



Induced accident in the maritime sinister of Costa Concordia

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Abstract

This study determined by the theory of the Maritime Accidents the causal factors that led to the catastrophe of the passenger's vessel Costa Concordia. In the study we've applied the key elements of such theory, as they are the pressure of production and/or the pressure of technological advances, acting on the individual risk homeostasis of the operator. After performing this analysis, we set up a discussion in which we have established that this case meets the foundations of the induced maritime accidents (strong core, protector ring, positive and negative heuristics) and the existence of the key elements as were the captain and the first mate. It was established conclusions that these foundations are combined and accumulated in such a way that caused the rupture of the margin of safety, leading to the inevitable. If he had managed to maintain a margin of safety permissible, the sinister passenger vessel Costa Concordia would have been avoided.

Keywords: Maritime Safety; Safety Margin; Risk Homeostasis; Maritime accidents; Human Factors

1. Introduction

The International Maritime Organization (IMO) Resolution of the Maritime Safety Committee (MSC) number 255 of the year 1984, specifies what it is a marine casualty and remarks that it does not include a deliberate act or omission (Schröder-Hinrichs et al., 2011). With the intention to cause harm, moreover IMO consider definitions and human factors on its Resolution A 1075(28), where to establish that the purpose of a safety analysis is to get a more thorough understanding of the underlying safety issues that can cause or contribute to a casualty or incident (Ellis, 2011). In this sense the Induced Accident Theory (IAT) can bring a new different perspective to "the causality credo" establishing that when the balance between the pressures of production and or technological advance faced to the individual homeostasis to the risk (Alexander, 2012), generates a large individual comfort range to the risk and this can break an acceptable

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operational safety margin, leading to the disaster(Schröder-Hinrichs and Hollnagel, 2012).

Different to MRS Titanic nowadays cases such as motor vessel Prestige or passenger's vessel Costa Concordia, among others are disclosed in real time in regard to the public knowledge, including the Italian COSMO-SkyMed (CSK) constellation of was tasked to acquire high resolution images of the wreck data (Fumagalli et al., 2014). This promotes a reaction of the public opinion more swift and forceful and that as a whole to the importance of maritime transport for humanity, whose international trade of about 9.2 billion tons of goods were transported on merchants ships DWT of 1.63 billion with an average age of 20 to 21 years (Fransoo and Lee, 2013). Highlights the fact that this is not a system of which we can dispense with and therefore, it is essential to know the causes that motivate the marine casualties (Lee, 2008) to minimize its recurrence(Anderson, 2015).

By 1820 the United Kingdom (UK) adopted the Passengers Act and with France in 1848 agreed, to the first regulating navigation at sea on the navigation lights. More recently in January 2010, the resolution of Maritime Safety Committeenumber 255 of the 1984 year and in 2014 the resolution A 1075(28), however, were lost 4,443 ships from 1989 to 2010 and 18,189 lives as a result and from 2002 to 2013 were lost 1,673 ships.

2. Analytical review and proposals

Concerned about accidents, from IAT point of view we may consider alternating thoughts. As indicated by Charles Perrow (2011) which presents the theory of why accidents occur and some of them inevitably due to the fact that the productive systems that build society are too complex or Dietrich Dörner's theory (Dörner, 1996; Perrow, 2011) or failures of design raised by Henry Petroski (1994). So we can assume those theoretical matrixes with IAT's wrong mental construction of the operator and then take the wrong decision and consequently detonate the sinister (Arroyo and Ypiens, 2002).

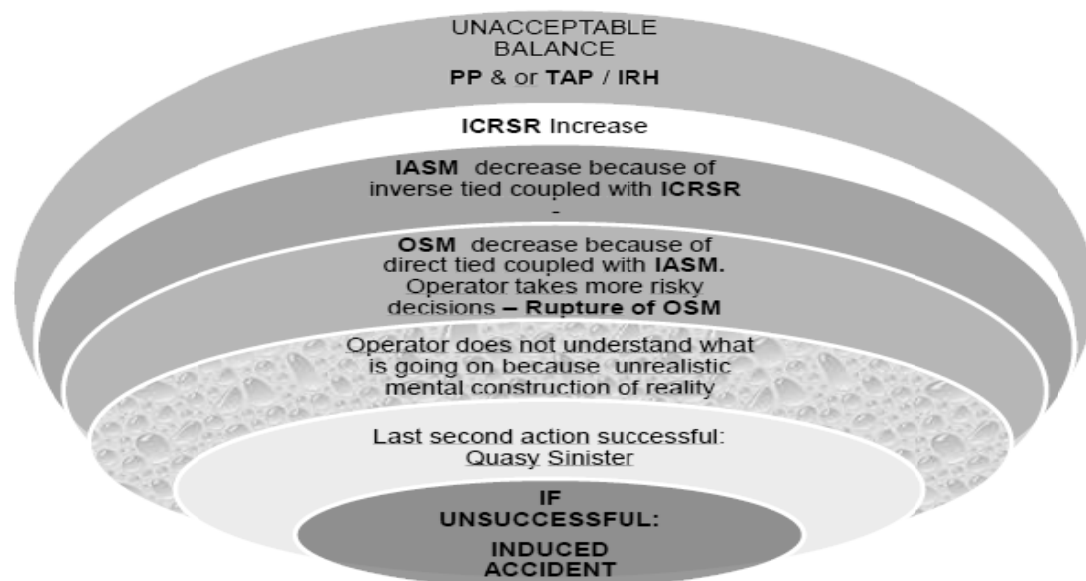


Figure 1: Induced accidents sequence.

Source: Authors.

As well could happen to Costa Concordia, when something had accumulated reducing the margin of safety, to a point of inducing decisions that led to the accident, as seen in Figure 1, where the Risk Homeostasis (RH), the Individual Comfort Risk Safety Range (ICRSR). The Individual Accepted Safety Margin (IASM) and the Operational Safety Margin (OSM), corresponding to Induced Accident Theory (IAT), develops the sequence toward the accident (Hasegawa and Awal, 2013). We have so that the human being is to some extent lags behind in the technological advances and as a possible reaction, the operator acts to balance its area of “conformity-satisfaction” modifying the Risk (increasing), by the way of the Margin of Safety (downwards).

Induced Accidents Theory (IAT) complies with the theory fundamental of Imre Lakatos (Lakatos and Zapatero, 2007) and is based, on the fact that accidents occur motivated to the infringement, decrease or absence of an acceptable OSM. It generated among others due to an unacceptable balance of the Pressures of Production (PP) and or Technological Advance Progress (TAP). In front of the Individual Homeostasis of Risk (IHR) that makes reacting by regulation, avoidance or conformity, some Individual Comfort Range to Risk (ICRSR), that consequently drive an Individual Accepted Safety Margin (IASM), that goes coupled to the OSM, which could lead to sinister. The term Psychological Homeostasis was introduced by Walter Bradford Cannon in 1932 and appoints the general trend of any organism to the restoration of internal balance each time it is altered (Anderson, 2015). See Figure 2, where PP, TAP, IRH balance could reach to an unacceptable OSM.

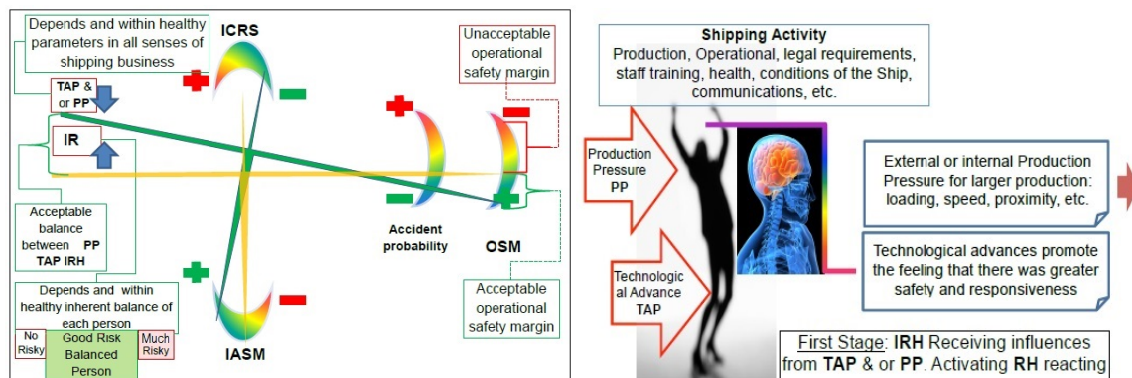


Figure 2: Operational safety margin and homeostasis risk first stage.

Source: Authors.

A human being is doing his job on board to reach target production with Safety, in the First Stage, in a particular moment, the PP and or TAP arise, pushing to more risky decisions, as seen in Figure 2 on the right side. This ICRSR in a normal situation in a well-trained crew is maintained within a range of preventive and precautionary. This dynamic of ICRSR arrives, as seen in Figure 4, to the Second Stage, variation so-called Homeostasis of the Risk, that in phase A, the ICRSR, could become bigger (2B1), meaning that he will accept a smaller IASM (2B2). With the consequence, as seen in Figure 3, to may decide to accept in Third Stage a smaller OSM (3B), closer to the risk with the consequent increased likelihood of the occurrence of the incident as seen in Figure 3 on the right side.

These internal imbalances that can occur both at the physiological level and psychological, are produced by a timely damage or because of a need (Arroyo and

Ypiens, 2002), and have been named in the theory of Induced Accident, as the Individual Range of Comfort to Accept Risk (ICRSR).

In the sinister of Costa Concordia, by applying IAT view, going deepen, as has previously been an outline, the IAT is focused on the treatment given to the margin of safety and looking at the foundations of the IAT proposal (Chen and Chou, 2012).

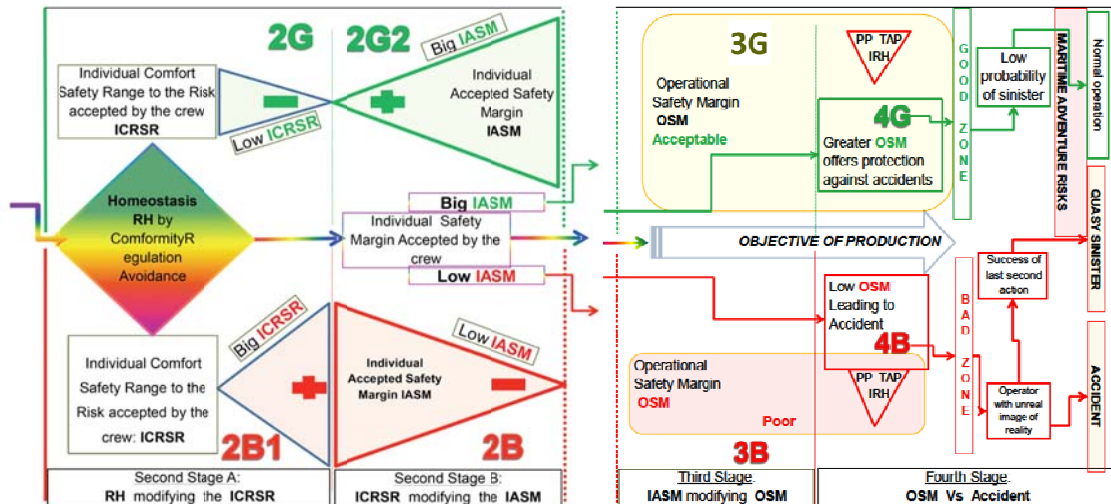


Figure 3: Homeostasis of risk second, third and fourth Stages.

Source: Authors.

3. Costa Concordia accident

The information of the events that we shall use comes from the Costa Concordia Report of the Research (CCROR), carried out by the technical body of maritime accident investigations of the Italian Ministry of Infrastructure and Transport of the incident (MIT) that occurred on January 13th 2012 (Volo and Pardew, 2013), were the ship contact against the rock "Le Scole", Giglio, Italy (Mullai and Paulsson, 2011).

From CCROR, the human element is the root cause of the accident, both in its first phase, as determined by the non-conventional actions that led to contact with the rock and that the Costa Concordia (Regoli, et al., 2014) at the time of his departure from the port of Civitavecchia, fulfilled completely with all of the SOLAS requirements applicable (Dankowski et al., 2014). During the crucial phase prior to impact, in which successive actions that gave rise to the incident when the captain guided the ship toward restricted shallow waters (Schröder-Hinrichs and Hollnagel, 2012, 2013).

3.1 Application on the Costa Concordia

We will only take into account the first phase of the sinister contact with the rock, using the IAT focussed in the homeostasis and operational safety margin (Li, Yin and Fan, 2014) interlink process, as follow:

IAT view: From CCROR, it could be established that when sailing to, approaching to and contact the rock, there were at all time on the bridge the three decks officer, including the first deck officer, the captain (arrived when sailing at 21:34:36) and the helmsman, the chief purser, the metre and the catering services manager.

- At 21:34:36, the captain comes on the bridge and orders the helmsman to move the rudder in manual mode. (IAT view: captain in control of bridge).
- At 21:36:02, first deck officer ordered the helmsman to come alongside for 285° and 290° after one minute. (IAT view: first deck officer participating in control of bridge).
- From 21:37:11 to 21:38:47, captain at phone asking about the safe distance from Giglio's coasts there is a safe depth enough to pass, he replies is safe till 0.3/0.4 nautical miles. (IAT view: this could show pre-decision of captain to go as proximate to Giglio as ever).
- At 21:36:35 (VDR) captain orders to set on the radar a distance circle of 0.5 miles and at 21:39:14 he takes the command of the watch. (IAT view: The captain will accept the greater risk, (larger ICRSR, lower IASM and confirm captain in control of bridge).
- At 21:39:30, until this point, the ship is still on the course as planned. The bowheads towards Punta Capo Marino and the ship proceeds, at a distance of 1.35 miles and a speed of 15.4 knots. The captain now gives orders to the helm for bows moves away from the planned course. (IAT view: captain accept greater risk, lower IASM and lower OSM, first planning to approaches Giglio's coast (before departure) was already a risky decision that diminished the OSM; now this second decision could be originated from a wide ICRSR of the captain).
- At 21:40:48, the captain orders, in English: 325°, the helmsman answers, to confirm the order 315°, the first deck officer intervenes to correct the interpretation of the helmsman but pronounces 335°, then the captain reiterates its order 325° and then the helmsman confirms 325°. (IAT view: again it is noted deficiencies in the helmsman but not enough to captain realize and change to rudder angles orders. The intervention of the first deck officer giving 10 degrees more to starboard could only be a bad interpretation of the 325° ordered by the captain, but also not in accordance with the risky approaching maneuver he could use this opportunity to move the ship away from the coast without confronting or disobeying the captain).
- At 21:43:44, the speed is 15.9 knots, the captain orders, (always in English language) 350°, the helmsman does not confirm properly (repeats 340°) and the order is confirmed again, specifying the side "starboard" and warning that otherwise would end up on the rocks (IAT view: captain known risk to port side, but also he did not realize reality because an erroneous image in his mind of it, thinking ship is wider from coast or at least that there were not rocks by the bow, to IAT these confirm again the large ICRSR, the dangerous shorter IASM of the captain with the consequence much dangerous shorter OSM, to base decision).
- The turning radius is such that the ship is located 0.5 miles SW of the planned route so much closer to the coast than planned. (IAT view: captain known risk to port side, but he continuous to do not realize reality because an unreal image of it thinking ship is wider from coast).
- From this moment the captain starts giving orders no more for bows but for rudder angles (IAT view: In this moment the captain star to realize which is the true reality that ship is extremely close to shore, he is no more blind from balance PP/TAP/IRH, his ICRSR became very small so IASM grows. But as before in time, it wasn't described real obstacles on navigation route, maybe he did not known Le Scole rocks were just in front ship's bow; which means from IAT view: accumulated short OSM).
- At 21:44:20 hard to starboard, rudder fully starboard. (IAT view: These last orders would seem to confirm the previous assumption that the captain was beginning to

realize the true situation and now it gets such a conviction more dangerous, a suddenly zero ICRSR).

- 21:44:36 mid ship, the bow is less than 150 meters from Scole rock, while the ship is off planned course by more than 809 meters; (IAT view: 44% of a nautical mile, absolutely broken the OSM).

- 21:44:45 port twenty, after this order the helmsman heads erroneously to starboard to correct himself and go alongside to port as requested by the captain and then pulling again to the left as requested by the captain, but spend about 8 seconds for the correction of the manoeuvre; (IAT view: decision makers ruled by a wide ICRSR with a short IASM did not consider from the beginning the safety margin as a priority, so with a very short OSM did not take precautionary actions, until it was too late and OSM was completely broken).

- At 21:45:05 hard to port the helmsman runs correctly. The Second Deck Officer from the left wing warns that the left side is gone aground, a second later it was heard a loud crash.

- At 21:45:07 the ship collides into the rocks. The speed decreases to 8.3 knots, loses propulsion of the two engines and adrift proceeds with direction of 350° (IAT view: When operator realize it is too late and the last second action unsuccessful, accident is imminent).

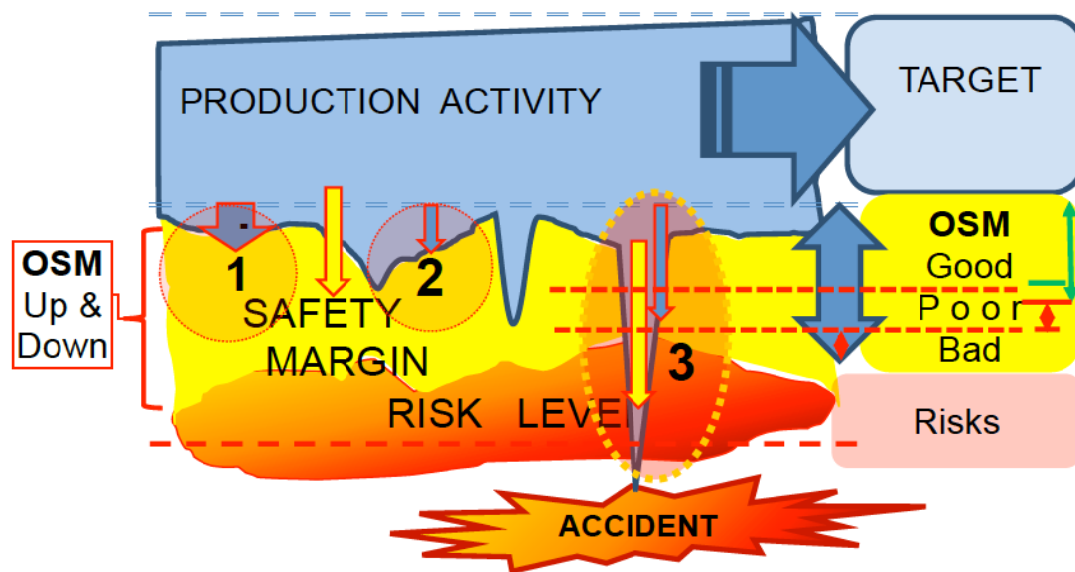


Figure 4: Costa Concordia Induced Accident.

Source: Authors.

The Operational Margin of Safety, OSM, as seen in Figure 5 increase and decrease because balance of PP and or TAP Vs. the IRH of the operator, who perceive the higher margin due to technological progress, then decreases with his more risky actions: In cases 1 and 2 the Costa Concordia captain decided a coast approach (Toesca et al., 2013) shorter than routinely normal to Giglio, plus no warning from first deck officer, resulting in a reduced OSM but still enough to make the system will recover, while in case 3 the accumulated Homeostasis to the risk of operators, IRH, when captain continues to a more dangerous shorter coast approach to Giglio, plus any warning or actions from first deck officer, decreased the OSM to the point of deleting it thereby undermining the system causing the disaster at Les Scole Rocks (Pellegrino, 2014).

4. Discussion

The IAT's answer to the soft manoeuvre, the poor technical expertise and non-conventional actions that led to disaster were originated from an unacceptable balance of IRH of the captain and of the first deck officer induced by the PP of salute Giglio adding the TAP transpose to the captain, resulting in a very large ICRSR, generating a very small IASM that breaks the OSM, this causing the disaster (Neri et al., 2016).

It could be established that this case involves the ignorance of the danger that was stalking and which subsequently is expected to converge and also match with the Strong Core of IAT (That accidents are built hard by its protagonists without them being truly aware of this).

The captain took the helm with sufficient time to correct the dangerous course of the ship (Mouawad, 2013), but allowing she forward toward the danger without any action to counter it, this is voluntarily consuming the OSM, up to decrease it to an intolerable level, which match again with IAT's Strong Core (That accidents happen because the OSM decreases to an intolerable point materializing the sinister (or quasi-sinister, if a successful last second action)).

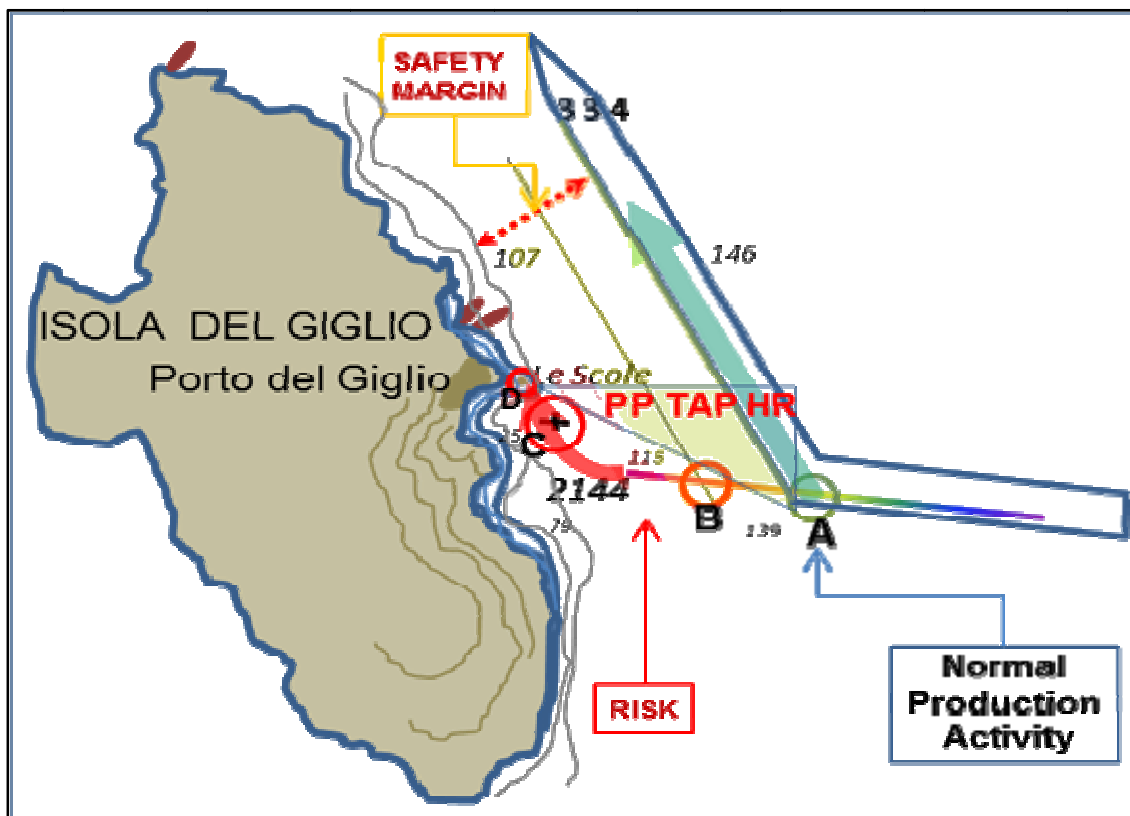


Figure 5: Costa Concordia safety margin.

Source: Authors.

The difficulties of the captain to read the radar, the use of a mapping totally inadequate and the inappropriate use of the navigation systems, it represents a very large ICSR. Not to take into account those safety parameters declined more the OSM, by his

increased ICRSR when overestimated his capacities and feeling in control ignoring to verify positions.

The distraction of the captain due to the existing presence of non deck staff personnel on the bridge and some telephone conversation; the orders given by the captain to the helmsman, assigning a course to follow, instead of rudder angles, it implies that it had happened before and it looks normal, that the salute to Giglio was not considered a restricted manoeuvre but navigation at the open sea. Those contribute to the decline of the OSM.

The anomalous attitude of the captain when not verifying the original navigation plan and go beyond the point of rotation provided without checking the actual distance to the coast, the passive attitude of the members of the navigation team and even the first deck officer alerted or urged the captain of the imminent danger of that route so close to the coast. From IAT the attitude of the first deck officer, it is clear that this manoeuvre shouldn't be an open sea case, however did not make any warning to the captain, previously mentioned that such an approach to Giglio was a true madness, the reasons for such behaviour could be the avoidance and conformity from the physiological homeostasis as a silent entity (not contradicting the captain, he is owner of the command). Without a doubt, this contributed to accumulating the decline of the OSM. As seen in Figure 5, the Costa Concordia were complying her normal route but in point (A) instead of turning to starboard within her normal activity of production and maintain its acceptable operational safety margin, OSM, it is decided to continue straight ahead approaching to Giglio island and reducing the acceptable OSM in search of the previously calculated new turning point (B) and not respectful continued her navigation up to another turning point (C) extremely close to the coast which totally violated the OSM. Also, can be seen in Figure 7, the effects of PP, TAP and HR cone which represents the combination of factors which possibly led to the crew in charge of navigation to take those very wrong decisions that brought the breakdown of the OSM and the catastrophe befell at point D.

5. Conclusions

That Homeostasis of risk could be the reason why captain and first deck officer might have caved and accepted that kind of risk, showed poor technical expertise and decided to do non-conventional actions that suppressed the OSM leading to the catastrophe. Costa Concordia case complies with fundamentals of the Induced Accident Theory and the chain of events that leads to the accident possible began with the IRH negative unbalanced of the captain and the first deck officer, due to the production pressure to salute Giglio combined with the technological advances of the ship assumed by captain as if were of himself, as well as the passive first deck officer performance.

That it should be studied more deeply the strength of the IRH of decisions makers to avoid reaction toward increase profusely their ICRSR; and also it must be considered this type of scenario to compensate, to build or to preserve an appropriate operational safety margin sufficiently solid.

This accident was built hard in a network of accumulated faults by its protagonists affected by their IRH in front of the PP and TAP without being truly aware of this, generating the deterioration of the OSM to an intolerable point that leads to contact the rock.

That to use the strategy favoring a wide OSM as a central factor, can be very helpful for the operator decision-making avoiding to divert in multiple confusing isolated

considerations which in turn can boost a dangerous big ICRSR and consequently a small OSM.

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