Analysing Uncertainties and Risks in Dynamic Retail Operations. Interpretive Structural Modelling (ISM) Approach

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Abstract

Uncertainties and risks are increasingly affecting supply chain performance, hence are subjects to growing attention of academics and managers. However, much of the existing research focuses rather on stable environments such as manufacturing industry. This study, in contrast, explores more complex and dynamic settings of the retail operations of the cruise ship industry. By application of Interpretive Structural Modelling (ISM) approach it has been revealed that uncertainties and risks in such environment are much more autonomous, with fewer links between them, and limited number of dependencies. This creates new challenges, but also opportunities for risk management professionals.

Keywords: Retail Supply Chain, Uncertainties and Risks, Interpretive Structural Modelling (ISM)

Background

In recent years supply chains have experienced increasing uncertainties and risks associated with rapidly changing market environment, more demanding customers and business partners, and fierce competition (Colicchia & Strozzi 2012). These volatilities come from various sources, such as supply, demand, internal processes, control systems, and external environment (Christopher & Peck 2004). The common perception is that uncertainties and risks are negatively impacting firms processes and performance, however, they can also play a positive role by stimulating competitiveness.

Theoretical economists indicate that without uncertainty and risk there would be no profit. Knight (1921, p.198), for example, argues that 'imperfect knowledge of the future' causes distractions of the 'perfect competition', therefore creates chances for achieving competitive advantage for firms that can better predict and exploit future opportunities. This view is shared also by contemporary thinkers; Teleb (2007, p.206) observes that 'the most successful companies are precisely those that know how to work around inherent

unpredictability'. In the field of supply chain management Fisher (1997) insists that uncertainty and risk are naturally associated with innovative products, which are typically characterised by greater profit margins, therefore they must be considered as beneficial.

Although the claims that proper management of uncertainties and risks can improve competitiveness and performance are justifiable (Waters 2007, p.87), the common perception is that on lower, company and supply chain levels uncertainty and risk typically increase vulnerability, negatively affecting their performance and shareholder's value (Hendricks & Singhal 2003). It is therefore required from academics and practitioners to seek new ways to analyse, control and mitigate their negative consequences (Manuj et al. 2014). In response to those calls a new academic field, coined Supply Chain Risk Management (SCRM) emerged with focus on supply chain risk identification and mitigation. A number of approaches have been proposed to achieve those objectives, including avoidance, postponement, hedging, information sharing, increasing flexibility and improving security (Manuj & Mentzer 2008; Tang & Tomlin 2008). This followed by creation of various analytical solutions and frameworks aimed at investigating and tackling uncertainties and risks in supply chains (see e.g. Norrman & Jansson 2004; Tang & Nurmaya Musa 2011; Colicchia & Strozzi 2012).

Selecting an appropriate tool is critical for understanding risks and uncertainties in supply chains and their subsequent mitigation. Many of the existing methods focus on analysing them in isolation, therefore missing an important element of interdependence (Mitchell 1995). Interpretive Structural Modelling (ISM) model, on the other hand, emphasis on capturing direct and indirect relationships between specific uncertainties and risks, furthermore, it allows to establish an order between these relationships (Warfield 1974; Faisal et al. 2006). These detailed insights can be used to tackle them in more informed and efficient ways.

Purpose

Much of the existing research concerning supply chain uncertainty and risk focuses on analysing secondary data or literature reviews (Colicchia & Strozzi 2012; Tang 2006), conceptual frameworks (Christopher & Peck 2004), and surveys (Wagner & Bode 2006). Their main attention is on exploring uncertainties and risks at the high level view (big picture), or analysing other aspects in their context, e.g. performance or supply chain management strategies (Wieland & Wallenburg 2012). Furthermore, these studies were conducted mainly in manufacturing settings, overlooking other industries, such as retailing.

This research, on the other hand, focuses on analysing uncertainties and risks in complex settings of the retail operations of the cruise ship industry. Furthermore, Interpretive Structural Modelling (ISM) method have been selected, which enables to capture causalities and links, as well as order between various types of risks and uncertainties. This approach uncovers more nuanced view at a micro, company level, which adds new insights into these phenomena.

The overall objective of this study is twofold. Firstly, the author explores uncertainties and risks at the lower level of an organisational structure of the selected complex and dynamic case study company. This perspective is important because decisions made at

this level have a direct impact on supply chain management processes, hence on the operational performance. In other words, identifying and investigating uncertainties and risks affecting these functions is crucial to improve decision-making processes, therefore to achieve better performance.

Secondly, by application of ISM approach the research provides detailed view on how specific uncertainties and risks relate to each other, their strengths and order. This insight within practical settings enables managers to make better, more informed decisions regarding specific uncertainties and risks in relation to performance.

Following Mitchel's (1995, p.116) view that uncertainty is merely a 'component of risk', the author adopted for the purpose of this study a wider definition of risk, which include also uncertainty. Therefore, in the remaining parts of this research the term risk will be used to represent both risk and uncertainty.

Methodology

The case study research design has been selected to gather detailed information regarding risks in a company running retail shops on cruise ships. The case methodology is suitable for exploring contemporary phenomena, and in particular to answer 'how', and 'why' questions, which is the main focus of this research (Yin 2014, chap.1). Furthermore, this research design is recommended for investigating and deep understanding of dynamic and complex processes within single case settings (Eisenhardt 1989, p.534). The retail operations of the cruise ship industry represent such settings, making it a suitable area for utilising case study methodology. The research process consists of the following sequence of steps (Figure 1).

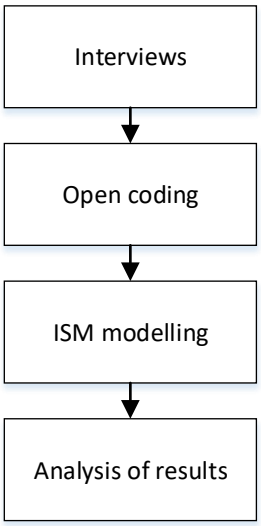

Figure 1 Research process

The cruise ship industry is a fast growing part of the global economy, becoming increasingly important for some countries (Bull 2013; CMW 2016). Yet, it is one of these areas, where the academic research is underdeveloped. Existing research studies concerning cruise ships industry are scares and they focus rather on its primary functions,

such as: fuel, hotel, technical, and corporate management, than on the retail operations (Erkoc et al. 2005; Véronneau & Roy 2009; Ankudowicz et al. 2017).

The case organisation's supply chain is quite complex and dynamic; the company runs over 200 shops across over 50 ships sailing around the World. It utilises various modes of transportation, including road, air and sea. Furthermore, it is affected by specific, non-existent in land retailers and manufacturing industry challenges, such as fixed delivery windows, variable lead and replenishment times, highly changeable customer profiles, limited storage space, and multitude of law and tax regulations varying by region and country.

The author conducted fourteen interviews with employees occupying various, but mainly managerial positions within the organisation's supply chain functions, including shop management, buying and merchandising department, customer service, logistics and operations department. The interview schedule contained questions regarding operational processes, performance, uncertainties and risks. An extract from the interview schedule regarding uncertainties and risks is included in the Appendix.

Interview transcripts have been coded using 'open coding' technique (Strauss & Corbin 1998, chap.8) with a support of the qualitative data analysis software - NVivo. The NVivo enabled the author not only to categorise the phenomena, but also to create 'conditional matrix', capturing relations between the categories (Strauss & Corbin 1998, chap.12). In effect fourteen risk categories have been identified, with eighty-two references between them. The relations resulted from indicating by interviewees links between these categories during interviews. Table 1 presents a sample of six (out of thirty-two) unique links between individual risk categories.

Table 1 Relations between specific risks categories

Impacting risk category	**Impacted risk category**	**Number of references**
Bad weather	Stock issues	2
Inaccurate forecasting and planning	Poor performance	1
Inaccurate forecasting and planning	Stock issues	4
Inadequate customer service	Poor performance	9
Incorrect product classification and range	Poor performance	3
Incorrect product classification and range	Stock issues	2

Further analysis was focused on examination of risk categories and their relationships using ISM method (Warfield 1974). The ISM allows to capture, rank, and map multilevel relationships between risks; in particular it enables to identify their primary, and secondary sources, their order, and links between them. There are a variety of applications of ISM within supply chain management discipline, which guided this research (see e.g. Mandal & Deshmukh 1994; Faisal et al. 2006; Diabat et al. 2012).

Following the ISM approach the self-interaction matrix has been created (Table 2), showing relationships between all risk categories, using following symbols:
V – for risk category *i* impacting risk category *j*
A – for risk category *j* impacting risk category *i*

X – both risk categories *i* and *j* impacting each other
O – there is no relations between risk categories *i* and *j*

Table 2 Self interaction matrix

Categories	**14**	**13**	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1. Bad weather	O	O	V	O	O	O	V	O	V	O	O	O	O	X
2. Inaccurate forecasting and planning	O	O	V	O	O	O	O	O	V	O	O	O	X	
3. Inadequate customer service	A	O	A	A	O	O	O	A	V	O	O	X		
4. Incorrect product classification and range	O	V	V	O	O	O	O	O	V	A	X			
5. Inefficient internal processes	O	O	A	A	O	O	O	O	V	X				
6. Poor performance	A	O	A	A	A	A	A	O	X					
7. Poor supplier service	O	O	V	O	O	O	O	X						
8. Problems with internal deliveries	O	O	A	A	O	A	X							
9. Ships itinerary issues	O	O	V	O	O	X								
10. Sickness on board	O	O	O	O	X									
11. Staff issues	O	O	V	X										
12. Stock issues	A	V	X											
13. Storage issues	O	X												
14. Unpredictable passengers	X													

The objective of the next, iterative step of the ISM model is to assign to each risk category a level within the model hierarchy. The levels to which individual risks are assigned depends not only on the number of categories within reachability and antecedent sets, but also on a type of links between these categories. Tables 3 and 4 present first and last iterations of this step of analysis. Overall there were five iterations leading to identification of five levels of the ISM model hierarchy.

Table 3 Supply chain risks levels – first iteration

Category	Reachability set	Antecedent set	Intersection	Level
1	1, ~~6~~, 8, 12	1		
2	2, ~~6~~, 12	2		
3	3, ~~6~~	3, 7, 11, 12, 14		
4	4, ~~6~~, 12, ~~13~~	4, 5		
5	4, 5, ~~6~~	5, 11, 12		
6	~~6~~	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12,14	6	I
7	3, 7, 12	7		
8	~~6~~, 8	1, 8, 9, 11, 12		
9	~~6~~, 8, 9, 12	9		
10	~~6~~, 10	10		
11	3, 5, ~~6~~, 8, 11, 12	11		
12	3, 5, ~~6~~, 8, 12, ~~13~~	1, 2, 4, 7, 9, 11, 12, 14		
13	~~13~~	4, 12, 13	13	I
14	3, ~~6~~, 12, 14	14		

Table 4 Supply chain risks levels – final result

Category	Reachability set	Antecedent set	Intersection	Level
1	1, 6, 8, 12	1	1	IV
2	2, 6, 12	2	2	IV
3	3, 6	3, 7, 11, 12, 14	3	II
4	4, 6, 12, 13	4, 5	4	IV
5	4, 5, 6	5, 11, 12	5	V
6	6	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12,14	6	I
7	3, 7, 12	7	7	IV
8	6, 8	1, 8, 9, 11, 12	8	II
9	6, 8, 9, 12	9	9	IV
10	6, 10	10	10	II
11	3, 5, 6, 8, 11, 12	11	11	IV
12	3, 5, 6, 8, 12, 13	1, 2, 4, 7, 9, 11, 12, 14	12	III
13	13	4, 12, 13	13	I
14	3, 6, 12, 14	14	14	IV

Having identified risk levels, they are next used to build the ISM diagram, which is described and discussed in the following section.

Discussion

The ISM model enables creation and visualisation of hierarchy and interdependence between all risk categories; in the case study organisation the author identified fourteen such categories consisting a complex network (Figure 2).

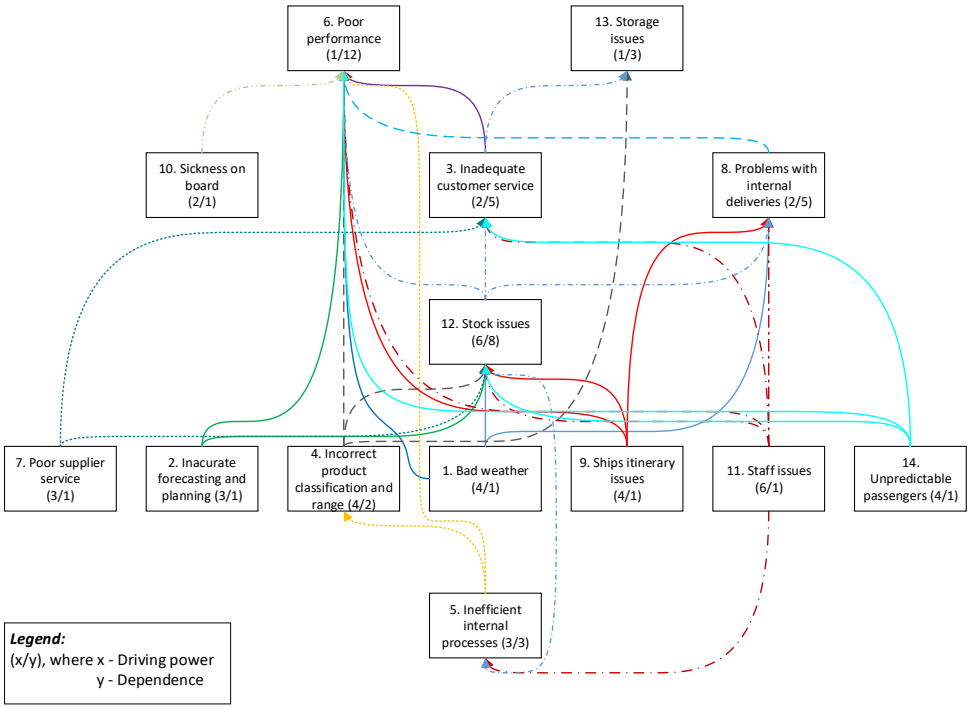

Figure 2 ISM model for risk categories

It can be observed that there are five levels of supply chain risks, where at the top of the hierarchy (level I) there are two categories (poor performance and storage issues) characterised by lowest reachability set. Those categories have the greatest level of antecedents related to them; and because they aggregate those antecedents they have the most significant overall indirect impact on company's performance. On the other hand, at the bottom level (V) there is located a risk category (inefficient internal processes) characterised by high upper level linked categories and no antecedent categories; however, this category has a direct impact on other categories. In between top and bottom levels there are three more levels (II, III and IV), which have a variety of dependencies with other categories.

More detailed analysis of specific risks and their impact on the overall risk situation in the analysed firm reveals that stock and staff issues have a significant impact on the other categories. Having the greatest driving power, they influence directly not only company's performance, but also other aspects of the company's operations, such as internal deliveries, customer service, and other internal processes. Amongst other risk categories having substantial impact on the overall risk are unpredictable passengers number and profile, bad weather, issues with ships itineraries, and product classification and ranging. Those risks are assigned to the lower, fourth level, but their combined driving power has substantial impact on the other categories located at the same or upper levels.

On the other hand, there are risk categories that are largely influenced by other. In addition to mentioned earlier poor performance, two categories are specifically important: inadequate customer service and problems with internal deliveries; they are both impacted by four other risk categories.

A typical ISM procedure include also Impact Matrix Cross-Reference Multiplication Applied to a Classification (MICMAC) analysis (Mandal & Deshmukh 1994; Faisal et al. 2006; Diabat et al. 2012). MICMAC enables to visualise the result of research and conditionally recommend action strategies. The process of building the MICMAC is to create two-dimensional matrix, where one dimension consists of driving power, and the other the dependence. Such a matrix can be then split into four quadrants containing four different categories: autonomous, dependent, independent, and linkage (Figure 3).

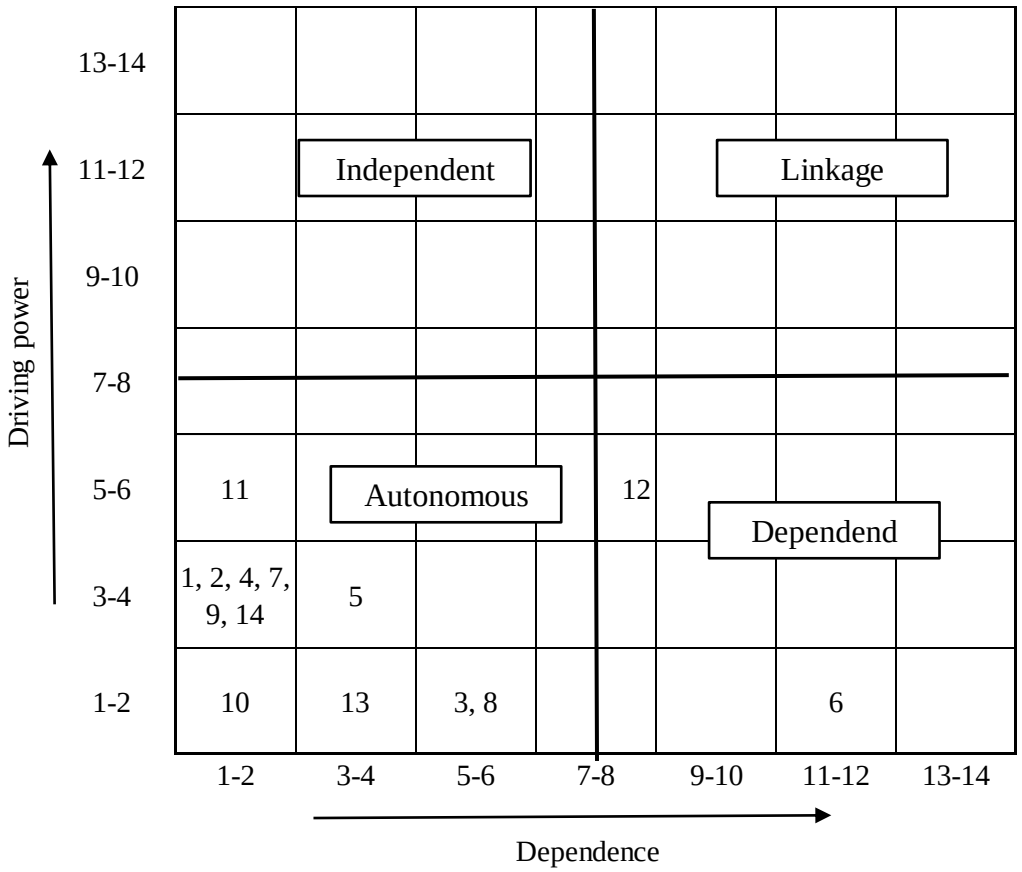

Figure 3 Driving power and dependence MICMAC matrix

It can be observed that in this case most risk categories are classified as 'autonomous', with fairly week driving and dependence powers. Despite the fact that these risk categories are relatively weak if analysed individually, collectively they contribute the most to the overall risk level in the case organisation, and as such they need to be analysed and mitigated.

The weakest amongst all risk categories is the sickness on board (category 10), which can be classified as an external risk. The cases of sickness, especially 'norovirus', are quite common on board of cruise ships, moreover, they significantly affect performance, especially revenue. Another external category is the bad weather (category 1), which has also a significant negative impact on revenue as a result of security restrictions imposed on passengers. Some of the interviewees, especially ship crew members, indicated that sickness and bad weather are the biggest challenges in achieving their revenue targets.

The 'dependant' quadrant of the MICMAC matrix contain only two risk categories: 'poor performance' (6), and 'stock issues'. Although the former one is completely dependent on other risk categories, the latter has a significant impact on other categories, including performance, and it is the one single most important category in this case study that need to be carefully considered.

In the analysed case study there are no risk categories that can be classified as independent or linkage, characterised by stronger driving and dependence powers. This

is a result of the fact, as discussed earlier, that most of the risks are rather dispersed and weak individually.

This exploratory study revealed that in a complex and dynamic environment, such as represented by retail operations of the cruise ship industry uncertainties and risks are fairly dispersed and autonomous, affecting limited number of dependent categories. From a practitioner's perspective this situation makes analysing and mitigating risks more challenging. Moreover, presented in this paper detailed analysis revealed benefits of applications of analytical tools such as Interpretive Structural Modelling. This method enables researchers and risk managers to analyse and provide required insights to make informed risk mitigation decisions.

Contribution

Existing studies have been focused mainly on exploring uncertainties and risks at various stages of supply chain process, and on capturing correlations between possible. However, they lack of deep insights into this phenomenon, especially their causes and effects, which are required for theory to be robust and useful (Christensen & Raynor 2003).

The research reported in this paper partially fills that gap providing a better understanding of uncertainties and risks at the company level, in particular from a perspective of practitioners, who are responsible for making managerial decisions. It has been revealed that in a complex and dynamic conditions, such as retail operations of the cruise ships industry there are numerous uncertainties and risks, and although individual impact some of them may be limited, their cumulative power is significant affecting firm's operational and financial performance.

The Interpretive Structural Modelling method, applied in this study, enabled to analyse in details relations between various sources of uncertainty and risk. Visualisation of the results by presenting ISM diagram of relationships between risk categories, and further MICMAC analysis highlighted those categories that require special attention from the risk management function.

Further research should include an impact and probability of specific risks on other risk categories. Cases of sickness on board or bad weather are the examples of weak interdependent links with other categories, however their impact on overall performance is significant.

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Appendix – Extract from the Interview schedule

1. Can you specify main risks that affect your department's performance, and performance measures?
2. What actions do you take to mitigate these risks? Are these actions in your opinion adequate?
3. What kinds of uncertainty you and your department experience?
4. How do you perceive these uncertainties: as mainly having negative or as positive effects? Why?
5. What kinds of risks, in your opinion, cause these uncertainties? Can you link these uncertainties with risks they may cause?
6. How the uncertainties affect processes in your department, and how do you manage them?