Universidad de Alcalá

Research Project

MODELLING VALUE CREATION FOR AIRLINES COMPETITIVENESS

Experts' Report

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Modelling Value Creation for Airlines Competitiveness

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Cover photo by Lars Hentschel, Airliners.net: Airbus A320-214 in flight.

Preface

The airline industry is changing rapidly. The many challenges and opportunities that airlines face every day make it one of the most competitive industries of all. Needless to say that leading and managing an airline, or its operational units, is not an easy job.

Airlines' management teams are invariably compelled to readapt their policies to the customer preferences, and the ever-changing "external factors" impose severe constraints to growth and competitiveness of airlines. Complexity has unequivocally seized an industry where value is increasingly more difficult to create, and taking the benefits out of it, a question of survival (IATA 2014). To make matters worse, no magic formula seems plausible to cope with this panorama.

However, airlines' managers should not despair. History shows us that some pathways are more likely to succeed than others. And among all possible management options, one approach remains conspicuous: the competitiveness equation in airlines needs to be solved from inside the organization, no matter how tough the environment becomes.

In the race for finding the right pathway, value creation is key. No other factor is so fundamental to competitiveness and market survival. However, value creation is a rather complex process, full of ambiguities and misunderstandings; a kind of slippery floor for managers.

With so much at stake, this research project dives deep into the very essence of the airlines' value creation engine. The research generates novel data from experts on the value constraints and the fundamental value creation units within the organizations. Furthermore, we study the relationships of these elements with the airlines' operating margin, and build a "non-traditional", network-based, model on the basis of complexity-based computational techniques.

The resulting model, and the outcomes obtained from the subsequent simulation scenarios, are not a concluding step to solve all the critical competitive issues in the airline industry. Nonetheless, this research provides a proof of concept and sets the grounds for a fresh complexity-based thinking in airlines, the fruits of which will open new opportunities to airlines practitioners.

PURPOSE

This research project has a dual purpose: 1) to offer executives and decision-makers a broad picture of the external variables and structural components that shape network airlines' engine for value creation, and 2) to address the question: what actions could be more appropriate to increase value creation in airlines and to stay competitive. Therefore, the goal pursued by this research project is of a practical nature, with a particular focus in providing new ideas that support management teams in their process of improving value creation and anticipating performance.

TECHNIQUES

To accomplish our first purpose, namely to provide a picture of the airlines' value creation engine, the research team carried out extensive fieldwork in order to collect relevant data on value creation from experts. This involved launching a Delphi survey and setting up an Experts Panel. After data were collected, a statistical exploratory data analysis was conducted.

Our second purpose, the identification of appropriate actions for value creation, involved specific modelling and simulation work, as a step towards reproducing the impact of key variables on airlines' value creation and performance.

Two factors differentiate this research project from other studies: 1) all the inputs, analysis and modelling tasks involved, as well as the outcomes obtained, are built on the knowledge and experiences provided by airlines practitioners (experts), and 2) the qualitative and quantitative techniques used are of "non-traditional" type. The latter means that the research team has intended to surpass the conventional, and most of the times ineffective, "cause-and-effect" mindset, to instead apply a complexity-based view of the firm that incorporates more elements from reality (Navarro-Meneses 2015).

The authors have tried to avoid mathematical complications which are not fundamental to understanding the conclusions and lie beyond the scope of this document. Notwithstanding, those readers interested in getting a deeper understanding of the computing techniques used by the research team are invited to contact the authors (see contact information).

AUDIENCE

The audience of this document is limited to the participants in the Experts Panel. However, we encourage you to share the document, or any part of it, with people you trust inside or outside your company, provided the terms of the creative-commons license attached are met.

Note that this document refers to the data you provided through the project's Delphi survey, such as your answers and a benchmark of your data versus the aggregated panel data. Keep this document safe if you do not want to share your data with others.

ORGANIZATION OF THIS DOCUMENT

This document is organized into three main chapters and four appendices:

- Chapter 1: Analysis of the Delphi survey
- Chapter 2: Value network analysis
- Chapter 3: Modelling and simulation
- Appendix A: your answers vs Experts Panel aggregated responses

- Appendix B: Techniques
- Appendix C: Panel members
- Appendix D: Glossary
- Appendix E: References.

Chapter 1 provides a descriptive statistical analysis of the data obtained throughout the different Delphi survey rounds. For a detailed comparison of your answers to the Delphi survey with the aggregated data from the Experts Panel see Appendix A.

Chapter 2 characterizes the airlines' value creation engine as a network of interconnected nodes (constraints, value repositories) and links (relations between nodes), having effect on the operating margin. A network graph is an excellent tool for visualizing the complexity of the airlines' value creation engine. Furthermore, the network properties provide a wealth of information on the relationships between the constraints, value repositories and operating margin in network airlines.

Chapter 3 proposes a model for airlines' value creation, specifically describing how the key components of the model work and what its main limitations are. Finally, the outcomes obtained from a sensitivity analysis measuring the impact of key value-creation variables on the operating margin are presented.

Appendix A provides a detailed comparison of your answers to the Delphi survey against the aggregated results obtained from the Experts Panel. Appendix B extends the information regarding the techniques used in the research project. Appendix C lists the relation of Panel members. Appendix D is a glossary of key terms used in the document. Finally, Appendix E contains the references cited in the chapters.

HOW TO USE THIS DOCUMENT

Whether you are persuaded that in airlines research there cannot be really much new, or you already have a well-formed idea of how critical the role of value creation is for airlines' survival, **Chapter 1** can help you understand how an actual airlines' value creation engine works.

This can be chiefly achieved by opening one's mind to the knowledge of other experts in the industry, specifically the kind of knowledge that helps identify the key constraints for value creation, how value emerges from within the organization, and what impact value creation has on the operating margin. The mere process of feedback and benchmarking of your experience will surely be of particular interest to you.

If you have questioned yourself before about how an airline's value creation engine looks like, **Chapter 2** provides you with a visual approach to the interconnectedness of value constraints, value repositories and operating margin. In addition to the worth of such visual representation, by analyzing the value network graph we can take a deeper look into the properties of the airlines' value creation engine and better understand its performance.

Furthermore, if you wonder what would happen if a specific node (value repository) in the network failed to deliver, or you would like to know about the effects when the relationship between two value repositories strengthens or weakens, **Chapter 3** provides you with a working model that enables us to test different scenario hypothesis. With this model, the most critical scenarios affecting value creation and airlines' operating margin can be simulated right from your computer, without the need for shocking your organization.

We recommend that you first read the chapters in sequential order because they build on one another. After you have read the document at least once, you can always come back later straight to the point you wish to consult. By becoming familiar with this material, you will gain an understanding of how a complexity-based view of airlines works, what this research has carried out, and what you can expect from the modelling and the simulations accomplished.

ADDITIONAL INFORMATION AND READER FEEDBACK

This research project has involved many people from both the airline industry and academia. However, in spite of the potential that mutual collaboration between airlines experts and researchers has, it is still rare to see an experienced research team with background in complex social systems venturing into the domains of a specific industry. We have taken the risks of such a challenge with determination and an innovative approach. Our hope is that this research project delivers some answers to some of the questions of your everyday responsibility.

Your suggestions for improving this research are highly welcome. For information on how to provide feedback, or send a question about the project and its outcomes, contact franciscojavier.nava@edu.uah.es. You can also visit the project's website at http://www.valueinairlines.com to stay tuned.

Acknowledgements

Many highly experienced and talented people from the airlines industry around the world have been involved to a greater or lesser extent in this research project. The project's primary participatory group was the Experts Panel, to which selected experts were invited to join.

The Experts Panel did not only host a four-round Delphi survey, but also channeled the interest of those experts who recognized the importance of providing more and deeper knowledge into the practices driving the creation of value in network airlines. Despite their busy agendas, participants in the Experts Panel painstakingly sought to address the issue of value creation in airlines, and provided the key data requested by the research team. Without their insightful contributions and enthusiasm for sharing their knowledge, this research project would not have been possible.

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Introduction

The fundamental research question posed in this project is "What should network airlines be doing to create value and stay competitive?" Three subsidiary questions underpin this core research question, which themselves provide the guidelines for our three-step research procedure:

- What are the key components comprising the airlines' value creation engine?
- How can we visualize value creation in airlines? what conclusions can we infer from such visualization?
- What actions help create value in network airlines and which affect performance positively?

From the questions above, we quickly realize that data on value creation is a critical asset in order to make our conclusions reliable. However, companies do not usually generate value-driven data and, when available, experience shows that managers are typically hesitant to share this strategic information with others. Hence, our first concern in the project was how to collect this type of data, and from where.

In examining the key characteristics of the Delphi method (see Appendix A), it becomes clear why its data extraction process matches well our expectations. First, because our research focuses on future actions rather than current practice. Second, because relatively little is known about these actions. Third, because the research questions lend themselves to making use of a wide range of experts geographically dispersed internationally. Fourth, because our research is an iterative process, where each question builds on the answer to the previous question. For these reasons, the Delphi method is our choice for generating data on value creation in airlines.

It is worth noting at this point that given the research question(s) and the Delphi method used to collect the data, our research process is essentially qualitative in nature. Our intention thus becomes the exploration, identification and description of multiple complex relationships regarding value creation in airlines, rather than the quantification of a single consensus or framework. As a result, when planning the research design, careful attention was paid to the following practical issues:

DELPHI DESIGN

The broad range of expertise and layering of the questions for this research required a phased approach of four Delphi rounds, each with its own objective yet relevant to the next Delphi round.

In Round 1, the focus was on the (divergent) identification of the key components shaping the airlines' value creation engine. Specifically, the goal was to identify as many value constraints and value repositories as possible.

Round 2 of the Delphi method aimed at building "experts consensus" on the top 10 constraints to value creation and the top 15 value repositories. The research team set these limiting numbers to prevent participants from over tiring, as well as to avoid an overly complex network graph and subsequent model.

Having got an idea of the structural components making up the airlines' value creation engine, the focus shifted in Round 3 to the identification of the connections between the constraints and the value repositories, the connections among the value repositories themselves, and between the value repositories and the operating margin.

Finally, Round 4 of the Delphi survey aimed at building "experts consensus" on the questions asked in Round 3, adding a novel question about the sign of the relationships previously identified by the experts.

EXPERTS SELECTION

An important practical consideration concerned who a qualified expert might serve on the Delphi Experts Panel. Unmistakably, the answer to this concern was influenced by the particular research questions posed in the project.

The research question required panel members to be experts on different functional areas in the network airlines industry. Therefore, criteria for membership to the Experts Panel was based on the years of experience and the positions of responsibility held by candidates. For deciding the members of the Experts Panel, the professional LinkedIn network of one of the authors served as the tool used to review the candidates' curricula and as communication channel to forward the invitations to join the Panel.

On invitation, experts were kindly requested to participate in the research project and provide their best insight into the structural components of the airlines' value creation engine and its interconnectedness, as well as to assess the impact of the components on the operating margin of airlines.

EXPERTS PANEL QUESTIONS

Our experience says that much of the research outcomes in projects like this depends on the type of questions put to the Panel members. Thus, the research team made a careful selection and wording of the questions, consistent with the goals pursued in each Delphi round and the research project.

The questions posed to the Panel members in Round 1 were twofold: "What do you think are the main external constraints to value creation in airlines?" and "What are the key value repositories in airlines that affect airlines' operating margin?" An explanation of what a value repository is, was provided in the questionnaire, along with link to download Navarro-Meneses article entitled "Complexity-based view of the firm: Evidence, features and method" (Navarro-Meneses 2015).

With their Round 1 answers at hand, the Panel members were asked in Round 2 to agree on the top 10 constraints and the 15 top value repositories previously identified. Specifically, the questions posed were: "What do you think are the 10 key constraints to value creation in network airlines?", and "What do you think are the key 15 value repositories affecting performance in network airlines?"

The questions posed in Round 3 pursued to gain insight into the interconnectedness of the structural components of the value creation engine collected in rounds 1 and 2. In particular, the questions in Round 3 were threefold: "How do the 10 consensus value constraints impact on the 15 consensus value repositories?" "How are the 15 consensus value repositories interlinked and how they impact on each other?" and "How do the 15 consensus value repositories impact on airlines' operating margin?" The questionnaire consisted of several matrix-type questions, where experts could mark whether or not a particular relationship existed and provide the weight (strength) of a particular relationship by choosing one among five levels in a Likert-type scale (zero, very weak, weak, strong and very strong).

Finally, with all the aggregated information gathered in Round 3 on their hands, the Panel members were asked in Round 4 to carry out three different tasks:

- "Set the final sign and strength of the links between the 10 consensus value constraints and the 15 consensus value repositories"
- "Set the final sign and strength of the links between the 15 consensus value repositories", and
- "Set the final sign and strength of the links between the 15 consensus value repositories and airline's operating margin".

Similarly as in Round 3, the questionnaire in Round 4 consisted of several matrix-type questions where experts provided their insight into the strength and sign of the interconnections among components.

All the Delphi questionnaires were conducted using an online Qualtrics-created survey.

Chapter 1: Analysis of the Delphi Survey

In Chapter 1 we analyze the data collected in the four rounds comprising the project's Delphi survey. For the sake of clarity, we have divided this chapter into five sections: one providing an overall analysis of the Panel members' profile and participation, and one section for each Delphi round. Note that the data obtained from the Delphi survey is key to feed the subsequent network characterization and modelling and simulation tasks presented in this document.

PARTICIPANTS

The total number of Panel members providing a response at any round of the Delphi survey is 33 (for a relation of members see Appendix C). However, not all members produced a response considered technically valid by the research team, so we will specifically focus only on those members providing a valid response, either complete or incomplete, to the Delphi survey. This being the case, the adjusted total number of **Panel members was 28.**

Members by functional area

The professional profile of the Panel members is mixed and varied, thus covering a broad spectrum of functional areas within network airlines organizations. Table 1 shows the distribution of Panel members according to the functional areas where they perform their responsibilities.

Area	No. Participants
Commercial	9
Network & Revenue	7
Sales & Distribution	5
Corporate	4
Engineering	3
TOTAL	**28**

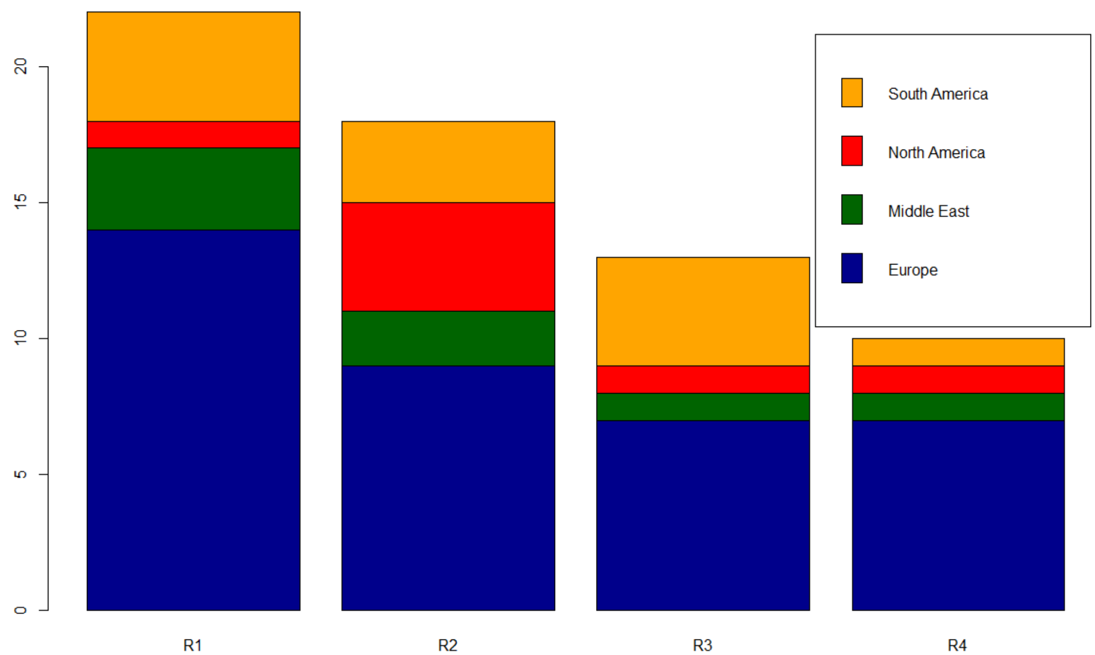
Table 1. Distribution of members by functional area of responsibility

As we can see in the table above, Panel members perform their responsibilities in a wide range of functional areas. This not only reveals a high diversity among members, but it also helps us prevent bias in the research.

Members by geography

Geography is another key factor that helps us characterize the Panel members' profile. In this regard, a wide range of geographies is a good indicator that would move us away from research bias.

Figure 1 summarizes the distribution of the geographies of Panel members in each round of the Delphi survey.



(*) R1: round 1, R2: round 2; R3: round 3; R4: round 4

Figure 1. Distribution of participants by geography

The figure above indicates that the members from Europe are the largest group, followed by the members from South America, North America and Middle East, in this order. This geographical distribution pattern remains virtually unchanged across the four rounds of the project's Delphi survey. Such a mixed distribution of geographies fulfils the research team's criteria for having a wide geographic coverage that prevents bias in the research.

Members by organic position

When analyzing the positions held by the Panel members, we must take into consideration the heterogeneity existing in the way different airlines refer to organizational positions. This sometimes makes it troublesome to compare among levels of responsibilities in different airlines, particularly when members are from different companies and/or geographies.

That said the research team has synthesized the different positions found in the Panel according to the level of responsibility stated in members' curricula. Table 2 below summarizes the distribution of Panel Members by the positions of responsibility held.

Position	No Participants
Senior Vice-President	2
Vice-President	15
Director	8
Manager	3
TOTAL	**28**

Table 2. Distribution of Panel members by organic position

From the table above we can conclude that the group of Vice-presidents is the largest among Panel members, followed by Directors, Managers and Senior Vice-Presidents, in this order. This distribution of organic positions fulfils a key criteria set by the research team at the start of the project, namely that the Panel members should be executives with decision-making capability in their respective organizations. The distribution shown in table 2 ensures that all data collected in the research project come from the people with the greatest knowledge and experience within the airline industry.

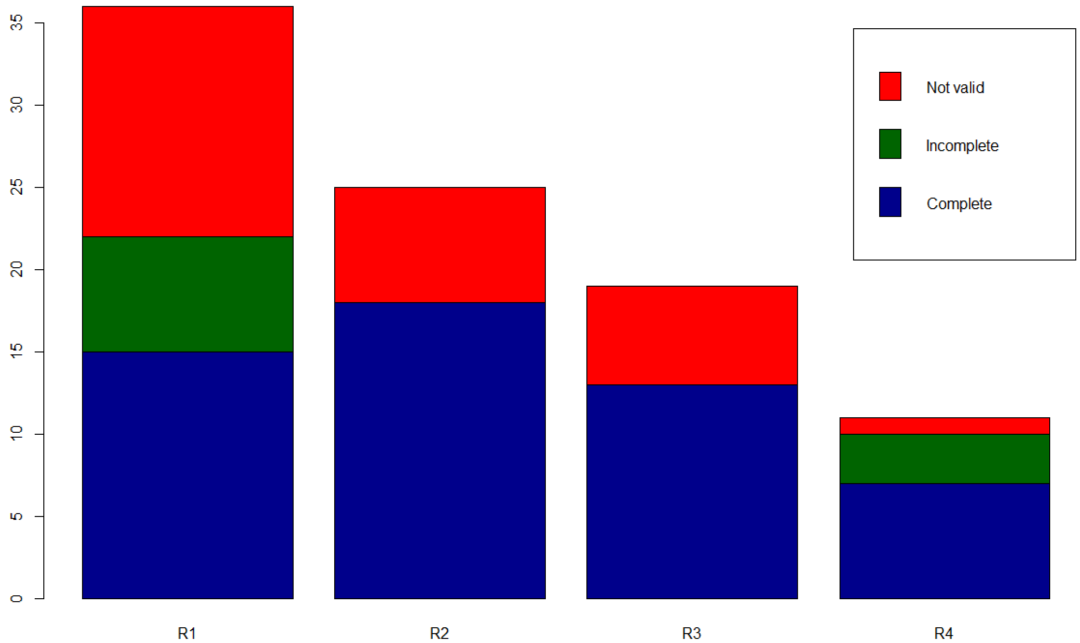
Type of responses

Panel members provided different types of responses to the questions posed by the research team, which fall into two broad categories depending on its validity to be processed and analyzed by the research team: valid and not valid responses.

Valid responses are those that could be satisfactorily processed and analyzed by the research team, and thus incorporated to the stream of the research. Valid responses were themselves "complete", whenever Panel members provided responses to the entire questionnaire, or "incomplete", if members responded only partially to a Delphi questionnaire.

Not Valid responses are those members' submissions lacking the possibility to be processed and analyzed by the research team members, either because of an incorrect submission process or because of a technical failure occurring during submission. Not valid responses were excluded for the purpose of this research by the research team.

Figure 2 shows the distribution of the different types of responses provided by Panel members along the four rounds of the project's Delphi survey.



(*) R1: round 1, R2: round 2; R3: round 3; R4: round 4

Figure 2. Type of responses provided by Panel members

As seen in the figure above, the proportion of "complete" responses mostly increased across the four rounds of the Delphi method, at the same time as the proportion of "not valid" and "incomplete" responses decreased. This trend is consistent with the fact that some members at the initial stages of the Delphi method could have been hesitant to participate in the research, thus they preferred to explore what there was inside the project's questionnaire submission system before deciding. This might have been the reason behind a good number of all "not valid" responses.

Furthermore, the decrease in the number of total valid responses across the four Delphi rounds is consistent with our experience and other similar published Delphi-driven research projects. Last but not least, from a methodological perspective, the total number of valid responses is a significant number even for a Delphi survey, which ensures the reliability of the outcomes of this research.

DELPHI ROUND 1 ANALYSIS

In Round 1 of Delphi the Panel members were asked two main questions:

- Q1: "What do you think are the main external constraints to value creation in airlines?"
- Q2: "What are the key value repositories in airlines?"

Both questions were open-ended, which means that the Panel members were free to write down whatever constraint and value repository they thought was key in airlines' value creation. This process, known as "group visioning" or "divergent thought", sought to drive a scattered creative process where Panel experts provided as many different responses as possible.

The table 3 below shows the frequencies of the main constraints identified by the Panel members. Note how the top 4 constraints cited in Delphi Round 2 ("Labor cost", "Competition from other airlines", "Government regulation", "Fuel cost") amount together to more than 50% of all the responses given by members.

Constraints	Frequency	Percentage
Labor costs	18	15
Competition from other airlines	16	13
Government regulation	15	12
Fuel cost	14	12
Airport fees	8	7
GDS feed	6	5
Leisure travel demand	5	4
Business travel demand	5	3
ATC fees	3	2
IT systems costs and complexity	2	2
Other cited constraints	30	25
TOTAL	**121**	**100**

Table 3. Delphi Round 1: Summary of top cited Constraints

On the other hand, the analysis of the responses to the question "What are the key value repositories in airlines?" revealed a very different pattern. Here members' responses appear much less clustered than in the case of Constraints, with the first four cited Value Repositories amounting barely to a 26% of the total number of responses.

As table 4 shows below, we find an evident high level of dispersion in the responses, which may be due to the broad idea of "value" existing among the Panel members and their different backgrounds and organic positions.

Value Repositories	Frequency	Percentage
Capacity management	6	7.9
Information management	5	6.6
Network	5	6.6
Customer experience	4	5.3
Scheduling	3	3.9
Sales	3	3.9
Procurement	3	3.9
Operations management	3	3.9
Relationships with stakeholders	3	3.9
Corporate culture	3	3.9
Products and services	3	3.9
People and talent	3	3.9
Process and cost optimization	3	3.9
Digital channels	2	2.6
Alliances	2	2.6
Other cited value repositories	25	32.9
TOTAL	**76**	**100**

Table 4. Delphi Round 1: Summary of top cited Value Repositories

DELPHI ROUND 2 ANALYSIS

With the aggregated information from the "Constraints" and the "Value Repositories" identified in Round 1 in their hands, the Panel members were asked in Round 2 to reach consensus on the key top 10 Constraints and top 15 Value Repositories making up an airline value creation engine. Specifically, the questions asked in Round 2 were these:

- Q1: "What do you think are the 10 key constraints to value creation in network airlines?"
- Q2: "What do you think are the key 15 value repositories affecting performance in network airlines?"

The analysis of the responses to Q1 and the comparison with the responses given in Round 1, show how the triad comprising "Government regulation", "Fuel cost" and "Competition from other airlines" remain at the top of the list (see table 5). This give us a general idea of the high degree of consensus reached by Panel members with respect to Constraints.

Top 10 Constraints	Frequencies	
	Round 1	Round 2
Government regulation	15	15
Fuel cost	14	11
Competition from other airlines	16	11
Commoditized product offering	1	11
Power of unions/labour force	1	10
Labor costs	18	10
Slot availability	1	8
Excess capacity	1	7
Capital intensity	1	7
Business travel demand	5	7

Table 5. Comparison of top 10 Constraints, Round 1 vs Round 2

The process of consensus reached in Round 2 becomes more evident when we observe the number of Constraints with hardly any significance in Round 1 that appear at the top of the table in Round 2 (e.g. "Commoditized product offering", "Power of unions/labour force", "Slot availability", "Excess capacity", "Business travel demand"). An analogous process, but in the opposite direction, occurs with "Labor cost", which drops to the middle of the table despite being the most cited Constraint of all in Round 1.

Moreover, the analysis of responses to Q2 and the comparison of the top 15 Value Repositories in rounds 1 and 2 (table 6) reflect a similar underlying process of consensus. For example, in this case, some of the most cited Value Repositories in Round 1 (e.g. "Network", "Capacity management", "Customer experience", "Information management") remain at the top of the list in Round 2, despite the large number of different Value Repositories cited by the Panel members.

Round 2 also shows the entry of some new Value Repositories in the top 15 list with hardly any significance in Round 1 (e.g. "Brand", "Innovation", "Safety and security", "Alliances") and the drop of other highly cited Value Repositories (e.g. "Scheduling", "Procurement", "Relationships with stakeholders", "Digital channels"). This process of entries/exits is characteristic of communities sharing aggregated knowledge and building consensus.

Finally yet importantly, let us recall now that the top 10 Constraints and the top 15 Value Repositories are the only ones qualifying for the next rounds of the Delphi method. All other Constraints and Value Repositories, although also important, had to remain excluded from further analysis.

Value Repositories	Frequencies	
	Round 1	Round 2
Network	5	17
People and talent	3	16
Revenue management	2	16
Management/Leadership	2	15
Capacity management	6	14
Corporate culture	3	14
Customer experience	4	13
Alliances	2	12
Brand	2	12
Innovation	1	12
Distribution strategy	2	11
Safety and security	1	11
Customer-centric proposition	2	10
Information management	5	10
Process and cost optimization	3	10

Table 6. Comparison of top 15 Value Repositories, Round 1 vs Round 2

DELPHI ROUND 3 ANALYSIS

Based on the top 10 Constraints and top 15 Value Repositories determined in Round 2, the Delphi method continued on to ask the Panel members the following questions:

- Q1: "How do the 10 consensus value constraints impact on the 15 consensus value repositories?"
- Q2: "How are the 15 consensus value repositories interlinked and how they impact on each other?"
- Q3: "How do the 15 consensus value repositories impact on airlines' operating margin?"

What follows is the analysis of the responses given to these questions by the Panel members. For the sake of clarity, we have used a heat-map like plot, which graphically displays the **most cited level of strength** of the interconnections.

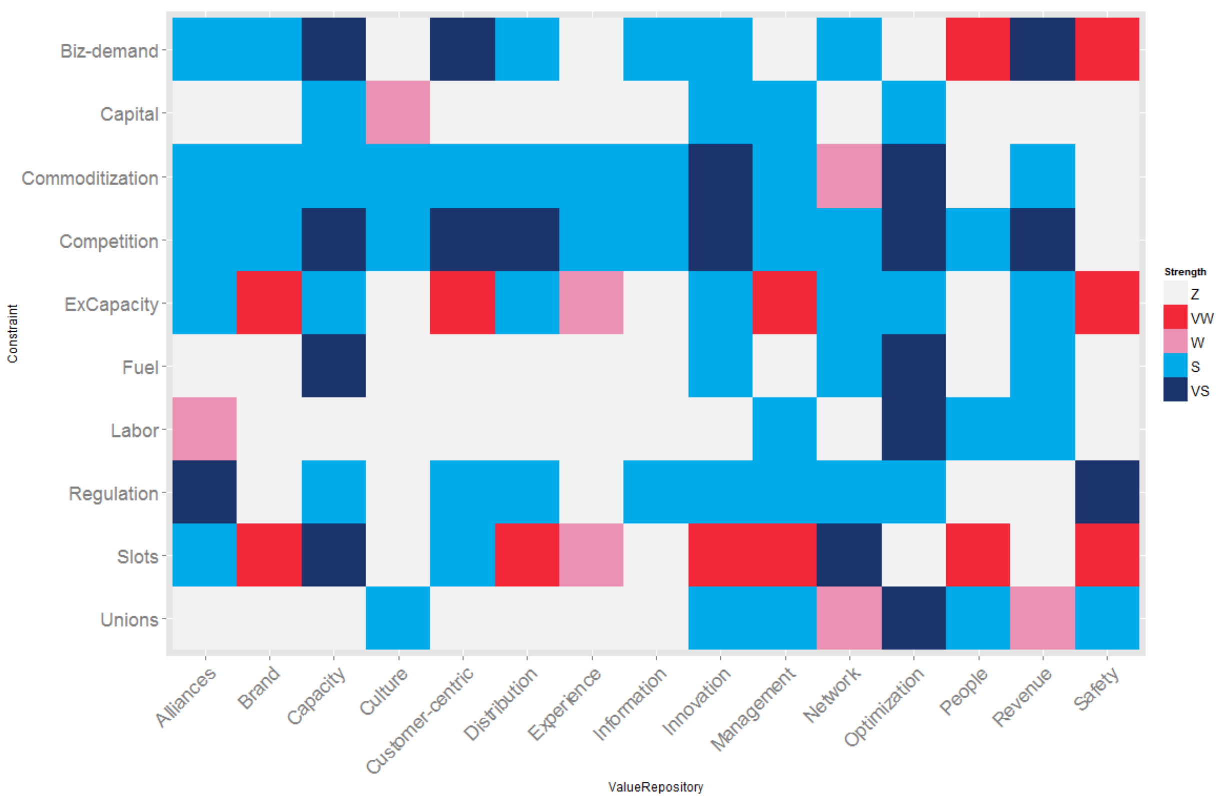
Note that the term "interconnectedness" contains five levels of strength represented by colors: dark blue for "Very Strong", light blue for "Strong", pink for "Weak", red for "Very Weak", and white for "Zero" interconnectedness. For example, the interconnectedness between "Biz-demand"

(Constraint) and "Safety and security" (Value Repository) is most frequently cited by Panel members as "Very Weak", thus coloring in red color.

Interconnectedness between Constraints and Value Repositories

The analysis of the responses to Q1 shows a wide dispersion in the most cited strength of the interconnections between Constraints and Value Repositories. This is visually apparent by the fact that none of the levels of strength (colors), as displayed in Figure 3, is predominant in the heat-map plot.

It is worth noting that constraints such as "Fuel cost", "Capital intensity", and "Labor costs", although they are of some of the most important constraints of all, present a high number of "Zero" interconnections. In other words, although they are key Constraints to value creation, they are weakly connected to Value Repositories.



(*) Z: Zero, VW: Very Weak, W: Weak, S: Strong, VS: Very Strong

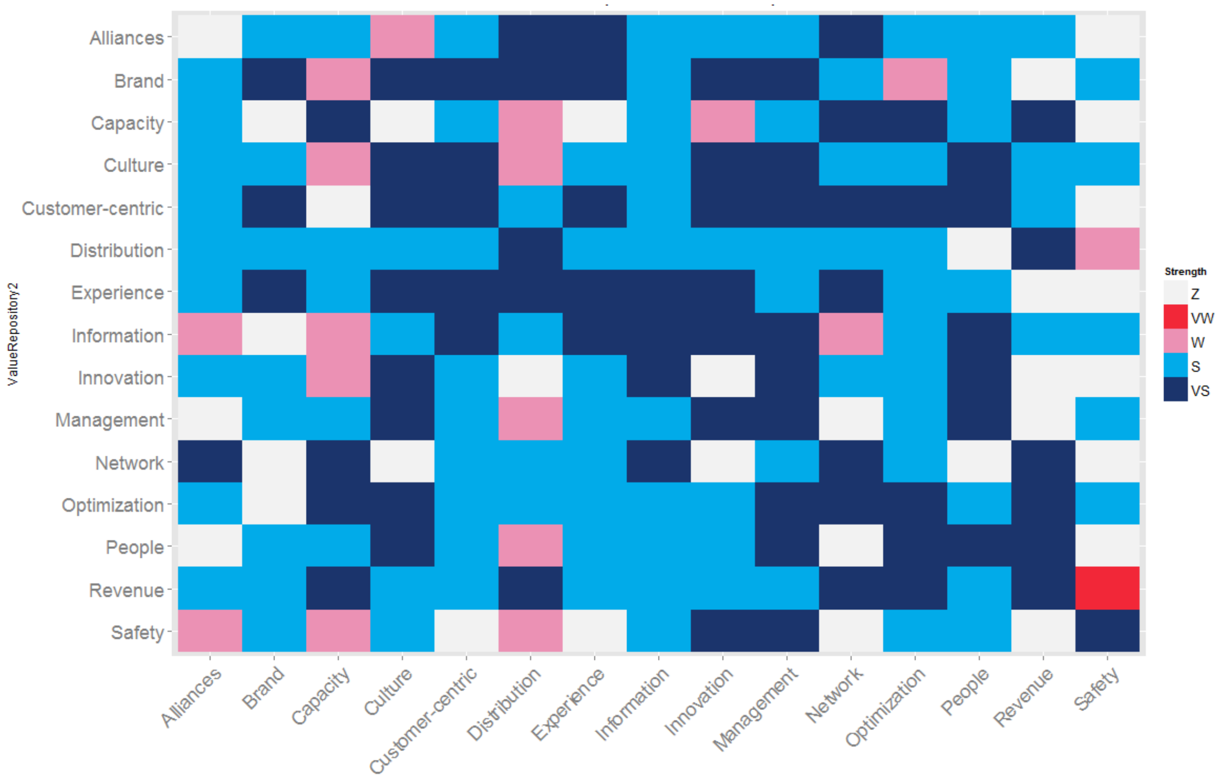
Figure 3. Most cited strength of interconnections between Constraints and Value Repositories (Round 3)

This observation contrasts with the mostly "Strong" interconnectedness featured by constraints such as "Commoditized product offering" and "Competition from other airlines". Also worth noting is how "Slot availability" and "Excess capacity" are the constraints with some of the weakest number of interconnections of all.

The analysis from the Value Repositories side shows that only one Value Repository, "Process and cost optimization", has mostly "Very Strong" interconnections with Constraints. On the contrary, "Safety and security" is the Value Repository with (mostly) the weakest interconnections of all Value Repositories.

Interconnectedness among Value Repositories

A quick visual observation from the heat-map plot in figure 4 is the almost total lack of red color, namely "Very Weak" interconnections, with the exception of a single interconnection between "Safety and Security" and "Revenue Management". This adds to the fact that dark blue ("Very Strong") and light blue ("Light Blue") interconnections are the predominant in the plot.



(*) Z: Zero, VW: Very Weak, W: Weak, S: Strong, VS: Very Strong

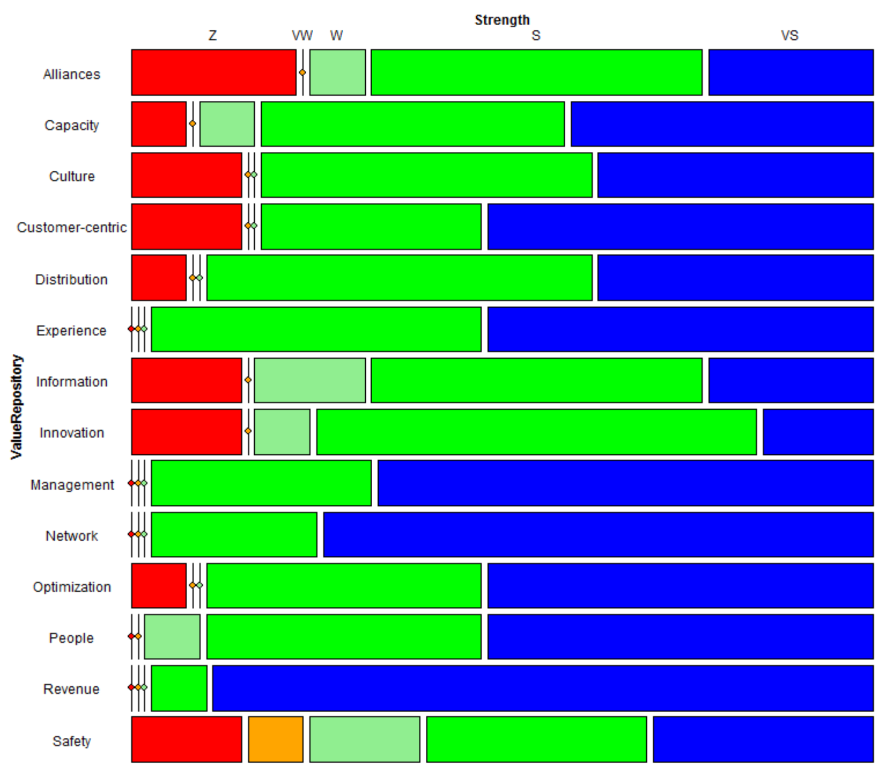
Figure 4. Most cited strength of interconnections among Value Repositories (Round 3)

Some Value Repositories are particularly worth noting for their high strength of interconnections. This is the case of "Customer Experience" and "Customer-centric proposition", which mostly present "Very Strong" interconnectedness with other Value Repositories. Other Value Repositories such as "Distribution Management", "Process and cost optimization", and "People and talent", also stand out for its "Strong" level of interconnectedness.

Interconnectedness between Value Repositories and Operating Margin

Panel members' responses to the question of interconnectedness between Value Repositories and Operating Margin mostly reflect, without exception, either a "Very Strong (VS)" or a "Strong (S)" interconnectedness with airlines' Operating Margin. This fact can be visually observed in figure 5 by noting the preponderance of the green and blue color bars.

It is worth highlighting the very strong interconnectedness assigned by Panel members to Value Repositories such as "Revenue Management", "Network" and "Management/Leadership", not to mention the "Strong" interconnectedness given to "Innovation", "Alliances", and "Distribution Management", to name just a few examples.



(*) Z: Zero, VW: Very Weak, W: Weak, S: Strong, VS: Very Strong

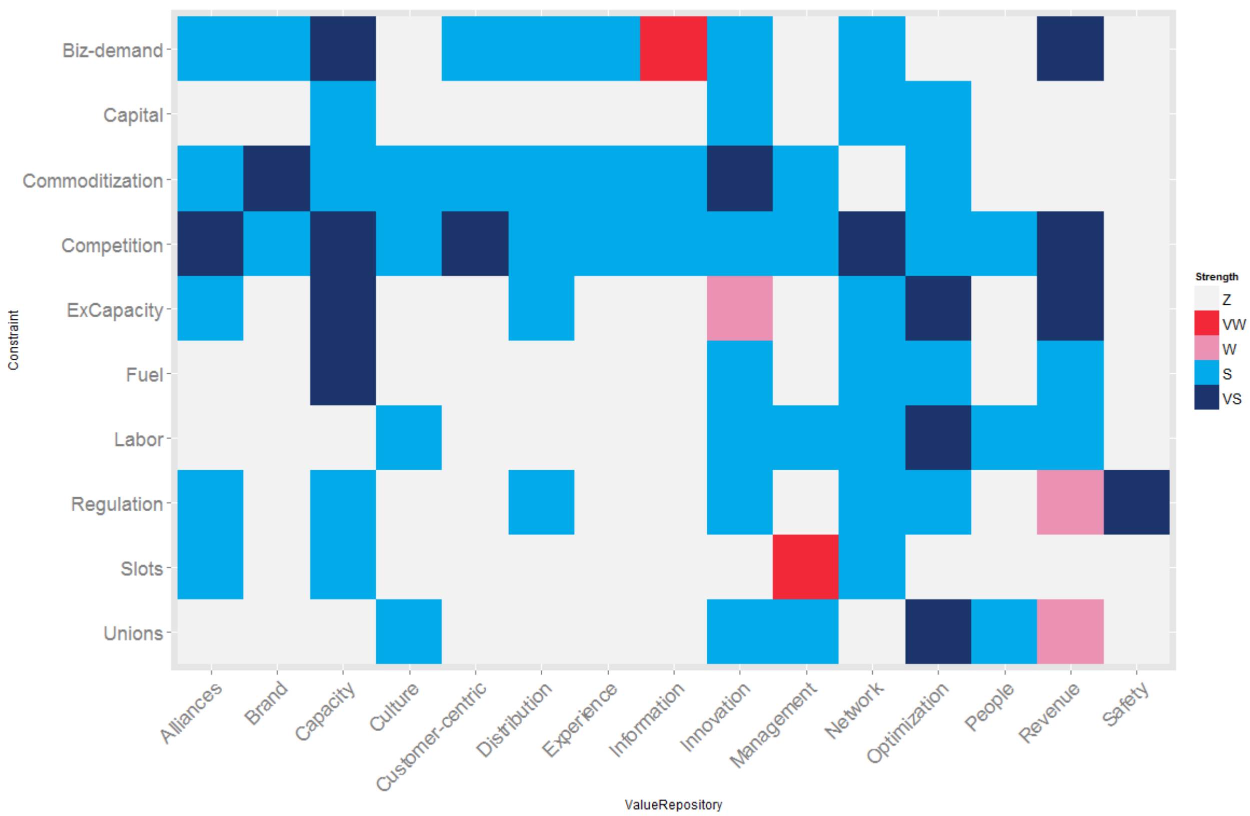
Figure 5. Most cited strength of interconnectedness between Value Repositories and Operating Margin (Round 3)

DELPHI ROUND 4 ANALYSIS

Interconnectedness between Constraints and Value Repositories

The comparative analysis of Panel members' responses on the interconnectedness between Constraints and Value Repositories in rounds 3 and 4, lead us to conclude the following:

- There is a decrease in the number of interconnections cited as "Very Weak". Visually this is reflected by the lower number of red rectangles shown in the heat-map plot (figure 6)
- The number of interconnections cited as "Zero" have moderately increased from Round 3 to Round 4, therefore many of the interconnections with the highest strength have lost momentum
- Those interconnections cited as "Strong" and "Very Strong" by Panel members in Round 4 had practically the same strength in Round 3.



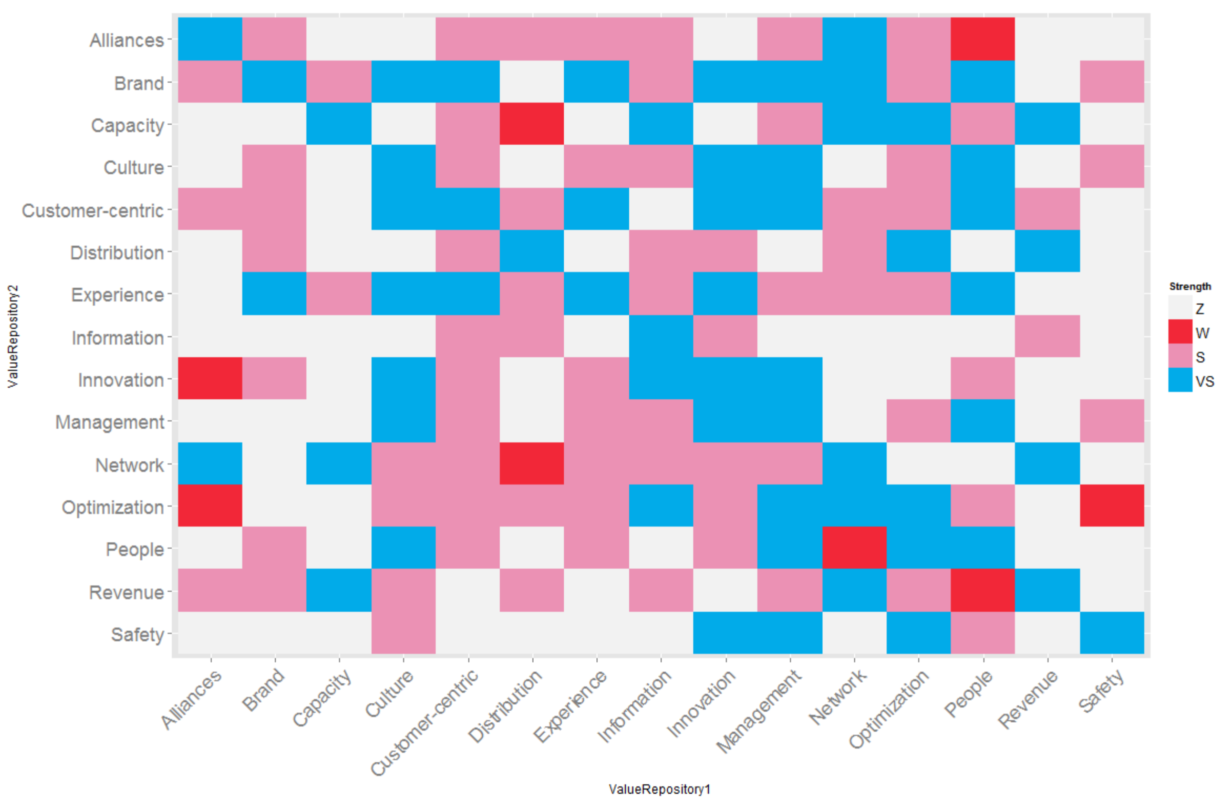
(*) Z: Zero, VW: Very Weak, W: Weak, S: Strong, VS: Very Strong

Figure 6. Most cited strength of interconnectedness between Constraints and Value Repositories (Round 4)

Therefore, by comparing the results obtained in rounds 3 and 4, we may conclude that the Panel members have fundamentally reached a broad consensus on the interconnections with a "Strong" and "Very Strong" level of strength. Similarly, the Panel members have extensively reduced the strength of a good number of the interconnections cited as "Weak " and "Very Weak" in Round 3, moving them to a "Zero" level of interconnectedness in Round 4. This is perfectly consistent with the "experts consensus" process driven by the Delphi method.

Interconnectedness among Value Repositories

Round 4 analysis of the interconnectedness among Value Repositories reflects a remarkable change with respect to Round 3. The most significant evidence of this change is the disappearance of the interconnections mostly cited as "Very Strong" (dark blue color) by the Panel members, whereas the predominant most cited strength has become "Strong" (pink color), as can be clearly observe in figure 7.



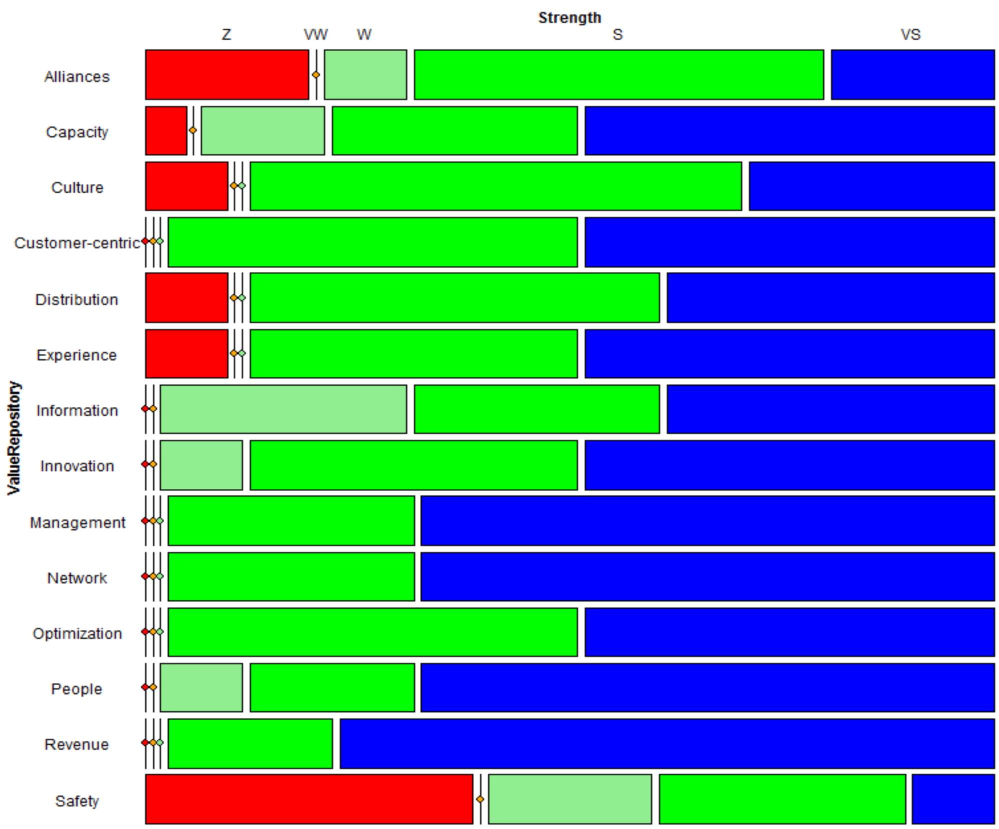
(*) Z: Zero, VW: Very Weak, W: Weak, S: Strong, VS: Very Strong

Figure 7. Most cited strength of interconnectedness among Value Repositories (Round 4)

Also worth noting is the growth in the number of "Zero" (non-existent) interconnections among Value Repositories with respect to Round 3, not to mention the increase in the interconnections mostly cited as "Very Weak".

Interconnectedness between Value Repositories and Operating Margin

Round 4 responses to the interconnectedness between Value Repositories and Operating Margin mostly reveal an increase in the strength of these interconnections with respect to Round 3. As we can observe in figure 8, the proportion of mostly cited "Very Strong (VS)" interconnections has increased almost for all Value Repositories. The only exceptions being the interconnections of "Alliances", which maintains the same strength as in Round 3, and of "Safety and Security", which is now mostly cited now as a "non-existent" interconnection by Panel members.



(*) Z: Zero, VW: Very Weak, W: Weak, S: Strong, VS: Very Strong

Figure 8. Most cited strength of interconnectedness between Value Repositories and Operating Margin (Round 4)

Chapter 2: Value Network Analysis

With the data on the key structural components and interconnectedness of the airlines' value creation engine gathered, the image of a network is a natural one to use next, especially as we try to capture the components of the system and their interconnectedness (Kolaczyk 2009). Notwithstanding the foregoing, the term "network" is one used ambiguously and in a variety of ways (i.e. as a graph, as a collection of interconnected things). In this project, we used the term "network" in its most general sense to refer to a graph representing such a network, or simply a "network graph".

With no intention to dig too deep into the science of "network analysis", it is worth, however, to provide the reader with some convincing reasons to become familiar with networks. One of the main reasons is in line with the recent explosion of interest in network-based approaches to modelling and analysis of complex systems. Much of the impetus for this growth derives from a pervasive emphasis across the sciences on understanding how the interacting behaviors of constituent parts of a whole system lead to collective behavior and systems-level properties or outcomes. Moreover, this network-based perspective has been found useful across a diverse range of disciplines such as engineering, finance, marketing, political science, public health, etc.

Among the many methods provided by modern "state-of-the-art" network analysis, the one we used in the project had to do with the descriptive analysis of data. This approach primarily involved the visualization and numerical characterization of the airlines' value creation network. Specifically, the research team tried to construct a visual summary of the airlines' value creation engine, which in turn led to combining a number of important aspects of the data collected in the Delphi survey in one single diagram. Under this approach, a graph was used to represent the network, with vertices corresponding to the Constraints, the Value Repositories, and the Operating Margin, and edges, to the interconnection between pairs of vertices.

VISUALIZING THE AIRLINES' VALUE CREATION NETWORK (AVCN)

In this section, we address the problem of displaying the airlines' value creation network (AVCN). In other words, we consider drawing a graph that can help us visualize the such network and extract some descriptive conclusions.

First, we start by looking at a number of ways to lay out our AVCN graph, followed by some ways to decorate such layout using a combination of mathematics, human aesthetics, and algorithms. Figure 9 offers a first approach to the graph of the AVCN, considering different levels of strength of interconnectedness between the Constraints, the Value Repositories and the Operating Margin.

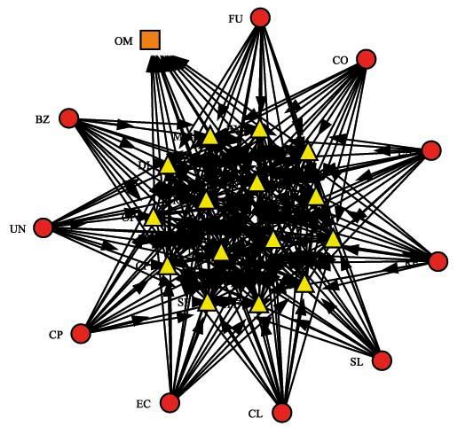
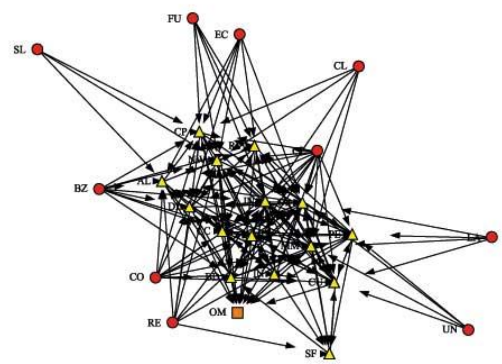
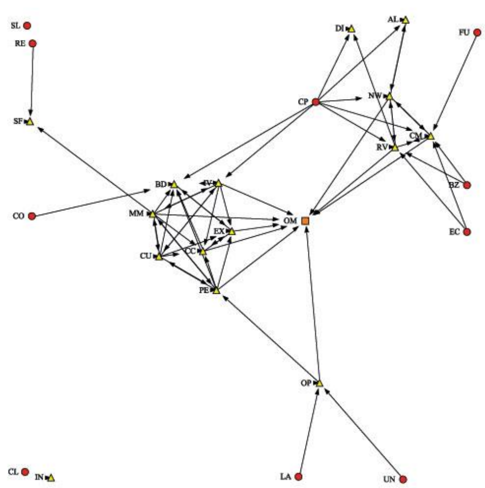
<table>
<tr>
<td>
</td>
<td>Type: directed-weighted
Layout: Fruchterman-Reingold
Colors: Red-circle:constraints, Yellow-triangle: value repositories, Orange-square: operating margin
Nodes: 26
Edges: 390
15 self-loops
Degree: 29.99
All existing interconnections are displayed</td>
</tr>
<tr>
<td>
</td>
<td>Type: directed-weighted
Layout: Fruchterman-Reingold
Colors: Red-circle:constraints, Yellow-triangle: value repositories, Orange-square: operating margin
Nodes: 26
Edges: 238
15 self-loops
Degree: 18.31
Only Strong & Very Strong interconnections are displayed</td>
</tr>
<tr>
<td>
</td>
<td>Type: directed-weighted
Layout: Fruchterman-Reingold
Colors: Red-circle:constraints, Yellow-triangle: value repositories, Orange-square: operating margin
Nodes: 26
Edges: 77
15 self-loops
2 isolated nodes
Degree: 5.92
Only Very Strong interconnections are displayed</td>
</tr>
</table>

Figure 9. The AVCN on varying levels of strength of interconnectedness

A first impression that the reader may form when looking the AVCN at the top of figure 9, is that of a heavily connected graph, where everything seems highly connected to everything else. Actually, this "clogged" graph makes it visually difficult for the reader's eye to discern between the links. No doubt, the AVCN graph at the top does not help much if we seek clarity, nor does it allow us to infer valuable conclusions from a visual standpoint, other than the AVCN is inherently complex.

Therefore, if we want to be able to extract some conclusions of the type of what are the key nodes or key interconnections in the AVCN, one possible solution is to discriminate the number of interconnections by their strength. The graphs in the middle and at the bottom of figure 9 display only the links of higher strength, with the graph at the bottom showing only those links cited as "Very Strong" by the Panel members. Specifically, the latter graph is made up of the same 26 nodes as the graph at the top, but with only 77 links. This is a number well below the 319 links of the graph at the top. As we can see, the AVCN becomes now much clearer now to our eyes.

This significant reduction in the number of links in the AVCN graph enables us to outline some valuable perceptions:

1. Some Value Repositories are more critical than others when it comes to value creation: Revenue management, Capacity management, Customer experience, Customer-centric proposition, Innovation
2. Some Value Repositories are much more influenced by Constraints than others: Process and cost optimization, Brand, Revenue management, Capacity management
3. Some Constraints are much less relevant to value creation than we might have initially thought: Slots availability and Capital intensity
4. Just nine different Value Repositories mostly affect Operating Margin.

At this point, the use of some network scaling method is of great help where it comes to address the above observations more carefully and understand the underlying organization of the AVCN. Specifically, by using a Pathfinder Network Scaling method we are able to reconstruct the AVCN-building process, as shown in figure 10 below, where the links in the graphs are determined by the patterns of dissimilarities between the Constraints, the Value Repositories and the Operating Margin.

Figure 10 contains three graphs simulating the motion through three different stages in the AVCN-building process (from upper left to bottom center). Each graph incrementally assigns higher distances (dissimilarities) among the set of links and the set of nodes upon their relative positions.

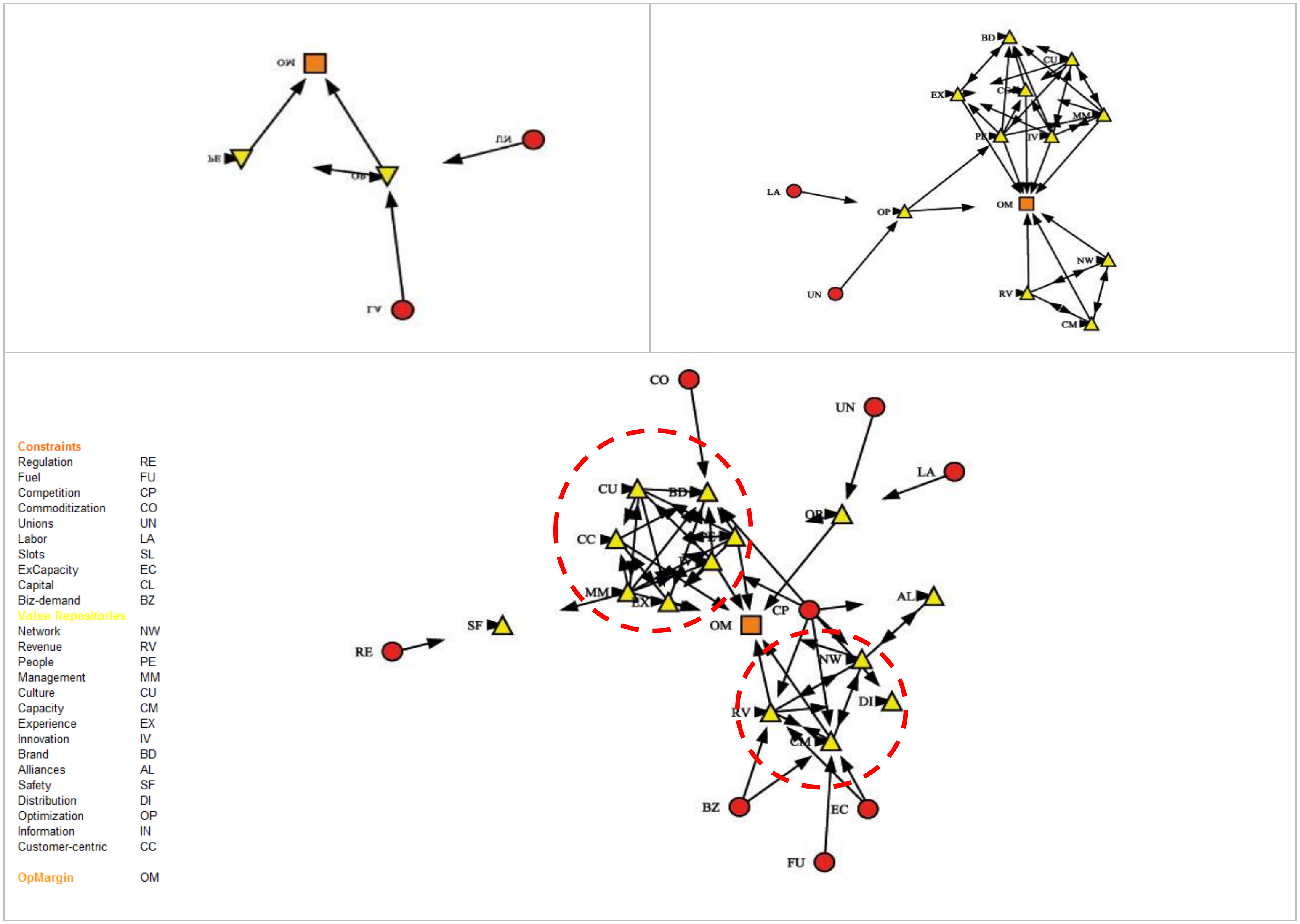


Figure 10. The AVCN-building process

The graphs so created enable us to explain the underlying organization of the AVCN in a highly schematic way, as well as to visually determine its key components and interconnectedness with the airlines' Operating Margin. Furthermore, we are able to graphically visualize the clustering processes growing around the airlines' Operating Margin in the form of two groups of Value Repositories marked with two red circles (see figure 10).

The analysis of the AVCN graph can be taken one step further by using Hierarchical Clustering (HC) techniques and its resulting tree-like dendrogram (see figures 11 and 12). The HC algorithm produces, as the name indicates, an entire hierarchy of nested partitions in the structure of Value Repositories, comprising the following clusters when the strength of the interconnections is either "Strong" or "Very Strong":

- Cluster 1 (Red), containing two Value Repositories: Information Management and Process and cost optimization
- Cluster 2 (Green), containing six Value Repositories: Network, Revenue management, Capacity management, Alliances, Distribution management, and Customer-centric proposition
- Cluster 3 (Blue), containing seven Value Repositories: People and talent, Management-Leadership, Safety and security, Corporate culture, Innovation, Brand, and Customer experience.

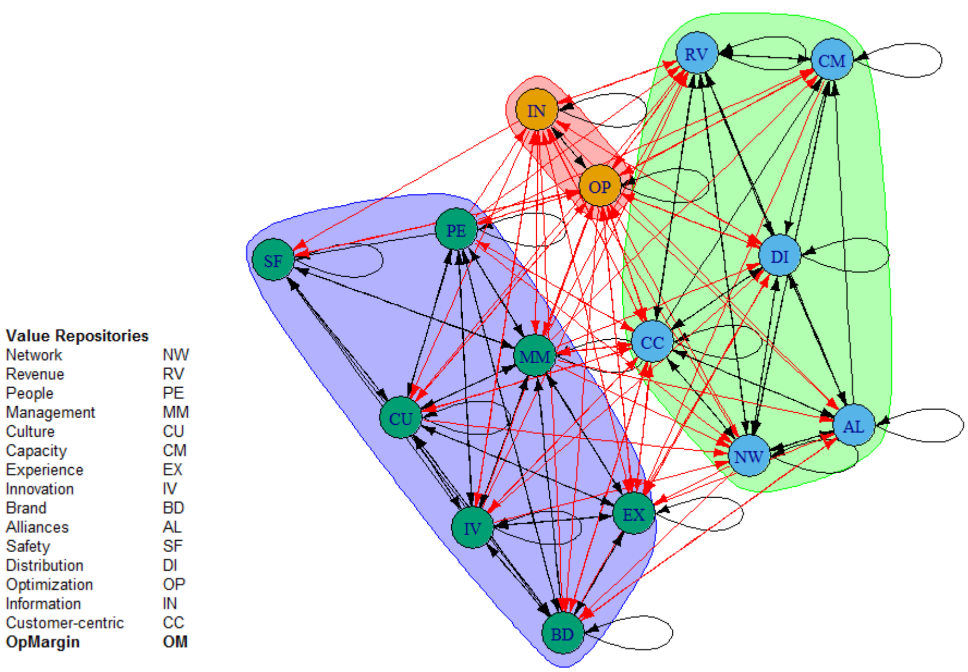


Figure 11. Clusters growing in the AVCN

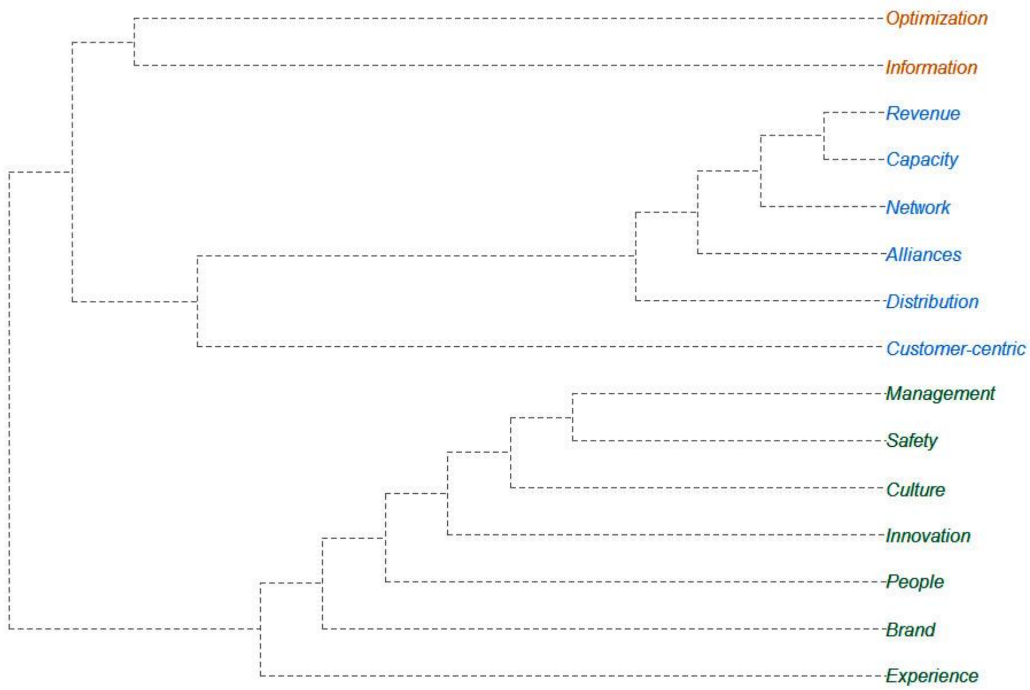


Figure 12. AVCN clusters tree-like dendrogram

In the figure above, the HC algorithm takes the distance information (dissimilarity) between the Value Repositories and links the pairs of them that are close together. This process is repeated to link these newly formed clusters to each other and to other Value Repositories to create bigger clusters, until all of them are linked together in a hierarchical tree. The height of the links indicates the distance between the Value Repositories.

WHAT VALUE REPOSITORIES ARE THE MOST IMPORTANT IN THE AVCN?

To determine the most important or influential Value Repositories within the AVCN, we use a network centrality measure known as Eigenvector centrality. This measure is based on the notion of “status” or “rank” of the Value Repositories, and seeks to capture the idea that the more central the neighbors of a Value Repository is, the more central that Value Repository itself is.

Eigen centrality is therefore an approximate measure of the importance of each Value Repository in the AVCN, and its measures are presented in the table 7 below. According to these measures, we may conclude that the “Customer-centric proposition” is the most influential/important Value Repository of all.

Based on this result, we assign a maximum score of one to the importance of "Customer-centric proposition" and calculate the importance of each subsequent Value Repository with respect to the former. Note how the customer-related Value Repositories (including Brand, Customer experience) are among the highest ranked Value Repositories in the AVCN, whereas "Safety and security" is the less important Value Repository.

Value Repository	Importance
Customer-centric proposition	100
Brand	98
Customer experience	95
Revenue management	94
Network	88
Process and cost optimization	87
Distribution management	86
Corporate culture	80
Alliances	79
Management (Leadership)	79
Capacity management	78
People and talent	78
Information management	73
Innovation	70
Safety and security	50

Table 7. Most important/influential Value Repositories in the AVCN

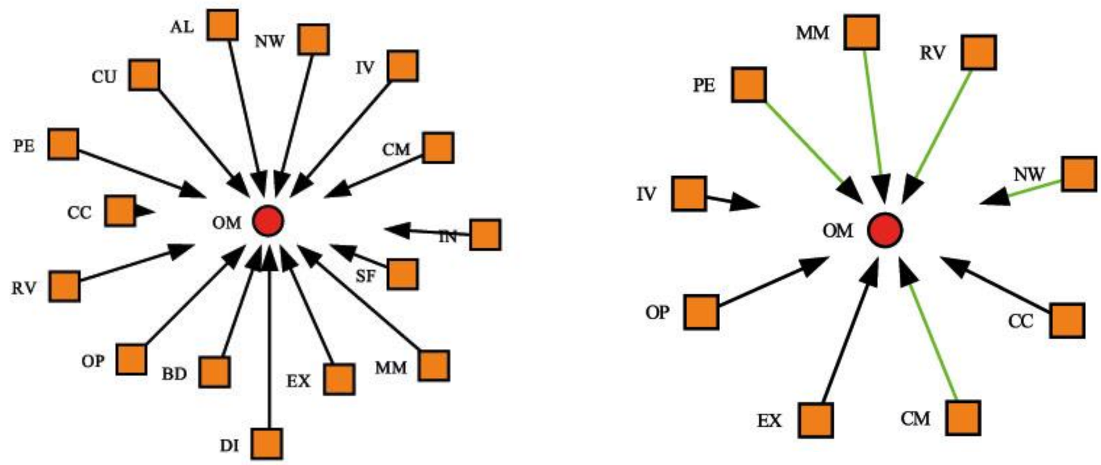
WHAT AFFECTS MOST THE OPERATING MARGIN?

Up to this point, we have been able to identify the nine Value Repositories affecting airlines' Operating Margin (see figure 10). Now we are interested in figuring out what those Value Repositories are, and what the strength of the interconnection between each Value Repository and the Operating Margin is.

We resort to the AVCN graph to visually determine the interconnections having an impact on the airlines' Operating Margin. As we can see in the graph on the left in figure 13, all top 15 Value Repositories identified by the Panel members have some kind of interconnection with the Operating Margin. However, what varies from one Value Repository to another is the strength of the interconnectedness.

In contrast, the graph on the right shows that only five Value Repositories have a "Very Strong" interconnectedness: Network, Capacity management, Revenue management, Management

(Leadership), and People and talent; and those with a “Strong” interconnectedness come to four: Innovation, Process and cost optimization, Customer experience, and Customer-centric proposition.



Network (NW), Revenue management (RV), People and talent (PE), Management/Leadership (MM), Corporate culture (CU), Capacity management (CM), Customer experience (EX), Innovation (IV), Brand (BD), Alliances (AL), Safety and security (SF), Distribution management (DI), Process and cost optimization (OP), Information management (IN), Customer-centric proposition (CC), Operating Margin (OM)

Figure 13. *Left:* Value Repositories connecting with the Operating Margin. *Right:* Value Repositories with “Strong” (black arrows) and “Very Strong” (green arrows) interconnectedness.

Chapter 3: Modelling and Simulation

The previous chapters in this report provided us with the key data needed to build the airlines' value creation network, or AVCN (Chapter 1), and the tools to analyze the interconnectedness among the AVCN components and between these and the Operating Margin (Chapter 2). Now it is time to address the question on how to convert the AVCN into a practical model that enables airlines' management teams to simulate futures value creation scenarios and anticipate the effects on the Operating Margin.

The technique used for modelling and simulation is known as Fuzzy Cognitive Map (FCM). FCMs enable us to model the properties of the AVCN and to determine possible future states of the AVCN and instabilities. For a more detailed information of how FCMs work, please refer to Appendix B.

In particular, FCMs are most useful when other more refined methods fail. This usually occurs in broad knowledge domains with only partial experts, in situations with little or no relevant historic data, and in cases where most information is qualitative and fuzzy. FCM models use a mix of qualitative and quantitative approaches, consider multivariate interactions that lead to nonlinearities, and aim to make implicit assumptions (or mental models) explicit (Jetter, Kok 2014). All these special properties of FCMs seem to match perfectly our modelling and simulation needs.

Upon modelling our AVCN using a FCM, the subsequent simulation tasks are performed by studying how uncertainty in the outcome variable (Operating Margin) can be attributed to different changes in the sources of inputs (Value Repositories). In other words, this simulation technique, also known as sensitivity analysis, refers to the understanding of how the interconnectedness parameters of the AVCN influence the optimization of the Optimization Margin.

It is worth noting that the ultimate goal of our FCM is not to create a ''true'' model of the AVCN, but a useful and formalized description of the perception of a group of experts in the airline industry. The benchmark for our FCM ''validation'' should therefore be if it adequately describes what the Panel members know about value creation in airlines, which would otherwise require them to take an active role in practical model testing.

THE AVCN-FCM MODEL

The construction of our AVCN-FCM model is a multi-step process that captures causal knowledge in the form of a network (or map), formally describes the AVCN as an adjacency matrix, and applies neural network computation to refine the model and analyze model results.

For the purpose of our research, the FCM model construction framework consisted of three steps:

1. Knowledge capture (Step 1). This process step includes all the elicitation activities that lead to elaborate one individual (weighted) causal cognitive map describing the AVCN for each Panel member
2. Detailed design of the FCM model (Step 2), which includes the aggregation of the individual causal cognitive maps into one single relational adjacency matrix, and the implementation of the FCM inference engine
3. Simulations and interpretation of results (Step 3). This is accomplished by choosing the input vectors and carrying out a sensitivity analysis on the basis of real-case AVCN scenarios.

Step 1

As seen in Chapter 1, the Delphi method is the technique used in this research project to capture knowledge from the Panel members. The Delphi method therefore encompasses all the elicitation activities needed to produce the individual cognitive maps prior to the construction of the final AVCN-FCM model. Furthermore, as far as the analysis of the data captured through the Delphi method is complemented with the network analysis presented in Chapter 2, we can make ourselves a more precise idea of how the AVCN looks like and what the key construction parameters for the FCM model are.

Step 2

In Step 2 we mathematically aggregate the individual cognitive maps from the Panel members in a single integrated AVCN-FCM model. This is accomplished by translating each individual map into square adjacency matrices of the same size. This operation results in a new matrix, the entries of which are the average of the weights of the interconnections assigned by the members.

As you already may know, we used a Likert-type five levels scale of measurement where the Panel members assessed each interconnections as “zero” (0), “very weak” (0.25), “weak” (0.5), “strong” (0.75) or “very strong” (1).

We also incorporated to the adjacency matrix the sign of the causal relation between two components of the AVCN, ranging from “positive” (+1) to “negative” (-1). The sign of the weight indicates positive causality between component A and component B, which means that an increase of the value of component A will cause an increase in the value of component B, and a decrease of the value of component A will cause a decrease in the value of component B. When there is negative causality between two components, then the increase in the first component means the decrease in the value of the second component and the decrease of component A causes the increase in value of B. When there is no relationship between components, then the weight is zero. The strength of the weight indicates the degree of influence between component A and component B.

The resulting AVCN-FCM adjacency matrix is shown in table 8.

Nodes	#	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Regulation	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.75	0.5	0.00	0.63	0.00	0.75	0.00	-0.75	0.00	-0.75	1.00	-0.75	0.75	0.25	-0.5	0.00
Fuel	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.75	0.63	0.00	0.00	0.00	1.00	-0.13	0.75	0.00	0.00	0.00	0.13	0.75	0.13	0.5	0.00
Competition	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-1.00	-1.00	0.75	0.75	0.75	1.00	0.75	0.88	0.88	1.00	0.00	0.88	0.75	0.75	0.75	0.00
Commoditization	4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.5	0.5	0.13	0.75	0.63	0.75	-0.75	0.75	0.88	0.75	0.00	0.75	0.75	0.75	0.75	0.00
Unions	5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.5	0.38	-0.75	-0.75	-0.75	-0.13	0.13	-0.5	0.25	0.25	0.38	0.00	-1.00	0.13	0.00	0.00
Labor	6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.5	0.5	0.75	0.75	0.75	-0.38	-0.25	-0.38	0.00	0.5	0.00	0.00	-0.88	0.00	0.00	0.00
Slots	7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.13	0.13	0.25	0.13	0.75	0.25	0.25	0.00	0.63	0.00	0.25	0.25	0.00	0.25	0.00
ExCapacity	8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.75	-1.00	0.00	0.38	0.25	-1.00	0.38	0.5	0.13	0.75	0.00	0.63	0.75	0.00	0.13	0.00
Capital	9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.75	0.00	0.00	0.63	0.13	0.75	0.13	0.75	0.00	0.00	0.00	0.00	0.75	0.00	0.00	0.00
Biz-demand	10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	1.00	0.00	0.13	0.38	1.00	0.75	0.75	0.75	0.75	0.00	0.75	0.25	0.38	0.75	0.00
Network	11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.5	0.00	0.25	1.00	0.75	0.5	0.75	1.00	0.00	0.75	0.75	0.5	0.75	1.00
Revenue	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.5	0.5	0.25	1.00	0.00	0.00	0.00	0.75	0.00	1.00	0.75	0.75	0.75	1.00
People	13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.75	1.00	1.00	1.00	0.75	1.00	0.75	1.00	0.5	0.75	0.00	0.75	0.75	1.00	1.00
Management	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.75	1.00	1.00	1.00	0.75	0.75	1.00	1.00	0.75	1.00	0.75	0.75	0.75	1.00	1.00
Culture	15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.75	1.00	1.00	1.00	0.00	1.00	1.00	1.00	0.00	0.75	0.25	0.75	0.5	1.00	0.75
Capacity	16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.25	0.00	0.00	1.00	0.75	0.00	0.5	0.00	0.25	0.75	0.75	0.00	0.00	1.00
Experience	17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.5	0.5	0.75	0.75	0.75	0.00	1.00	0.75	1.00	0.75	0.00	0.75	-0.75	0.75	1.00	0.88
Innovation	18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.75	0.75	1.00	1.00	0.5	1.00	1.00	1.00	0.5	0.75	0.75	0.75	0.75	1.00	0.88
Brand	19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.5	0.75	0.75	0.75	0.5	1.00	0.75	1.00	0.75	0.5	0.75	0.00	0.00	0.75	0.75
Alliances	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.75	0.00	0.00	0.5	0.75	0.5	0.5	0.75	1.00	0.00	0.75	0.5	0.5	0.75	0.75
Safety	21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.25	0.00	0.75	0.75	0.5	0.00	0.00	0.75	0.00	1.00	0.25	0.75	0.00	0.5	0.5
Distribution	22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.75	0.25	0.5	0.25	0.5	0.75	0.5	0.5	0.75	0.00	1.00	0.75	0.75	0.75	0.75
Optimization	23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.5	0.75	1.00	0.75	0.75	0.75	0.75	0.00	0.75	0.75	0.75	0.75	1.00	0.75	0.75	0.88
Information	24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.75	0.5	0.75	0.75	0.5	0.75	0.75	0.75	0.75	0.75	0.75	0.75	1.00	0.75	0.75
Customer-centric	25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.75	0.75	0.75	0.75	0.75	1.00	0.75	1.00	0.75	0.00	0.75	0.75	0.75	1.00	0.88
OpMargin	26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 8. FCM adjacency matrix

Generally, the AVCN-FCM model will calculate the value of each component by computing the influence of all other components to the specific components. This is done by applying the calculation in the following equation:

$$x_i(t) = f\left(\sum_{\substack{j=1 \\ j \neq i}}^{n} x_j(t-1) w_{ji}\right) \quad (1)$$

Where $x_i(t)$ is the value of component C_i at time t, $x_j(t-1)$ is the value of component C_j at time t-1, w_{ji} is the weight of the interconnection between component C_j and component C_i, and f is the sigmoid function: $f = \frac{1}{1+e^{-\lambda x}}$

Step 3

Step 3 is the stage dedicated to set the initial values of components that feed the model. Once the initial vector has been determined, the AVCN-FCM model can start performing simulations in a series of iterations. At each running step of the FCM, the value of components is recalculated according to (1).

In FCM terminology, a running step is defined as the time step during which the values of the components are calculated. As we have seen in (1), the value of each component is defined by taking all the causal linkage weights pointing to this component and multiplying each weight by the value of the component that causes the linkage, and adding the last value of each component. Then, the sigmoid function is applied and thus the result belongs to the range [0,1].

It is worth noting that input vectors for our AVCN-FCM model can be chosen to reflect a particular value creation setting or policy choice that a management team in a particular company wants to investigate. For the purpose of this research, the research team chose a random input vector in order to generate a Base scenario against which different scenarios could be compared.

SCENARIO SIMULATION

Simulations using the AVCN-FCM model can take place in a variety of ways. For example, we might use a structure assessment test, to compare the AVCN structure with that of a real-world airline, or we might want to conduct an extreme conditions test, namely to test if extreme Constraints and/or Value Repositories values lead to unmanageable airline behavior.

Yet, however valuable these techniques may be, the simulation technique chosen in this research project is the sensitivity analysis (SA). SA, broadly defined, is the investigation of the potential changes in the AVCN components and their impact on the Operating Margin to be drawn from our model. SA is a very helpful tool for decision support, and one of the best methods available to sum up the implications of the AVCN_FCM model.

The SA technique used in this research examines components influence based on the Operating Margin variation while simultaneously changing input parameters. This method is performed by utilizing a random sampling technique to build an input vector and then calculating an output value by applying the equation in (1). Table 9 summarizes the different scenarios tested in the SA.

Scenario #	Goal	Related AVCN Components
1	Assess the impact of a tougher business environment	Regulation Fuel cost Competition from other airlines Labor cost Business travel demand
2	Assess the impact of better customer-oriented processes	Process and cost optimization Customer-centric proposition Innovation Information management Customer experience
3	Assess the impact of more productive assets management	Network Distribution management Capacity management

Table 9. AVCN-FCM simulation scenarios

Base Scenario

The Base scenario refers to a set of basic assumptions on the weight and the sign of the interconnections between the AVCN components and the Operating Margin, which are expected to result in an outcome of reference. From this Base scenario, new variant scenarios (those specified in table 9) can be constructed by changing input values. Once this has been done, the deviation between the variant scenario outcome and the Base scenario outcome is measured and interpreted.

For the inference of the Base scenario, we use random input values as the first input. The inference results for the Base scenario are shown in figure 14. As we can see, after performing the inference for fifty time steps, the model reaches an equilibrium point at which the AVCN state vector does not change anymore.

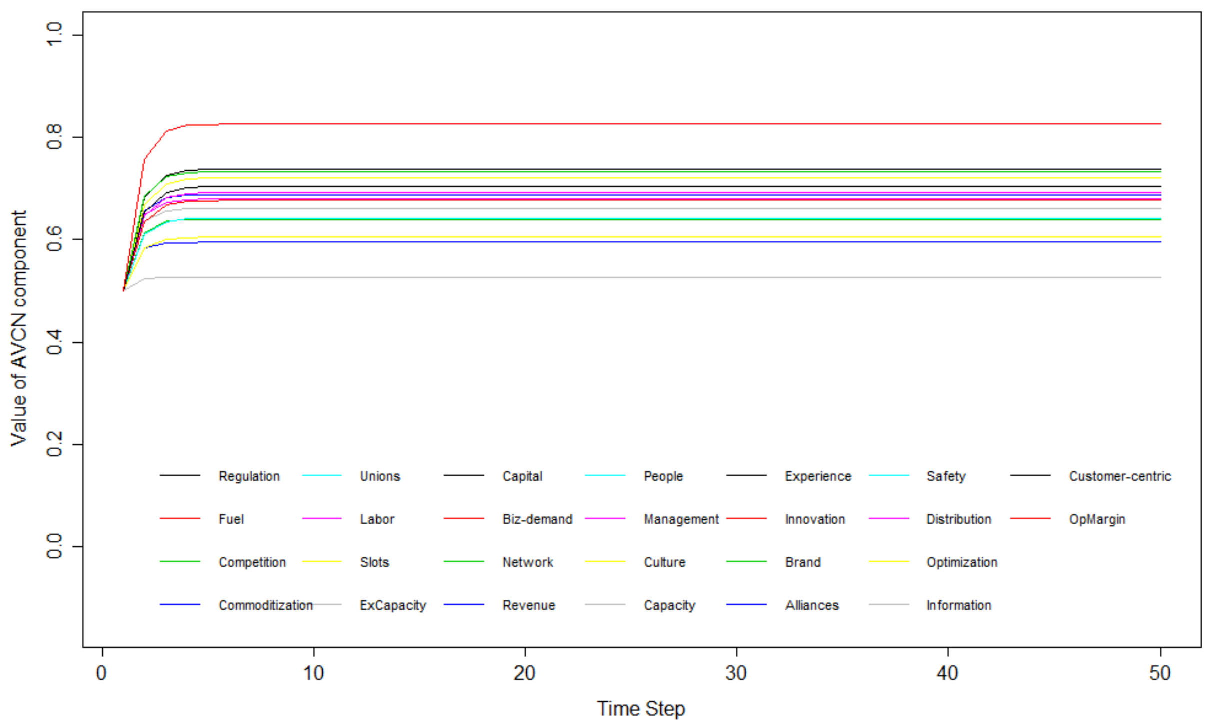


Figure 14. Simulation result for the Base scenario

Specifically, the resulting state vector with which we will compare the remaining simulation variants, are shown in the table 10 below.

Value Repositories					
Network	0.64	Capacity	0.66	Safety	0.64
Revenue	0.69	Experience	0.74	Distribution	0.68
People	0.72	Innovation	0.68	Optimization	0.61
Management	0.69	Brand	0.73	Information	0.53
Culture	0.72	Alliances	0.60	Customer-centric	0.70

Operating Margin	
OpMargin	0.83

Table 10. State vector of AVCN components for the Base scenario

Simulation #1: Tougher Business Environment

This simulation was conducted to assess the impact of a tougher business environment on the AVCN components, including the Operating Margin. In particular, a tougher business environment was defined as one with a more strict regulatory framework, higher resources costs (i.e. fuel and labor costs), higher competition from other airlines, and a lower business travel demand.

For the purpose of the inference, we used as input values the ones contained in table 11, while all other components remained the same as in the Base scenario.

AVCN Component	Input value
Regulation	-0.9
Fuel	-0.9
Competition from other airlines	-0.9
Labor	-0.9
Business travel demand	-0.9

Table 11. Input vector for Simulation #1

The simulation results are displayed in figure 15, with the state vector and the differences with the Base scenario in table 12.

We can see that the Operating Margin is expected to decrease before a tougher business environment, in accordance with airlines' business reality. In this scenario, the drop in the "Capacity management" Value Repository would be the highest of all. This, in turn, would seriously affect the revenue, distribution and the resource-driven value repositories, specially those related to the people (most probably due to layoffs). Furthermore, a tougher business environment would lead to a negative impact on the more customer-oriented value repositories, such as "Brand", "Customer experience" and "Customer-centric proposition", and those dedicated to organizational improvement, such as "Innovation", "Information management" and "Process and cost optimization". In summary, the simulated tougher environment scenario would generate a shock on the viability of the airline.

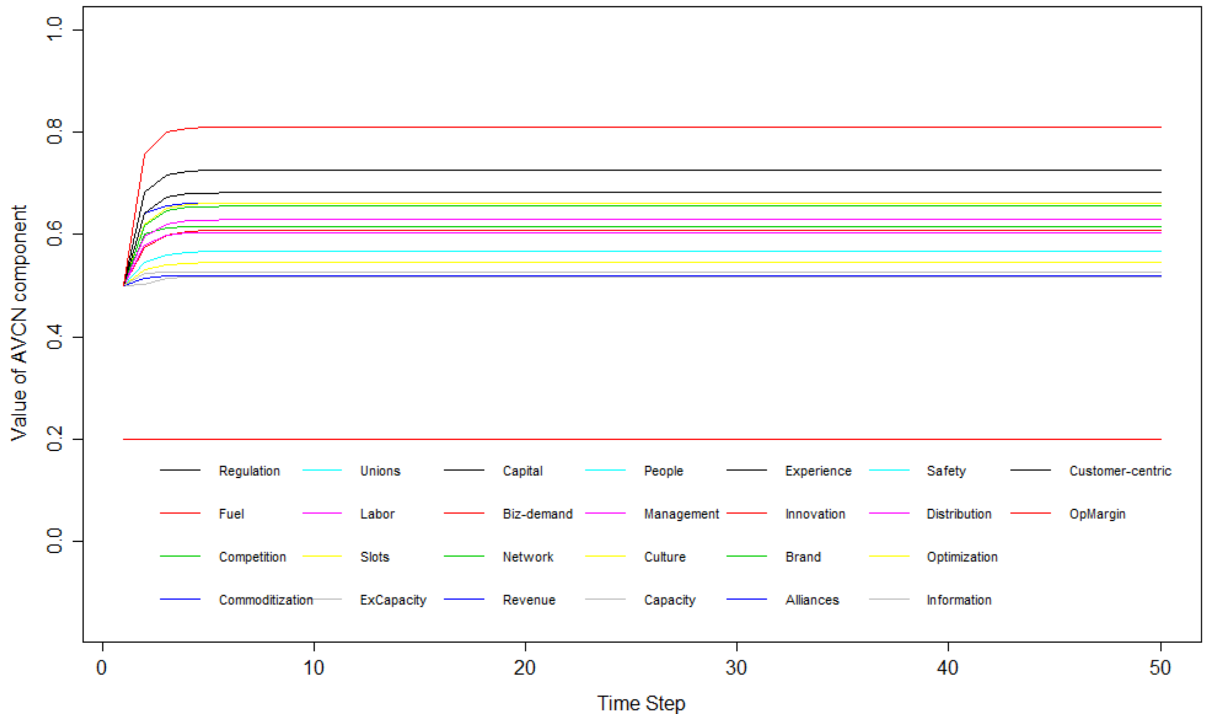


Figure 15. Results for Simulation #1

Value Repositories								
Network	0.56	-12.3%	Capacity	0.46	-30.5 %	Safety	0.57	-11.8%
Revenue	0.60	-12.7%	Experience	0.72	-2.4%	Distribution	0.55	-18.6%
People	0.70	-8.5%	Innovation	0.61	-10.5%	Optimization	0.54	-10.0%
Management	0.63	-9.4%	Brand	0.61	-17.0%	Information	0.53	0.0%
Culture	0.66	-8.5%	Alliances	0.47	-20.3%	Customer-centric	0.64	-9.3%

Operating Margin		
OpMargin	0.80	-3.0%

Table 12. State vector of AVCN components for Simulation #1

Simulation #2: Implementation of Better Customer-oriented Processes

Another simulation was conducted to assess the impact of better customer-oriented processes on the AVCN components and the Operating Margin. To achieve this scenario, we simulated the increase by airlines of the input value of the following Value Repositories with respect to the Base scenario:

- Process and cost optimization
- Innovation
- Customer experience
- Information management
- Customer-centric proposition.

For the purpose of inference, the changes above translated in the following input values that fed the AVCN-FCM model, all other value repositories values remaining the same as in the Base scenario (table 13).

AVCN Component	Input value
Process and cost optimization	0.9
Innovation	0.9
Customer experience	0.9
Information management	0.9
Customer-centric	0.9

Table 13. Input vector for Simulation #2

The simulation results are displayed in figure 16. The outcome vector and the deviations of the AVCN components with the Base scenario are shown in table 14.

As we can see, it is expected that the implementation of better customer-oriented processes would have a positive impact on the airlines' Operating Margin. Moreover, this scenario would affect positively the people-related value repositories (i.e. "People and talent", "Management/Leadership" and "Corporate culture"), in line with what an airline experience management team would also expect, since the role of people in carrying out any customer-oriented policy is key.

Last but not least, this scenario would also affect positively the perception of the brand by consumers, as well as the "Revenue management" and "Distribution management" value repositories, most probably due to the increased business activity generated by more loyal customers.

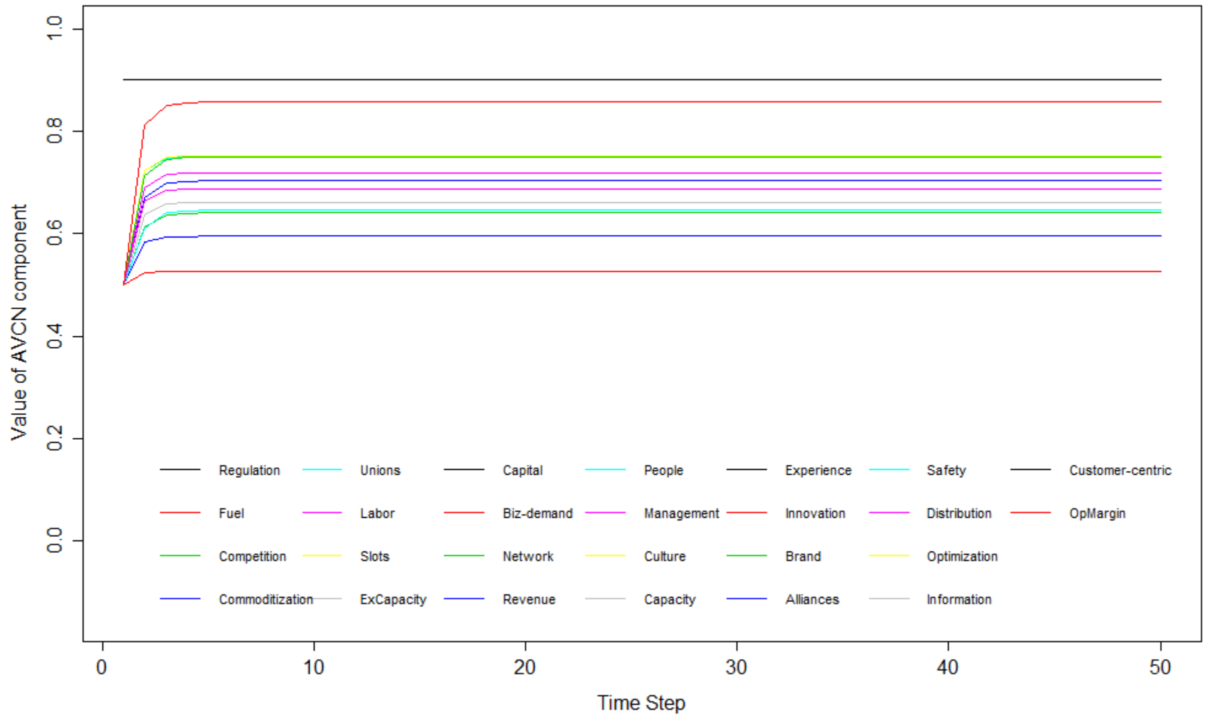


Figure 16. Results for Simulation #2

Value Repositories								
Network	0.64	0.1%	Capacity	0.66	0.1%	Safety	0.64	0.6%
Revenue	0.70	2.2%	Experience	0.90	NA	Distribution	0.68	1.2%
People	0.75	4.3%	Innovation	0.90	NA	Optimization	0.90	NA
Management	0.72	4.0%	Brand	0.75	2.4%	Information	0.90	NA
Culture	0.75	4.3%	Alliances	0.59	0.0%	Customer-centric	0.90	NA

Operating Margin		
OpMargin	0.86	4.0%

Table 14. State vector of AVCN components for Simulation #2

Simulation #3: More Productive Assets Management

The third simulation was conducted to analyze the impact of increasing the values of the asset management related value repositories, namely "Network", "Revenue management", "Capacity management" and "Distribution management".

The analysis of the simulation results (figure 17) and the final AVCN state vector (table 15) show the positive impact of the simulation on the Operating Margin. This outcome is in line with what an experienced airline management team would also expect from business reality.

However, the impact of Simulation #3 changes are rather limited in scope when compared to the impacts of Simulation #2. As we can observe in table 15 below, Simulation #3 state vector shows many value repositories not really affected by the changes in the input vector, which would be in line with airlines' business reality.

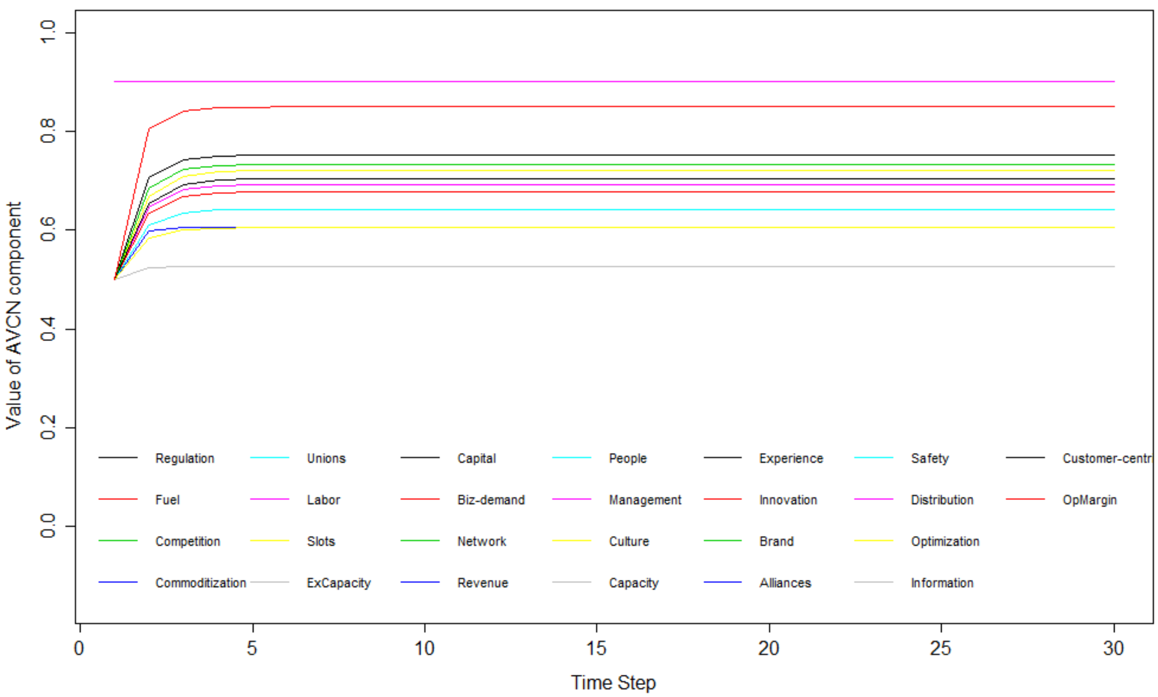


Figure 17. Results for Simulation #3

Value Repositories								
Network	0.90	NA	Capacity	0.90	NA	Safety	0.64	0.0%
Revenue	0.90	NA	Experience	0.75	1.9%	Distribution	0.90	NA
People	0.72	0.1%	Innovation	0.68	0.0%	Optimization	0.61	0.0%
Management	0.69	0.0%	Brand	0.73	0.0%	Information	0.53	0.0%
Culture	0.72	0.1%	Alliances	0.61	1.7%	Customer-centric	0.70	0.1%

Operating Margin		
OpMargin	0.85	2.9%

Table 15. State vector of AVCN components for Simulation #3

Conclusion

Our AVCN-FCM model offers a wide range of possibilities for airlines' value creation and competitiveness analysis and decision-making. Specifically, the AVCN-FCM model can be employed as a crucial stepping-stone between qualitative experts' knowledge and quantitative models. Furthermore, the model is well suited to study feedbacks and test unintended side effects of various value-oriented policy interventions.

The model can also be a key method for scenario generation in airlines struggling to assess its value creation policies and anticipate performance. The resulting scenarios can be used as a standalone output or as an input for the generation of value creation roadmaps, e.g. to see how different value creation models play out against the future states of the business environment, or to assess the impact on different policies on the airlines' Operating Margin.

Other applications of the AVCN-FCM model and its accompanying simulation/inference engine might involve creating the basis for further discussions between C-level executives, management teams and airlines' decision makers, contrasting simulations against stakeholders opinions, or comparing them to already existing scenarios in order to provide the input for more quantitative models.

Appendix A: Mr. Bartsch's Benchmark of Responses

In this Appendix we provide you with benchmarks of your Delphi method Round 4 responses upon the aggregated responses from the Experts Panel. In particular, the tables presented below provide:

- A benchmark of your responses vs Panel members responses for the interconnectedness between Constraints and Value Repositories (table A.1)
- A benchmark of your responses vs Panel members responses for the interconnectedness among Value Repositories (table A.2)
- A benchmark of your responses vs Panel members responses for the interconnectedness between Value Repositories and the Operating Margin (table A.3).

The following tables are a graphic illustration of the differences between your responses and those of the Panel members, the latter represented as the average values of all experts' responses. These tables offer you the opportunity to assess the level of agreement or disagreement with the Panel members.

Interconnectedness between Constraints and Value Repositories

As shown in table A.1, the most notorious differences (those at or above 70% difference rate) between your responses and those of the Panel members, upon the interconnectedness between Constraints and Value Repositories, are the following:

- Constraints vs Customer experience, 100% difference rate
- Constraints vs People and talent, 90%
- Constraints vs Brand, 80%
- Constraints vs Capacity management, 70%
- Constraints vs Safety and security, 70%
- Constraints vs Information management, 70%.

If we analyze where the lower differences are, that is, where there has been a higher level of coincidence between you and the Panel members (less than 50% difference rate), the results obtained are these:

- Constraints vs Network, 40% difference rate
- Constraints vs Alliances, 40%
- Constraints vs Customer centric proposition, 30%.

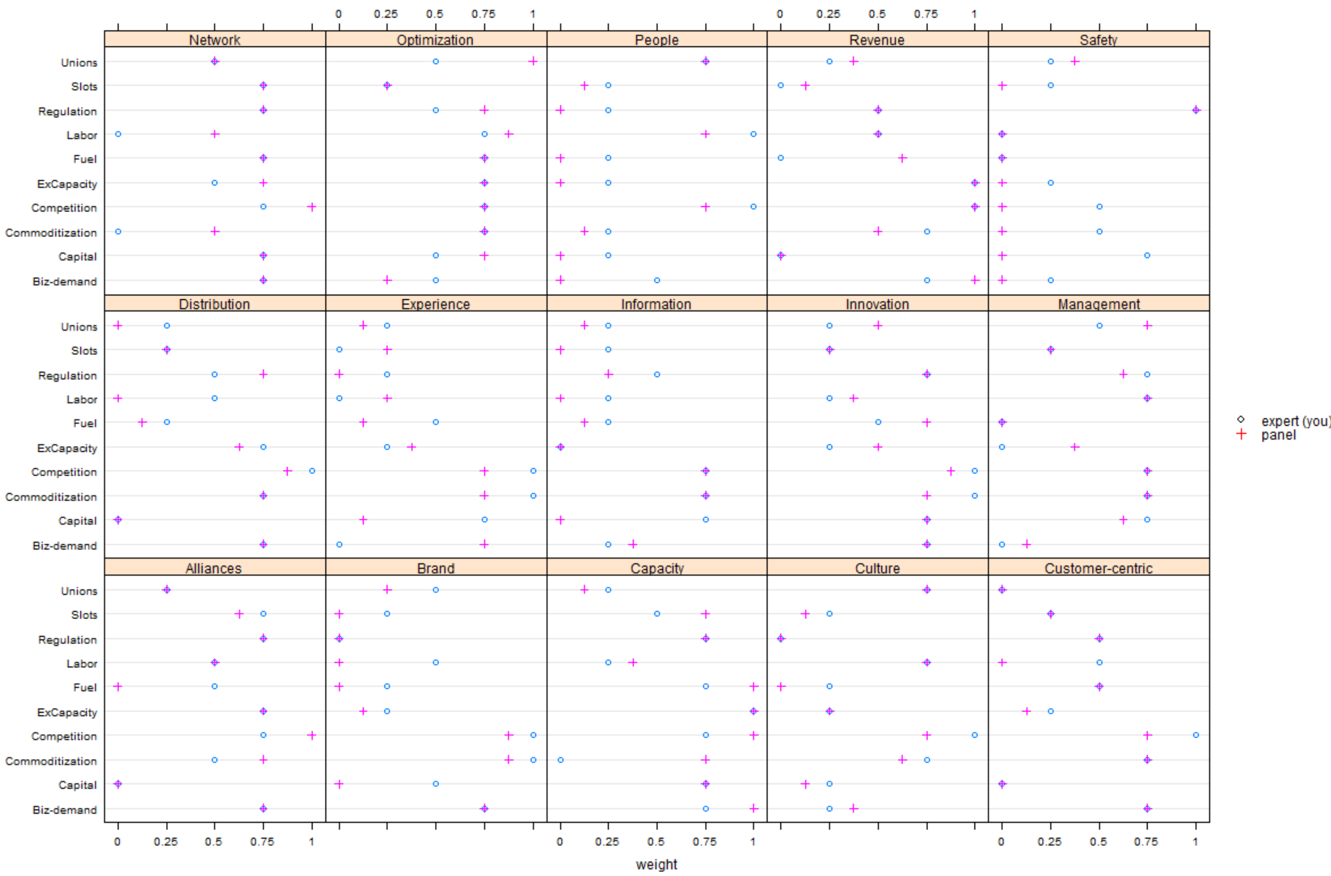


Table A.1 Benchmark on the interconnectedness between Constraints and Value Repositories

Interconnectedness among Value Repositories

From the analysis of responses in table A.2, it is worth noting the high level of coincidence between your responses and those of the Panel members, reflected by the high number of responses whose difference rate is at or below 20%:

- Corporate culture, 13% difference rate
- Distribution strategy, 13%
- Management (leadership) 20%
- Innovation, 20%
- Information management, 20%
- Alliances, 27%
- Customer centric proposition, 27%.

Furthermore, when we look at the highest differences, the difference rates remain between 50-40%, with the highest difference in 53%, as shown by the cases below:

- Value repositories vs Network, 53% difference rate
- People and talent, 47%
- Capacity management, 47%
- Process and cost optimization, 47%.

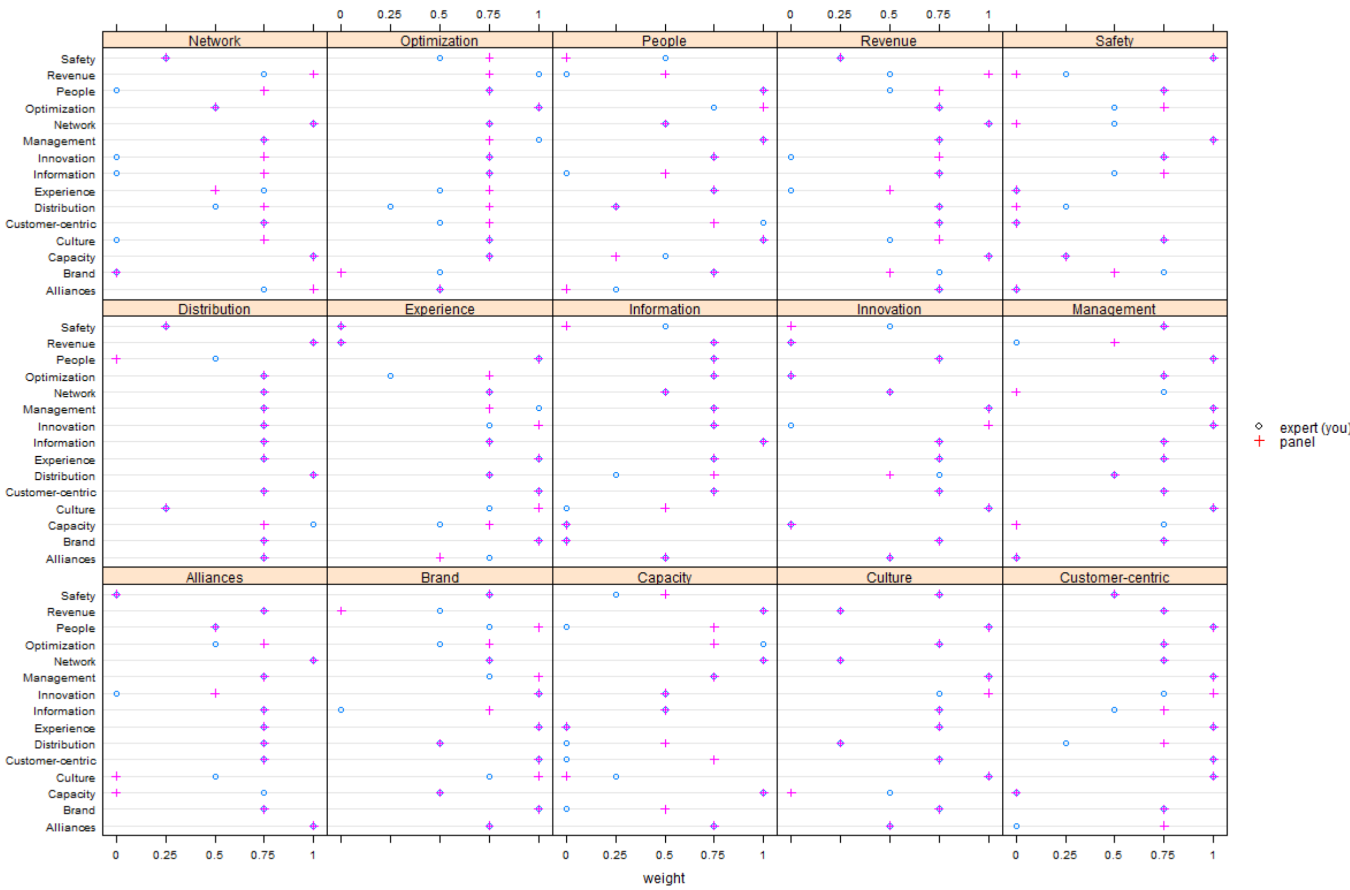


Table A.2 Benchmark of the interconnectedness among Value Repositories

Interconnectedness between Value Repositories and the Operating Margin

Now we present the benchmark of your responses upon the Panel members responses on the interconnectedness between Value Repositories and the airlines' Operating Margin (see table A.3).

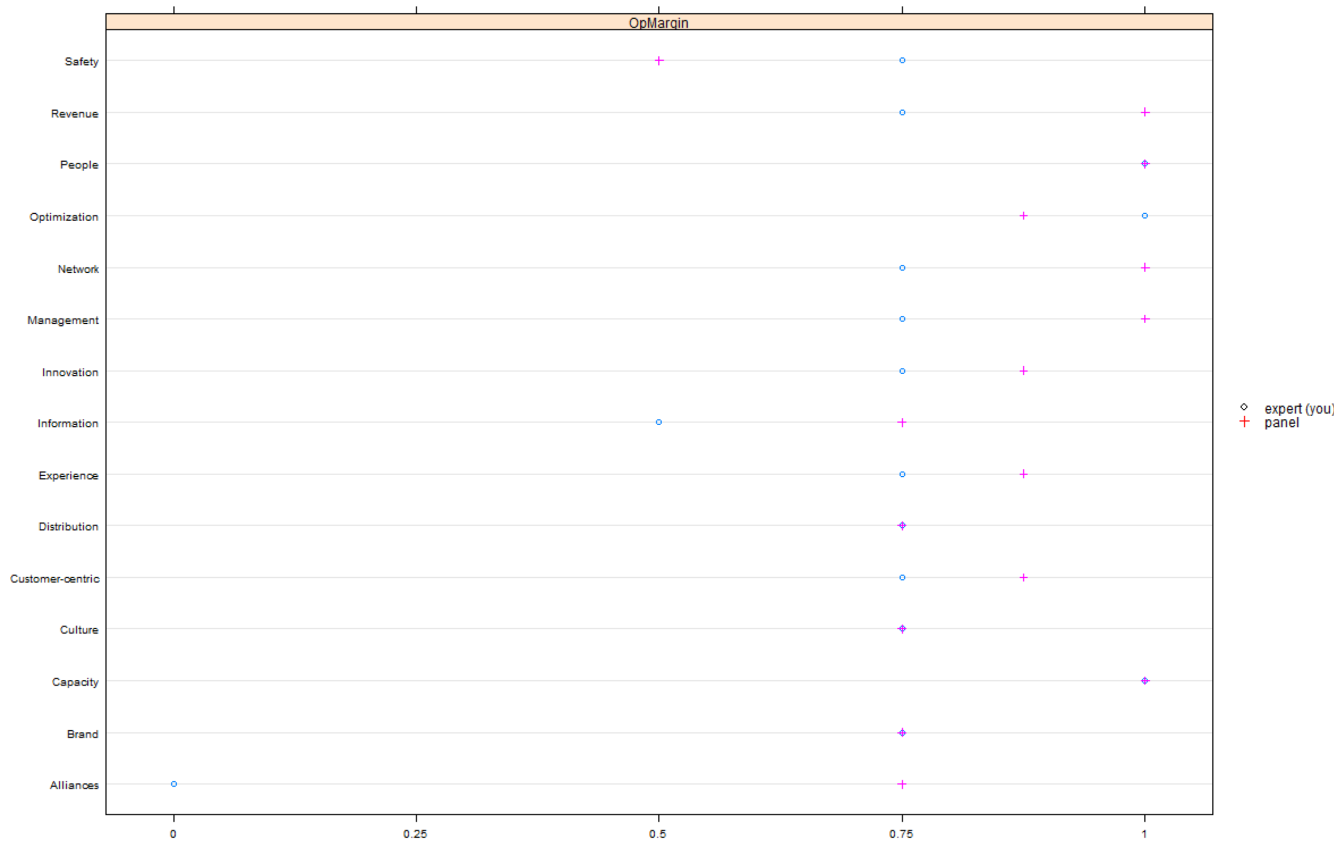


Table A.3 Benchmark of interconnectedness between Value Repositories and Operating Margin

The difference rate between your responses and those of the Panel members is 67%, which implies that 10 out of 15 questions were answered differently between you and the Panel members. The most noticeable difference refers to the interconnectedness between "Alliances" and "Operating margin", which was valued by you as "non-existent", whereas the Panel members labelled the interconnecttion as "Strong".

Appendix B: Techniques

THE DELPHI METHOD

The Delphi method is a versatile research method used for futures research, or for research into areas where knowledge is incomplete. The Delphi method involves an iterative survey of experts. Each participant completes a questionnaire and is then given feedback on the whole set of responses. With this information in hand, (s)he then fills in the questionnaire again, this time providing explanations for any views they hold that were significantly divergent from the viewpoints of the others participants (Slocum 2005).

The explanations serve as useful intelligence for others. In addition, (s)he may change his/her opinion, based upon his/her evaluation of new information provided by other participants. This process is repeated as many times as is useful. The idea is that the entire Panel can weigh dissenting views that are based on privileged or rare information.

The Delphi has been used in research to develop, identify, forecast and to validate in a wide variety of research areas (Skulmoski, Hartman et al. 2007).

In general, the Delphi method was invented to overcome some of the following difficulties when carrying out research tasks:

- The problem does not lend itself to precise analytical techniques but can benefit from subjective judgments on a collective basis
- The individuals needed to contribute to the examination of a broad or complex problem have no history of adequate communication and may represent diverse backgrounds with respect to experience or expertise
- More individuals are needed than can effectively interact in a face-to-face exchange (except through the face-to-face Delphi's shuttle process between plenary and sub-groups)
- Time and cost make frequent group meetings infeasible
- Disagreements among individuals are so severe or politically unpalatable that the communication process must be refereed and/or anonymity assured
- Heterogeneity of the participants must be preserved to assure validity of the results, i.e. avoidance of domination by quantity or by strength of personality.

The Delphi method is a flexible research technique well suited when there is incomplete knowledge about phenomena. There are many rich research opportunities in the airline industry that focus on problems, opportunities, solutions and forecasts. The Delphi method is a suitable candidate for such research projects. It is not just a quantitative method, but works very well in qualitative research (Skulmoski, Hartman et al. 2007).

Furthermore, no two Delphi studies are the same. There are many varieties of Delphi ranging from qualitative to quantitative, to mixed-method Delphi. While there are many varieties of Delphi, common to all are design considerations that need to decided upon including sample composition, sample size, methodological orientation (qualitative and/or quantitative), the number of rounds, and mode of interaction. Considering these choices help to add rigor to the method. Increased rigor contributes to a successful Delphi and deeper understanding of the airline industry.

FUZZY COGNITIVE MAPS (FCM)

Fuzzy Cognitive Maps are graphs consisting of nodes, so-called ‘‘concepts’’ that are connected through arrows that show the direction of influence between concepts. A positive (negative) arrow pointing from concept A to concept B indicates that concept A causally increases (decreases) concept B. To reflect the strength of causal links, weights are assigned to the arrows.

FCMs are also regarded as a simple form of recursive neural networks (Kosko 1987). Concepts are equivalent to neurons, but other than neurons, they are not either ‘‘on’’ (= 1) or ‘‘off’’(= 0 or -1), but can take states in-between and are therefore ‘‘fuzzy’’. Fuzzy concepts are non-linear functions that transform the path-weighted activations directed towards them (their ‘‘causes’’) into a value in [0,1] or [-1;1]. When a neuron ‘‘fires’’ (i.e. when a concept changes its state), it affects all concepts that are causally dependent upon it. Depending on the direction and size of this effect, and on the threshold levels of the dependent concepts, the affected concepts may subsequently change their state as well, thus activating further concepts within the network.

FCM have several properties that make them useful for modelling the AVCN. FCMs are based on causal cognitive mapping, which provides an efficient way to elicit, capture and communicate causal knowledge and help respondents to become better aware of their own mental models. Maps can be based on interviews, text analysis or group discussions and can be easily modified or extended by adding new concepts and/or relations or changing the weights assigned to causal links.

Inputs from large, diverse, and even dissipated groups can thus be easily integrated in order to overcome the limitations of expert opinions and group-think. Furthermore, FCMs allow a quantitative analysis of the behavior encoded in the FCM models to aid decision making: planners can agree on plausible combinations of input values for independent FCM variables and calculate the states of depend variables to assess the impact of input variation (e.g. particular policies) and alternative system description (e.g. different mental models of a complex problem). This, in turn, can be linked to a future state that is internally consistent because it is the result of a calculation that simultaneously considers all direct and indirect connections between all concepts.

Appendix C: Panel Members

The Experts Panel was the primary participatory group across the research project. The Panel was created on an on-line basis, and gathered a number of experts from different network airlines and geographies. The research team specifically invited participants for the occasion.

The following table contains the list of Panel members, indicating their names, position and name of the company:

Name	Position	Company
Mr. Amin Abdulhadi	Director Flight Operations Engineering & Administration	Scandinavian Airlines
Mr. Thomas Bartsch	Former SVP Commercial Intelligence	Qatar Airways
Mrs. Daniela Baytelman	VP Distribution & Ancillary Revenue	LATAM Airlines
Mr. Dimitris Bountolos	VP Customer Experience	Iberia Líneas Aéreas
Mr. Duncan Bureau	VP Global Sales and Distribution	Air Canada
Mr. Anthony Doyle	Director New Product Development	Air Canada
Mr. Ferrán García	Strategic Planning & CEO Office	Iberia Líneas Aéreas
Mr. Raúl Gutiérrez	VP & Chief Information Officer, Club Premier	Aeromexico
Mr. Hans Gydal	Director Sales Excellence	Scandinavian Airlines
Mr. Martin Hoffman	VP Value Stream Owner - Plan to Execution	Scadinavian Airlines
Mr. Carlos Jovel	VP Revenue Management and Pricing	LATAM Airlines
Mr. Rahul Kucheria	Head of Loyalty	Qatar Airways
Mr. Rodrigo Llaguno	VP Customer Experience	Avianca
Mr. Juan Felipe Luque	Director of Cargo Operations	Avianca
Mr. Jiří Marek	Executive Director Sales & Distribution	LOT Polish Airlines
Mr. Juan Alberto Martín	VP Joint Business Agreements	Iberia Líneas Aéreas
Mr. Rafael Andrés Martínez	Head of Distribution & Revenue Mmgt	Aerolíneas Argentinas
Mr. Albert Muntané	Head of Network and Distribution	Air Europa
Mr. Mark Nasr	MD Corporate Strategy and Development	United Airlines
Mr. Mauro Oretti	VP Sales & Marketing	SkyTeam
Mr. Ole Orvér	SVP Network Management	Qatar Airways
Mr. Mariano Salinas	Strategy & Business Development Director	Avianca
Mr. Federico Soto	Former Head of Strategic Management Office	Iberia Líneas Aéreas

Mr. Maarten van der Lei	VP Pricing & Revenue Mmgt Europe KLM	AirFrance/KLM
Mr. Warner van der Veer-Jehee	VP Safety & Quality at KLM E&M Division	AirFrance/KLM
Mr. Helmut Woelfel	VP Commercial	Lufthansa
Mr. Maarten van der Lei	VP Pricing & Revenue Mmgt Europe KLM	AirFrance/KLM
Mr. Warner van der Veer-Jehee	VP Safety & Quality at KLM E&M Division	AirFrance/KLM
Mr. Helmut Woelfel	VP Commercial	Lufthansa

Some of the Panel members chose not to make their personal profiles public. The following table contains less detailed information about these members.

Position	**Type of company**	**Geography**
VP Network Operations	Network Airline	Middle East
VP Aircraft Maintenance	Network Airline	Europe
Director Customer Experience	Alliance-Brand	Worldwide
VP Customer Experience and Technology	Alliance-Brand	Worldwide

Appendix D: Glossary

Adjacency matrix

A means of representing which vertices (nodes) of a graph are adjacent to which other vertices.

Airlines Value Creation Network (AVCN)

A network connecting the external constraints to value creation, the sources of value creation within the organization (value repositories) and the operating margin.

Delphi method

A structured communication technique originally developed as a systematic, interactive forecasting method which relies on a panel of experts.

Dendrogram

Tree diagram frequently used to illustrate the arrangement of the clusters produced by hierarchical clustering.

Eigenvector

A special set of vectors associated with a matrix equation that are sometimes also known as characteristic vectors, proper vectors, or latent vectors. The determination of the eigenvectors is important in many disciplines, where it is equivalent to matrix diagonalization.

Fuzzy cognitive maps (FCM)

A map within which the relations between the elements (e.g. concepts, events, project resources) of a "mental landscape" can be used to compute the "strength of impact" of these elements.

Network analysis

Network analysis is a quantitative methodology for studying properties related to connectivity and distances in graphs.

Hierarchical clustering

A method of cluster analysis which seeks to build a hierarchy of clusters.

Value Repository

Interacting network that groups together internal cross-functional activities, resources, people, processes and/or systems with the sole purpose to create unique and differentiated value.

Sensibility analysis

The study of how the uncertainty in the output of a mathematical model or system (numerical or otherwise) can be apportioned to different sources of uncertainty in its inputs.

Appendix E: References

IATA, 2014. Vision 2050.

JETTER, A.J. and KOK, K., 2014. Fuzzy Cognitive Maps for futures studies—A methodological assessment of concepts and methods. *Futures,* **61**, pp. 45-57.

KOLACZYK, E.D., 2009. *Statistical Analysis of Network Data. Methods and Models.* Springer.

KOSKO, B., 1987. Adaptive inference in fuzzy knowledge networks, *Proc. 1st Int. Conf. Neural Networks* 1987, pp. 261-268.

NAVARRO-MENESES, F.J., 2015. *Complexity-based view of the firm: Evidence, features and method.* Retrieved from http://ssrn.com/abstract=2552459.

SKULMOSKI, G.,J., HARTMAN, F.,T. and KRAHN, J., 2007. The Delphi Method for Graduate Research, 2007, pp. 1-21.

SLOCUM, N., 2005. *Delphi: Participatory Methods Toolkit.* Retrieved from http://archive.unu.edu/hq/library/Collection/PDF_files/CRIS/PMT.pdf.