A Case Study of Black Swans and Antifragility

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Abstract. We attempt to apply the model of Adaptive Cycle of Change (ACoR) to a case of a virtual team with the aim to first, provide a better understanding; and second, explore the connections between the Black Swan/ Antifragility theories of Nicolas Taleb and the ACoR. Therefore, the Black Swan theory is extended with new instances, providing a stepping of swans ranging from black, over grey to white swans. The applicability of Virtual Teams in the ACoR model is elaborated based on an own illustration, including all elements of virtual teams. The findings in this study therefore provide connections of the ACoR, Taleb's theories and virtual teams.

Keywords. Adaptive Cycle of Resilience (ACoR), Virtual Organizations, Black Swan Theory, Antifragility, Virtual Organization (VO), Virtual Team (VT).

Introduction

This paper attempts to describe the case of a virtual organization/ virtual team (VO/VT), through its life cycle, in detailed correspondence with the quadrants and phases of the adaptive cycle of resilience (ACoR). Furthermore, we are aiming at including in this illustration the concepts of Taleb's ideology that support, or at times, challenge the principles of ACoR. The purpose of using linked or opposing viewpoints from various perspectives in this study is to test ACoR and attain a broader – deeper analysis. Therefore, the main questions that we seek answers to are:

- How are the phases of a VO/VT recognized in the four quadrants of the ACoR?
- What is the connection between Taleb's theory of Black Swans and Antifragility, and the theory of ACoR in the case analysed?

Since the role of ICT in the theory of ACoR is particularly important, it becomes equally vital to answer the following subquestion in addition:

- How does Taleb's theory reflect the ICT role in the elaborated aspects?

In order to substantiate the answers to the above issues, we gathered data from different sources of literature, with a view to confirm the objective facts used in our justification. These relate to the virtual team's history, external environment, objectives

and structure. Most of the arguments provided, intend for explaining those in a detached way. In case we can identify the basic principles of each quadrant (certainty and uncertainty about what you want or can), we will accept the linking between the life cycle and ACoR. Also, if the main concepts of the theories are in harmony, we will consider them compatible. The paper consists of four parts; the first describes the theories that will be used to demonstrate the life cycle of the case as illustrated in the ACoR, the second part involves the exemplification of the theories' mixing with the completion of a sequential circle (reports on the main questions), the third investigates the subquestion, and the fourth states the limitations and highlights lessons learned from the case study.

1. The Theories

This section describes Taleb's theories of Black Swans [1] and Antifragility [2], in addition to the theory of the Adaptive Cycle of Resilience [3]. As a result, we will subsequently be able to explain the similarities, differences and connections between the three systems of ideas. The purpose is to identify these factors through the portrayal of a virtual organization's life cycle as an ACoR that includes Black Swans and potentially antifragile, robust, or fragile attributes.

1.1. Black Swan

In the Black Swan theory, Taleb elaborates on the massive impact of highly improbable and unpredictable events; such events that no one can predict in advance. This inability of humans to estimate or expect rare - random events represents one of the fundamental ideas of this theory, described as the "randomness that produces the texture of life". So, a 'Black Swan' is a highly unlikely event, which changes our view when it arises, as we were not mindful of it until it presented itself; we could only see the 'White Swans' before the 'Black Swan' occurred. A Black Swan has three main characteristics: (1) it is not predictable, (2) it has an extreme impact and (3) humans usually assign those events limited meaning afterwards, which makes them appear less random than they are in reality. This unsound notion of simplifying and reducing the complexity of reality, by story telling and over-interpretation of events, is called the narrative fallacy. Therefore, our inability to foresee and realize Black Swans leads to deficiency of estimating future events. Taleb considers Black Swans to take place in almost every situation of life.

The world is less predictable and more complex than humans think it is. The oversimplification of options and facts in addition to the ignorance towards the rarity of events, results in a lot of information being ignored, which in turn gives rise to Black Swans. In other words, people should not rely too much on what they know or think they know, but rather realize that there is more unknown in the world. If they do, then Black Swans are more probable to occur. This draws attention to the tendency to draft faulty conclusions based on the past. So, the role of information can have a reverse impact on our ability to forecast: the more we read, the less we might be able to forecast. "Additional knowledge…can be useless, even actually toxic" is the bottom line here, which shows the relationship between knowledge and Black Swans.

To summarize the mistakes we make according to Taleb: we remain blind to Black Swans, we tend to underestimate extremes, we tend to miscalculate and make

false prognoses about the future, we stick to what we know and become thus more resistant to new, different or contrary options. As a result, plans fail, especially because of the neglect of uncertainty's sources outside a plan itself. Unexpected and unforeseen external influences are likely to appear and delay schedules, typically of complex projects *(Balance between remember and rigidity trap = use the past differently)*.

Consequently, we shall learn to interpret past events with a different thinking pattern, in order not to be plagued with the narrative fallacy, which leads to miscalculation of the future. Taleb also gives practical advices for coping with randomness; differentiate between positive and negative eventualities, open your mind to attempting preparedness further than trying to predict Black Swans, seize any opportunity and beware of precise plans by governments.

Finally, the theory involves the idea of one single event that is able to change the whole aggregate (Extremistan randomness), prevailing over an event that contributes to the whole collectively and does not alter it noticeably (Mediocristan randomness). The world is moving unremittingly from Mediocristan to Extremistan and thus increasing the occurrence of more uncertainty. This development is underpinned by the ongoing globalization. Nevertheless, the antidote for Black Swans could be: avoid being unprepared for them (but still you cannot foresee them). This is the basic concept behind turning Black Swans into Grey Swans; reduce the surprise effect of Black Swans. So, prepare yourself doesn't mean try to predict the future, it rather means accept and be alert to the fact that *future is unpredictable; just don't let it control you*.

1.2. The Extension of Taleb's Black Swan

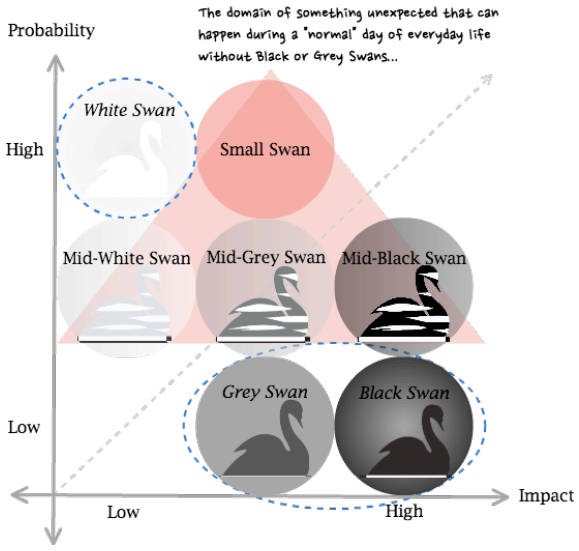

Figure 1: Extension to Taleb's Black Swan: Stepping of Swans

Based on the characteristics of the Black, Grey and White Swans, we were "inspired" to extend these concepts in order to utterly cover the current world of Extremistan but also Mediocristan randomness. The visualization of this extension is shown in figure 1. The ideas of Taleb are outlined with blue. Our addition is introduced by the triangle of the new concepts of a Small Swan and a series of three Mid-Swans. The Small Swan is an event with high probability to arise but medium impact. The Mid-Swans have a

medium probability to arise: the Mid-White one as a White Swan has a low impact, the Mid-Grey results in a mediated impact and the Mid-Black Swan causes a high impact, but has an increased possibility of emerging compared to a Black Swan. We define this triangle as the domain of unexpected events in a Mediocristan day of everyday "normal" life. One example of a Mid-White Swan and how you can prepare for this could be the following; if the normal estimation time for a specific route is for instance 30 minutes, then you should not think about the possibilities of facing something unexpected like traffic or a bike accident. Instead, you should prepare yourself by evaluating the possible consequences. It is indeed wiser to concentrate on how to cope with the influences of such events instead of calculating the chances of them to arise. This is similar to the logic of having an insurance. So in our example, you should always calculate a higher than the "normal" time of the 30 minutes for following the specific route. The small swans and mid-swans are random as well and one has to be aware that they can happen anytime.

1.3. Antifragility

This theory revolves around the central idea that certain "things" are able to benefit from great impacts and gain from disorder. They thrive and grow when exposed to volatility, randomness, disorder and uncertainty. This introduces the concept of Antifragility; Antifragility is beyond resilience or robustness. The resilient resists shocks and stays the same, whereas the antifragile gets better with every shock. The theory also analyses how individuals deal with black swan situations and what they can learn from these situations, so that next time they don't get too astonished by the disorder; maybe they can even reach the point of exploiting the shake and revolt (reach Antifragility).

Unfortunately, Antifragility is not part of the accepted way of thinking about success, economic growth or innovation, and this is why we don't see it in places that are obvious. We are still trying to follow an outdated model; we prepare ourselves on the line of last chaotic events. Although this approach may prepare us a little better to face the situation, still there is no guarantee that we will be able to avoid the next chaotic event, since it may not be of the same scale as the previous ones and be indeed entirely random.

Fragility can in fact originate from the denial of volatility; we could harm the natural Antifragility of organisms and hurt systems by playing "the conductor". Some antifragile systems crave for volatility and we make social, political and other systems vulnerable to Black Swans when we over-stabilize them. So, human over-intervention to smooth or control processes causes a switch from one kind of system, the *Mediocristan*, to another, the *Extremistan.* According to Taleb, "Human-created stability is a ticking time bomb waiting to go off any moment".

Therefore, preventing randomness in an antifragile system is not always a good idea, as contrasted with adding randomness, which is possibly the needed fuel for an antifragile system. By giving an example of *Mithridatization*, which is the process of consuming small doses of lethal poison in order to build resilience against that poison, Taleb argues that disorder of any kind in small dosages is beneficial for organizations, economies and individuals, as it builds resilience in them. We should first make things more resilient to defects and minimize the harm (or maximize the gain) by means of forecasting errors, or even exploit these errors; making lemonade out of the lemons as

opposed to trying to predict and understand the dynamics of events. *(= Balance between revolt and poverty trap & Antifragility ≠ rigidity)*

Taleb further explains the tradeoff between the Antifragility of the collective and the fragility of the individual with the example of the restaurant industry. Individual restaurants are fragile; they compete with each other and may go bust at any moment, but the collective of local restaurants is antifragile for that very reason. Had restaurants been individually robust, hence immortal, the overall business would be either stagnant or weak. The fragility of every startup is necessary for the economy to be antifragile, and that's what makes entrepreneurship work, among other things. This can be easily applied to VOs, which are collective and hence antifragile, compared to individual organizations which are much more fragile and vulnerable to black swans.

Antifragility is the combination of aggressiveness plus paranoia i.e. clip your downside, protect yourself from extreme harm, and let the upside, the positive Black Swans, take care of itself. However, the ability to use the option given to us by Antifragility is not guaranteed and there can be a long gap between invention of things and practical implementation. For him the loop works as: Random Tinkering (antifragile) → Heuristics (technology) → Practice and Apprenticeship → Random Tinkering (antifragile) → Heuristics (technology) → Practice and Apprenticeship.

Taleb emphasizes that governments should spend on non-teleological tinkering, not on research. In the antifragile case (positive Black Swan businesses) such as trial and error, the sample track record will tend to underestimate the long-term average; it will hide the qualities, not the defects. Finally, he proposes some rules on how to practice antifragility, such as building redundancy by avoiding optimization, and avoiding specialization by supporting more varieties. Both optimization and specialization can make you vulnerable in the sense that they both constitute human over-intervention.

1.4. Adaptive Cycle of Resilience (ACoR)

The adaptive cycle of resilience reflects a cyclic development path that can be recognized in every change process and consists of four quadrants:

1. Equilibrium
2. Crisis
3. New Combinations and
4. Entrepreneurship

Within those quadrants, four phases (transitions between the quadrants) are described: release (1^{st} to 2^{nd}), reorganization (2^{nd} to 3^{rd}), exploitation (3^{rd} to 4^{th}) and conservation (4^{th} to 1^{st}). In this section of the paper, each phase of the cycle is described. It is followed by the stage of a life change process that is examined through the lens of the adaptive cycle theory and coincides with each of the phases.

The starting point of describing the adaptive cycle of change can be quadrant 1, which represents the equilibrium state. It is a matter of at which stage the unit of analysis currently stands, which at times is not easily recognizable. At equilibrium, the goals, and the plans of how to fulfil those are clear. Confidence about the future is evident and emanates from a general contentment about the current achievements and the available resources. Therefore, only small changes are necessary at times, always within the existing broader strategy, in order to improve market power and

profitability. However, the equilibrium situation can be disturbed by external- strongly influential and possibly unforeseen- factors that lead to the crisis state (quadrant 2) and to uncertainty about future development, desires and capabilities. A so-called 'Gestalt' switch to uncertainty occurs and this reveals insufficiencies of existing competences, in addition to the need to add diversity to the dominant activities [4]. In other words, it is required to search for alternatives; likewise, drastic changes of behaviour have to take place in order to resolve the crisis. The aforementioned transition is, according to Holling (2001), called release phase [5].

The transition from the second to third quadrant (else called reorganization phase) is marked by a perspectival shift from fear for the future towards confidence about the future and more specifically, from the search for new alternatives towards the development of a variety of new possibilities. In order to achieve this change inspiration has to be found, for the available possibilities to be revealed. The goal is to be driven at a set of realistic choices, in the sense that there are sufficient resources to carry them out. After an extensive analysis and evaluation of the options, a juncture is reached where the decision about the next step has to be implemented. In other words, since the fulfilment of all the opportunities has zero probabilities, a decision has to be made to respond, hereafter actively, to the internal and external threats [3].

The exploitation phase represents a decision among the different new combinations. The decision making process means that only one of the available alternatives will be chosen and further developed, and the remaining will be discarded. The selection can be based on reduction ad absurdum, thus on excluding the further development of the options until one is left. The moment of the final choice, for the opportunity to be realized, indicates the transition from the third to fourth quadrant. This final choice refers in fact to a management decision, which derives from rational reasoning or "irrational" intuition and 'Gut' feeling, and will often lead to an uncertain result regarding the success of it implementation. Hence, whether this choosing is the best one or not, only time will tell [3].

The phase of conservation refers to the hard and constant work that is required in order to accomplish the switch to full certainty again, or else to a new equilibrium. So, it is an incremental movement towards a new stable situation, during which it is important to build upon knowledge, power, and resources. In order to do so, efficiency and effectiveness, re-establishment of routines and optimization of operations play a significant role. Once quadrant 1 is reached again, the cycle starts afresh [6].

2. The Case Study

In this section, the case of a virtual organization, more specifically, an example of a virtual team will be described to provide an explanation on how a VO/VT can be linked to the four (4) quadrants and phases of the adaptive cycle of resilience (ACoR). In addition, it will be examined how Taleb's theories can be integrated and support the case. Martins et al, (2004) define virtual teams as followed:

> *"Virtual Teams are teams whose members use technology to varying degrees in working across locational, temporal, and relational boundaries to accomplish an interdependent task."* [7]

This definition associates the same characteristics which characterize VOs, to VTs. Camarinha-Matos & Afsarmanesh decribe that "when a business opportunity happens (e.g. a consultation activity), similarly to the VO creation, a temporary coalition of experts – a Virtual Team (VT) – could be rapidly formed according to the specific needs of that business opportunity" [8]. Thus, a VT can be considered as a VO, since both share the same characteristics, differing from each other in terms of scope.

The organization used to elaborate on, is Boeing-Rocketdyne (BR), which is the major manufacturer of liquid fuelled rocket engines in U.S. [9]. The case study we are going to analyse is about an inter-organizational virtual team called SLICE (Simple, Low-cost, Innovative Concepts Engine), which had the task to create a highly innovative product over a 10-month period. We will show how the company adapted the use of a new collaborative technology and thus successfully achieved its expected objectives [10]. Therefore, we will describe how this organization formed a virtual team, for which reason it was formed, and how this case can be related to the quadrants of ACoR model.

Figure 2 illustrates the summarized exemplification of the theories' mixing with the completion of a sequential circle, which will be explained in detail in the next sections.

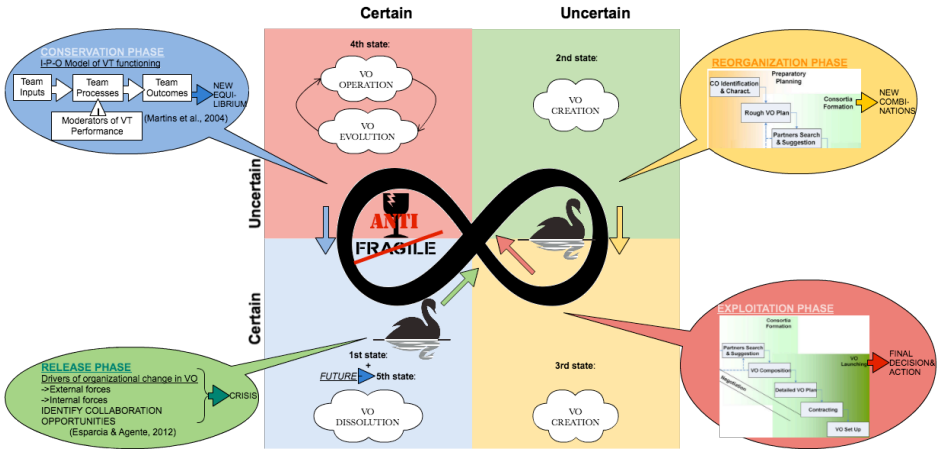

Figure 2: Virtual Teams in the Adaptive Cycle of Change.

2.1. Phase 1: Release - Transition from Quadrant 1: Equilibrium (lower left) to Quadrant 2: Crisis (upper right)

We will start the description of the linking from the first quadrant, which is the Equilibrium state. This is the only situation of full certainty and clear view of the future, but what can lead an organization away from it? One of the forces that could and should drive organizational change is the identification of a Collaboration Opportunity (CO) that triggers the creation of a VO/VT. This will disrupt the balanced way of working within the organization, cause uncertainty about the desired and the achievable goals and "release" a Crisis situation. So, the 1st quadrant is the situation of an organization before joining a VO/VT and the Release phase is the CO identification.

The organization we studied can be considered to have been initially in equilibrium, since it was the major manufacturer of liquid fuelled rocket engines in U.S. However, Taleb supports that Black Swans are increasingly dominating the environment. By reason of the technology, internet and globalization, the world has become a more complex system. According to him, complexity not only increases the incidence of Black Swans but also makes forecasting impossible [11]. This statement seems to be valid in our case, since BR suddenly faced competition from Eastern European countries and needed to lower all costs associated with its rocket division subdued by price pressures. The market was also expanding due to the extended commercial launches of communication satellites and so the competition increased exponentially. Therefore, BR was pressured by external forces for change and adaptation to the dynamic environment and had to act drastically in order to remain competitive and yet the major manufacturer in the market without losing any market shares in the long run. The organization wanted to respond fast enough to be able to face the external threat and thus decided to create a virtual team called SLICE ([9], [10]). BR identified the opportunity to develop a revolutionary new product and entered the crisis quadrant through the "release" of this opportunity. Nevertheless, our viewpoint about the forces of competition or expansion of the market is that these influential powers cannot be really characterized as Black Swans, but rather as Mid-Grey Swans. The probability of these events to surface is "medium", at times maybe it is even expected that the competition will rise. The effect depends on the organization itself, but we think it is anyhow less than the impact of a Black Swan. Therefore, we consider these forces Mid-Greys.

2.2. Phase 2: Reorganization - Transition from Quadrant 2: Crisis to Quadrant 3: New Combinations (lower right)

When the VO starts being created (2nd quadrant), uncertainty is at the utmost and this uncertainty is reduced by going through the Reorganization phase, which ends in the new doable combinations, or else, in finding the new suitable partners (3rd quadrant). This phase relates to the first stages of the VO creation: the CO characterization and rough VO planning, which is the determination of a rough structure of the potential VO. We also consider here part of the next stage of the VO's creation that involves the partners search; this step is mostly concerned about the identification of potential partners and their assessment [8]. The process of analysing your options to estimate which are the pragmatic ones provides more certainty about what you can do, but you are still uncertain about what you want to do. All these actions facilitate the switch from fear for the future towards confidence about the future and lead to the final selection of a partner, which marks the next transition.

The company of our case decided to create the virtual team SLICE in order to develop an innovative new product while adapting to a new collaborative technology. The preparatory planning phase followed, which included the establishment of a generalized structure for the potential virtual team, the identification of the required competencies and capacities, as well as the form of the team and corresponding roles. At this stage it is important to define the partnership form, which is typically regulated by contracts and cooperation agreements. The next step is also devoted to searching for potential partners, their identification and assessment [8]. Through the literature review conducted, we could not find evidence of the means that BR utilized to search for the members of the VT.

2.3. Phase 3: Exploitation - Transition from Quadrant 3: New Combinations to Quadrant 4: Entrepreneurship (upper left)

After the evaluation of the potential partners, which shows us the possible and realistic New Combinations, a final decision about the next step has to be implemented and this decision denotes the transition to VO Operation (4th quadrant) and Entrepreneurship via the Exploitation phase of ACoR. This consists of the following parts of the VO creation: negotiation, VO composition and VO launching stage. Negotiation is the general continuous process to reach agreements and align needs with offers. It always runs in parallel to the next steps that follow and can be seen therefore as complementary. VO composition involves defining a determinate structure and responsibilities to the members. The latter includes the detailed VO planning, contracting and set up of the VO/VT; once partners have been selected and collaboration agreements are reached, this step addresses the refinement of the VO plan and its governance principles, the definite formulation of the contracts, the configuration of ICT infrastructure, orchestration of collaboration and more. Then the VT can be launched effectively and commence operating [8]. Furthermore, once the VO starts operating you become more confident about what you want (you have a clear business plan), but you are still uncertain about whether this is feasible. VO operation and VO evolution can be both part of the Entrepreneurship state and form a small cycle within the cycle. This best shows the limitation of the sequential nature of ACoR, since different units within an organization can be at different phases of the cycle and even one unit, as a VT, can include various cycles through its lifecycle.

In the investigated case, after the necessary search and evaluation process, the virtual team SLICE was formed and consisted of three (3) companies: RocketCo, SigmaCo and StressCo. SLICE was a new type of organization; an inter-organizational virtual team, which also came with some problems, since the members had different engineering and cultural backgrounds, were geographically distributed and did not know each other. Furthermore, they could not travel a lot due to their participation in other teams within their companies and could devote about 15% of their time, so they would meet face-to-face only in the end of the project.

All three companies involved in the SLICE project had to negotiate policies and terms before launching the team for operation. Mainly in the composition step, the responsibilities and skills of each member and how resources would be shared amongst the team was discussed. One of the terms under the SLICE agreement was the free flow of information between the members of the team. Furthermore, the existence of some governance principles was important since the task of the team was to develop a highly complex rocket design that could be marketed by the three companies; the project was more than ambitious with the goals of reducing the cost of a rocket engine to 1/10, getting the engines to market 10-times faster and increasing the useful life of the rocket by 300%. So, RocketCo executive management was appointed in charge of overseeing the technical quality of the work and recognized the revolutionary nature of the design task upon the initial specifications for the new rocket design. Since the product components were tightly coupled, the team members from all three companies needed to work in highly interdependent iterative virtual brainstorming sessions with lots of data. Finally, during the set up of the VT and for the configuration of ICT, an “Internet Notebook” and “Project Vault” were developed, with a view to manage the huge amount of data collected during the project. While the team members had experience with usual communication technology method such as e-mail, file transfer, and video

conferencing, the Internet Notebook was seen as the most suitable tool for a complex engineering design collaboration, because it supported multiple media types across multiple platforms for entering engineering content (i.e., graphical entries). Yet, every member had to be specific with details for every entry due to lack of information, vast amount of data and different terminology because of different engineering backgrounds ([9], [10]).

It should be noted at this point that Taleb supports the idea of the operation of a virtual team with his concept of Antifragility and his focus on ways to always look for new combinations in order to be able to adapt to any change and be less affected from Black Swans that might occur. More specifically, to discuss the role of Antifragility during a VT's operation, teams must be built in such a way that they not only aim at achieving success in terms of reaching predefined goals, but also learning through the process of failing. Hence, give the entire community (perhaps a VBE) an insight about the possible causes of failure. This builds Antifragility in the greater team at the expense of individual failures.

2.4. Phase 4: Conservation - Transition from Quadrant 4: Entrepreneurship to Quadrant 1: Equilibrium (lower left)

The entrepreneurship quadrant translates into confidence about the desired objectives but still uncertainty regarding their ability to lead to success, which is explored via operation or evolution. Hackman & Morris (1975) developed the inputs-processes-outcomes (I-P-O) model, as cited by Martins et al. (2004), which we are going to use for the description of this state. The model is a dominant framework used in the study of teams that provides a sound basis for organizing and integrating the literature on VTs (shown in Figure 3). Inputs (design and compositional) are the characteristics of a team such as member personalities, knowledge, skills, and technology or experience that influence how teams operate and perform. Processes represent dynamic interactions among group members as they work on a group's task. Outcomes represent task and non-task consequences of a group's functioning.

In our case,

- Team inputs consist of the different engineering backgrounds with different skills and technology that have affected the performance of the VT i.e. when entering data with lots of details in the use of ICT.
- Team processes include "how" teams achieve their outcomes.
    - Planning processes include reducing manufacturing costs, decreasing engineering hours, winning market share, increasing product quality.
    - Action processes entail the communication, coordination, and monitoring of the group's progress. In our example these processes involved the use of Internet Notebook.
    - Interpersonal processes refer to the relationships among group members; these could range from conflict to trust and social integration.
- Moderators of Virtual Team Performance take note of a wide range of contingency factors such as the time spent working in the group, and the team's social context or how often they can meet face-to-face. These circumstances may explain some of the often inconsistent results of VT performance. In the case of the VT that we studied, although the members of

the team spent only 15% of their time and met in person only once in the end of the project, it was successfully brought to its end.

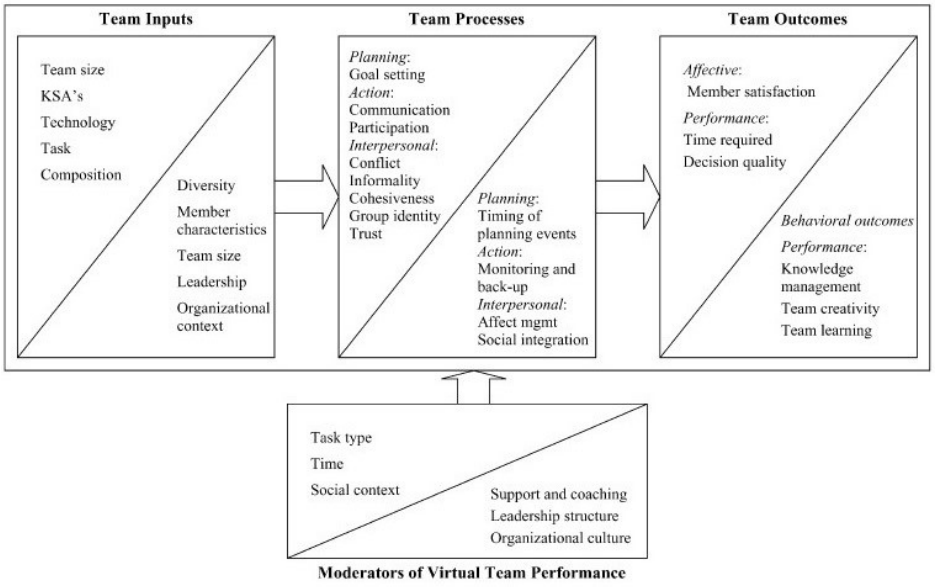

Figure 3: I-P-O Model of virtual team functioning (Martins et al. 2004, pp. 810)

The last transition to a new equilibrium through the Conservation phase leads to the 5th quadrant that can be considered to be the VO/VT's Dissolution. The reason for this is that when the VO/VT completes its project and decides to dissolve, then the whole uncertainty originated from the VO creation will be removed and the company can return to a stable position of full certainty, until the next CO identification or Release phase.

Finally, as the SLICE team members were not physically collocated, they had to communicate at distance, which could have impacted on information accuracy and timelines. That caused some misalignment, which had to be resolved. Also, since the members came from different companies, they needed to overcome differences in their technical terminology. So, the team started operating and evolving, thus forming a cycle within the greater cycle, while being in the entrepreneurship stage, until eventually achieving its targets and reducing the created misalignment. Hence, in the end they were able to cut manufacturing cost and increase product quality within the deadline they had set in the beginning. The project was a success and justified the usefulness and value of a multi-organizational team. The total number of engineering hours also decreased by 50%. The team agreed to several guidelines that derived from experiencing different issues throughout the project. In the end via operation and evolution, by adopting the use of a collaborative technology and successfully achieving its challenges, the team was able to dissolve and transit to the equilibrium quadrant again. Nevertheless, that does not mean that a Black Swan and a crisis situation cannot occur again. They might experience something similar in the future. Uncertainty is the

only certainty and keeping that into account, might help organizations deal with the "stormy present" better.

3. The Role of ICT in Taleb's theories

3.1. Black Swans and the role of ICT

A study from 1986 to 2007 shows the rising significance of ICT and thus illustrate the related vulnerability to black swans: computer capacities increase annually by 58%, telecommunications capacity by 28%, and stored information by 23% per annum [12]. According to Taleb, emerging disruptive technologies can, and often do represent positive black swans. Achievements as for instance the development of personal computers or the rise of the world wide web can be labelled as complex black swans within the ICT domain with a significant impact on the whole society. Those technologies were "unplanned, unpredicted, and unappreciated upon their discovery, and remained unappreciated well after their initial use" [1].

Linking the role of ICT to the ACoR, Black Swan ICT innovations can direct companies into the second, the crisis quadrant. One reason for this development: the management appeared to be not adequately aware of the impact of newly developing technologies. Kodak for example missed to align their core business to digital photography - instead, the management did underestimate the technology and subsequently went into bankruptcy. Tablet computers and smartphones can be considered as a current disruptive technology, a technology which is likely to rule out traditional desktop computers in near future. When Apple introduced the first iPad in 2010, most experts underestimated the impact tablet computers might have. Related to this, Taleb describes another phenomena, which can also be applied to the emergence of tablet computers: the "unforeseen applications of the technology" [1].

New technologies often lie outside forecasts, thus companies have to identify market changes early enough in order to be able to align in time. In the transition to the third, the new combinations quadrant in the ACoR, companies identify and decide on technologies. The decision can be problematic since ICT innovations can turn out to have less impact and market scope than initially thought. Therefore, the decision on the alternative to implement has a fundamental influence on the success.

Extending the ICT link in the black swan theory, many crisis situations caused by ICT innovations should rather be labelled as middle-grey swans, as described in our extension to Taleb's black swan theory. Disruptive ICT innovations did not occur 'over-night'. Rather, the establishment in the market took months, more often even several years. Consequently, environmental changes are predictable to a certain degree. The management of many ICT producing companies was not aware of the impact of disruptive technologies in their environment, and consequently kept on improving the already proved business strategies, instead of aligning to changes. Taleb describes this phenomena as the 'tunnel' view experts often develop, which means they rely on their past experiences and simultaneously, their awareness for solutions outside their scope decreases.

Summarizing, Taleb's theories express that companies cannot be adequately prepared for crisis situations since ICT black swans can never be predicted. On the contrary, companies can prepare for possible impacts of black swans, for example by becoming more flexible in order to be able to adapt to new technologies. Thus, once

again referring to the discussion on middle-grey swans, by preparing for the impact, black swans can be turned into grey, middle-grey or even middle-white swans.

3.2. Antifragility and the role of ICT

Taleb describes technological achievements as a fallacy expressing that technological innovations give us the impression that we are moving forward, but in reality it turns out to be an illusion. Most of the time, people and organizations ignore the fact that our greatest asset is the built-in Antifragility of certain risk taking systems [2]. If the focus is set on innovation instead of worrying about the future of a product, then the market can take care of itself, owed to its built in risk appetite. Either innovation succeeds and we make profit; or it fails, then we gain insights for future developments. Thus, the whole system becomes more Antifragile.

Taleb expresses that new ICT innovations are found through tinkering of ideas - not just following a theory and its implementation. However, companies are reserved towards taking risks because they are more concerned about retaining their current market position and increasing revenue. This can be seen as connected to the 'remembrance' phase of ACoR cycle, where companies rely too much on past experience - a situation giving rise to rigidity and stagnation. Taleb's advice: never ask people what they want, or worse, what they think they will desire tomorrow. People do not know what they want. Steve Jobs for example distrusted market research and focus groups (those based on asking people what they want), but still Apple introduced successful, innovative technologies. This is owed to Steve Jobs, having followed his own imagination and relying on the theory that people don't know what they want until you provide them with it.

In terms of the ACoR cycle, the tinkering of ideas should happen during the "Exploitation" phase, when organizations move from new combinations to entrepreneurship, the phase where the actual operation and evolution of VOs take place. During this phase, the teams can experiment with different ideas and gain the insight of "what works and what doesn't work". This will make the teams more antifragile towards market volatility. Adhering to a single plan and working towards achieving that goal may help the team launch a product sooner into the market, but if the product fails it might be a black swan for the organization.

4. Discussion

The paper interpreted the cycle as a sequential process. This sequential character constitutes a limitation of the current case study, since the life cycle of a VO/VT is a complex entity; it can include a variety of cycles generated from different incorporated change processes and interdependencies between the various changes and events. Therefore, it becomes almost impossible to take into account the whole network of connections, and correlated effects, that is created. Nevertheless, we concentrated on a single process as one isolated cycle and tried to explain its size and speed. So, it became obvious that crises determine the autonomy and survival not only of corporations but also of teams formed across their units.

We think that Taleb would not support such a sequential process, because he implies the need for preparing yourself with the concept of Antifragility while being at the first main development of the ACoR. By interpreting his views, the transitions

between the different phases happen so rapidly that it is too simplified to demonstrate these indefinite interchanges in a single model; this would constitute a narrative fallacy. Furthermore, it is really difficult to identify with accuracy the various phases of an organization, to identify for instance when an organization is at the reorganization phase; even the business itself is not aware on occasion. This is partly because different parts of an organization can be at different stages. Therefore, the provided linking to the ACoR of this paper does not serve as exclusive or exhaustive.

However, we believe that the purpose of both theories (Taleb's and ACoR) are in their essence creating awareness, which can facilitate the process of better dealing with uncertainty; that is reflected by the quote: "Uncertainty is the only certainty there is, and knowing how to live with insecurity is the only security" (John Allen Paulos). We think it would be interesting to further research this observation. For example, if a company confronted with a crisis becomes aware of these theories, will it be able to withstand the crisis?

Furthermore, by analysing our case we realized that there are information-acquiring implications in every phase. During the release phase, information about the CO itself can assist in identifying the importance and potential impacts of the VO/VT creation. You can never predict a Black Swan, but you can prepare yourself by evaluating the possible consequences of extreme events [11]. Through the reorganization and exploitation phase, obtaining as much information as possible is equally important. In the first instance, data gathering is essential to providing the necessary inspiration and, therefore, revealing all the new possibilities, new combinations and potential partners. In the second instance, collecting input to the fullest about the different combinations that were reached at the previous stage facilitates their evaluation and exploitation. Eventually, it eases the final decision that has to be made; the final selection of partners. Finally, during the conservation period information is linked with a decrease in uncertainty [6]. Moving towards success denotes moving away from uncertainty. Needless to say, technology can play an active role in every information-acquiring process.

Among other observations, we discuss the importance of obtaining as much information as possible. However, we should be more cautious with this statement. Taleb suggests that too much information can lead to the "tunnel view", which means we tend to turn a blind eye to useful information that is still completely unknown to us. At this point, we would say that it is more important to try to keep a balance between the revolt and remember forces rather than try to acquire as much data as possible. Since the cycle is ceaseless, it is not only about tackling the crisis, but also preparing yourself for the future. We think you can prepare yourself by learning to manage these two forces.

In reality it is of course more complicated, since you always have to keep two more balances. According to Holling, there should be stability between the right amount of "remember" or "revolt" that lead to new equilibriums and exploring new situations, respectively, and too much of "remember" or "revolt" that lead to the rigidity and poverty trap, respectively. This is also supported by Taleb, who implies that we can never prepare for Black Swans based on past Black Swans since the next one will be again a random, low probability and high impact event. Nonetheless, they have the ability to provide us with progressive insight, which is part of the remembrance stage at the left side of the ACoR. For the revolt implication, Taleb says that companies should be attentive to constant revolt, because by provoking crises and taking advantage of opportunities they can become antifragile. This eventually creates

growth and development and can be associated with the second main development of the ACoR. However, he also states that multiple shocks, which can be parallelized with release phases, can potentially generate Antifragility. So, becoming antifragile by going through the ACoR repeatedly and finally learning to adapt to change may ultimately be the solution to the rapidly changing environment. We believe that becoming aware of the theories of Taleb and ACoR can utterly assist in altering each one's behaviour towards change (become less resistant). Business is its people and if individuals can change, then the aggregate behaviour of the business will adjust as well. This brings us to our next point.

After the successful collaboration of the VT we investigated, can we claim that the companies involved became more "antifragile"? Since you become more antifragile by going through the cycle over and over again, we can possibly claim that it was a step towards building resilience. By activating the initiation of a new cycle (fi by identifying a new collaboration opportunity) they can potentially be led to growth and development through the ACoR once more. It all boils down to balancing the revolt (future) and remember (past) forces again. According to Taleb, challenging the current state can build Antifragility and create room for innovation.

Finally, a limitation of this paper stems from our model of the new concepts of Black Swans. Similar to any model, it tries to simplify reality and this can again lead to a narrative fallacy. However, our purpose was to distinguish between a Black Swan that is impossible to predict, which makes the preparation for it non-viable, and other "milder" Swans that may be expected periodically, which eases the preparation process.

5. Conclusion

The findings in this study illustrate the applicability of the VO/VT lifecycle to the ACoR. The sequences of the ACoR and VOs/VTs are connected as illustrated in figure 2:

- VO creation is assigned to the crisis and new combination quadrants of ACoR
- VO operation and evolution is contained within the Entrepreneurship quadrant of ACoR
- VO dissolution is contained within the equilibrium quadrant of ACoR.
- VO operation and evolution can potentially originate and form a new whole ACoR.

The last point shows that in reality the cycles may not be as sequential as described and the VO cycles may at some point overlap with another quadrant of ACoR cycle.

Referring to the second key hypothesis of this study, the theories of Taleb's Black Swan and Antifragility can be recognized within the four quadrants of the ACoR. Taleb's theories are implemented throughout the cycle, assigned to the two main movements within the ACoR:

- Black Swans create severe uncertainty and therefore 'release' crisis situations. So, they are connected with the first main development of the cycle. However,

they provide us with insights, which can be applied during the remembrance stage (2nd development). The theories are compatible with the necessity of a balance between remembering and being rigid. Black Swan might not be predictable but the model introduced implies that forecast and preparation for Small Swans and Mid-Swans might be manageable.

- Antifragility is -in the fullness of time- achieved by multifarious shocks and this translates into following the cyclic development path of ACoR perpetually. In the end, being antifragile means being able to grow despite the crises that might arise. So, although the fact that this concept is mainly connected to the second development of ACoR, being antifragile also means precipitating release phases to "get stronger". Therefore, once more it can be recognized throughout the cycle.

Finally, ICT innovations can constitute black, grey or middle-grey swans since new, successful disruptive technologies affect whole societies. As a consequence, those swans have an impact on many companies, which can direct them into the crisis quadrant. The identification of new business opportunities by adapting to those innovations is therefore the outcome. So, although ICT plays a key role in coping with uncertainty it can also be seen as a disrupter of equilibrium. Hence, the role of ICT can be seen as a paradox. On one hand, random tinkering on the "Exploitation" phase may give rise to innovation and hence build Antifragility in the system while on the other hand constant use of ICT during the "Release" phase may lead organizations to a crisis phase.

To conclude, we consider that we adequately identified the main principles of each quadrant of ACoR in the lifecycle of a VO/VT and thus believe that there is a linking between these concepts. In addition, despite the fact that there are some "dark" spots in the investigation of the connections between the theories studied, they all agree on the basic ideology and hence we identify them as compatible.

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Appendix

	ACoR theory says...	Taleb's theory says...	
1st main development of ACoR	Right loop: uncertainty, novelty & experimentation. Necessary for destructive or creative change	Black Swan events cause crisis situation & create severe uncertainty	It can be associated with the 2nd development as every Black Swan can provide us with hindsight.
2nd main development of ACoR	Left loop: market power, capital, stability & conservation. The well being increases	Becoming antifragile means building resilience and creates growth & development	It can be associated with the 1st development as every shock can lead to a release phase.
Revolt phase	It is necessary to maintain a balance between "revolt" and "poverty trap"	Poverty trap" creates vulnerability: avoid specialization (vs varieties), avoid optimization (vs redundancy), avoid human over-intenvention	"Mother nature is the best risk manager and loves redundancy" (Taleb et al., 2009)
Remember phase	It is necessary to maintain a balance between "remembrance" and "rigidity trap"	"Rigidity trap" creates vulnerability: we cannot prepare based on past events	
Role of information & Use of Technology	Although ICT plays a central role in coping with uncertainty, it can also be seen as a disrupter of equilibriums	Many Black Swans are ICT related Challenging the current market model will build antifragility and create room for innovation	
The final message	Businesses have to become more adaptive to change in view of coping with uncertainty, but firstly we have to alter our BEHAVIOR towards change!	Businesses have to become more antifragile to cope with uncertainty and change of behavior is a way to achieve this!	

enables