design market strategy. Also, Case 3 points out its role as innovation co-producer specifically in the case of mobilizing projects, focused on technological innovations. The CEO refers: *"These projects, which are subsidized by public funding, aim to create new technological products".* Case 3 takes a leading role in these projects, selecting the participating companies and coordinating all the works. In the case of non-technological innovation, Case 3 CEO claims that the company is an innovation transporter, as *"We only apply existing theoretical models, defined by other players".*

The functions developed by the four consultancies are more or less identical (please see Appendix 2). Among the consultancies, Case 4 has the wider spectrum of functions. The functions provided in services and in manufacturing are not perceived as different. All consultancies provide services in the areas of innovation diagnostic, identification of market trends and technology road mapping, as an important part of their corporate mission. The innovation manager of Case 1 states *"(…) Our work with a client typically starts by a diagnostic. It is critical to evaluate well all departments´ needs to do a holistic and detailed analysis (…)".*

Only half of the consultancies interviewed support their clients in the definition of new products/services: Case 1 gives support in the general definition of the new offering; Case 4 supports specifically the conceptualization and design of new services, applying tools such as the blueprinting. CEO of Case 4 gives an example *"A big retailer contacted us to create a new service, and we sought to involve international specialists to help us defining how to operationalize a service with these characteristics. The retailer benefited from our and our partners state-of-the-art know-how. And it was designed a totally customised solution".* All consultancies work alongside with their clients to define new marketing and organizational strategies. They help customers to enter new markets, providing them marketing information regarding the market environment (customers, competitors, distribution and communication channels,

business laws and procedures) as well as analysing and selecting entry modes. They support their clients in the definition and implementation of new processes and procedures, namely related with quality or innovation topics.

The function of identification of potential partners as well as the partners´ matchmaking is critical for the consultancies that work mostly in technological areas (Case 2 and Case 3). Only one of the consultancies (Case 4) can provide services in area of testing and scaling. The majority of the consultancies are involved in the training of the company´s staff, even though they don´t act at recruitment level. None of the consultancies works directly in the area of innovation protection due to the knowledge requirements, even though they consider it a fundamental issue. Most consultancies also give support in the certification processes of companies according to quality standards. The identification of investment needs also makes part of the consultancies services, and two of the consultancies prepare applications to UE funding.

**Value-added: Impacts**

All consultancies consider that their main contributions as innovations intermediaries are information and advice, assets that are equally important to service and manufacturing industries. The CEO of Case 4 stresses *"We function as a decipherer for businesses, with a helicopter vision. We are aware of what is happening in certain industries in several countries, through studies that are published and that give a reliable picture of reality. We actively collect business data, engaging with other international players. We share information about industries and trends"*.

Some consultancies highlight their industry specialization, what makes their contribution more valuable in some industries/areas: Case 3 concentrates on ICT and electronics industries; Case 4 is focused in the fashion and retail industries. Also two consultancies emphasize its expertise in specific knowledge areas: Case 4 considers being a specialist in marketing domain; Case 2 stresses its expertise in the areas of science and technology. Case 2 and Case 3 point out the importance of their information and advice regarding the entrance in new markets. Both companies have dedicated structures or partnerships with local consultancies in target markets that allow them to participate actively in the definition of its clients´ internationalization strategies. Case 2 and Case 3 also highlight their contributions in terms of advice concerning the innovation funding.

Another impact of the consultancies´ support can be the access to other players in the innovation system. Case 2 positions itself as a *"unique catalyst for links among companies, scientific and technological institutions, public administration, and other international organizations"*. Case 3 points out its added-value in IT industries: *"We are an interface, connecting the users and sources of technology"*. These two consultancies also mention the importance of their contribution in facilitating the access to funding sources. Case 4 and Case 1 refer that they can facilitate it customers´ access to other players if necessary, even though this is not envisaged as a core service.

Case 1 and Case 4 consider that impacts at executive education level are also of utmost importance for companies. Case 4 offers tailor made training services as well as workshops of short duration. Due to its linkages to the academic world, Case 4 proposes to offer a superior training service, drawing on state-of-art knowledge and best practices. Case 1 manager refers: *"We have our own training academy, highly*

*specialized in management training, with a special focus on business cases, business analysis, project management and high-performance competencies".*

Regarding innovation outputs, Case 3 stresses the importance of its support regarding technological innovation. For this consultancy, the support in non-technological innovation is envisaged as secondary and they just recently introduced services in this area. The CEO clarifies: *"We have been working in the non-technological areas more recently. Initially, our team only used to prepare applications for financial support, and then there was an evolution to less technological areas due to customers´ needs".* Case 2 highlights its expertise in technological areas, helping the clients to structure its innovation processes, to identify, design and manage external partners in the areas of technology. Nevertheless, it also provides support regarding the clients´ internationalization strategy. For Case 2 CEO the projects that involve manufacturing clients are *"(…) more complex, including several areas of intervention, and endure longer. As a consequence, the results obtained can be more interesting and the value-added is more significant. Services, due to their dimension and absence of innovation strategy, require less involvement from the service provider and, although the results appear faster, they are not so visible".* Case 1 gives support to companies´ technological and non-technological innovation needs. It highlights that manufacturing companies usually look for support in technological areas while service companies have a more enlarged view of innovation. Case 4´s contribution is more centred in non-technological innovation, specifically in the definition of new marketing strategies.

### Value-added: Challenges

Case 1, Case 2 and Case 3 point out that manufacturing companies, when compared to service companies, are more professional, with clearly identified and verbalized needs and expectations. Projects that involve manufacturing are more challenging, including several areas of intervention, while service projects tend to be less complex.

Furthermore, Case 4 considers that a consultancy when fulfilling the needs of manufacturing companies *"(…) needs to deal with an array of technologies and products".* In the case of services, *"(…) the technology innovation is mainly related with information technologies, and the needs of companies are usually similar, so the solutions are identical. Technologies in services aim essentially to manage the clients´ interaction and the service delivery".*

Case 2 highlights that usually manufacturing companies have an innovation or R&D department, or are taking in consideration to develop one. Their innovation processes are normally more structured, when comparing to service companies, what facilitates the consultant-client collaboration.

Case 4 considers services´ unique characteristics (intangibility, inseparability, heterogeneity and perishability) makes working with services *"more demanding"* than with manufacturing, since in service innovation *"(…) it is necessary to manage more variables, not only the service offering itself but also the clients, employees, as well as the physical environment. The moments of truth, when client and provider meet, ought to be carefully designed and managed. As a result, human resources´ training and clients´ management and education are of utmost importance. Similarly the management of the physical environment surrounding the service provision is a key element in services".*

A synthesis of main empirical findings is provided in Appendix 3.

## 5 Discussion and conclusions

Compared to manufacturing companies, service companies are more recent consultancy clients. Nevertheless, the value proposition of consultancies is not specifically directed to service industry, as these innovation intermediaries do not customize their offerings and organizational structures to adapt to this type of client. For consultancies, service clients and manufacturing clients are similar, so one may conclude that they have is a broad perspective of innovation. But, in reality, service innovation is analysed using the same lenses of manufacturing innovation, and innovation is mostly understood as new technologies.

The technological facet of innovation is considered of utmost importance and the consultancies that are specialized in technological innovation offer services along the innovation value chain, from diagnosis to searching for funding opportunities (namely through the preparation of applications to EU funding). This is not necessarily unexplained, as innovation in manufacturing industry was given focus for more years, in an explicit way, and it was only recently that service industry gained importance and started to focus on innovation. Naturally, and as a consequence, consultancies´ business models have been developed to target manufacturing industry.

Additionally, even though the majority of the consultancies claim that service clients are not distinct from manufacturing clients, in reality they perceived them different to some extent.

Firstly, service companies compared to manufacturing companies are perceived as being smaller, with fewer resources and innovation processes less structured. Secondly, according to the consultancies, services needs are focused in non-technological areas and market issues and the main interlocutor in service companies is typically the marketing department, while manufacturing needs are centred in technologies and the key interlocutor of manufacturing is the R&D or the innovation department. Thirdly, technology is not understood as so strategic in services as in manufacturing, as services technologies seem quite similar, and mostly focused in ICT. Fourthly, manufacturing projects are perceived as more ambitious, sophisticated, integrated along the innovation value chain and more challenging than services projects. Nevertheless, service projects are considered complex due to the services unique characteristics and the large number of variables to manage in a service provision.

Overall, while supporting the innovation processes of their clients, consultancies see themselves as innovation facilitators, offering valuable information and advice to their clients. Consultancies who are specialised in technological areas envisage themselves as innovation brokers or carriers, providing access to sources of ideas and knowledge, yet not being involved in the process of new product development alongside with their clients. They do not feel they have the necessary expertise. The (only) consultancy that was specialised in non-technological innovation highlighted its role as a co-producer of innovation, either when designing new products or when defining new strategies (marketing or organizational ones).

This raises two new research questions.

Firstly, **are consultancies mostly innovation facilitators or is their supporting role as innovation intermediaries more complex than anticipated?** Contrary to consultancies´ perspective, the evidence points out that consultancies support can go beyond the role of facilitator since they design new strategies alongside with is clients. In the case of new technologies, consultancies act as brokers or carriers, facilitating the processes of technology identification and transfer. They work mostly as interfaces between their clients and the knowledge sources (such as research centres, universities, and other players of the innovation system). But, when they design new internationalization strategies or new organizational processes and procedures together with their clients, they seem to act as co-producers of innovation. Then, even though they can help to identify non-technological innovation and good practices, organizational and marketing innovations are designed alongside with the clients and customised to their needs and characteristics.

Secondly, **why do consultancies not envisage themselves as co-creators of innovation?** It seems that consultancies when (auto) evaluating their role as innovation intermediaries they only take as reference the technological side of innovation. It may be that the non-technological dimension of their support is not associated with innovation or is less important. Even though they are involved in the design of non-technological innovations, they see themselves as facilitators because they act mostly as brokers for technological innovation. This supports the understanding of innovation has resulted from studies of manufacturing and that service innovation has been neglected (Tether, 2005).

Regarding the framework proposed by Pinto et al (2016), consultancies highlighted the relevance of the functions of diagnostic and search for information and knowledge. This is explainable since consultancies have been perceived as "company´s physicians", assisting companies to articulate and define their needs. The functions of conceptualization of new offerings, and of testing and scaling of innovation are not provided by most of the consultancies, which associate innovation with new technologies. Since they are not experts in technology development, they cannot develop, test and scale new technological offerings. Intriguingly however, only one of the consultancies, specialized in non-technological innovation and service industry, offers all those functions. Concerning service offerings, they can support their clients in the definition of new or improved services, as well as in their testing and scaling. The functions of conceptualization of new marketing and organizational strategies are provided by all consultancies, even though the majority does not envisage them as strategic. This may indicate that consultancies´ functions could be enriched if they enlarge their perspective of the innovation concept to provide customized services to manufacturing and service companies. Non-technological innovation can be a competitive mechanism for service and manufacturing companies.

Because of the type of support provided, all consultancies highlighted that information and advice are their most significant contribution to the innovation processes of companies, independently of their industry (services or manufacturing). Allowing access to other players in the innovation system is considered critical but only by the consultancies specialised in technological areas, who act as bridges between users and sources of knowledge. The brokering function is of paramount importance in the

manufacturing industry but seems to lose some relevance in service context. Another area where their contribution is perceived as important is training, since learning helps to configure the right environment for the innovation. The education and training of company´s workers is provided by most consultancies, relying either on dedicated structures, or on online channels or external partners.

Arguably, consultancies roles as innovation intermediaries may go beyond the role of facilitator. In this context, a brokering-based definition of innovation intermediaries (Howells, 2006) might undermine their potential concerning non-technological innovation. Taking in account that service innovation comparatively to manufacturing focuses more strongly on non-technological innovation (Tether, 2005), it seems important to review the concept of innovation intermediary. In this context, the use of a definition of an innovation intermediary that is purpose-based, describing an intermediary as an entity that acts to boot innovation, and that considers an enlarged view of innovation, could be more appropriate.

The research reinforces the importance of a synthesis approach to innovation and of a more enlarged vision of innovation, which includes both technological and non-technological facets, extending the innovation intermediaries and service innovation literatures by addressing a literature gap. It tests an existing theoretical framework on the functions of intermediaries in services and provides insights into the business models, roles and functions of consultancies as innovation intermediaries. Drawing on this study, consultancies can profit from other experiences and adjust their business models to provide more efficient solutions to their clients.

## 6 Limitations and future research directions

Our research provided insights on consultancies business models, roles and functions in services and manufacturing and contrasted them, supporting the recognition that studies of services have the potential to highlight aspects of the innovation process that have been neglected in manufacturing studies (Drejer, 2004).

Nevertheless, as a qualitative study, this research does not allow generalization of findings. It brings new insights and more detailed information about innovation intermediation performed by consultancies in service industry.

Our sample included only Portuguese consultancies, whose main clients were local companies, and therefore reflects the specificities of the local consultancy market. The analysis of this phenomenon in other realities could certainly enrich our knowledge.

In this study, only one consultancy was specialized in non-technological innovation, and half of its clients are from service industry. All the others have clients from both sectors, and are more focused on technological innovation. A future study including other consultancies, especially those involved in organizational and marketing issues, may be desirable.

The analysis was based on the perspective of the service provider. The findings should be complemented by the viewpoint of the service companies regarding consultancies´ engagement to support their innovation efforts.

The research concluded that the framework proposed by Pinto et al (2016) is adequate

to deal with intermediation in services and in manufacturing, contributing to the synthesis approach of innovation. It may be interesting to validate it empirically, developing an adequate scale for questionnaire-based survey.

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## Appendix 1: Main dimensions of the analysis: Definitions

| Dimension | Description |
|---|---|
| Business Model: Offerings | The offerings/value proposition is about the company´s products/services that meet the needs of its customers. Chesbrough (2005) classifies intermediaries´ offerings in three main areas: information, access, and funding. |
| Business Model: Customers | Business customers can be macro-segmented according to their industry (manufacturing or service industry). Different customer segments require specific products, channels, and relationships. |
| Business Model: Resources & Partners | Resources can be categorized as human, financial, physical and intellectual. Due to the nature of the intermediaries´ activities, people and knowledge constitute key resources.<br>Key partnerships include the network of suppliers and other partners who help the intermediary creating its value proposition. |
| Collaboration process: Roles & Functions | The companies´ activities support the production of its value proposition (Osterwalder and Pigneur, 2010). According to the literature (Howells, 2006; Den Hertog, 2000; Miles et al, 1995), intermediaries can act as facilitators of innovation, carriers, sources or co-producers of innovation. Pinto et al (2016) made an analysis of the main functions of intermediaries, which comprises 12 functions. This tool provides an enlarged view of innovation, strengthening the synthesis approach. |

| Dimension | Description |
|---|---|
| Value-added: Impacts | Dalziel and Parjanen (2012) present a general-purpose methodology for measuring the impact of innovation intermediaries. The immediate impact can be analysed at three levels: information and advice (strategic information and advice, feedback on products and services, and information and advice on selling in new markets, operating in new markets, and on raising capital), business linkages (linkages with service providers), and business services (business planning services and executive education). The intermediate impact on firm performance can be measured at four levels: revenues (change in revenues, export sales), employment (change in employment, market share - new customers, and investment - financing). The measurement of the immediate impact was found more interesting to our analysis as it is straightforward. The measurement of the intermediate impact was not used in our analysis, since requires isolating the impact of intermediary activities from the other factors that may affect firm´s performance (Dalziel and Parjanen, 2012).<br><br>The Oslo Manual (2005) adopts an enlarged view of the innovation activities outputs, considering four types of innovations: product (new or significantly improved good or service), process (new or significantly improved process), marketing (new marketing strategy) and organizational innovations (new organizational strategy). |
| Value-added: Challenges | The unique nature of services, characterized by perishability, variability, intangibility, and inseparability, affects its management. Services tend to have an orientation to innovation that differs from that of manufacturers: manufacturers tend to place greater emphasis on ‘‘hard’’ strengths and sources of technology, such as R&D, acquisition of equipment, and collaborations with universities and research institutes, whereas services emphasize ‘‘soft’’ advantages and attributes, such as staff skills and inter-organizational cooperation practices (Tether, 2005). The “soft side” of service innovation (non-technological innovations) is easily overlooked by traditional indicators such as R&D expenditures and patents. The “continuous change” mode of innovation (by opposition to the “staircase innovation”) is more common in services than in manufacturing. |

## Appendix 2. Consultancies´ functions.

| Functions | Case 1 | Case 2 |
|---|---|---|
| 1. Analysis and definition of innovation needs | It provides a holistic innovation diagnosis, including all the company´s departments, to understand the company´s approach to innovation and its needs and expectations. Complementarily, it does its own market research (analyses the technological options, market needs and trends, and best practices), relying on its own research unit. It organizes idea generation workshops in the company, to identify and rank the several opportunities. A very small number of opportunities are selected and a strategic plan is defined. | It offers a great diversity of services to private companies, including the diagnosis of R&D and innovation activities, identification of trends, technology surveillance and the definition of strategic and innovation plans. |
| 2. Identification of user needs and major trends | | |
| 3. Signalisation of technological options | | |
| 4. Conceptualising new service offers | It can assist its clients doing a general definition of the new products/services. It supports the clients´ introduction of new and scientific organizational models, as well as and new marketing strategies, to boost the client´s competitiveness. | Not provided |
| 5. Conceptualising new organisational methods | | It helps in the process of creation of development of R&D and innovation structures. |
| 6. Definition of new marketing strategies | | It assists companies in the definition and implementation of internationalization strategies (to the markets of Brazil, USA, China, and Southeast Asia). |
| 7. Identification of potential partners | It can collaborate on the identification and (if necessary) contact with company´s innovation potential partners. | It is specialized in the design and implementation of partnerships between companies, science and technology institutions, and international institutions. It is a privileged interface between private companies, universities and other knowledges centres, and national and international public organizations. |
| 8. Testing and scaling | Not provided | Not provided |
| 9. Selection and training of specialised workforce | It 1 has its own training academy, which provides training in the areas of innovation and business management. | It acts at training level, identifying needs and structuring the training plan. It applies pedagogical tools such as e-Learning. |

| | | |
|---|---|---|
| 10. Protection of innovation assets | Not provided | Not provided |
| 11. Accreditation/ certification | It supports the implementation and certification of innovation standards and frameworks, such as NP 4457:2007; IMBOK; ISO/TC 279. | It offers support in the implementation and certification of RDI Management Systems according to NP 4457: 2007. |
| 12. Investment appraisal | It can help the clients to assess their innovation investments, even though it does not work in the areas of funding and preparation of applications to EU funding | It identifies funding opportunities and prepares and makes the follow-up of funding applications. It promotes companies´ participation in national and international projects of R&D (UE funding). |

| **Functions** | **Case 3** | **Case 4** |
|---|---|---|
| 1. Analysis and definition of innovation needs | It does the company diagnosis, with a special focus in technological areas. Some companies, due to their dimension, do their own diagnosis and look for consulting support to define the possible solutions. It searches for information about market needs and new technologies. It helps clients to define the overall innovation strategy. | Its services include an innovation diagnosis, analysis of emerging trends and customer needs as well technological options, and the definition of the client overall strategy. |
| 2. Identification of user needs and major trends | | |
| 3. Signalisation of technological options | | |
| 4. Conceptualising new service offers | Not provided | It helps clients defining new offerings (core and supplementary services, using tools such as blueprinting and flowcharting). Its support in marketing areas is regarded as very important. The company prepares marketing plans as well as studies and does specific marketing audits. The support to its clients regarding organizational strategies is done too, usually grouped with the support provided in developing new services and new marketing strategies (complex innovations). |
| 5. Conceptualising new organisational methods | It supports companies in the identification and implementation of new management tools. | |
| 6. Definition of new marketing strategies | The company supports its clients in their internationalization processes, acting mostly at strategic level. Typically, they do not prepare marketing plans. | |

| | | |
|---|---|---|
| 7. Identification of potential partners | It helps to define and establish (technological) partnerships between companies and entities of the S&T system. In some technological projects that involve an array of players, it acts as architects in the fuzzy front of innovation. | It can also identify possible partners and, in some cases, to provide access.<br>It urges its clients´ to identify their main innovation partners at 4 levels (clients, collaborators, suppliers and investors) and to incorporate their contributions in company´s innovation. |
| 8. Testing and scaling | Not provided | It also is prepared to help its clients testing and scaling service innovations. |
| 9. Selection and training of specialised workforce | Not provided | The company´s training services, especially in the areas of marketing, are considered strategic. |
| 10. Protection of innovation assets | Not provided | Not provided |
| 11.Accreditation | It offers services regarding management systems accreditation. | Not provided |
| 12. Investment appraisal | It can help in the identification of necessary investments and, often, prepares and manages the applications for EU funds. | Concerning investment appraisal, it helps clients to identify the necessary investments, costs and possible capital sources. |

*Source: Own formulation*

## Appendix 3. Empirical perspective over consultancies as innovation intermediaries.

| Dimension | Characterization | Comments |
|---|---|---|
| Business Model: Offerings | Information and access to other players | Consultancies act mostly at information level. |
| | | The provision of access to other players is mostly done by consultancies specialized in technological innovation. |
| | | The funding level is essentially focused on the elaboration of companies´ applications to EU funded programs. |
| Business Model: Customers | Inexistent market segmentation according to industry | Consultancies do not perceive manufacturing companies different from service companies. |

| Dimension | Characterization | Comments |
|---|---|---|
| | Services and manufacturing have different dimensions/resources | Manufacturing is a traditional and more important client. |
| | Service and manufacturing interlocutors are different | Typically, service companies vis-à-vis to manufacturing companies are smaller, with fewer resources, and don't have a well-defined innovation strategy. |
| | | In services, marketing department is the main company's interface regarding innovation issues; in manufacturing, the interlocutor is the R&D or the production department. |
| | Service and manufacturing needs are distinct | Manufacturing companies are concentrated on production matters, while services focus on market differentiation. |
| | | Manufacturing innovation needs are more clearly defined, comparing to services. Typically, only manufacturing companies have a "technological strategy", and their spectra of technological innovations can be quite diverse. |
| | | Manufacturing needs a more holistic support (technological and non-technological), allowing cross-selling. Service industry relies largely on non-technological innovation, even though technological innovation can be a concern. |
| | Relationships with manufacturing can last longer | The relation with manufacturing companies can endure longer, due to the dimension/complexity of these companies. Normally, they require a wide range of the consultancies´ services. |
| | Dyadic and triadic relationships | Typically, consultancies provide services directly to their clients (in the case of non-technological innovations) or involve a third party or more players (in the case of technological innovations). |
| | | Mobilizing projects usually involve more complex relationships. |
| Business Model: Resources & Partners | Importance of partnerships | Universities and other knowledge centres are considered fundamental sources of scientific knowledge. |
| | | Partnerships with other consultancies are also important to ensure a better service quality. |
| | Staff is a critical resource | Consultants with different academic and professional backgrounds are strategic assets. |

| Dimension | Characterization | Comments |
|---|---|---|
| | Organizational structure is not aligned by client´s industry | Innovation services are industry agnostic, even though collaborators with specific industry expertise are very valuable. |
| Collaboration Process: Role& Functions | Innovation facilitators and carriers | All consultancies work to identify knowledge gaps and search for information and knowledge to facilitate clients´ innovation. |
| | | Two of the consultancies, specialized in technological issues, stress the importance of its brokering role, where they act proactively as bridges between the users and the sources of technology. They also support the technology transfer, acting as carriers. |
| | Innovation co-producers | The co-production role is emphasized by one of the consultancies, specialized in marketing areas. The design of new offerings and new marketing strategies involves co-production. |
| | | In the case of projects aiming to develop state-of-art technology and involving several actors, the consultancy envisages itself as a co-producer (Agogué, 2013). |
| | Similar functions | Consultancies' main functions as innovation intermediaries are rather similar. Functions provided in services and in manufacturing are not perceived as different. |
| | Focus on diagnostic, identification of user needs/trends and technological options, and strategy definition | The most essential functions are related with the company´s diagnostic, the search for information, and the definition of the clients´ overall strategy. |
| | | The conceptualization of new services offerings is not the domain of consultancies specialized in technological innovation. |
| | | None of the consultancies provides support in the protection of innovation assets. |
| | | The testing and scaling is only offered by one consultancy and it is specifically related with service offerings. |
| | | Consultancies are less present in the innovation implementation phase, due to the specificities of the tasks. |

| Dimension | Characterization | Comments |
|---|---|---|
| | Specificities of support at non-technological level | The support given by most of the consultancies in terms of marketing strategy is much related with the internationalization process of the clients. |
| | | The assistance regarding organizational innovation is mostly concentrated in the definition of internal innovation structures and procedures as well as the implementation of quality standards in several areas. |
| | | The provision of training services in the areas of innovation, marketing and business management is considered crucial. It is perceived as a trigger of future innovations. |
| Value-added: Impacts | Importance of information/advice | The immediate results are mostly information and advice, assets that are equally important to service and manufacturing industries. Consultancies are warehouses of knowledge (scientific knowledge, best practices), with guidance function. |
| | | The access to other players (business linkages) is two-fold: access to sources of knowledge and access to funding sources. |
| | | The access to knowledge sources is mostly associated with technological innovation and manufacturing companies. Clients want access to possible technology suppliers (universities, research centres, …). |
| | | The provision of business services (executive education) is mostly connected with non-technological innovation. Training increases organizational knowledge, facilitating innovation. |
| | Priority of technological innovation and manufacturing projects | The support in technological areas is considered of utmost importance by two consultancies. The support in non-technological areas is seen as a complement and a way to potentiate the support given in technological areas. The services provided regarding non-technological innovations are considered in a second level, less interesting as a source of profit, having a punctual nature and always related to the main support provided regarding technological issues. Therefore, manufacturing projects comparing to service projects are more complex, of greater dimension, usually apply to external funding, |

| Dimension | Characterization | Comments |
|---|---|---|
| | | and the results are more impressive and tangible. |
| Value-added: Challenges | Consultant-client interaction in manufacturing is easier | Manufacturing companies, due to its dimension and dedicated resources to innovation, have well-defined expectations, and seek for a precise and focused intervention, while service companies are constrained by their dimension/size. |
| | Manufacturing projects are more complex | Manufacturing companies deal with an array of technologies and products. Services technological innovation is mainly related with information technologies, and the solutions adopted by companies are quite similar. |
| | Service innovation is more challenging to deal with | Innovation in services, due to services peculiar characteristics, can be more difficult to manage, measure and protect as it involves more variables/players (clients, employees, suppliers) and it is intangible. |

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# Roles and responsibilities of open innovation specialists based on analysis of job advertisements

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**Abstract**. Innovative companies are increasingly creating new open innovation functions and employing open innovation specialists to facilitate innovation processes. However, research that explores these emerging jobs remains scarce. This study examines the worldwide job market for 'open innovation' specialists as per job title and/or job description, and analyzes 100 job advertisements related to 'open innovation' specialists published during two periods in 2014 and 2016. The findings identify the key responsibilities of dedicated open innovation specialists and associated skills, and the competencies that companies seek in candidates. In addition, the findings indicate that companies need open innovation specialists to not only work in R&D departments. In addition, the ability to influence others and prior start-up experience have become basic requirements to apply for open innovation specialist positions.

**Keywords.** Open innovation, job skills, competencies, job description, open innovation specialist, job advertisement, roles.

## 1 Introduction

Since 2003, when Henry Chesbrough introduced the term 'open innovation' (OI), it has become very popular among scholars and practitioners. Many firms have opened up their companies' boundaries and embraced open innovation as a business strategy (Chesbrough and Bogers, 2014; Dahlander and Gann, 2010; Gassmann et al., 2010; Mortara and Minshall, 2014). Open innovation adoption requires changes in the organizational structure and work practices of R&D professionals (Salter et al., 2014), and the redefinition of tasks, tools, processes and reward systems (e.g. Alexy et al., 2014; Mortata et al., 2014). Considering the intensity of necessary changes related to the personnel involved in open innovation, academic research has paid little attention to the human side of open innovation (Bianchi et al., 2011; Bogers et al., 2018; Podmetina et al., 2013; Mortara et al., 2014; Salter et al., 2014; Vanhaverbeke et al., 2014; West et al., 2006; Wynarczyk et. al., 2013).

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According to the report of the Word Economic Forum on the Future of Jobs (WEF, 2016), disruptive changes to the business models, together with the other major drivers of global transitions, are expected to have a significant impact on creating new jobs that did not exist a few years ago. Indeed, this rapid change is also observed in companies as open innovation functions and new roles are formalized (Alexy et al., 2014; Dabrowska and Podmetina, 2014; Mortara and Minshall, 2014). In addition, new open innovation job titles have emerged, and a LinkedIn search reveals over 52,000 job titles related to "open innovation", only 15 years after the introduction of the term (LinkedIn, 2018).

Apart from creating new jobs, the adoption of open innovation practices also changed the way companies recruit new staff, and what skills and competencies they are seeking (Di Minin et al., 2010). Once a company decides to open up its innovation process, employees are expected to possess certain competencies and skills in addition to technical/scientific or managerial expertise (Bredin and Söderlund, 2006; Huston and Sakkab, 2006). However, the description of these required competencies and skills remains vague.

At the same time, the confusion about the nature of the open innovation term (Trott and Hartmann, 2009) and the different processes and practices associated with it, leads to asking what the roles and responsibilities are of open innovation specialists. To the best of our knowledge, before this study, there was no prior attempt to analyze the job advertisements related to open innovation that aimed to identify the skills, roles and responsibilities of open innovation specialists in companies. Thus, by analyzing the job market, this paper focuses on identifying common skills and competencies of open innovation specialists, as well as their roles and responsibilities. Moreover, it analyses the differences in competence profiles across organizations and differences of organizational functions where open innovation specialists are needed.

The main research questions are:

(Q1): What are the roles and responsibilities of open innovation specialists in a company?

(Q2): What common competencies do organizations seek from open innovation specialists?

(Q3): What are the differences between competence profiles and job responsibilities across organizations?

Given the sparse literature on the topic, we answer these questions through a qualitative analysis of job offers posted worldwide and collected during two periods: February 2014 and February 2016. One hundred job advertisements with 'open innovation' in the job title or job description were analyzed.

The remainder of this paper comprises five sections. In the next section, we present the theoretical foundations of the human side of open innovation and related skills and competencies. Next, we describe the research design and methodology. In section four we present the findings, which is followed by a discussion and conclusions.

# 2 Theoretical background

## 2.1 Open innovation

Open innovation was originally presented as a paradigm shift for high-tech industries, e.g. large manufacturing firms (Laursen & Salter, 2006), chemicals (Kirschbaum, 2005), pharmaceuticals (Lichtenthaler, 2008, Lichtenthaler, 2007, Lichtenthaler & Ernst, 2008, Lichtenthaler, 2010; Thong and Lotta, 2015), electronics (Christensen et al., 2005), automotive (DiMinin et al., 2010), and communications (Asakawa et al., 2010). It can be observed that today, research has also expanded to a wide range of other industries (Chesbrough and Bogers, 2014). Open innovation can be defined as *"the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively."* (Chesbrough, 2006b, p. 1). However, after being criticized about the lack of a proper definition of open innovation (e.g. Knudsen & Mortensen, 2011; Ozman, 2008; Trott & Hartmann, 2009) and after applying recent conceptualizations (Gassmann and Enkel, 2004; Dahlander and Gann, 2010; West and Bogers, 2014), a few years later the definition was re-defined as a *"distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model"* (Chesbrough and Bogers, 2014, p. 17).

As the concept gained interest from academia, several classifications of open innovation activities emerged. For example, Gassmann and Enkel (2004) classified the open innovation process as the *outside-in*, the *inside-out*, and the *coupled* process. Chesbrough et al. (2006) distinguished the purposive inflows and outflows of knowledge into *inbound* and *outbound* open innovation. Inbound open innovation reflects the outside-in process, and outbound open innovation the inside-out process. Later, Dahlander and Gann (2010) emphasized the monetary directions of the knowledge flows by adding the *pecuniary* and *non-pecuniary* dimensions to this classification. As a result, they distinguished two forms of inbound innovation – *acquiring* and *sourcing*, and two forms of outbound open innovation – selling and revealing. Following the classifications by Gassmann and Enkel (2004) and Dahlander and Gann (2010), in their latest work Chesbrough and Bogers (2014) defined the mechanisms to help in managing the knowledge flows in open innovation. For the purpose of this study, we will apply the classification of open innovation (inbound, outbound and coupled) and supporting mechanisms described by Chesbrough and Bogers (2014).

### 2.2 Skills, competencies, roles and responsibilities of open innovation specialists

Many practitioners and researchers in academia use the term 'skills' and 'competencies' interchangeably (as an example, see section on the analysis of job advertisements). However, skills should be treated as one of the integral elements of competencies, along with "motivation, character traits, knowledge and behaviour" (Proctor and Dutta, 1995, p. 19). According to Colombo and Grilli (2005), skills of an individual are associated with educational background (e.g. Bachelor, Master, Doctoral level), their nature (e.g. engineering, economic), and length of professional experience (e.g. prior employers, prior position).

There is also a vast confusion in regard to competencies, which is often reflected in the inconsistent use of terms, as well as different understandings, e.g. based on cultural differences (Boon and van der Klink, 2002; Cseh, 2003). Most researchers use the term "competency" for describing essential human knowledge, attitudes, and skills at work (Du Chatenier et al., 2010; Sandberg, 2000) and abilities to perform non-routine tasks (Kanungo and Misra, 1992). Competencies can be defined as the "*abilities to successfully meet complex demands in a particular context through the mobilization of psychosocial prerequisites (including both cognitive and non-cognitive aspects)"* (Rychen and Salganik, 2003, p.43) or simply, as an integrated set of "*knowledge, attitudes, and skills of a person*" (Mulder, 2007, p.11). As noted by Kamoche (1996) many researchers and practitioners have composed behavioral profiles of generic competencies that are used for performance evaluation or recruitment. For the purposes of this paper, we will follow the simplified definition of competencies, described by Mulder (2007) and apply it to competencies of open innovation specialists.

Since open innovation requires opening up companies' boundaries (Chesbrough, 2003) and comprises complex activities and mechanisms that companies can adopt, it also includes various tasks that range from technical to marketing and legal (Bianchi et al., 2011) followed by a variety of job responsibilities that are associated with certain personal traits. For example, Chesbrough (2003) identified two critical traits – *risk propensity* and *pragmatism* – that are needed to overcome the so-called 'Not-Sold-Here Syndrome' (Katz and Allen, 1982). While analyzing the role of licensing managers, Bianchi and colleagues (2011) emphasized the *mediating attitude* in terms of conflict minimization between internal and external stakeholder, and *systemic approach*. Du Chatenier et al. (2010) analyzed open innovation teams' competencies, and pointed out the three most important competencies that individuals working in these teams should possess: *combinatory skills, social astuteness, sociability*. Several consulting books also describe needed skills for open innovation teams (e.g. Hafkesbrink and Schroll, 2010; Lindegaard and Kawasaki, 2010; Sloane, 2011), however, these descriptions are mainly based on authors' own experience. The study by Sartori and colleagues (2013) compiles some of these characteristics of individuals that are needed for working in open innovation teams. They mention for example entrepreneurial *mindset*, *communication skills*, *ability to comprehend complex requirements, relationship building, curiosity, holistic point of view*. The report by Mortara et al., (2009) distinguishes four categories of skills for open innovation: *introspective, extrospective, interactive* and *technical*, and the accompanying set of desirable personal attributes. Concerning entrepreneurial mindset, the study by Di Minin and colleagues (2010) provides evidence that firms that adopted open innovation have changed the way they

recruit new staff. FIAT, for example, includes *entrepreneurial attitude* in the assessment of new personnel. Several other papers (e.g. Cloyd and Euchner, 2012; Dodgson et al., 2006; Di Minin et al., 2010) also mention the need for stimulating entrepreneurial behavior in R&D departments. Soft skills such as *passion* and *optimism* of managers in OI-driven organizations are emphasized by Martino and Bartolone (2011). Another study (based on an Italian sample) by Petroni and colleagues (2012) explores how the adoption of OI has changed the organizational structures of R&D and HR practices. They conclude that, with the shift from closed toward open innovation, the greater value is placed on engineers who are *capable to work in an external environment* and have *project management skills*. The new roles have been identified in these organizations, involving *technological monitoring*, *gatekeeping* (Chen et al., 2004), *boundary-spanners* or so-called *"T-shaped managers*" (Chesbrough, 2012). Based on case study of Philips, Hacievliyagil and Auger (2010) also emphasize that researchers have changed their working time allocation, as they spend their time on business aspects (e.g. negotiation of partners, scouting for external ideas) apart from work in research labs. Fleming and Waguespack (2007) noted that leaders in open innovation communities need to possess certain social capital, defined as *the boundary-spanning* or *brokerage* of collaborative relations, apart from technical expertise. The study by Saebi and Foss (2015) argues that in order to successfully implement open innovation companies should align the organizational aspects with employed open business model. This includes designing new organizational roles and supporting governance mechanisms. For example, by adopting a market-based innovation strategy, R&D employees should develop expertise in communicating and interacting with researchers and managers across various industries (*T-shaped managers*); for network-based innovation strategy, the emphasis should be placed on *integration experts* who facilitate the integration of externally acquired knowledge across different internal units.

Mortara and Minshall (2014) noted that as the role of open innovation in companies has become strategic, new functions and roles have emerged that are explicitly linked with open innovation. For example, they mentioned the positions as Vice President for Open Innovation at Unilever, or Open Innovation Director at Crown Packaging and Philips, as examples of newly created jobs. With regard to positions of open innovation managers, the recent report by Vanhaverbeke and colleagues (2017) explores their LinkedIn profiles, but not in terms of their roles and responsibilities on the job.

Nevertheless, to the best of our knowledge, there has been no prior attempt to analyze the job offers related to open innovation to identify skills and responsibilities of open innovation professionals in companies, which this study attempts to do.

## 3 Research Design and Methodology

Employing an open innovation specialist is emerging management practice, as the concept of open innovation was only introduced in 2003. Hence, the research on their roles and responsibilities is still at a very early stage. The aim of this paper is to explore the roles, responsibilities and competencies of dedicated open innovation specialists, thus we adopted a qualitative research strategy. This strategy allows seeking answers to "what", "why", and "how" questions (Yin 2014), and thus is particularly suitable for the study. This study intends to analyse the documentary evidence by means of content

analysis (Boettger and Palmer, 2010; Krippendorff, 2013). Qualitative content analysis in particular can be used to describe a phenomenon, allowing researchers to understand the social reality in a subjective way (Carliner et al., 2015; Zhang and Wildermuth, 2009). This inductive approach to analysis and purposively selected samples (Carliner et al., 2015; Krippendorf, 2013) yields light on general job descriptions that represent the overall view of OI positions, based on the formal description of job advertisements. Carliner and colleagues (2015) who used qualitative content analysis of job descriptions to analyze performance consultants' positions, used a similar justification and approach. However, their work does not consider job descriptions included in job advertisements.

Due to the very limited research on competencies for OI specialists and their roles from the academic perspective, we decided to analyse current job advertisements related to OI in order to investigate what common skills and competencies companies are seeking while recruiting new staff, as well as the roles and responsibilities of open innovation specialists. Although this method has not been used before in the field of OI (except one documented attempt by Ziebarth and colleagues (2010), who developed software tool to match competence profiles with job offers to support competence management for open innovation), other disciplines successfully use content analysis of job advertisements to study emerging phenomena in their field. For example, Aguinis and colleagues (2005) used it to analyze certified HR professionals, Chen and Zhang (2015) for data management professionals, Park and Lu (2009) for metadata professionals, and many others in the field of e.g. health education (e.g. Baker and Cissell, 1994) or librarian education (Shahbazi et al., 2016: Shank, 2006; Tang, 2013).

The job offer analysis, which aimed to study job advertisements listed by companies worldwide, was done in two steps – the first search was done at the beginning of 2014 and the second about two years later. In both cases, the careerjet.com search engine was used, due to the fact that it compiles job offers from different international and national sources. Even though this website is very useful when searching for job offers, it must be kept in mind that most of the job advertisements are repeated, as most companies choose many different channels to post their jobs. The keyword used was "open innovation" in the job title, job description, or job function. Out of 354 and 484 job advertisements in 2014 and 2016 respectively, 100 were selected for the analysis after the exclusion of duplicates and according to other criteria (e.g. "open innovation" used in the general companies' description, job offer posted in English). The main limitation of this study is also related to the main criterion – job advertisements in English – that excluded job offers written in local languages.

All job offers were collected in an MS Excel dataset that was later exported to Nvivo10 software, where the analysis took place. Wordle.net was used for the analysis.

Fig. **1** presents the countries where the jobs were advertised. In both analyzed years, most of them were posted in the USA (33 in 2015 and 25 in 2016). In 2016, Germany was second (4 jobs), followed by China (3), the Netherlands (3), and countries such as Canada, Thailand, Switzerland and Ireland, that had not featured in 2014.

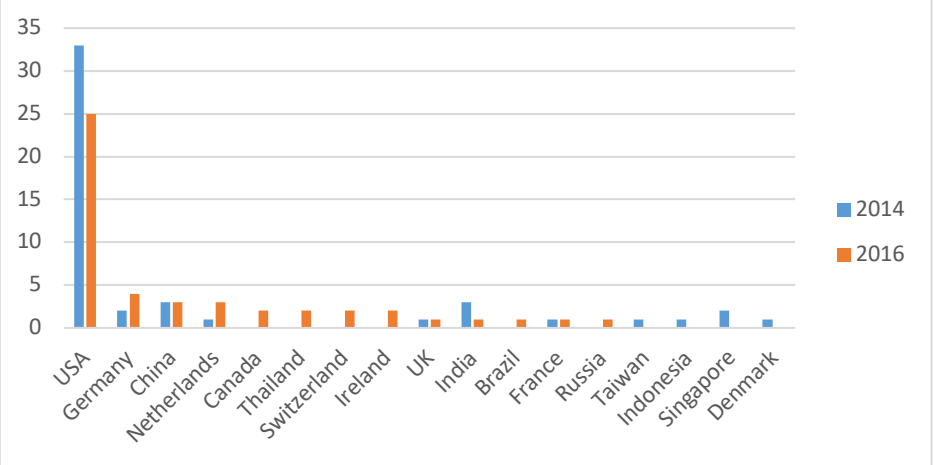



**Fig. 1.** List of countries with open innovation job posting in February 2014 and 2016.

It is important to note that the analyzed job offers include all available offers at different stages of a career – from internship positions to the director or head of a unit.

## 4 Findings

The analysis is presented in three blocks. The first block provides findings based on the general overview of the total sample. The second block focuses on jobs from two periods (2014 and 2016) that include 'open innovation' in the job title only. The third block compares the results from 2014 with those from 2016 based on the whole sample of 100 job offers.

### 4.1 Overview of job advertisements in the field of open innovation

As mentioned in the research design section, the selected job advertisements included 'open innovation' in the title of the job, in the description of roles and responsibilities, or in the job function. It was observed that out of 100 jobs related to open innovation, 23 mentioned 'open innovation' professional directly in the job title. In 2014 there were four (4) explicit 'open innovation' positions, compared to 19 in 2016, which indicates the growing role of open innovation in companies' structures.

There are many job offers that only mention 'open innovation' in the job description, usually in one of five ways:

1) *The ideal candidate for the position needs to have a knowledge of how to best leverage open innovation platforms to source innovation.*

*2) The candidate will manage and grow the project pipeline via both internal and open innovation.*

*3) The candidate needs to have knowledge and experience in identifying innovative partnerships and executing collaborative models for partnership 'in the spirit of open innovation'.*

*4) The candidate will internally promote the different Open Innovation activities and identify specific needs for them.*

*5) The candidate will be working in open innovation environment.*

In total, out of 100 jobs related to open innovation, 40% were for managerial, 14% for directorial, and 10% for senior positions. Fig. 2 presents the word buzz of other position titles related to open innovation (after excluding the most common "open innovation", "manager", "director", "senior"). The results indicate that companies seek leaders, engineers, business development managers, product (marketing) managers, analysts, technology scouts, event managers, new business opportunity managers, and business strategy managers.


**Fig. 2.** Word buzz of job titles in the field of open innovation.

Another finding is that the positions related to open innovation are not only located in R&D departments but are also divided between other organizational functions. These include strategic management, marketing and sales, corporate communications, IT, and purchasing divisions. This adds to the notion of the multidisciplinarity of open innovation, and the tasks and responsibilities of open innovation specialists.

In regard to industries, it was noticed that even though open innovation was originally comprehended as a paradigm shift for large manufacturing firms, it has rapidly extended to new industries including service industries, supporting the insights of Chesbrough (2011) and Chesbrough and Bogers (2014). The consumer goods industry displayed the highest demand for open innovation specialists, followed by the consulting, pharmaceutical, telecommunications, electronics and healthcare sectors (see Fig. 3).

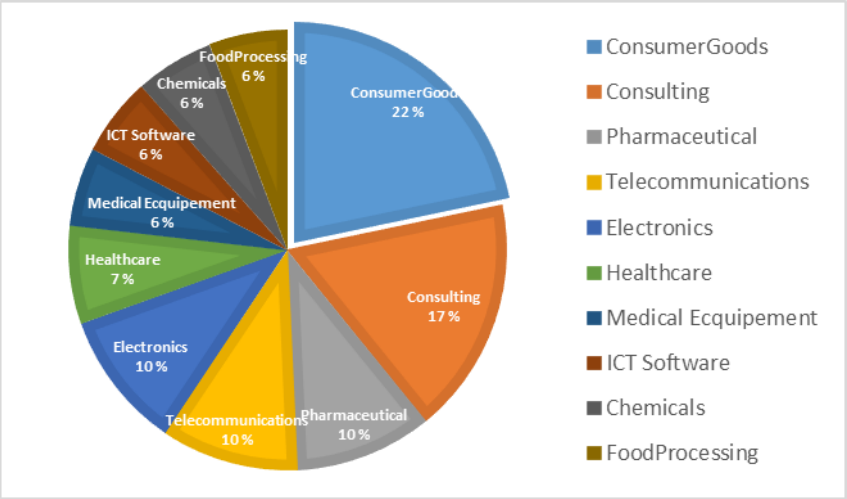



**Fig. 3.** The structure of the top 10 industries with job offers related to open innovation.

### 4.2 The 'Open Innovation' specialist – commonalities and differences

Interestingly, the analysis of 23 positions that directly named open innovation professionals found support for findings from another study, which argues that companies define open innovation differently and might have difficulties with identifying which practices can be perceived as open or closed (Dabrowska et al., 2013). To picture it, we used Chesbrough and Boger's (2014) classification of open innovation activities and counted the number of activities mentioned as part of the open innovation specialists' job responsibilities (See Table 1). The analyzed companies stated between four (4) and 11 different OI activities in their job descriptions. The median value was eight. All firms indicated that the candidate should have expertise in inbound open innovation (scouting for new ideas and technologies outside and collaborating with intermediaries, suppliers and customers), 43% of the firms expected the OI specialist to be responsible for the cooperation with universities, and 21% for the cooperation with start-ups. A significant number of the analyzed job profiles (over 69%) stressed that one of the responsibilities of the job is the cooperation within ecosystems or networks or with stakeholders. For the inside-out mechanisms of OI, the most commonly mentioned responsibilities were those related to joint ventures, networks and alliances (over 21%) and activities related to start-ups: spin outs, incubation etc. (over 21%).

**Table 1.** The number of open innovation activities indicated in 23 job advertisements related to open innovation specialists.

| | | Number of companies who mention the activity as part of the open innovation specialist's responsibility | % |
|---|---|---|---|
| **Outside-in** | scouting | 23 | 100,00 |
| | in-licensing IP | 2 | 8,70 |
| | university research programs | 10 | 43,48 |
| | funding start-up companies in one's industry | 5 | 21,74 |
| | collaborating with intermediaries, suppliers and customers | 23 | 100,00 |
| | utilizing non-disclosure agreements | 0 | 0,00 |
| | crowdsourcing | 3 | 13,04 |
| | competitions and tournaments | 2 | 8,70 |
| | communities | 0 | 0,00 |
| | spin-ins or spin-backs | 0 | 0,00 |
| **Inside-out** | out-licensing IP and technology | 2+ 2 | 17,39 |
| | donating IP and technology | 0 | 0,00 |
| | spin-outs | 5 | 21,74 |
| | corporate venture capital | 0 | 0,00 |
| | corporate incubators | 5 | 21,74 |
| | joint ventures and alliances (i.e., becoming a supplier to or a customer of a new initiative, vs. executing the initiative internally). | 5 | 21,74 |
| **Coupled** | strategic alliances, joint ventures, consortia, networks, ecosystems and platforms, all involving complementary partners | | |
| | networks | 23 | 100,00 |
| | joint ventures | 5 | 21,74 |
| | ecosystems | 16 | 69,57 |

*Source: Author's own analysis, based on Chesbrough and Bogers (2014) classification of open innovation activities*

In regard to job responsibilities, one position for an open innovation professional in the chemical industry in an R&D division went beyond the tasks on R&D or innovation management, and involved tasks from HR management (talent management, interviews

with candidates, training). For example, apart from responsibilities like:

> *"Drive Open Innovation: initiate new research projects with academic and industrial partners (…) Generate and monitor new collaboration projects (…) Motivate and coach colleagues to drive (open) innovation on Innovation Campus, further develop innovation culture, support innovation processes from idea finding to project start (…) Organize open innovation workshops with customers.", it also included:*
>
> *"(…) organization of events and workshops at universities, represent and present the company at universities (…) Talent Management (…) further develop concept of talent management. (…) Push development of competencies of PhD candidates and PostDocs, including feedback, and organization of trainings (…) Conduct competency-based interviews with candidates".*

This may indicate that the roles and responsibilities, and related to them the skills of open innovation professionals, are becoming more interdisciplinary.

Nonetheless, common skills that the candidate should possess were also identified. Fig. 4 presents the word buzz of the common skills, which indicates that the ideal candidate should have *excellent communication*, *leadership* and *project management skills*; have *problem-solving* skills and be *able to think strategically* and *work in cross-functional teams*; possess *excellent interpersonal skills*; be *able to work independently and as part of the team*, and have the *ability to influence others*. Concerning knowledge, most of the job advertisements mention *cross-disciplinary knowledge* (be it the combination of technology and business; R&D with marketing and management or R&D and sales management) however, more attention in placed on *prior work experience* and proven track record.


**Fig. 4.** Word buzz of common skills for open innovation professionals based on job advertisement analysis.

Based on the analysis of 23 positions, all naming 'open innovation' in the job titles, we can also map the *key areas of roles and responsibilities* of 'open innovation' professionals. Table 2 presents the summary, with examples taken directly from the job advertisements. The key areas are named in descending order, which means that scouting was mentioned the most often (as part of each and every job responsibility of an open innovation professional). Hence, one of the main responsibilities of this professional would have been *scouting for technologies, ideas, solutions and/or*

*business opportunities*. It is followed by *developing, managing, building innovation ecosystems* and strategic partnerships. Also, the person was expected to *create and develop open innovation strategies* for the company and manage multiple projects. From the internal perspective, the person was expected to *organize, plan, and manage cross-functional initiatives* within the company to *promote open innovation initiatives*. What was less emphasized, but still relatively common, was *building and designing prizes and challenges for open innovation platforms* and *internal and external crowdsourcing initiatives*. Furthermore, the person was expected to *organize and participate in open innovation events and workshop*s as well as to support the structuring of strategic deals.

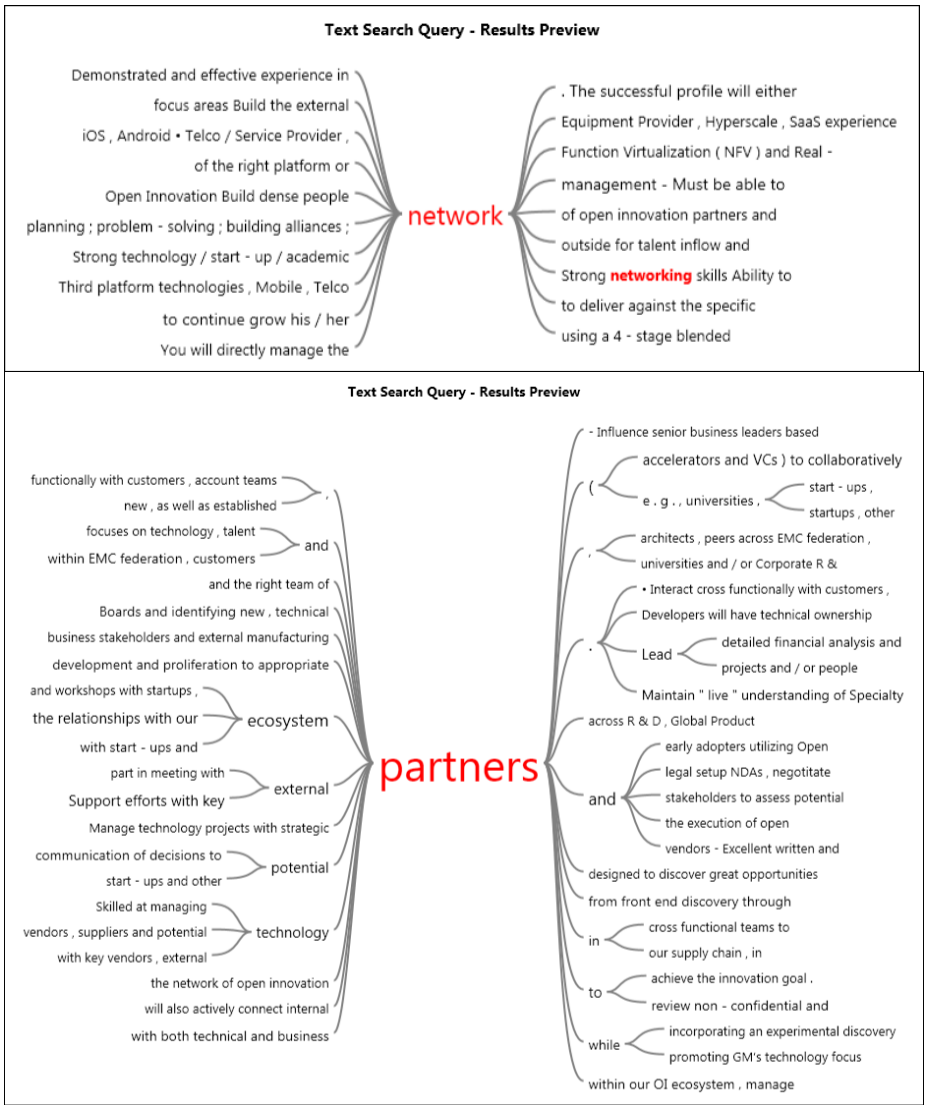
**Table 2.** Key areas of roles and responsibilities based on analysis of 23 job offers with

| Key areas of responsibility | Examples of Roles and Responsibilities |
|---|---|
| **Scouting** for technologies, ideas, solutions, business opportunities | *Scout for innovative and disruptive technologies,*<br>*Scouting technologies or business opportunities at universities, institutes, or companies, incl. start-ups*<br>*Build and implement state-of-the-art digital scouting capability that provides early warning to emerging disruptive technologies and opportunities*<br>*Evaluate research and new technologies, identify promising candidates, and articulate possibilities to technical and non-technical stakeholders*<br>*Identify strategic innovation targets (startups and/or early stage technologies* |
| **Strategic Ecosystem/Networks/ Strategic partnership**<br>*(to develop, manage, build, influence, engage)* | *Develop and influence the innovation ecosystem to drive capability, scout for emerging technology, foster external partnerships and incubate strategic collaborations*<br>*Engage the broader ecosystem including academic/research institutions, entrepreneurial start-ups and other potential partners.*<br>*Build and manage relationships with ecosystem partners (e.g., universities, startups, other R&D labs) designed to discover new business opportunities*<br>*Engage with the innovation ecosystem and to identify and develop high impact opportunities.*<br>*Within our OI ecosystem, manage key external partner engagements*<br>*Manage the network of open innovation partners.* |
| **Open Innovation Strategy**<br>(to create, develop) | *Collaborative development of open innovation strategy in the context of innovation management.*<br>*Create & develop Open Innovation strategy that focuses on technology, talent and partners while incorporating an experimental discovery mindset.*<br>*Development of new strategies to get ideas, resources and technology from the outside.* |

| Key areas of responsibility | Examples of Roles and Responsibilities |
|---|---|
| **Project Management** | *The execution of open innovation projects.*<br>*Manage technology projects with strategic partners, universities and/or Corporate R&D Tech Leads to develop prototypes / products with business stakeholders and external manufacturing partners*<br>*Manage technology development projects for technologies that may be adjacent or transformative to the traditional businesses.*<br>*To manage multiple projects concurrently moving them through planning to delivery and execution.* |
| **Cross-functional management** | *Partners in cross functional teams to develop and manage technology strategies*<br>*Works closely with packaging, process development, and manufacturing to identify technology needs, working to then identify potential external solutions*<br>*Work cross-functionally to communicate competitive insights within the beverage/snack category and to the broader organization.*<br>*Interact cross functionally with customers, account teams, partners, architects, peers*<br>*Organize, plan, and manage cross-functional, high visibility initiatives within the Open Innovation team* |
| **Open Innovation platforms**/internal and external **crowdsourcing** (to manage, design) | *Crowdsourcing communities*<br>*Care of crowdsourcing community on the platform and support of the local community*<br>*Manage open innovation platforms*<br>*Design open innovation activities (e.g. prizes, challenges)*<br>*Open Innovation platforms – craft challenges, crowdsourcing*<br>*Organize and manage external and internal crowdsourcing initiatives to collect new ideas from employees* |
| **Open Innovation events** (to manage, design, organize, coordinate) | *Manage and coordinate Open Innovation events.*<br>*Design and conduct events with partners (e.g. workshops, students' events).*<br>*Deliver experiences and workshops with start-ups and ecosystem partners.* |
| **IP Management** (emphasized the least) | *Develop ownership strategies (IO) and implementation plans for technology platforms*<br>*Structure strategic deals (equity investment, commercial and/or M&A)* |

While analyzing the job offers with open innovation in the title, we used Nvivo10 to map the pattern of the most frequently used words (see Fig. 5. Word tree for pattern in words: network, partners, ecosystem in 23 job descriptions with open innovation in the title.). Apart from job responsibilities in building and managing the network of partners,

the word *networking* was also used as a desired qualification (e.g. the person should have a strong technology/start-up/academic network or should demonstrate experience in network management). Other common words were *partners* and *ecosystem,* this also supports our main findings that companies place the responsibilities of engaging and building ecosystems, as well as building relationships with various partners, in the hands of open innovation specialists.



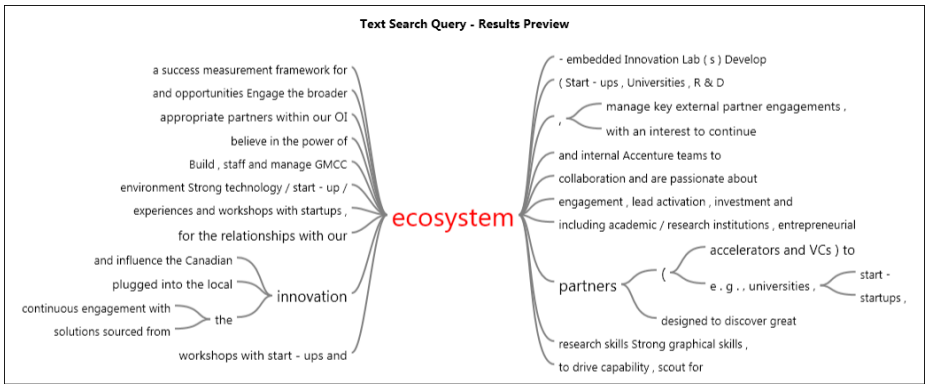



**Fig. 5.** Word tree for pattern in words: network, partners, ecosystem in 23 job descriptions with open innovation in the title.

### 4.3 The evolution of jobs related to open innovation

This section focuses on presenting findings based on the comparison of job advertisements with 'open innovation' in the title and in the job description posted in 2014 with the ones posted in 2016. As mentioned in the first section, the jobs advertisements with a clear open innovation function have boomed.

Interestingly, it can be noted that in 2016, compared to 2014, companies placed stronger attention on the *ability to influence others* as a job requirement, with a proven track record and experience in this domain. In addition, in case of positions of open innovation professionals, influencing was part of the job responsibility (See Table 3 for details).

**Table 3.** List of job titles mentioning the 'ability to influence others' in jobs posted in 2016.

| Job Title | Industry | Roles and Responsibilities | Job requirements |
|---|---|---|---|
| Open Innovation Consultant; Open Innovation Business Strategy Analyst | Consulting | *he/she will lead and deliver results through influence and building alliances.* | *Ability to deliver results through alliances and influence* |
| Open Innovation Manager | Electronics | *Influence senior business leaders based upon business strategies to identify and acquire external technology to deliver on current and future business deliverables* | |
| Senior Software Engineer, Open Innovation Lab | Engineering, Software | | *Ability and track record of influencing and collaborating with others* |
| Head of Open Innovation | Automotive | *develop and influence the innovation ecosystem to drive capability, scout for emerging technology, foster external partnerships and* | *Highly capable networker that holds established credibility with external stakeholders as a thought leader and influencer* |

| Job Title | Industry | Roles and Responsibilities | Job requirements |
|---|---|---|---|
| | | *incubate strategic collaborations* | |
| Project Leader | Pharmaceutical | *Apply your technical, commercial and influencing skills to strengthen the adoption of Bio-based materials across our global organization* | *Outstanding communications and influencing skills including fluent written and spoken English* |
| Connected Home Architect | Power and Gas | | *Someone who can lead multi-functional teams and stakeholders typically through influence in a complex matrix organization*<br>*Strong people leader with exceptional stakeholder management skills and the ability to operate and influence at all levels.* |
| Market Analyst Leader/Senior Manager | Home Appliance | | *Excellent organizational, communication, and influencing skills* |
| Director – Treatment and Analytics | Manufacturing | | *Strong influence management capability needed* |
| Engineering Supervisor | Aerospace | | *Must be able to influence peers on the relationship between scope, schedule, and resources.* |
| I&R Refrigeration Innovation Intern | Building Technologies | | *Ability to work effectively and influence others in a diverse and dynamic work environment* |
| Senior Manager Emerging Technologies | Chemicals | | *Understanding and influencing OEM strategies concerning applications and material solutions* |
| Technology Scout | Information Services | | *Effectively communicating and presenting technical complex data (both verbally and written) to influence all levels and global audiences*<br>*High degree of emotional intelligence and excellent facilitation and influencing skills.*<br>*Effective leadership, communication and influencing skills are necessary for success in this role* |

| Job Title | Industry | Roles and Responsibilities | Job requirements |
|---|---|---|---|
| | | | *Ability to influence decision-making is critical to bringing complex issues to successful conclusion.* |
| Associate Principal Engineer Team Leader | Consumer Goods | | *Strong organizational positioning skills with a demonstrated ability to influence through organizational awareness and effective, clear communication* |
| Digital Innovation Management | Consumer Goods | | *Ability to influence peers and management (IT, non-IT, internal and external) to drive project and process outcomes* |

Research indicates that there was another new requirement in 2016 – the candidate's *prior start-up experience*, which was not emphasized in 2014 (see Table 4). Also, surprisingly *knowledge of IP management* was not indicated as often as a job requirement compared to 2014, where it was highlighted more than twice as often as in 2016.

On the other hand, the *entrepreneurial skills/mindset* were mentioned more often in 2014 compared to 2016 and were related to positions of technology scout (chemicals), leader open innovation (consumer goods), consumer market & intelligence (healthcare, cosmetics), and program manager (power and gas).

**Table 4.** List of job titles in 2016 emphasizing start-up experience and entrepreneurial skills.

| Job Title | Industry | Roles and Responsibilities | Job requirements |
|---|---|---|---|
| Head of Open Innovation | Automotive | | Startup experience |
| Open Innovation Senior Manager | ITC Manufacturing, Computer Hardware, Electronics | Identify strategic innovation targets (startups and/or early stage technologies) Evaluation and competitive analysis of startup technologies | |
| Open Innovation Consultant; Open Innovation Business Strategy Analyst | Consulting | Relationships with our ecosystem partners (e.g., universities, startups, other R&D labs) designed to discover new business opportunities | Prior experience in startups 2+ years of technical start-up or entrepreneurial experience with enterprise technologies |
| New Business Opportunity Manager | Healthcare | Responsible for establishing mutually beneficial relationships with startups and entrepreneurs. | knowledge: accelerators, start-ups, incubators is a differentiation |

| Job Title | Industry | Roles and Responsibilities | Job requirements |
|---|---|---|---|
| PhD student | ICT Software | Support intra- and entrepreneurship challenges (hackathons) with employees, students and startups. | |
| Intern Digital Ventures | Consulting | | Have working experience in e.g. consulting, startups or tech-/ engineering-driven environments |
| Director Innovation Incubator | Financial services | | Start-up experience |
| Senior Director Transactions | Pharmaceutical | | Knowledge: IP management; start-ups; strategic management |
| Digital Innovation Management | Consumer Goods | | Ability to influence peers and management (IT, non-IT, internal and external) to drive project and process outcome |

## 5 Discussion

In this rapidly changing and networked business environment, our findings indicate that firms are increasingly creating specific open innovation functions and designing completely new roles. This responds to previous calls for empirical inquiries addressing the "human side" of open innovation research (e.g. Mortara and Minshall, 2014; Podmetina et al., 2013; Vanhaverbeke at al., 2014; West at al., 2006).

Due to our curiosity about who the specialists are behind open innovation adoption, we have explored the roles and responsibilities of open innovation specialists and addressed the skills and competencies related to these roles. It is clear that research in this area is scarce. Thus, we analyzed 100 job advertisements related to open innovation profiles. We identified the most desired set of skills for open innovation professionals (i.e. excellent communication skills, leadership and project management skills, problem-solving, strategic thinking and ability to work in cross-functional teams, interpersonal skills, ability to work independently and as part of the team, and ability to influence others). Concerning knowledge, most of the job offers mentioned cross-disciplinary knowledge. Interestingly, the entrepreneurial skills/mindset were not considered as important, which contrasts with the findings of other researchers (e.g. Cloyd and Euchner, 2012; Dodgson et al., 2006; Di Minin et al., 2010, Mortara et al., 2009). However, the data indicate that companies pay attention to a proven track record and emphasize prior experience with start-ups as a main job requirement. This may suggest that large companies try to increase the collaboration with start-ups, and seek experienced candidates who are not influenced by corporate mentality.

When comparing the two periods when we collected our data, significant changes were

observed. First of all, the number of job profiles indicating 'open innovation' in the title of the job increased. The analysis revealed that in 2016, compared to 2014, companies shifted toward creating, sustaining and influencing the ecosystem. Not surprisingly, *the ability to influence others* was becoming more emphasized as part of the job requirements. The job requirements were focused more on *prior experience* and *proven track record* (especially for managerial positions), rather than on candidates' skills and knowledge. To build and manage relationships with ecosystem partners (e.g. universities, start-ups, other R&D labs); scouting for emerging technologies looking for business opportunities both inside the firm and outside – these are just a few examples of roles and responsibilities assigned to open innovation candidates. Furthermore, cross-functional cooperation was considered an important part of the OI specialist's daily routine. Cross-functional cooperation is considered as internal openness in some studies (e.g. Love et al., 2011), stressing that it also aims at increasing the innovation output of the firm (Powell et al., 1996; Tsai, 2001; van den Bosch et al., 1999). Interestingly, some companies extended the responsibilities to tasks related to human resource management (e.g. talent management, recruitment, selection and training), indicating the true multidisciplinarity that is expected from the right candidates.

In addition, our findings indicate that even though open innovation was originally coined as a paradigm shift within large manufacturing firms, it has rapidly extended to new industries, supporting the findings of other academics (Chesbrough and Bogers, 2014). Furthermore, our findings suggest that the open innovation function has spread beyond traditional R&D and innovation departments toward strategic management, marketing and sales, corporate communications, and even IT and purchasing departments.

The relatively small number of public job advertisements related explicitly to 'Open Innovation' specialists, when compared to the LinkedIn profiles of over 52,000 positions, can be explained by the conclusions of Vanhaverbeke et al. (2017) who found that open innovation managers usually have long tenures in the company. This indicates internal promotions without the need to go public and search for new specialists. This fact also addresses the question whether companies prefer to train employees on open innovation rather than hire external open innovation professionals (Podmetina et al., 2013).

## 6 Conclusions and avenues for further research

This paper provides a significant contribution to the open innovation field of research by triggering the discussion on essential skills of employees in firms implementing (or planning to implement) open innovation. It presents an interdisciplinary approach by integrating open innovation and human resource management research streams, and by analyzing job profiles of open innovation professionals. It calls for new research on HRM and open innovation by developing sets of skills and competencies needed for the successful adoption of open innovation, providing training and education recommendations for industry, consulting and higher education, and bringing the role of the individual to the front of open innovation research. In addition, the results contribute to the current stream of innovation literature by identifying the key areas of

roles and responsibilities of open innovation professionals. To the best of our knowledge, prior to this study there was no attempt to analyze job advertisements related to open innovation that aimed to identify the skills, roles and responsibilities of open innovation specialists in companies.

The results of this study can be used by companies for creating job descriptions and/or planning to recruit new staff. Moreover, they can be used by universities or other educational institutions while developing the curricula. For example, considering the fact that the majority of the job advertisements stressed that candidates should possess cross-disciplinary knowledge (be it the combination of technology and business, R&D with marketing and management, or R&D and sales management), it can be argued that open innovation should be taught not only on innovation management majors/programs/courses, but should also be available for students from other departments such as engineering, chemistry, biology, pharmaceutical etc. At the same time, basic knowledge of marketing, management and sales should be emphasized, with focus on developing and improving communication, leadership and problem-solving skills. We anticipate that the results will create a discussion on required and desired skills of employees in companies adopting or planning to adopt open innovation, as well as job responsibilities of open innovation professionals.

This study also has some limitations. First, it is based on the analysis of job advertisements that were posted in specific periods in 2014 and 2016, and only reflects jobs advertised in English. This means that it does not include companies with open innovation professionals that were not seeking to recruit new staff at the time. Second, due to the sample size and adopted research methodology, the results cannot be statistically generalized. Third, as indicated by Carliner and colleagues (2015) we acknowledge that job descriptions and advertisements may not match the actual job responsibilities, as they may reflect over-idealized expectations of the position, or in line with findings by Mathews and Redman (2001) they may be poorly designed by unexperienced recruiting organizations.

In order to improve the validity and generalizability of the results, future research could analyze the importance of personal traits and individual skill endowment (c.f. Bianchi and colleagues, 2011). In addition, interviews with companies with open innovation divisions could shed light on the actual roles and responsibilities of open innovation professionals. As the findings reveal the growing importance of open innovation professionals in building and influencing the ecosystems, as well as emphasize candidates' prior experience in working with start-ups, we call for further research in this domain. Furthermore, this study opens new horizons for teaching open innovation, both within university curricula and for practical business training. It sheds light on the importance of practical skills and experience and the necessity of on-the-job training, and puts pressure on transforming teaching methods to more interactive and practice-oriented ones.

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