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INGENIERO INDUSTRIAL

IMPACT OF GLOBALIZATION ON SUPPLY CHAIN SUSTAINABILITY AND RISK MANAGEMENT

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Chicago, Illinois
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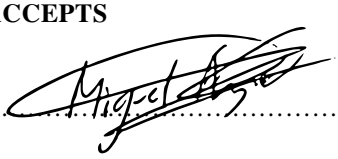
Signed……  ……

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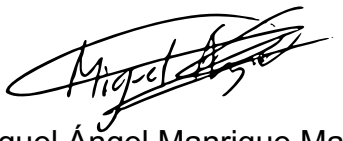

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IMPACT OF GLOBALIZATION ON SUPPLY CHAIN SUSTAINABILITY AND RISK MANAGEMENT

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in the Graduate College of the
Comillas Potifical University

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Chicago, Illinois
August 2019

IMPACT OF GLOBALIZATION ON SUPPLY CHAIN SUSTAINABILITY AND RISK MANAGEMENT

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Collaborating entity: Illinois Institute of Technology.

ABSTRACT

With increasing levels of globalization, the management of supply chain activities has become more complex. The flow of goods and services (including the storage of raw materials, work-in-progress inventory, and transportation of finished goods from point of origin to point of consumption) is not limited to regions or countries but has become a more international process. Today, a company operating in the United States might have its manufacturing facilities in Asia and its customers in Europe.

The broad range of activities required to plan, control and execute a product's flow, from acquiring raw materials to production and distribution to the final customer, can now be optimized and conducted wherever such activities are most cost-effective. However, how does this fact affect sustainability and risk management? These two factors play a key role on how a business is run in an increasingly environmentally focused world where political, social and economic issues affect corporations more than ever. The main purpose of this project is to analyze the extent to which globalization affects transportation sustainability and how can it be improved, as well as whether exposure to new managerial risks can be handled and overcome. In order to do so, a case study will be analyzed. Anritsu is a Japanese multinational with business all around the globe. In the year 2014, they implemented Kinaxis' *RapidResponse* software. This project will address how their sustainability and risk management were before and after the implementation to analyze the extent to which a software can mitigate the effect of globalization on supply chain risk management and supply chain sustainability. Finally, this project will address whether or not this solution can be extended to other organizations in other industries.

IMPACTO DE LA GLOBALIZACIÓN EN LA SOSTENIBILIDAD Y GESTIÓN DEL RIESGO DE LA CADENA DE SUMINISTROS

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Entidad colaboradora: Illinois Institute of Technology.

RESUMEN DEL PROYECTO

Con los niveles de globalización en aumento, la gestión de las actividades correspondientes a la cadena de suministro se ha vuelto más compleja. El flujo de bienes y servicios (incluyendo al almacenamiento de materias primas, el inventario del trabajo en curso y el transporte de los productos terminados desde punto de origen a punto de consumo) ya no se limita a regiones o países, sino que se ha convertido en un proceso internacional. Hoy en día, una empresa que opera en Estados Unidos puede tener sus instalaciones de producción en Asia y sus consumidores en Europa.

La amplia gama de actividades requeridas para planificar, controlar y ejecutar un flujo de producto, desde la adquisición de las materias primas hasta la producción y distribución al consumidor final, pueden ahora optimizarse y ser llevadas a cabo allí donde tales actividades son más rentables. Sin embargo, ¿cómo afecta esto a la sostenibilidad y la gestión del riesgo? Estos dos factores juegan u papel clave en cómo se gestiona el negocio en un mundo cada vez más centrado en el medio ambiente donde los problemas políticos, sociales y económicos afectan a las corporaciones más que nunca. El objetivo principal de este proyecto es analizar en qué medida la globalización afecta a la sostenibilidad en el transporte y cómo puede ser mejorada, así como en qué grado la exposición a nuevos riesgos de gestión puede ser manejada y superada. Con este propósito, un caso de estudio será analizado. Anritsu es un multinacional japonesa con negocios al rededor del globo. En el año 2014, implementaron el software *RapidResponse* de Kinaxis. Este proyecto abordará cómo tanto la sostenibilidad como la gestion del riesgo eran antes y después de la implementación para analizar en qué medida puede un software mitigar los efectos de la globalización en la gestion del riesgo y la sostenibilidad de la cadena de suministro. Finalmente, este proyecto abordará en qué medida esta solución puede ser extendida a otras organiaciones que operen en otras industrias.

ACKNOWLEDGEMENT

Writing a final project is certainly not an easy task. It takes time, a great deal of reading, and, of course, a lot of effort. However, there are people that have made this process a lot smoother. This section is reserved for all of them. Those who, in one way or another, have helped me complete this project.

I would like to first mention my dear parents, Yolanda and Quico. I always think of them as a beautiful tandem capable of achieving anything when working together. They complement each other just like salt and pepper. If it was not for them and their continuous support, inspiration, trust, determination and confidence, I would not be writing these words right now. They have always guided me and offered help whenever I was in trouble. Although my being abroad for so long was difficult for them, as soon as they noticed how great of an opportunity studying in the U.S. was for me, they supported me without conditions. If everyone had parents just half as great as my parents are, I am sure the world would look a lot different. Thank you, mom and dad, for always believing in me and doing what is best for me. This one is for you!

On another note, I would like to mention my grandfather, Angel Antonio and my sister Yolanda. I have spent quite a lot of time with them throughout my life and they have definitely shaped me into the person I am today. These two are also an inspiration to me, and through lots of laughs and their full support they are a big part of why I have such a happy life. Thank you!

Of course, I would not like to forget about all those family members and friends that have always been there for me too. From sending me an article to look at, to taking me out for coffee or even to go for a walk and complain about how tedious writing a final project is. Their continuous help and the fact that they have always been there for me, in all the good times and the bad, have contributed to making this project the best it can be. Thanks, guys, for everything!

Last but not least, I would like to mention the supervisor of this project, Prof. Theodossios Rigopoulos. Theo, had it not been for your continuous feedback, help and guidance, this project would have never seen the light. Thank you so much for everything, from the sharing of your stories and experiences that have entertained me so much, to your helpful explanations of concepts and ideas. I am grateful for having had the opportunity to meet you and to learn from you about supply chain. Your ideas and directions have certainly made this project what it is today, and I hope it does you justice.

-The greatest project you will ever work on is you-

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CHAPTER 1

INTRODUCTION

1.1 State of the art

Globalization as a process by which companies, businesses and organizations operate at an international domain and develop influence based on this has been increasingly important during the last century, particularly around the 80s. However, as technology keeps improving and developing, it is becoming easier and more attractive for businesses to expend their reach at an international level. All this has shaped how companies all over the world shape their supply chain. Some of the benefits of globalization are:

Figure 1 - illustrative concept of globalization (Open source, 2019).

- Connectivity: Today more and ever in history connectivity has united everyone everywhere. With the so-called digital age and topics like the Internet of Things (IoT), connecting with others is accessible, easy and convenient. In other words, today it is possible to create and maintain relationships with partners all across the globe. In addition, globalization has also simplified the way companies and clients communicate, which has allowed for better and more transparency throughout the supply chain process.
- Growth: Not only has globalization allowed businesses to connect, but also has created many more opportunities for companies to grow. Because of connectivity is so developed and effortless, businesses can sell, produce and offer more choice and then before. This also extends to markets, which have seen a great impact in their size and diversity over the last decades due to the effects of globalization. Customers benefit from this growth as increased competition means that companies have to rethink their operations in order to compete, making them either more

sustainable or more transparent. This boosts standards, acting as a quality control for companies to improve.

- Integration: Globalization has as well offered new means of collaboration. Companies can share and joint efforts to boost sales and attract media attention, as well as promoting innovation and creativity.

However, globalization has also brought some new challenges:

- Increased risk: As the number of operations conducted at an international level increase, the risk of supply chain being affected by external factor becomes higher. Businesses operating outside of their home country must implement strategies to deal with problems such as political uprisings, natural disasters or economic recessions.
- Less predictability: As market grows led by increasing demands and greater need for supplies, predictability decreases, and trends become less clear. This is due to the fact that the amount of available data increases continuously, therefore it becomes increasingly difficult to analyze all of it, ultimately resulting in a challenging task to keep track of global trends.
- More channels: The chances of error increase as a result of an increase in the number of channels brought by the process of globalization. It is easy to lose track of all the items in the supply chain when more steps and destinations are added without the proper management and organization.

Globalization has definitely changed the world and keeps helping mankind to move forward. There is no denying that this process has not only changed the supply chain, but also the business world as a whole. It is true as well that supply chain management is more complex than ever before.

It is particularly interesting to study how this process has affected the consumer electronics and the telecommunication electronics equipment industry. As it will later on be explained, this industry has gained a lot of importance in the recent years and it is one of the most affected industries by globalization and its effects. In fact, it is one of the industries with more international presence and it has been proven that external factors such as political instabilities, economics crisis, and natural disasters affect this industry in a deeper and broader way than many others.

Most of the companies within this industry have taken the decision to rely on external software so as to mitigate this effect as much and as far as possible. An interesting company to study is Anritsu Corporation, a Japanese multinational and one of the biggest players in the market. In the case of Anritsu, they have implemented a software called Kinaxis to try to mitigate the negative effects of globalization from a supply chain sustainability point of view, as well as and risk management.

Their case will be the main object of study of this project and an analysis of their experience with the incorporation of the software will be discussed and reviewed.

1.2 Motivation

According to the web page *statista.com* the market for consumer electronics has been growing for the last 10 years, probably reaching 301 billion U.S. dollars in the year 2019. In fact, this tendency is expected to grow at an even faster rate in the years to come. However, this does not only apply to the United States, but consumer electronics all over the world have been raising during the last three years and again are expected to keep growing in the future.

This is the market where companies like Anritsu develop their business activity. In fact, the biggest companies in this sector operate at an international level, making crucial that their supply chain operates correctly. External factors caused by globalization such as environmental issues or increased operating risk have to be mitigated. Operations in the electronics sector require a great coordination between the different stages to manufacture the final product and afterwards, to place that product in the market where it is going to be consumed. Being efficient in this regard plays a key role as it is the only way to effectively compete and be competitive, as it involves rising the capacity of production and lowering the associated costs. Today, it is crucial to pay attention to how globalization affects each business' supply chain. As issues like climate change, political crisis, global disasters or international economic crisis might disrupt a business supply chain, being able to mitigate the effects these issues might cause plays an important role in succeeding, improving sales, lowering costs and raising benefit margins.

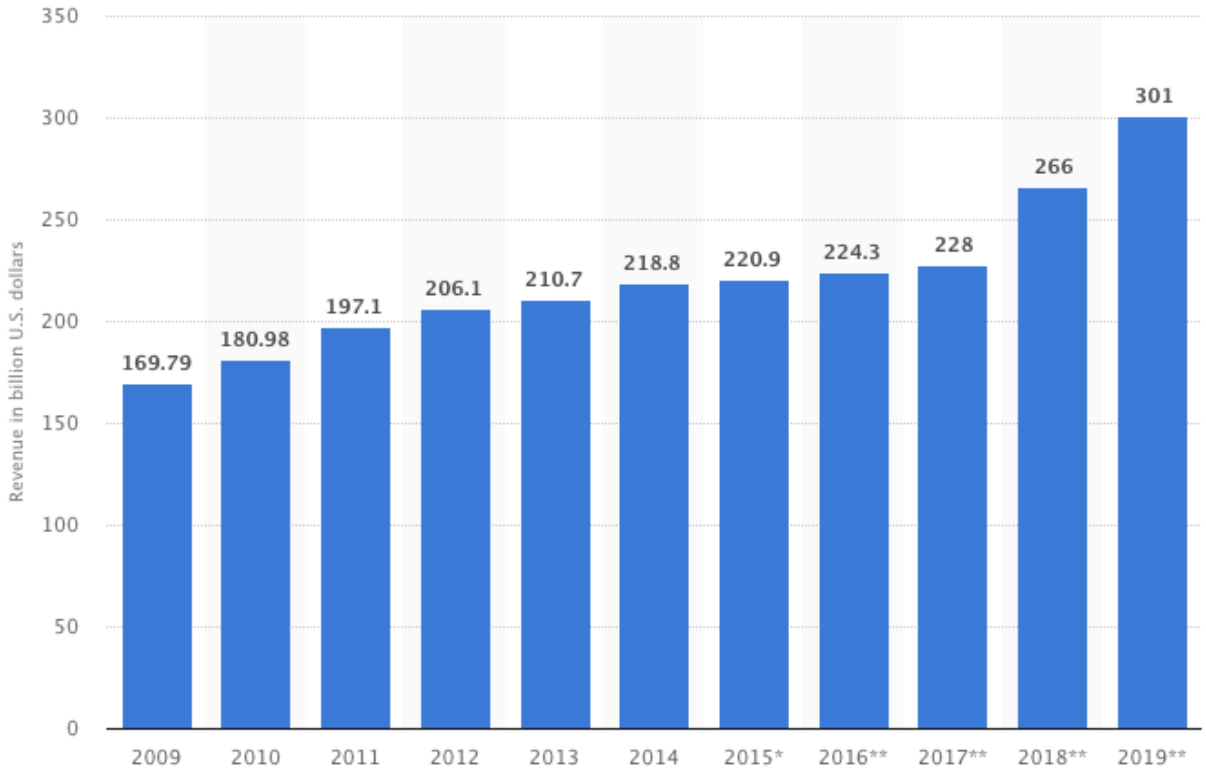


Figure 2 - Wholesale revenue consumer electronics (CE) shipments in the U.S. from 2009 to 2019 (in billions of U.S. dollars) (statista.com, 2014).

The purpose of this project is to focus on how globalization and climate change, affect supply chain sustainability and risk management in the consumer electronics sector, particularly analyzing the case of Anritsu, a company that incorporated the Kinaxis software to deal with these issues. With the available resources, tools and data, an analysis of how Anritsu's experience was before and after the incorporation of that software regarding those two points before mentioned. Afterwards, it will be discussed how the conclusions extracted from this analysis can be applied to other companies in the sector or even to other sectors.

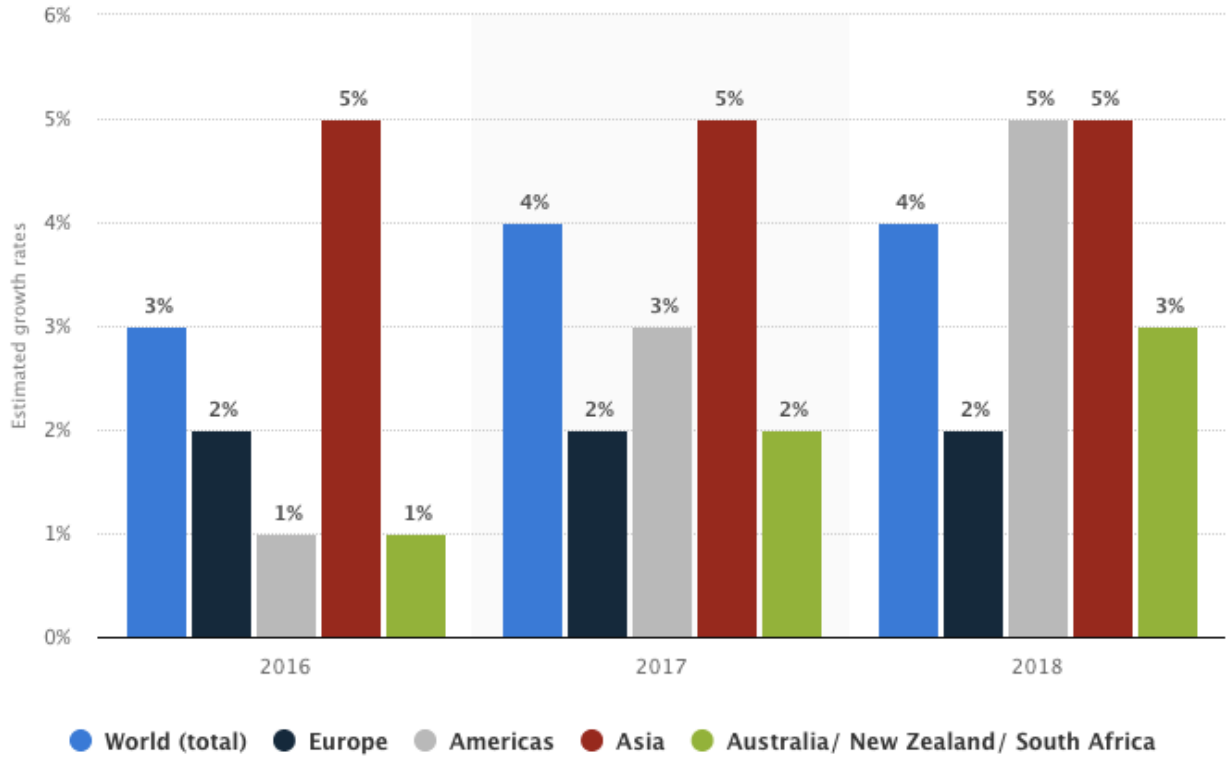


Figure 3 - Estimated growth rates for the global electronics industry from 2016 to 2018, by region. (statista.com, 2018).

1.3 Objectives of the project

The main objectives pursued to achieve while conducting this project are:

- Understand and broaden the knowledge about the consumer electronics sector, focusing on how they operate and what the major issues due to globalization apply to them at an international level.
- Understand and broaden the knowledge about supply chain, particularly that of consumer electronics companies, as well as getting to know what influences or disrupting elements there may be.
- Shape how globalization can negatively affect supply chain, especially regarding supply chain sustainability together with supply chain risk management.
- Identify possible solutions for these effects, particularly that offered by specialized software such as Kinaxis.

- Prove the positive impact in the business that these solutions might have, showing how they are able to provide a certain stability and to improve sales, reduce costs, improve the overall supply chain sustainability and offer better ways to manage risk.
- Get a deep and broad understanding about how the company object of study in this project operates, Anritsu. Analyze its supply chain and take a look at the decisions and measures they have undertaken to be able to successfully compete in a market characterized by being very influenced by globalization.

1.4 Working methodology

In order to accomplish the above-mentioned objectives, the following process of work is proposed:

a) It seems important to first understand the industry this project involves. Therefore, the first step of the process is to define the telecommunications electronics equipment industry. First, a view of the global position of the industry will be taken, comparing this one with other industries regarding size and volume of sales. Afterwards, an analysis of the major competitors within this industry will be undertaken. Knowing who operates in this market will allow to understand the market itself and finally, to shape how the fluence of globalization has impacted competency within this industry.
b) The second step in the process would be to analyze the particular company object of study in this project, Anritsu. To place the company in context, first the history of the company itself will be reviewed and then, this project will take a look to the current performance and products being manufacturer by the company with the ultimate goal of analyzing its supply chain nowadays.
c) The third step in the process is to analyze what the implementation of the Kinaxis software meant for Anritsu. An overall analysis of the implementation will first be offered and then some conclusions will be extracted regarding the advantages and possible disadvantages of the implementation to Anritsu's supply chain. Finally,

this project will highlight what the main challenges for the future are and how Kinaxis or other software might or might not be able to deal with those challenges.

d) Once a clear view of how the implementation worked for Anritsu is given, the next step in the process will be to focus on Anritsu's supply chain sustainability and analyze how it was before and after the implementation and extracting possible advantages and disadvantages. Again, conclusions will be made regarding possible challenges for the future of supply chain sustainability.
e) The same way supply chain sustainability will be analyzed in the previous step, now this project will focus on a risk management analysis particularly reviewing how things were before and after the implementation. Afterwards, the main advantages and disadvantages will be discussed and finally a brief conclusion will draw what the main challenges for risk management are in the future.
f) The sixth step of this project will be to incorporate an economic assessment of the implementation. Some numbers will be thrown in the project so as to check the economic repercussion of the implementation, both, regarding the money spent and the money saved thanks to the implementation due to the mitigation of the negative globalization effects in the supply chain of the organization object of study, Anritsu.
g) Finally, it will be considered the extent to which everything obtained and learned from analyzing the implementation can be used in other industries to mitigate the effects of globalization and some final conclusions on the issue will be offered.

The following table contains an expected timeline for the competition of the project, highlighting an approximation of the duration of each of the tasks and when will they will begin and end:

Project Timeline

Table 1 - Estimated timeline of the project.

Research Activity	Duration	Start	Finish
First idea about the topic (meeting)	1 h	Oct/23 18	Oct/23 18
Research and planning	-	Nov 18	Nov 18
Project planning, approach (meeting)	1 h	Nov/11 18	Nov/11 18
Introduction to the telecommunications electronics equipment industry	4 w	Jan 19	
Global position	1 w	Jan 19	Jan 19
Major Competitors	1 w	Jan 19	Jan 19

Analysis on how globalization has shaped competency	2 w	Jan 19	Jan 19
Analysis of Anritsu	4 w	Feb 19	
Brief history	1 w	Feb 19	Feb 19
Current performance	1 w	Feb 19	Feb 19
Products	1 w	Feb 19	Feb 19
Analysis of its supply chain	1 w	Feb 19	Feb 19
Implementation of the Kinaxis software	4 w	Mar 19	
Overall analysis of the implementation	1 w	Mar 19	Mar 19
Advantages on its supply chain	1 w	Mar 19	Mar 19
Disadvantages on its supply chain	1 w	Mar 19	Mar 19
Challenges for the future	1 w	Mar 19	Mar 19
Sustainability analysis	4 w	Apr 19	
Before Kinaxis implementation	1 w	Apr 19	Apr 19
After Kinaxis implementation	1 w	Apr 19	Apr 19
Analysis of advantages/disadvantages	1 w	Apr 19	Apr 19
Challenges for the future	1 w	Apr 19	Apr 19
Risk management analysis	4 w	May 19	
Before Kinaxis implementation	1 w	May 19	May 19
After Kinaxis implementation	1 w	May 19	May 19
Analysis of advantages/disadvantages	1 w	May 19	May 19
Challenges for the future	1 w	May 19	May 19
Economic assessment of the implementation	2 w	Jun 19	
Possible extension to other industries	2 w	Jun 19	
Conclusions	2 w	Jul 19	
List of References & Appendices	2 w	Jul 19	
Review	1 w	Aug 19	
Submit draft report	-	Aug 19	
Submit final report	-	Aug 19	
Final presentation to faculty	-	Aug19	

1.5 Resources to be used

In order to complete the project and so as to achieve the above-mentioned goals according to the process explained in the methodology section of this paper, the following tools and resources will be used. Firstly, it is important to remark the fact that as the main object of

study of this final project is the company Anritsu and its implementation of the Kinaxis software, the main source of information for the analysis will be all the available data from these two companies either on the internet or accessible from their websites. It will be particularly used technical data, articles, memories or other sort of inner communications within the businesses. Furthermore, it is intended to collaborate with representatives of both companies, having at least one meeting with them so as to understand first-hand how the implementation was and to know the opinion of those working for the respective companies.

In case it required to further explore any concept or idea, specialized bibliography will be consulted, either on the internet or searching for specialized documents online or physically at the university's library. Another important source of information will be the director of this project's works and lectures notes. These last options are expected to be particularly useful to deal with complex ideas in supply chain theory or methodology.

Apart from first-hand sources, several secondary sources will be used such as interviews with experts in the topic, articles online or specialized magazines.

CHAPTER 2

INTRODUCTION TO THE TELECOMMUNICATIONS ELECTRONICS EQUIPMENT INDUSTRY

This project will analyze how the implementation of a software (in this case, Kinaxis) can help companies (in this case, Anritsu) effectively mitigate the effects of globalization and climate change through risk management. In order to conduct this study, it is worth first taking a look to the industry in which the company object of analysis operates.

2.1 Global position

The Electronic Test and Measurement Instruments Manufacturing Industry is a relatively new industry compared to other well-established industries such as construction, nutrition or automation. Companies in this industry produce and manufacture that equipment used to test and measure electrical properties and signals. Some major companies, which will later on be analyzed, include Danaher, Keysight Technologies, National Instruments Corporation, Teradyne, Fortive Corporation, VIAVI Solutions Inc., and Texas Instruments Incorporated (all of them based in the United States), along with Anritsu Corporation, Yokogawa Electric and Advantest Corporation (all three based in Japan), Rohde&Schwarz (Germany), Spirent Communications (United Kingdom) and EXFO Inc. (Canada). Some of the primary products manufactured within this industry are frequency counters, logic analyzers, multimeters, oscilloscopes, voltmeters, and waveform synthesizers. Other products include instruments designed and manufactured for a specific application, for example, communications testing equipment or instruments to test semiconductors, used to test electrical equipment or to measure electrical properties.

Regarding the profitability of the sector in the United States, which accounts for the majority of the revenue in the industry, the approximate market capital is USD $25.7B. The performance of the sector in this country, compared to the S&P 500 Index for the last 10 years can be seen below, in Figure 4:

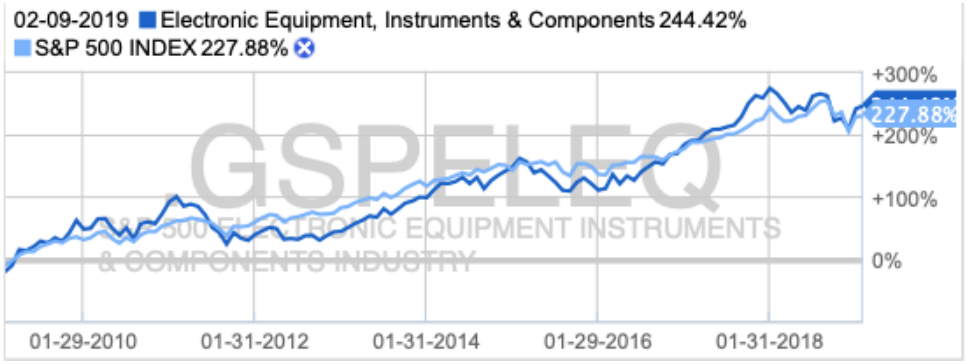


Figure 4 - Performance of the sector compared to the S&P 500 Index (fidelity.com,2018).

As for the economic and financial fundamentals of the sector, they are shown below, in the following table, Table 2:

Table 2 - Industry fundamentals as of Feb/08/2019 (fidelity.com, 2018).

P/E (Last Year GAAP Actual)	19.46
P/E (This Year's Estimate)	18.93
Enterprise Value	$15.78B
EPS (TTM)	$3.55
EPS Growth (TTM vs. Prior TTM)	113.00%
Revenue Growth (TTM vs. Prior TTM)	12.94%
Return on Equity (TTM)	14.35%
Return on Investment (TTM)	8.58%
Total Debt/Equity (TTM)	60.41
Dividend Yield	1.79%

Demand in this industry is primarily driven by growth in other industries such as electronics or semiconductor manufacturing industry, telecommunications and IT, aerospace, defense, automotive and transportation, education and government, industrial and healthcare. As in other industries, profitability is based on being able to control manufacturing costs and being capable of maintaining a continuous and fast product innovation. On the one hand, Economies of scale are enjoyed by larger companies, which benefit from areas such as sourcing components and product distribution. On the other hand, smaller companies usually compete by specializing in tools and equipment for niche markets and by manufacturing higher-quality products and so, gaining a reputation and a name. As in other industries, the largest 50 companies in the United States account for about 70% of revenue,

so it is a quite concentrated industry. However, taking a look into the geographic segmentation regarding production, the industry is much less concentrated, as three major countries share almost the same amount of market, as represented in Figure 5.

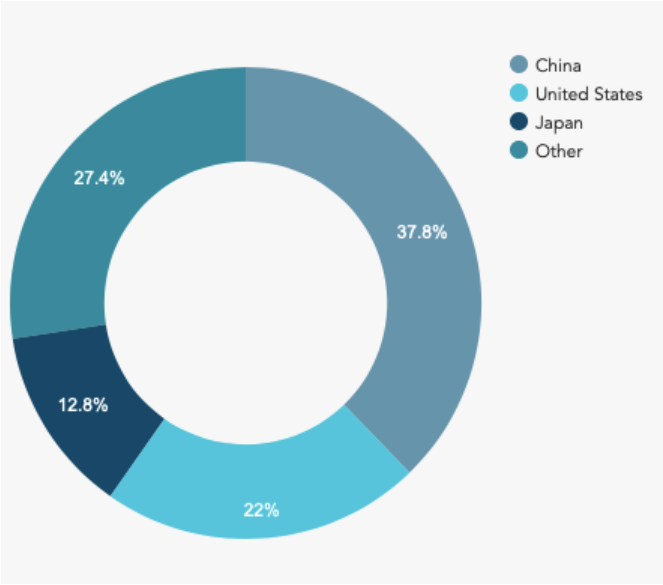


Figure 5 - Geographic segmentation of the Electronic Test and Measurement Instruments Manufacturing Industry (hoovers.com, 2018).

Regarding the global forecast for growth in the industry, according to MarketsandMarkets, this industry is expected to grow from USD $25.7B in 2018 to USD $32.3B by 2024, at a compounded average growth rate (CAGR) of 3.90%. This industry is expected to grow at the highest CAGR in the healthcare sector during the upcoming five years, due to the development of newer healthcare equipment, patient-monitoring systems, and personal emergency reporting systems. However, the automotive and transportation industries are expected to be the leading segment in the overall market during this period of time. Finally, APAC (Asia-Pacific area) is projected to continue leading the market, as shown in Figure 6. This region of the globe has very strong automotive, electrical and electronics industries. In fact, it is the largest producer of automobiles in the world. China, India, and South Korea are leading manufacturers of consumer electronic devices, and leaders in semiconductor fabrication and manufacturing. All of this contributes to the growth of the market.

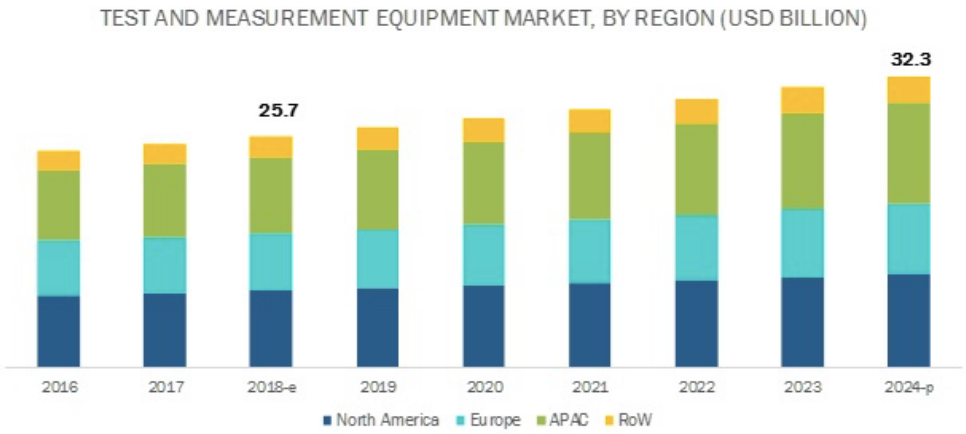


Figure 6 - Test and measurement equipment market, by region (marketsandmarkets.com, 2018).

2.2 Major competitors

In the electrical components and equipment industry, there are several major competitors, apart from Anritsu, which will be the object of study of the present paper:

1. InfoVista – Infovista offers network planning, service assurance and performance optimization solutions for mobile network operators. Founded in 1996, Infovista's headquarters is in Massy, Île-de-France. It is a private company, subsidiary of Apax Partners LLP, that has raised $73.7M in three rounds, being the latest one in July 2014. Jose Duarte is the CEO of Infovista. Infovista's latest funding round was a debt for $63.5M on Jul 2014. Main investors include Ares Management, GE Capital and Innovacom. Infovista's main competitors are TEOCO, Aerohive and Ruckus. It has an estimated annual revenue of $182.5M and an estimated number of employees of 896. In April 2015, it acquired Ipanema.
2. Astellia – ASTELLIA is a provider of network and subscriber intelligence solutions for mobile operators to maximize operational efficiency. Astellia, private company, was founded in 2000. Astellia's headquarters is located in Saint-Jacques-de-la-Lande, Brittany, FR 35091. It has raised $30.9M in one round. The latest round was in Aug 2017. Astellia's primary investor is EXFO Inc, since February 2018. Astellia has an estimated 400 employees and an estimated annual revenue of $42.7M. Its top competitor is Polystar, led by Mikael Grill.
3. Polystar – Polystar provides network management, monitoring and customer analytics solutions for businesses. Polystar was founded in 1983. Polystar's

headquarters is located in Farsta, Stockholms län, SE SE-120 32. Polystar's CEO, Mikael Grill, currently has an approval rating of 78%. Polystar has an estimated 200 employees and an estimated annual revenue of $40.0M. Polystar's main competitors are Anritsu, Empirix and Infovista.

4. Teoco – TEOCO is a provider of planning, assurance, analytics and optimization software solutions to communications service providers. TEOCO was founded in 1995. TEOCO's headquarters is located in Fairfax, Virginia, USA 22033. It has raised $60.0M funding in one round. The latest round was in Oct 2009. TEOCO's primary investor is TA Associates. TEOCO's Chairman & CEO, Atul Jain, currently has an approval rating of 77%. TEOCO has an estimated 1,300 employees and an estimated annual revenue of $295.0M. Its most recent acquisition was Preclarity.
5. Netscout – NetScout (NASDAQ, NTCT) is a provider of products related to integrated computer network performance management and services. It is the world leader in application and network performance management products and solutions. Backed by over 30 years of research and innovation into network operations, the company has developed a unique ability to capture, order, and analyze network traffic in real-time. It works with some of the leading organizations and top government agencies in the United States. NetScout provides both enterprise and service provider solutions. The platform combines world class technical assistance and a robust set of service offerings to support the business objectives of their customers and maximize their investment. It also brings knowledge transfer to improve IT staff productivity and collaboration. NetScout has received awards and recognitions from different organizations. In 2014, the company was named by Forbes as One of America's Best Small Companies making it to the list for the third time. In 2012, it was chosen as a Finalist for Public Company of the Year in the Leading Light 2012 Awards for its next generation communications technology, applications, and services. NetScout competes with riverbed, Apcon, and ExtraHop. The company Chairman and CEO is Anil Singhal with a 64% approval rating. Its headquarters are located in Westford, Massachusetts. NetScout has raised a total of $33M in funding. NetScout has acquired three companies, with the most recent being Tektronix Communications for an undisclosed amount on Oct 2014. It has an annual revenue of $910.1M and has an approximate of 3,000 employees.

6. Commsquare – Commsquare is a telecommunication firm that provides network monitoring and business analytics services. Commsquare was founded in 2001. Commsquare's headquarters is located in Mechelen, Antwerp, BE 2800. Commsquare's Managing Director, Stefan Engels, currently has an approval rating of 41%. Commsquare has an estimated 300 employees and an estimated annual revenue of $10.0M. Commsquare's main competitors are Polystar, V3D and Real Impact Analytics.
7. Informate – Informate is a provider of mobile metrics and data usage measurement solutions for tablets and smartphones. Informate was founded in 2008. Informate's headquarters is located in Mumbai, Maharashtra, IN 400064. Informate's President, Kedar Sohoni, currently has an approval rating of 60%. Informate has an estimated 163 employees and an estimated annual revenue of $4.4M. Informate is a Private company. Informate generates $27.1K in revenue per employee. Informate's top competitor is App Annie, led by Ted Krantz, who is their CEO
8. Accedian – Accedian is a provider of network performance monitoring and assurance solutions to mobile, enterprise and carrier networks. Accedian was founded in 2004. Accedian's headquarters is located in Saint-Laurent, Quebec, CA H4S 2A9. It has raised $31.0M funding in four rounds, the latest round was in Aug 2010. Some of Accedian's investors include Rho Capital Partners, Summit Partners and Skypoint Capital. Accedian's President & CEO, Patrick Ostiguy, currently has an approval rating of 59%. Accedian has an estimated 300 employees and an estimated annual revenue of $75.0M. Accedian's main competitors are EXFO, Creanord and CENX.
9. Empirix – Empirix designs and manufactures service assurance testing and monitoring equipment for IP-based communications networks. Empirix was founded in 1992 and is a private company. Empirix's headquarters is located in Billerica, Massachusetts, USA 01821. Empirix's CEO, John D Anna, currently has an approval rating of 92%. Empirix has an estimated 256 employees and an estimated annual revenue of $84.6M. Empirix's top competitor is NetScout, led by Anil Singhal, who is their Chairman & CEO.

Table 3 - Summary of the major competitors in the electrical components and equipment industry (owler.com, 2019).

RANK	COMPANY	LEADERSHIP	CEO SCORE	EMPLOYEES	TOTAL FUNDING	REVENUE
	Anritsu	 Hirokazu Hashimoto President & CEO	60/100	3,717	$0	$822.1M
1	infovista	 Jose Duarte CEO	60/100	896	$73.7M	$182.5M
2	ASTELLIa	CEO	--	400	$30.9M	$42.7M
3	Polystar	 Mikael Grill CEO	78/100	200	--	$40M
4	TEOCO	 Atul Jain Chairman & CEO	77/100	1,311	$60M	$295M
5		CEO	--	Input	--	Input
6	NETSCOUT.	 Anil Singhal Chairman & CEO	69/100	3,019	$33M	$910.1M
7	commsquare	 Stefan Engels Managing Director	41/100	300	--	$10M
8	Informate	 Kedar Sohoni President	60/100	163	--	$4.4M
9	ACCEDIAN	 Patrick Ostiguy President & CEO	59/100	300	$31M	$75M
10	EMPIRIX	 John D Anna CEO	92/100	256	--	$84.6M

Table 3 offers a summary of all major competitors of Anritsu Corporation.

2.3 Analysis on how globalization has shaped competency

Definition of Globalization

According to the dictionary Merriam-Webster, 'globalization' refers to the act or process of globalizing (state of being globalized), being that the act or process of becoming global, worldwide in scope as well as application. This specifically refers to the development of an increasingly integrated global economy marked especially by free trade, free flow of capital, and the tapping of cheaper foreign labor markets.

Figure 7 - Schematic representation of today's global economy (quora.com, 2018).

Regarding supply chain management, this process has made the broad range of activities required to plan, control and execute product's flow increasingly complex. In fact, a company operating in one point of the world, might have its manufacturing facilities somewhere else, thousands of kilometers away; and its costumers all over the globe. Furthermore, companies might even outsource their supply chain management activities to other companies in different countries, resulting in a reduction of its operating cost and ultimately, allowing them to compete more efficiently. In this sense, the process of globalization has really changed the way businesses operate, leading them to a bigger offer of opportunities to reach new customers in other markets. As a matter of fact, as barriers to trade fell all over the world and logistics improved due to increasing interconnections and better transportation, production shifted to lower-wage nations, with much lower sourcing

costs. As this trend strengthened, companies moved very fast into markets they did not know, with environmental factors they had never handled before (local regulations, working safety standards, social values, traditions, etc.), and without taking care of matters such as long-term logistics costs or possibility to reshore in the future.

However, on the other hand globalization also means new risks which companies did not have to deal with before, or at least they were a much lower of a threat. Some of those risks are direct and obvious, like increased competition or supply chain disruption, but others are much less obvious. As today's consumers care about ethical issues, workers safety and sustainable practices, global companies must take into account practices their customers do not see favorably and avoid them or this will result in a loss of demand for their products. In addition, raw materials and supplier relations must now be managed internationally, and therefore, any incident (political, economic, natural or social) in any country involved in this process might damage a supply chain that would have otherwise never been damaged. Companies now need to manage the associated risks of globalization, as these new risks can be extremely threatening and potentially damaging.

Both global and local businesses must be prepared for any event in the world that might make them rethink their operations, such as finding a new supply source or reroute some or all of their supply chain. In order to do so, companies are relaying on new technologies and software to increase their ability to react and some are starting to augment their global sourcing options. Some of the areas companies must work on in order to protect themselves from events that might cause a disruption of their supply chain are:

- Product costs vs. supply dependency: On the one hand, a low-cost supplier might result in dependency, but on the other hand, some small- and mid-market organizations do not have the purchasing power advantage or global sourcing opportunities as other larger competitors. This might result in them picking the lower-cost option in order to compete.
- Intellectual property: As intellectual property theft is increasingly raising and given the fact that standards and enforcement are very different from country to country, some smaller businesses might not have the ability to protect themselves in the global scenario.

- Offshoring, outsourcing, nearshoring or insourcing: All relevant factors, such as salaries, transportation and costs, shipping times, worker training, quality, sustainability, government policies and regulations, must be considered in order to determine which business model to use.
- Technology: Day by day new technologies and software emerge to chain current practices in the supply chain management and to improve its risk management. However, not all companies are the same and not all software serve for the same purpose, therefore, choosing the right one for each company plays a key role in mitigating the risks associated with globalization.
- Image: In the globalized scenario, customers have increasing options for their products and services, and so, they tend to pay increasing attention to where the products are manufactured and under what conditions. In addition to that, information is available for anyone and a bad reputation spreads very quickly today. Not taking enough care to where and how products are manufactured can lead to a loss of customers which will go directly to competitors.

In order to accurately and properly continue the analysis, some terms must be defined: climate change, global warming and climate disruption.

Definition of climate change

According to the dictionary Merriam-Webster, 'climate change' refers to the changes in the Earth's weather patterns. More concretely, and according to the Encyclopaedia Britannica it is the periodic modification of Earth's climate brought about as a result of changes in the atmosphere as well as interactions between the atmosphere and various other geologic, chemical, biological, and geographic factors within the Earth system. The atmosphere is a dynamic fluid that is continually in motion. Both its physical properties and its rate and direction of motion are influenced by a variety of factors, including solar radiation, the geographic position of continents, ocean currents, the location and orientation of mountain ranges, atmospheric chemistry, and vegetation growing on the land surface. All these factors tend to change through time.

Definition of global warming

According to the dictionary Merriam-Webster, 'global warming' refers to an increase in the earth's atmospheric and oceanic temperatures widely predicted to occur due to an increase in the greenhouse effect resulting especially from pollution. More concretely, and according to the Encyclopaedia Britannica, Global warming, the phenomenon of increasing average air temperatures that surround the surface of Earth over the last couple of centuries. Climate scientists have since the mid-20th century gathered detailed and increasingly accurate observations of various weather phenomena (for instance, temperatures, amount of precipitation, and storms) and of related influences on climate (such as ocean currents and the atmosphere's chemical composition). These data indicate and demonstrate that Earth's climate has changed over almost every conceivable timescale since the beginning of geologic time. The prove as well that the influence of human activities since, at least the beginning of the Industrial Revolution, has been deeply woven into the very fabric of climate change.

Definition of (extreme) climate disruption

According to the National Climate Assessment (NCA), 'extreme climate disruption' or 'global climate disruption' is the new term scientists are using to explain the extreme fluctuations that can and will occur to our weather systems as anthropogenic caused carbon dioxide and other greenhouse gases increase in our atmosphere, the oceans get warmer, and weather events go wild. It pretty much refers to the same phenomenon as 'global warming'. In fact, both terms are used in the same fashion. However, the NCA uses the term 'climate disruption' to particularly describe and emphasize the grave risks, and intensifying future risks, to communities – particularly indigenous communities, our economy, ecosystems, the environment and the natural world, public health, water quantity and quality, agriculture, and infrastructure.

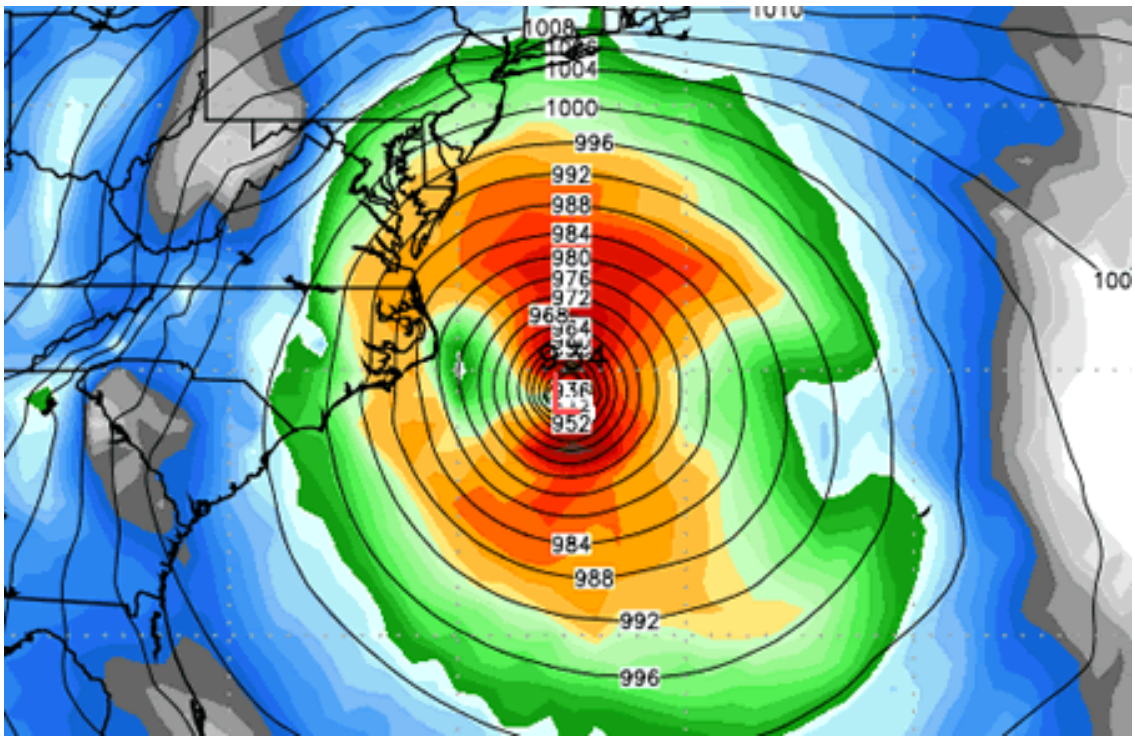


Figure 8 - Hurricane Sandy massive size (transitiontownpayson.com, 2018).

"Global warming became too black and white a concept to fit with the vagaries of weather systems and quickly grew to be the butt of jokes when the weather was unseasonably cold (ironically, there were early snowfalls on the day that the UK Climate Change Act was passed). 'Climate change' then became the preferred term, encompassing pretty much anything which might be considered 'unnatural'. But this was also open to criticism; after all, is climate not intrinsically variable? Hence the recent enthusiasm for 'global climate disruption', which nicely encapsulates the concept of unwanted and unnatural change."

In the same regard, and moving back to our supply chain analysis, as customers become increasingly conscious and ask themselves where their products are sourced, sustainable business practices play a key role in this respect. In order to maintain or even improve the number of costumers, companies are making of sustainability a business imperative, acting and making decisions with a long-term emphasis. In the same way technology and software can help businesses deal with the risk associated to globalization, it can effectively achieve sustainable goals, while reducing waste and the associated cost to excessive inventory, transport and disposal.

Regarding the industry, several initiatives have been taken in order to improve the supply chain sustainability. On the one hand, companies are trying to save capital reducing costs

systematically. Saving fuel can lower CO_2 emissions, which represents and increasingly costly overall cost, given the variability of fuel prices, but its tendency to increase over time. Some businesses tend to overproduce in order to operate their plants and factories at full capacity but wasting an enormous amount of fuel. Technology can effectively help predict demand quite accurately, so business can reduce the amount of waste they produce, reducing the quantity of raw materials used and manufacturing only the required number of finished goods. Another way companies are improving their sustainability standards are through optimizing their supply response by better supply chain design using newer and more effective technology. For instance, using artificial intelligence and machine learning, shipments can be combined so empty truckloads can be reduced, all with the advantage of better and higher customer service agreements. As costs are saved on good logistics that exceed their demand, costs are also saved on carrying excessive and unnecessary inventory.

On the other hand, some other companies are exploring the idea of creating a digital twin of their product so they can better predict its servicing needs and so, reduce the associated maintenance costs while potentially expanding the product's life (downtime being reduced). This refers to the commonly called and referred to as IoT (Internet of Things). These technologies enable a digital inspection of the product and they allow companies to repair it if needed. Without this visibility, companies run the risk of failures at inopportune times and the associated delays in delivering the goods. Targeted logistics help ensure the replacement and repairmen of the appropriate element is conducted on time, so everything runs flawlessly.

Finally, some other aspects to consider when making supply chain more sustainable are visibility, track and trace. Costumers tend to expect companies to provide some visibility on how products are sourced, what materials are used to manufacture them and what happen with them when the product's life comes to an end. This usually goes by detailing how much of a certain component is being used, where that component comes from, how do they recirculate it into the economy, etc. Technologies that enable to track materials, compositions and sources allow companies to become transparent and to build an image of trust with their customers. As data can certainly be used to study how a product is used, it can as well predict its life end. What is more, technologies can help find a path for died products to reenter the economy and so, facilitate the tracking and sustainable disposal of any component. Sustainable supply chains are not only seen as a viable business strategy

but also as a very powerful tool to boost business growth and to delight customers with innovative and transparent products. Digital supply chains and new technologies allow an increasing number of businesses to create and run a sustainable supply chain at scale.

Figure 9 - Digital supply chain transformation (uschamber.com, 2017).

CHAPTER 3

ANALYSIS OF ANRITSU

Figure 10 - Anritsu corporation Logo (anritsu.com, 2018).

Anritsu Corporation is multinational company based in Atsugi, Japan. They are involved in the information and communication field, more concretely, in the telecommunications electronics equipment market. It is best known for having produced the first wireless telephone network in the world. Currently, its measuring instruments business allow for the development, manufacture and maintenance of a range communication systems, through the provision of products and services. In addition to this, Anritsu has a certain involvement in other fields, such as IP network equipment and food and pharmaceutical products inspection equipment.

3.1 Brief History

First founded in 1895, Anritsu Corporation counts with 124 years of contribution to the development of a safe, secure and prosperous global society by offering original and high-level products and services. The year 1895 was marked by the demonstration of the world's first wireless telegraph, introduced by Guglielmo Marconi. Anritsu has outlined the birth and development of modern communications. The history of the corporation remains concurrent with the evolution of information and communication networks.

It was in this very same year, 1895, when the joint investment company 'Sekisan-sha' (predecessor of Anritsu) was first established. Five years later, in 1900, a telecommunication systems company called Annaka Electric Co. Ltd. was created. It was three years later when this company exhibited a wireless communication transmitter along with a 30 cm (1 foot) spark coil at the 5th Japan National Industrial Exhibition of 1903. In 1908, Sekisan-sha and Abe Electric Co. merged and established a corporation called Kyoritsu Electric Co. Ltd. This company focused on mass-producing common battery telephones (renamed public telephones in the year 1925). In 1912, Annaka and the Ministry of Post and Communications Electrotechnical Laboratory completed the manufacture of

the TYK Radio telephone, which was installed for cable and telegraph services between two prefectures of Japan, gaining attention as it was the world's first practical use wireless telephone. Twelve years later, in 1924 Annaka began to manufacture radio receivers, speakers and headphones, following the introduction in Japan of the radio broadcasting. A year later, they created the first 500 W broadcasting equipment for use at the Tokyo Central Radio Station, and three years later, Annaka manufactured a marine-use 2 kW remote operation wireless transmitter.

It was the year 1931 when both companies, Annaka Electric and Kyoritsu Electric merged to establish the today's Anritsu Electric Co. Ltd. Two years later, Anritsu produced the country's first TV broadcast transmitter, later supplied to an advanced technical school today known as Shizuoka University. In 1939 the corporation completed the first automated public telephone and developed AC-bias magnetic sound recorders, which were the prototype of modern tape recorders. In 1943, they began to manufacture repeaters for transmission by coaxial cables, and in 1949 they implemented the first split-up of radio receiver, measuring instrument and gramophone divisions to create new independent companies. In the fifties they developed strength meter for ultra-short-wave electric fields employing a doublet antenna and began the mass production of charge deferred payment-type public telephone. During the sixties, Anritsu was able to establish a new factory in Atsugi which later on began to manufacture industrial measuring instruments (electronic micrometers) and automatic check weigher (the AutoChecker). Later on, they succeed to apply hybrid thick-film and thin-film IC's, which allowed to start manufacture traffic information systems. An important year for the corporation was the year 1968, as it was when they were first listed on the First Section of Tokyo Stock Exchange.

During the seventies, they began to export public telephones to Australia and developed 2 Gb/s ultra-high-speed error rate detector. They also started producing optical communication measuring instruments. During these years, they established themselves in Rio de Janeiro, Brazil and New Jersey, United States. They completed the construction of their new head office building in 1979. The eighties were marked by the establishment of the company in Europe, more concretely, in Bedfordshire, United Kingdom. During this time, they developed the Optical Time Domain reflectometer ahead of the global trend and developed a 5 GHz pulse pattern generator, used in research as well as development of optical fiber communication systems and ultra-high-speed logic elements. In 1985 Anritsu

dropped the word 'Electric' to change its name to Anritsu Corporation. During the nineties, they Acquired US instrument manufacturer Wiltron Company and continued developing various and different measuring instruments for digital mobile communications.

In the 21st century, Anritsu has been a global leader for the manufacture and production of measuring equipment. This has allowed them to continuously grow with sustainable superior profits through innovation, using all knowledge of all parties involved with the company and contributing to the sustainability of society. Currently, Anritsu Group is composed of Anritsu Corporation, Anritsu Engineering, Anritsu Infivis, Anritsu Devices, and Anritsu Networks.

3.2 Current performance

Regarding the financial performance of Anritsu, some basic information about the company is the fact that by March 31, 2018, the sales volume were 85,967 million yen or 782.13 million US dollar, with a paid-up capital by that time of 19,064 million yen or 173.44 million US dollar. The corporation counts with 3,717 employees (consolidated) and with 844 (non-consolidated). As of March 2018, Anritsu's Price-to-Earnings Ratio (PER) was 62.66, its Return on Assets (ROA) 2.33% and its Return on Equity (ROE) equal to 3.72%. Finally, they count with an Operating Margin of 6.07% and a Profit Margin of 3.35%. These financial performance measures are above the average for the industry, which means Anritsu is doing very well financially speaking.

As of March 31, 2018, the financial highlights for Anritsu were the following, shown in Table 4.

Table 4 - Anritsu's Financial Highlights as of March 31, 2018 (nikkei.com, 2018).

FINANCIAL HIGHLI(

MAR 2018	JPY | USD
Revenue	775.64M
Gross Profit	366.93M
Operating income	47.14M
Income before tax	41.52M
Net income	25.98M
EBITDA	85.80M
Diluted EPS	0.18
Dividends Per Share	0.13
Total Assets	1,139.53M
Total liabilities	393.09M
Total equity	735.58M
Operating cash flow	71.69M

Currency in USD

Regarding Anritsu's top ten shareholders, they are by order of weight: Matthews International Capital Management LLC (7.4%), Asset Management One Co., Ltd. (5.6%), Nikko Asset Management Co., Ltd. (5.2%), Rheos Capital Works, Inc. (Investment Management) (5.1%), Nomura Asset Management Co., Ltd. (4.9%), JPMorgan Asset Management (Japan) Ltd. (4.1%), Sumitomo Mitsui Trust Asset Management Co., Ltd. (3.3%), Taiyo Pacific Partners LP (3.1%), The Vanguard Group, Inc. (2.5%), Mitsubishi UFJ Kokusai Asset Management Co., Ltd. (2.1%).

The weight of each shareholder is represented in the following diagram, Figure 11, where it can be observed that 43.06% of the shares are held by the top ten holders.

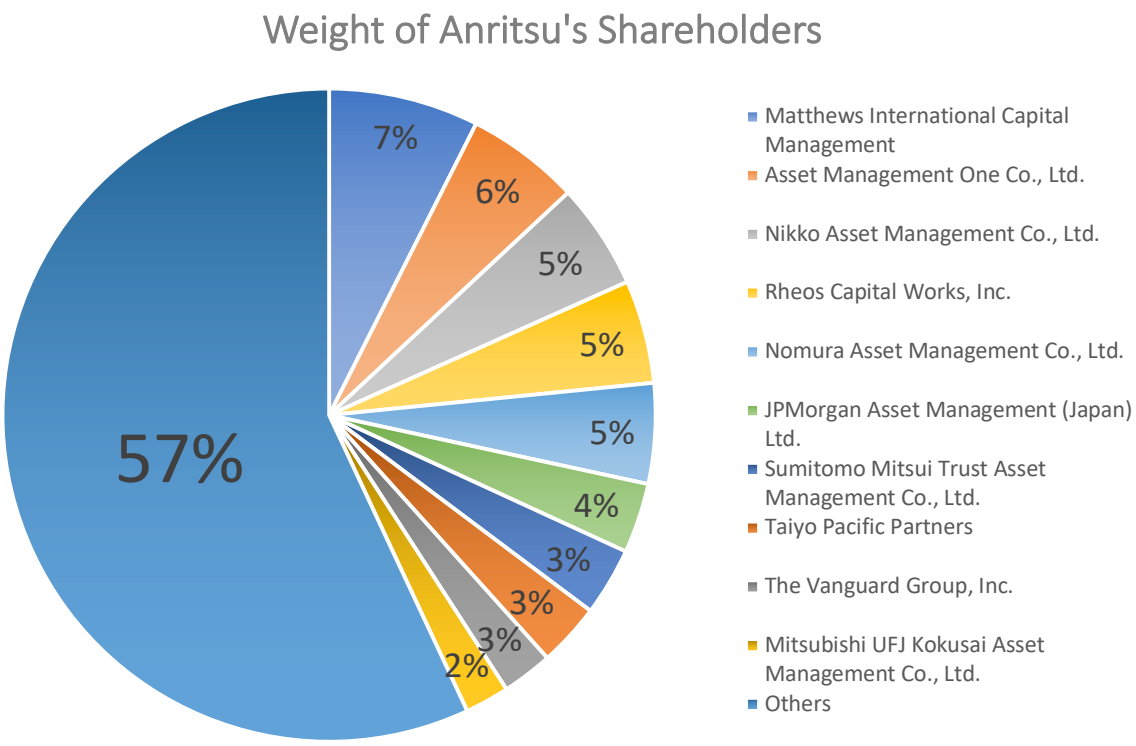


Figure 11 - Weight of each of Anritsu's shareholders.

The company has recently launched the so called 'GLP2020', a medium-term business plan aiming to renew their efforts to contribute to a sustainable society and to demonstrate their value as a vital component of the global society. This business plan intends to strengthen and consolidate the corporation's position regarding the industry in which they operate.

During the fiscal period 2015-2017, the most recent one, their Test and Measurement business fell slightly short of the corporation's target sales, however, the Food Product and Pharmaceutical Quality Assurance business exceeded their targets. Given the downward trend in the smartphone production, Anritsu moved to enact management restructuring in the Test and Measurement business. Currently, the corporation is focusing their efforts on preparing for the 5G market. Taking a series of measures under the GLP2020 plan to build a strong and resilient business, the company's forecast for 2020 are shown below, in Table 5.

Anritsu's ultimate goal is to become a leading company supporting the 5G and Internet of Things society, and to become a world-class quality assurance solutions partner.

Table 5 - Revenue and Operating Profit Forecast under the GLP2020 plan (anritsu.com, 2018).

GLP2020 : Revenue and Operating Profit Plans

			GLP2020	
Indicator		FY2017	FY2018	FY2020
Revenue		86 billion yen	92 billion yen	105 billion yen
Operating profit		4.9 billion yen	6.6 billion yen	14.5 billion yen
Operating profit ratio		6%	7%	**14%**
Net income		2.9 billion yen	5.0 billion yen	11 billion yen
ROE		3.7%	7%	**12%**
Test and Measurement business	Net sales	54.4 billion yen	60 billion yen	70 billion yen
	Operating profit	1.8 billion yen	3.5 billion yen	10 billion yen
	Operating profit ratio	3%	6%	**14%**
PQA business	Net sales	22.5 billion yen	23.5 billion yen	26.0 billion yen
	Operating profit	2 billion yen	2 billion yen	3 billion yen
	Operating profit ratio	9%	9%	**12%**

For reference: Exchange rates assumed under GLP2020 are: US$1=¥105 and 1 euro=¥125

In order to do so, they have established a medium-term guideline that includes a sales growth rate goal of 7% for both, the Test and Measuring business and the Food Product and Pharmaceutical Assurance Quality business. This guideline also sets an operating profit growth rate of 20% for the Test and Measuring business and a rate of 12% for the Food Product and Pharmaceutical one. This will result in a consolidated operating profit growth rate of 18% and a Return on Equity of about 15%, drastically improving the current financial measurements.

In other words, Anritsu is committed to the following three actions, as outlined in the GLP202: establishment of growth drivers, creation of a strong profitable structure, and creation of the next-generation mainstay businesses. This will contribute to improve the already outstanding financial measures of the corporation and continue the growth trend of the last couple of years as depicted in the following figure, Figure 12.

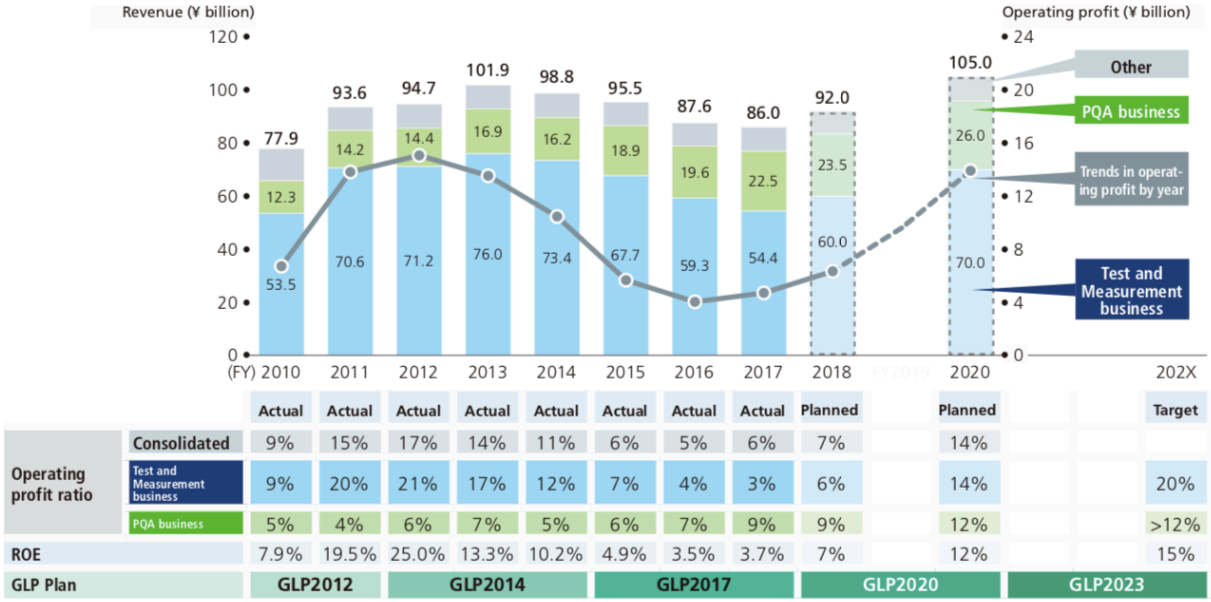


Figure 12 - Trends in Operating Profit by year from 2010 to expected in 2020 (anritsu.com, 2018).

The Mid-term Business Plan GLP2020 is outlined by initiatives that are designed to return the corporation's core business to a higher growth rate and to significantly improve their operating margin, improving the ROE and enhancing enterprise value while actively promoting growth investment in order to build a business portfolio independent of mobile communications systems cycles which affects the industry as a whole. The basic guideline for the financial strategy is the following: enhancement of corporate value, flexible strategic investment and building a robust earnings structure.

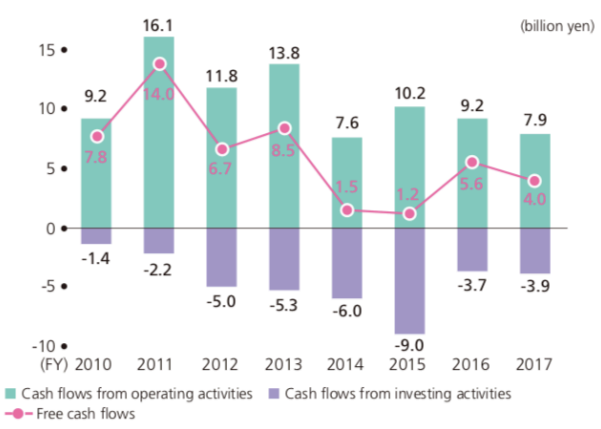


Figure 13 - Cash Flow Trends from 2010 to 2017 (anritsu.com, 2018).

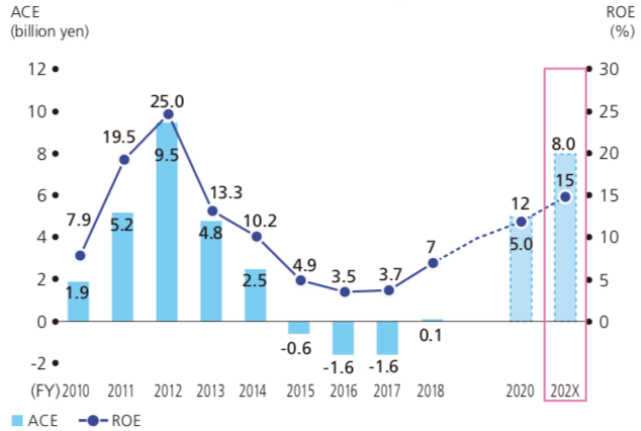


Figure 14 - ACE, ROE Trends, and Targets from 2010 to expected in 202X (anritsu.com, 2018).

3.3 Products

Anritsu's diverse portfolio of companies enhance our personal and business lives in an infinite number of ways... from communication systems and business intelligence to the safety of our foods and pharmaceuticals.

As mentioned earlier, Anritsu mainly offers five different types of products:

a) Test and Measurement:

- Mobile Wireless Communications: Anritsu is a pioneer in the implementation of next-generation wireless technologies while continuing to support existing standards. They offer solutions for the full range of 2G, 2.5G, 3G, 4G, and 5G telecommunications as well as current and next-generation 3GPP, 3GPP2, and IEEE standards including 1xEV, GSM/GPRS, W-CDMA, HSDPA, 802.11, and 802.16. Their portfolio encompasses instrumentation ready to test both early next-generation specifications and legacy technologies. From the chipset to the installed product, Anritsu's wireless test equipment covers the entire life cycle of wireless infrastructure and user equipment.
- Radio Frequency and Microwave: Anritsu is the industry standard for RF and Microwave Test and Measurement equipment for both field and lab environments, with instruments operating at all frequencies up to 110 GHz and beyond.
- Broadcasting and Multimedia.
- Devices and Components Test: The more complex the network or design, the more devices and components must be tested to ensure consistent performance and meet SLAs. Anritsu provides both inline components to continually verify signal strength, power, and throughput; and external test instruments that can quickly isolate a bad connection or failed component. Anritsu's broad experience in wireless and optical technology enables them to offer component and device testing solutions that are accurate, reliable and easy to use.

Figure 15 - Anritsu's vision of a safe, secure, and prosperous society realized by 5G and IoT (anritsu.com, 2018).

- Transport Datacom: Transport datacom applications require extremely high reliability as well as frequent monitoring and testing at each stage of the R&D, manufacturing, deployment and maintenance lifecycle. Anritsu provides a range of measurement instruments for Bit Error Rate (BER), Frame and Protocol testing, for networks using such technologies as IP, Ethernet, MPLS, SONET, SDH, DWDM, ATM, ISDN, SS7, VoIP, PDH, DSn as well as future systems up to 43.5 Gbps. Their products are used both by designers and manufacturers of transport and datacom systems and by end user companies monitoring their own systems.
- Optical: Anritsu offers a complete range of test and measurement equipment for the optical communications industry including R&D, production, installation, monitoring, and manufacturing. Anritsu is a recognized leader in high-speed optical technology offerings and field test solutions including evaluating a wide range of optical devices and fiber systems like DWDM. Critical measurements such as OTDR, Chromatic Dispersion, Polarization Mode Dispersion, Loss Test Set, and Optical Return Loss can be made quickly and accurately to maximize network performance and accelerate the deployment of new services.

b) Components and other accessories:

- High Return Loss Connectors and Cables: High frequency microwave connectors, including Anritsu's trademarked K, V and W1 connectors, are for use in commercial components, test fixtures, and military systems.
- Instrumentation Grade Adapters: Poor return loss can be a major source of measurement error. By selecting the correct adapter with better return loss, the measurement error is eliminated. Precision measurement adapters are available up to 110 GHz.
- Precision Terminations, Fixed and Step Attenuators: Leading in the field of impedance standards, Anritsu terminations and Attenuators are unsurpassed for precision and impedance match, resulting in increased measurement accuracy.
- Measurement Components and other Accessories: Offering a wide variety of standard/precision components as well as accessories – from batteries to calibration and verification kits – Anritsu's offerings help meet their client's measurement needs and requirements.

c) Service Assurance: The first to offer tailored OSS solutions, Anritsu customizes their monitoring and testing solutions to the client's requirements in order to provide the actionable business intelligence they need to optimize the customer experience and sharpen their competitive edge. Anritsu's Multi-Dimensional Assurance Solution provides CSPs (Communications Service Providers) with unrivalled visibility of network and service performance that enables optimization of customer experience and understanding of how customers use data services as well as how they are impacted by problems. The solution provides unique visibility into the experience of all their customers, including the numbers impacted by any problem, in the right context, and at the right time. Whether for a CTO who needs to see overall service performance, a product manager seeing if their new offering is succeeding, a corporate sales executive re-negotiating a multi-million contract or network planner deciding where best to invest new capacity – Multi-Dimensional Assurance has the actionable intelligence they need.

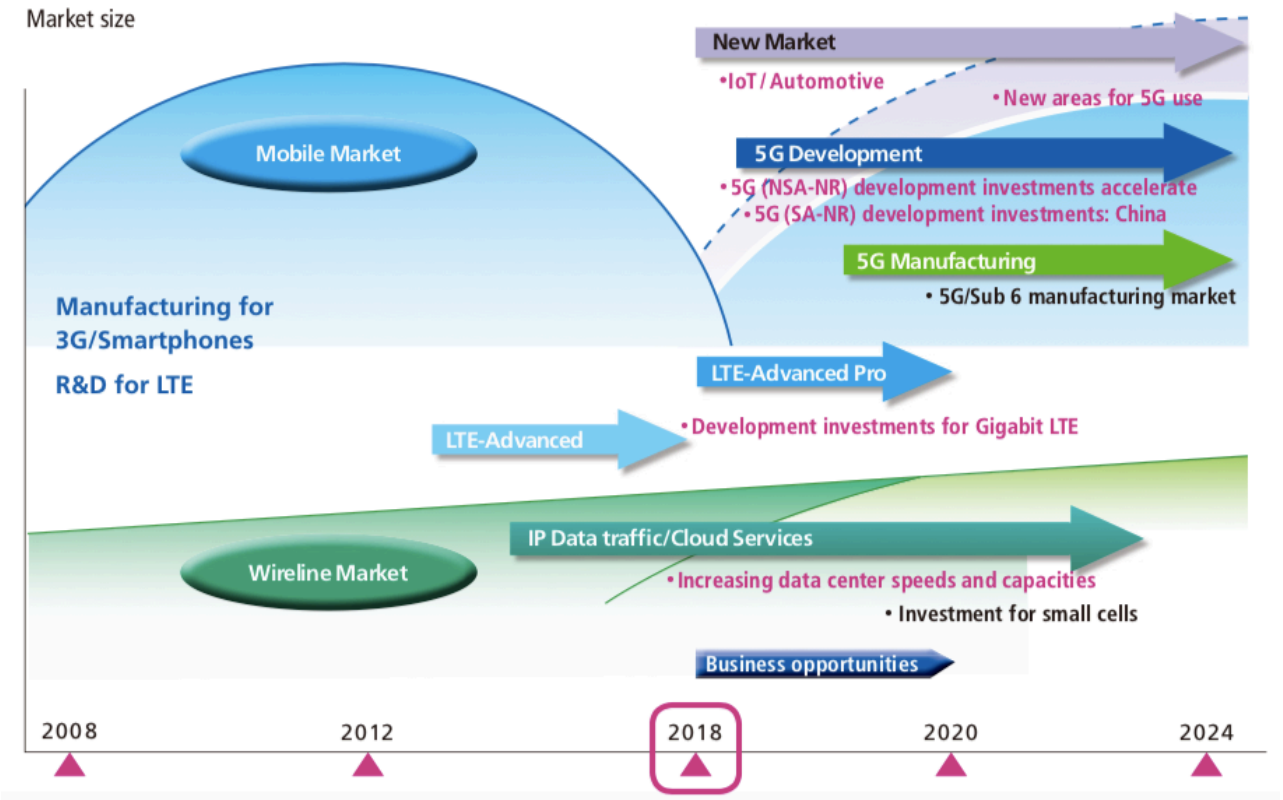


Figure 16 - Market Trends and Anritsu's Business Opportunities (anritsu.com, 2018).

d) Food and Pharmaceutical Equipment:

- X-Ray Inspection: Anritsu X-Ray Inspection Systems give food and pharmaceutical producers the best combination of contaminant detection, reliability, and low total cost of ownership. Anritsu has the advanced technology they can trust to protect their customers from even the smallest contaminants. With outstanding accuracy and precision, Anritsu's x-ray machines can detect metal, stone, bone, glass, and more, using their advanced HD and UltraHD technology. Beyond detection, Anritsu X-Ray Inspection provides missing product, shape detection, virtual weight, count, and package check. Anritsu UltraHD Technology is known for its ability to detect contaminants of only 0.2 mm diameter, including ferrous, non-ferrous, and stainless contaminants. Anritsu HD Systems can detect metal contaminants as small as 0.4 mm, and glass and stones at 1.0 mm to 2.0 mm.
- Checkweighers: Anritsu's precision inline checkweighers ensure product quality and determine weight. Anritsu checkweighers provide exceptional product safety, productivity, and excellent return on investment while ensuring

compliance with HACCP programs, all in a compact footprint. SSV Series: With accuracy as low as ±0.01g at 3σ and speed up to 600 products/min, the SSV promises top product inspection performance and productivity. Reliability: With nearly 100,000 installations worldwide, Anritsu checkweighers are built to last and consistently perform

- Metal Detectors: Anritsu's advanced Dual Wave metal detector solutions detect ferrous and stainless metals simultaneously. Accurate and efficient contaminant detection, all Dual Wave machines are easy to maintain and have a world-class reputation. They protect the client's brand and keep their customers safe with this innovative metal detection technology. Accuracy: Anritsu's dual frequency metal detection technology consistently finds the smallest contaminants in all product types Footprint: The industry's smallest dual-frequency system eases line integration but built strong for production environments.
- Checkweigher and Metal Detector Combination Systems: Highest Accuracy with Smallest Footprint Space. Anritsu's SSV checkweigher and metal detector combination systems provide outstanding weighing accuracy with simultaneous multi-frequency inspection to help find the smallest contaminant. It allows to maximize line space and ensure HACCP compliance with a solution that is compact, easy to maintain and simple to operate. Anritsu's precision engineering minimizes false rejects and provides unrivaled system reliability, giving you superior total cost of ownership. It allows to minimize false rejects, improve product inspection and protect customers with metal detection technology that offers the best performance for the food and pharmaceutical industries

e) Optical Devices and Ultrafast Electron Devices: A complete line of optoelectronic components for optical communication systems and fiber optic sensing applications. Anritsu provides Electronic Devices such as Optical modulator drivers, Amplifiers, and Filters for Ultra-High-Speed Communication networks.

Taking a look at what the revenue is for each of the business segments, the Test and Measuring segment is the one that reports the highest amount of revenue, followed by the Food Product and Pharmaceutical Quality Assurance segment, as shown in the following graph, Figure 17.

Figure 17 - Business review of each of Anritsu's business segments (anritsu.com, 2018).

3.4 Analysis of its supply chain

Anritsu's believes in the importance of doing the right supply chain management, striving to respond to the expectations and demands of society across the entire supply chain. To do so, they have been developing during the years a strong partnership through the willing involvement of suppliers and other stakeholders in various activities and by ensuring compliance with those applying relevant laws and regulations, as well as business practices, social norms, and initiatives for preserving the local environment. Anritsu's procurement operations reach beyond Japan and across the world, being global in scope. Therefore, their goal is to offer equal opportunities to every company in their home country and overseas through fair assessment practices.

Anritsu believes in the vital importance of moving as one with their entire supply chain, together with business partners. That is the reason why they conduct procurement in such a way that this activity becomes beneficial for all parties involved and to boost mutual growth. With that conviction, they established their Basic Rules of Procurement in the year 2005 aiming to reinforce mutual trust and seek the cooperation of suppliers and business partners.

The corporation's main procurement bases are established mainly in the United States, Europe, China, and its home country, Japan. Furthermore, the company is working on establishing a globally unified set of unified assessment criteria, approved by each location, to optimize the mutual use of the supply chain. Anritsu intends to promote parts procurement through international collaboration. In fact, mutual approval is offered by Anritsu as a means for recognizing business partners (known as Global Preferred Supplier, GPS) that provide the corporation with the products they commonly use within the Anritsu Group. In order to shorten the time to market for product development, Anritsu intends to

share development roadmaps and technological issues with those suppliers. The corporation has decided on a common standard for assessing suppliers between their operations in Japan and the United States and selected eight companies to their GPS list to enhance mutual interests and to build a stronger relationship.

Regarding Anritsu's medium- to long-term goals, they are working towards the following objectives stated in the previously mentioned GLP2020 new mid-term business plan:

1) Promote global CSR procurement – Anritsu promotes CSR (Corporate Social Responsibility) procurement tat strictly protects human rights, labor, safety, and health throughout the whole supply chain, overseas business partners included. In order to do so, Anritsu is working on strengthening and improving their global supply chain. In addition, the corporation is aiming to increase the CSR survey assessment scores through visiting their business partners and promoting CSR procurement activities based on CSR surveys.
2) Promote global green procurement – Anritsu is actively promoting environmentally friendly green procurement throughout the entire supply chain, overseas partners included. In order to do so, Anritsu is surveying the environmental initiative standing of their business partners and undertaking measures to raise the quality of the environmental initiatives of them. They aim to enhance the ratio of certified Environmental Partners among their business partners.

In order to accomplish those two goals, Anritsu has undertaking the following measures and activities:

- Anritsu Group CSR Procurement Guideline Formulation: In 2010, Anritsu formulated its CSR Procurement Guideline, complying with the Supply Chain CSR Deployment Guidebook published by the Japan Electronics and Information Technology Industries Association (JEITA). It I required for Anritsu's business partners to have an understanding of this guideline and to take initiatives for CSR procurement at the outset of business with new business partners and during policy briefings with suppliers.
- Initiatives for CSR procurement: Since 2011 Anritsu is actively asking for cooperation of business partners in promoting CSR procurement. In addition, the corporation is conducting CSR surveys for the purpose of reviewing the CSR

initiatives taken by their business partners. Six years later, in 2017, Anritsu claimed to have had positive results as 116 of their major business partners collaborated in this regard. Anritsu visited their business partners to further discuss their CSR activity initiatives. Moreover, Anritsu is seeking cooperation form their suppliers on clean procurement so as to achieve transparency in their transactions as they practice compliance. Finally, they have set up the Direct Delivery Mailboxes to promote CSR procurement based on the direct feedback from their partners.

- Green Procurement Guidelines: In accordance with the Green Procurement Guideline Anritsu established in 1999, the corporation is undertaking green procurement by preferentially procuring environmentally friendly parts and materials. In 2011, the company introduced the concept of preserving biodiversity to their activities and began implementing initiatives to deepen supplier understanding of biodiversity preservation. Since 2016, under their revised Anritsu Group Green Procurement Specification, they aim to unify their green procurement activities with those of group companies outside Japan that operate manufacturing bases.
- Environmental Partner Company Certification System: In the year 2001, Anritsu launched the Environmental Partner Company Certification system as a means of evaluating the status of the corporation's suppliers' environmental management systems and product assessment procedures. In order to do so, Anritsu rank their partners at three levels and encourage environmental initiatives of suppliers. In 2017, they contacted four business partners that showed room for improvement and elevated the Environmental Partner ranking of all four companies through improvement activities. As of April 30, 2018, the number of certified Environmental Partner Companies stands at 245.

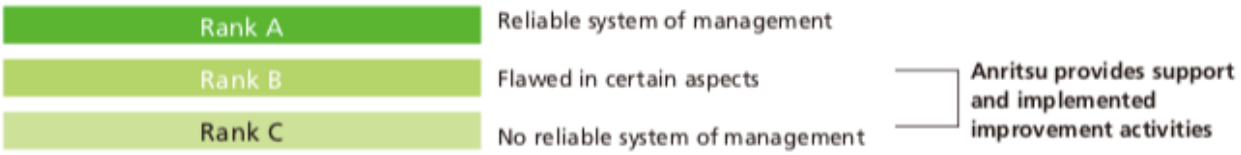


Figure 18 - Anritsu's Ratings in the Environmental Partner System (anritsu.com, 2018).

- Response to conflict mineral: Following the 2012 adoption of the Financial Reform Bill for the conflict mineral provision of the United States, Anritsu declared its support and began working with its supply chain to prevent the use of conflict

minerals in their products. The corporation also hold briefings with their business partners to prevent any oversights. Anritsu responded to customers inquiries related to this issue by requesting investigations by business partners in Japan and abroad. To date, there has been no use of conflict minerals at Anritsu.

- Exhibition of partner products and technologies: In 2016, an exhibition was held at Anritsu's head office in Japan, featuring products manufactured by 47 of their partners. This event was set to be hold every year since then to showcase the products and technologies of major business partners that procure products and materials for the Anritsu Group. The event also includes seminars featuring lecturers from their partners, aimed at keeping participants abreast of cutting-edge technologies.
- Initiatives for the UK Modern Slavery Act: In 2016, Anritsu published the UK Modern Slavery Act Statement. As one of their initiatives in 2017, they created a task force to conduct human rights due to diligence for the related departments and conducted CSR surveys of 116 of their major partners. Anritsu determined the human rights risk within the supply chain based on an analysis and evaluation of the CSR survey response details. As a result, they confirmed there are no urgent issues as of now and that the human rights risk is low.
- Business partner gathering: In 2018, Anritsu hosted a business partner gathering that drew 283 representatives from 153 Anritsu business partners, including overseas companies. They presented their strategies and business development plans under the theme of 5G/IoT toward becoming a global market leader. They called for even stronger partnership to expand their value chain through collaboration and co-creation under their global procurement system. Moreover, they presented awards to those of their business partners that excelled in all three aspects of quality, delivery, and pricing.
- Promoting Partner QU Proposal Activities: Anritsu is actively promoting the Partner QU (Quality Up) Activity as a communication channel for business partners so that they can offer proposals for improvement, requests, and opinions concerning Anritsu's procurement. A council that promotes and supports the activity deliberates and determines whether or not to adopt the proposals. In 2017, they adopted 36 out of 62 improvement proposals, which included changing the design to reduce costs and adopting a different procurement method to speed up delivery.

- Collaboration room: Anritsu maintains a collaboration room with the company to revitalize communications between their development engineers and business partners. They invite different manufacturers and agents to dispatch their sales engineers in a daily rotation and provide an environment for generating new solutions.

Finally, Anritsu established in 2005 a Basic Rules for Procurement, which contains the following items:

1. Selection of suppliers and partners - Anritsu always tries to keep the door open to any new potential suppliers and partners inside or outside Japan, due to their spirit of fairness and impartiality. Anritsu objectively selects their suppliers and partners based on proper standards – that is to say, focusing on quality, price, delivery schedules and environmental measures.
2. Partnership - Anritsu intends to build mutually beneficial relationships with all their suppliers and partners through sound business practices.
3. Compliance and secrecy protection - Anritsu conducts business in full compliance with relevant laws and does not disclose information acquired through business with suppliers and partners to any third party without these suppliers' and partners' prior consent.
4. Activity based on ethical concepts - Personnel involved in procurement keep in mind at all times the importance of performing assignments fairly, free of personal interests with suppliers and partners, while maintaining sound relationships with these parties.
5. Considerations of human rights and labor - Anritsu respects human rights and promotes industrial hygiene, safety as well as security, and requests that all their suppliers and partners agree to this policy and promote these activities as part of their supply chain operations. Anritsu may reconsider relationships with all those suppliers and partners whose business operations are linked with human rights violations. For example, the use of child labor, racial and sexual discrimination, etc. In addition to that, Anritsu will work together with their suppliers and partners regarding non-use of conflict minerals that lead to these human rights issues.

6. Environmental considerations - Anritsu stipulates Green Procurement Guideline and promotes green procurement by acquiring parts and materials that have been proven to be less damaging to the environment.

To promote their Basic Rules of Procurement, Anritsu communicates the following requests and requirements directly to all suppliers as it seeks their full cooperation in activities undertaken throughout the supply chain as a whole:

1. Observance of laws as well as social norms - Observance of relevant legislatures, for instance, prohibition of child labor, forced labor and cheap labor; and prohibition of discrimination as well as transaction with antisocial forces.
2. Environmental considerations - Realization of environmental initiatives and measures in line with Anritsu's Green Procurement Guidelines, environmental requirements, standards, etc.
3. Ensuring good quality, supply at fair prices and maintenance of delivery schedules.
4. Preventing leakage of secret information and respect for intellectual property rights.
5. Prompt response to contingencies and timely, appropriate information disclosure.

All of the above-mentioned points are enacted to help make sure that Anritsu Company conducts their business with partners and organizations who share its same view of corporately social actions throughout the supply chain management.

Figure 19 - Anritsu's Supply Chain Management (anritsu.com, 2018).

CHAPTER 4
IMPLEMENTATION OF THE KINAXIS SOFTWARE

Figure 20 - Logo of Kinaxis® (kinaxis.com, 2018).

Markets move quickly, supply and demand are characterized for being highly volatile and supply chains are complex. The future cannot be predicted and, of course, if something can go wrong it probably will. The success or failure of any supply chain basically depends on how quickly and effectively stakeholders can identify understand and respond to evolving situations. In other words, it cannot be afforded to be slow and inflexible. A lot of existing processes and supporting tools are designed to help make a better plan but in an unpredictable world, how good can it really get? Add to the fact that supply chain functions have been working in isolation and it can be seen why organizations are struggling amid the chaos. Processes are disconnected, difficult and slow. That's where RapidResponse comes in. With a modern solution to managing any supply chain. RapidResponse is able to break down the barriers to collaboration as well as consensus and compromise by bringing data analytics and people together in one central system, which means things can be done differently, things that were not able to be done before. With RapidResponse people across the organization can plan better, but as importantly when reality interrupts, and it will, people can work together in unison across the supply chain to recognize problems, analyze the impact of any decisions they are to implement, and take immediate action to ultimately drive significant business breakthroughs as a result.

As discussed throughout the present document, Anritsu is a company that provides testing and measurement equipment for research and development, as well as manufacturers, field and maintenance personnel, being responsiveness its top supply-chain priority. Nowadays, customers expect very short delivery times for their orders (precision equipment). To satisfy them, Anritsu is constantly looking at how it can tighten and improve their existing relationships with suppliers. For Anritsu, “Typically, material is the constraint”.

Anritsu is also working closely with its R&D department in order to fit new products and services into its existing and already complex supply-chain processes. To survive in a dynamic industry marked by cutting-edge technology, the company needs to differentiate itself through continuously develop innovative products. That never-ending process often requires contacting and dealing with new suppliers. A change itself that adds risk to an already risky and evolving supply chain.

In addition to what was mentioned before, Anritsu keeps deploying and developing various tools and information systems in order to streamline its supply-chain processes. As businesses become successful, organizations tend to grow and doing so, they become increasingly complex. Therefore, there is a need to focus on "standard functionality."

Recently, Anritsu has combined various supply-chain functionalities into one single internal organization, crossing therefore lines between different departments, such as sales, corporate and other departments. This change was considered to be an important part of Anritsu's efforts to reduce costs and so, meeting their customers' demands for short order lead times, as well as standardizing systems.

It is of extreme importance to achieve an integrated view of the supply chain, as it helps Anritsu to make better and more informed decisions, as well as turnaround quotes in a time lapse of hours. Today, with using the RapidResponse application from Kinaxis, this company can see product in the pipeline all the way back to its contract manufacturers. Such capability ultimately increases the likelihood of success in getting orders and meeting delivery commitments.

4.1 Overall analysis of the implementation

Being Anritsu's primary focus to support their R&D customers, as well as manufacturing and maintenance customers, the main objective pursued when implementing the Kinaxis® software was responsiveness.

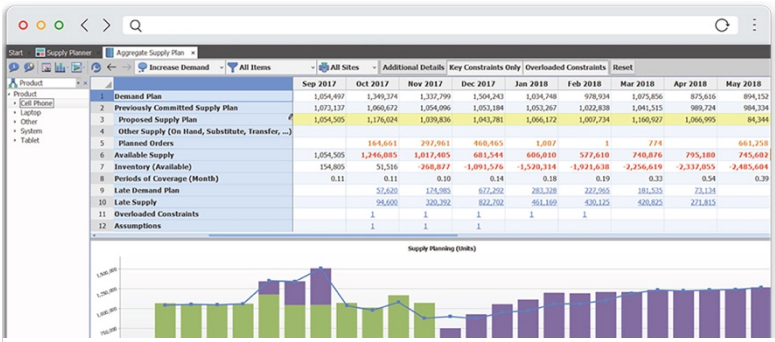


Figure 21 - Example of the interface of the Kinaxis® software solution (kinaxis.com, 2018).

Anritsu's customers require very precise test and measurement equipment in order to support all their measurement needs, and in a time when companies such as Amazon, have made customers expect next day delivery, even the most complex equipment configured according to customer specific requirement is still expected for short delivery. Given this, companies in the sector have been trying to tighten their relationships with their providers and suppliers. This is one of the critical ways companies can respond to better meet the needs and expectations of their customers. Although there are a lot of different ways to achieve this goal, responsiveness is one of the main areas of a supply chain organization that is critical to success.

Secondly, Anritsu's operations department is working closely with its R&D group in order to be able to fit new products into current supply chain suppliers and processes, being one of the main challenges with this the fact that Anritsu is in a very cutting-edge technology sector and companies in this sector need to have differentiators in their products. These differentiators allow Anritsu to beat the competition and sometimes they might happen to need a new technology or a new supplier. Anytime this happen, there is an increased risk in the supply chain management. Therefore, Anritsu has to work closely with their R&D group to provide those differentiators from a manufacturing and supply chain perspective, while also fitting in with the flow of the current products and processes. Manufacturing and R&D maintain a complex relationship: R&D has to be able to have advantages in their products that sometimes are difficult to support in the manufacturing supply chain. Having a very tight relationship with their R&D group to influence the design to make it so it can provide an efficient supply chain to the customers plays a key role to the success of Anritsu and the success of many other companies in the sector.

Finally, using tools and systems in streamlining the processes has as well played a key role when adapting third-party software such as Kinaxis. Organizations in supply chain tend to become increasingly complex in adding more manual processed spreadsheets, and it gets to be overwhelming in terms of managing the supply chain. Companies generally and Anritsu particularly need to focus on standard functionality, simplifying processes and maximizing their systems, and that can be achieved using third-party tools.

Anritsu's success is based on using third-party tools, Kinaxis, that oversees its manufacturing and procurement processes and being able to work very closely with its groups to fashion their goals.

During the last four years, Anritsu has undertaken a reorganization within its groups and departments that took a lot of different pieces of supply chain and put it into one single supply chain organization. This move was motivated by the aim of making sure all of their functions were aligned and that their strategies and key processes were goal-oriented. Before that, Anritsu has some groups in a division, some other groups in corporate and some others in sales, and therefore, having been able to align all those groups has played a key role to then take on the goals, being their primary goal cost reduction so as to become more competitive compared to their competitors. The different ways to reduce cost streamline their supply chain organization. In addition to this and as mentioned earlier, responsiveness is one of their primary goals together with cost reduction. Being able to quickly respond to customers ranging demands and in terms of lead time delivery or in terms of taking on larger orders that Anritsu can then turn around more quickly. The main strategy to be able to keep up with responsiveness is being focused on standard systems, particularly, being able to take many different tools, streamline then, eliminate some of them and bring in new tools that fit better into Anritsu's ERP system.

Integrated view of their supply chains has as well played a very important role. Having an integrative view is very crucial as giving visibility to their entire supply chain helps Anritsu to make better and more informed decisions. Serve as an example when they first receive requests from the field for a quote that they might have to turn around in just a few hours. Having an integrated view and seeing deeper down into the supply chain allow them to give better more accurate quotes to their customers that ultimately will increase the likelihood of a success of getting the order. Not only that but meeting their commitments as well as a company. One of the key characteristics of Anritsu is taking very seriously their commitments to their customers when they commit to certain deliveries.

Kinaxis' RapidResponse tool has been a very valuable in that Anritsu can now see down into their supply chain. In fact, they can see all the way down to actually their contract manufacturers. The business has never had such a visibility into their chain management's material, inventory or work in progress until they recently went live with the

RapidResponse tool. Essentially, they have been able to take out a middleman that before it was a chain of a planner to a buyer to a chain management, taking even days of communication to the situation now where the planner has a visibility all the way down to a chain management level immediately.

Regarding the triggers that led Anritsu to a change into adopting RapidResponse, was the fact that in order to operate successfully, the business needed to be able to do what-if scenarios, and be able to have accurate data that would provide them with a reasonable expectation to ultimately be able to deliver a product to a costumer. It might be that the order is, for instance, in two or three months of forecast and it could take a week to be able to really get back to from the request to the buyer and suppliers. By using RapidResponse's capability, something that could take a week can be undertaken in a matter of hours, outlining and pinpointing where their risks are in their supply chain and identify those, and get information back to then ultimately make better and more informed commitments to their customers and therefore, this will result in winning more business.

Regarding the challenge of getting the most accurate view of inventory levels both in-house and with contract manufacturers, Anritsu saw a void in their processes. It was really difficult for them to have good visibility both inside and outside the factory and using third-party tools such as the RapidResponse technology, they were able to get that visibility of the inventory in their chain management. They have as well used tools such as WIP (work in progress) tracking in their factories so they can identify where the WEIP and inventory is for all of their customer orders. This is critical, as many times customers have tight schedules. Serve as an example, deploying a base tower in the field that needs equipment right at a certain time, or in a manufacturing line where they are ramping up and they need their equipment right on a certain time for, say, the Christmas season for testing their cell phone manufacturing, or a R&D project where the design engineer needs a piece of equipment to be able to keep it on schedule. Ultimately, customers look at Anritsu's equipment as

Figure 22 - Supply chain visibility is possible thanks to third-party tools, such as Kinaxis' RapidResponse® (enterrasolutions.com, 2017).

something they need to meet their schedules, and so, being able to have that visibility and being able to commit and meet commitments plays a vital role to the success of the organization.

Furthermore, scenario simulations can take hours to coordinate and it is quite complex to investigate and evaluate multiple action alternatives. Those what-if scenarios play a very important role to make decisions within an organization and the have multiple benefits. One of the things that RapidResponse provides is the capability to undertake and analyze scenarios in a matter of minutes, pinpointing the associated risks that there are when trying to be able to meet Anritsu's customer requirements. Historically, in order to do the same, they would have to look though hundreds of parts and many different aspects of their ERP (enterprise resource planning) system to be able to identify where those risks were. RapidResponse provides with very accurate precision those risks, so instead of looking through those hundred parts, they would only require looking at three or four critical ones that they can act on right away and get back to customers on delivery schedules. In other words, to obtain all that information, Anritsu has to drill down to the specific parts that are most consumer and the complexity in their products is that they might have nine or ten levels in their bill of materials that they have to drill down. Historically, they had to do this going level by level by level to look at shortages, whereas RapidResponse can go through the whole structure in a matter of minutes and be able to give the, the critical constraining parts.

Moving on, it is important to evaluate the importance of each individual parts, as well as understand which are most important to the operation of an organization, especially from a risk management perspective. Regarding Anritsu, there is a recognition that some parts can be very rapidly expedited, whereas there are others that they know their risks that they manage, either through safety stocks or through different mechanisms to be able to ensure that they have material for their critical parts. Therefore, their planners are very familiar with which parts might be risk or what parts they know that they are short of, but it might just have a few days delivery and so there will not be any major problem with them. Taking into account that in some of the more complex manufacturing operations sometimes the smallest, cheapest part can be the one that brings the whole operation down, using a software such as RapidResponse, they can definitely pinpoint those areas that seems

insignificant but might be extremely risky. RapidResponse has been proven to be really useful for them.

4.2 Advantages on its supply chain

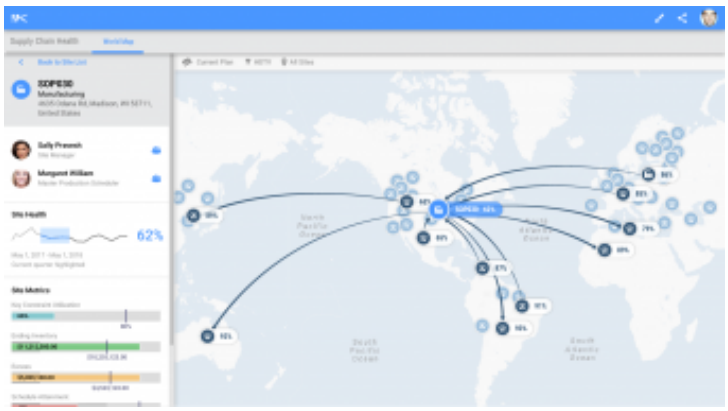


Figure 23 - Screenshot of Kinaxis® tool RapidResponse software (kinaxis.com, 2017).

Overall, the implementation of Kinaxis' RapidResponse software has had a very smooth transition on Anritsu's supply chain. This has allowed the organization to go form starting out like being forced to fight fires to being more proactive and managing exceptions. Senior management at Anritsu believed of the business to be excellent at firefighting, however, the challenge with this technique is that it takes a lot of resources and a lot of effort. Of course, there are a lot of casualties in the sense that they often missed something that might affect the customer. This was one of the main reasons to really turn their firefighters into a more analytical proactive supply chain specialists and so, what they did was: first, they implemented what-if scenarios and verified that there were materials in place for the customer, and then, once they had a good process for ensuring the material availability, they had implemented a new shortage management process that would be banished basically by exception rather than a lot of firefighting efforts.

It is important to analyze, however, what was causing the fires in the first place. The explanation for that is that there were a lot of different shortages where procurement might have been short cycled. They might have supplier interruptions and it was really hard for them to get data of what was the important data versus all the pile of data. If the firefighting analogy is taken a little further, one of the techniques firefighters use is they do a backburns, where they get rid of all the rubbish to prevent future fires from expanding. So, essentially, what they had to do was to do the very same thing except with their data. They had to get rid of all the data that was not important to get the data that was really important, so they

could act on just that data to support their customers. That is where a third-party tool, RapidResponse, has played a key role.

In the era of big data, there is more data both useful and not useful than ever before, and therefore, it is important to be able to make sense of all the available data and determine what is important and what is not. Anritsu has implemented several measures in order to do this. For instance, they had three different shortage reports in their previous process where procurement had some commonalities but some differences. If manufacturing had a shortage, they might have to talk to the planner to talk to the buyer and there would be a big number of emails going back and forth involved. What Anritsu did was they consolidated all that into one central shortage management process. In this process, RapidResponse would look at what shortage they had based on their backlog, what shores they have had based on their forecast and it would then have updates given by their buyers in their plan or it will state the current status. Instead of manufacturing having to send an email to a planner or send an email to a buyer, they would know in which report a shortage is located and they can find out the status at the very same moment as well as what benefit. The tool has been very useful for Anritsu as previously probably about forty to fifty percent of the time planners were spending chasing material and with this new process, they can cut that down to about ten percent. So, that represents a significant amount of time and of savings, and now those planners can be doing more analytics, or they can be doing more proactive improvements in their supply chain and manufacturing.

Shortages indicate a mismatch between supply and demand, so apart from dealing with the shortages themselves when they happen either proactively or reactively, it is important to make progress toward preventing the shortages from happening in the first place. This is where the power of being able to simulate demand on Anritsu's system comes into play. With RapidResponse, they can run simulations such as: if we load this order in the system, do we have enough material in place? Previously, it could take a plan hours to develop and understanding every single step in the chain management was a complex task, not to mention sometimes it was even required to guess and try to be close enough to reality in order to put all that information in the system. RapidResponse can do that in a matter of minutes and then, they can have the confidence that it is not going to cause a shortage as it goes into the system.

In order to improve responsiveness, processes have to be streamlined, yet they are more complicated than ever, and it requires a higher degree of control. It is a challenge for an organization such as Anritsu to make all these happen at the same time. One of the things they have been doing to streamline is being able to collect the data that they need, coming, again, RapidResponse to play a very important role. For instance, in streamlining, one of the things that is very important to the company is inventory. Managing inventory and making sure they have enough inventory to meet the customer needs but not so much that they are potentially risking excess or scrap material. Again, they had reports that took several days to run, but with RapidResponse they can look out at excess in one to three month increments and push out POS (points of sale) to prevent the material from being there in the first place based on their current demand. Demand is a challenging thing to manage because forecasts are always wrong and because they are always wrong, it is extremely important to have an agile supply chain that can pull in material when demand goes up and push it out when demand goes down.

It seems important to take into consideration the different metrics used to see any issues earlier and be able to respond more quickly. One of the key metrics for Anritsu is on-time delivery. They are firmly committed to responding to their customers quickly and so they have seen their on-time delivery in previous years at about 95%, which was already a quite good number, to go to about 99% after the RapidResponse implementation. Another metric they use is delivery dates to customers based on kind of expected response rates. In other words, for certain instruments that Anritsu manufactures, they have, say, a target of two-week delivery to any customers for these particular instruments, and so, they measure how often they can meet that two-week delivery as well as other internal metrics. They found that in previous years, they could meet that targeted delivery schedule to customers at a rate of about 80% of the time. After RapidResponse, they have been able to meet a fabulous 96% of the time.

In order to point out what caused a failure in on-time delivery Anritsu has undertaken several measures. As the reason for such a failure could be the logistics end, up in the supply chain or in procurement, it might be hard to do a diagnosis and figure out what caused the problem in the first place and then work back to preventing such a failure to happen in the future as well. Anritsu prepares daily reports that actually monitors any late delivery with a root cause and then, ultimately, propose a corrective action. Hour-late

deliveries are so low at the moment with the RapidResponse software and their time delivery is so high that it is fairly easy for Anritsu to manage that and get to that corrective action, whether it is a defective material or whether it is a late supplier. Naturally, it could be a variety of causes for such an issue to happen, but in their current process, with the RapidResponse software, they successfully manage that on a daily basis.

In addition to all the above mentioned, there is always a conflict between good customer service and what it costs to have such a good customer service. Being able to balance responsiveness versus the need for cost saving plays a decisive role when taking decision and undertaking actions. One of the things Anritsu has done is working with their suppliers on shortening their cycle times and their lead times, because the shorter their lead times are, the later they can make or need to make commitments to them. This is one way to balance the idea of cost versus responsiveness. Another way, for instance, is targeting, say, their top 50 accessories that drove their inventory significantly higher and worked together with suppliers to shorten their delivery lead times and so be able to manage a lower inventory. That has been proven to be a successful effort for Anritsu. Furthermore, another effort they have recently implemented, and closely related to RapidResponse is the MIO (multichannel inventory optimization) tool. This tool basically gives the optimum safety stock that it is required to have a good balance between what the cost of the inventory is and the risk of being short for a potential customer order. This third-party tool is expected to help the balance between cost and responsiveness for Anritsu, as some safety stock is always necessary.

4.3 Disadvantages on its supply chain

Getting advantages such as an increased efficiency, a higher flexibility and becoming faster at managing today's supply chain volatility comes with a price. As RapidResponse uses concurrent planning in order to make collaborative business decisions, there is an increased technological risk. This increased risk translates into the following points. In the case of Anritsu particularly, but any organization in the sector in general, the disadvantages are:

- Synchronization: In order to be able to access current performance as well as instantly see and interpret how changes across the end-to-end network impact, these third-party tools use single cloud-based platforms. These platforms use code bases

and data models to allow customers to synchronize all aspects of their supply chain, resulting this in a more dynamic supply and demand balancing, but an increased risk from a technological and computational point of view. The more you rely on the cloud and other offsite services, the more vulnerable you are to attackers, hackers, failures of third-party systems and so on. Of course, these services tend to be quite safe and private and they work on becoming increasingly unbreachable. However, anything in the cloud is subject to attacks and the risk is much higher than if organizations have a closed-on site system.

- What-next scenarios: Kinaxis RapidResponse allows customers to predict the future for any desired planning horizon using historical data and other information available. This allows for multiple scenarios, creation of supply chain replicas and capture of historical data in a matter of seconds, resulting in KPI and accountability-based decision-making. However, all these require an intensive training and the competition of different level courses. Learning all the possibilities of RapidResponse, like any other specialized software, happens through hours of practice and then, planning on having follow-up courses in the future, as the software will update, and new formation will be needed. All this adds up to a big number of hours, time that the operators and agents will not be able to properly work.
- Smart collaboration: This allows to engage different parties under common information sharing. This enhances a faster and a much smarter collaboration. RapidResponse matches suppliers with whom to work, gives context and archives all the decisions made, all within the same platform. Again, this interconnectivity requires a profound level of trust, as well as the fact that supplier and other parties' system and infrastructure have to be prepared for such a platform to be implemented, which is not always the case.
- Planning and execution alignment: RapidResponse has an ERP built-in solution allowing to connect all internal and external data sources without duplication. This includes multiple ERPs. This ultimately results, in a completely unified connected and digital enterprise with all the above-mentioned associated risks, as well as a small likelihood (but still existent) of losing some data or mismatching information.
- Augmented intelligence: RapidResponse automates the routine as well as escalates the exceptions. It uses predictive algorithms that keep learning from the increasing

amount of available data as well as keep themselves always synchronized between them. This allows the machines to bring out the data that really matters and operate themselves the data that is not so important or not useful at all. Although this might make the supply chain management a lot smoother and easier, important data might be lost in the process and organizations might lose the bigger picture of their supply chains.

- Personalized experience: RapidResponse's user interface tailors metrics and data according to the role of the operator. It includes as well as workflows, playbooks and alerts so as to guide the user throughout his or her working day. The interface does not require any coding, so the planning tool is smooth and easy to use. This supposes a risk by itself, as workers might become dependent of their machines and the moment a failure occurs or the system is down, they will not have the same reaction to contingencies.
- Practical innovation: Kinaxis implements real-world solutions to organization's supply chain problems. In order to do so, they keep innovating and putting in place practical applications. Although this has its unarguable benefits, it might rise the likelihood of a mistake taking place, as actualizations might fail or result in errors, and updating and innovating might increase the risk of a human mistake for not being able to properly use the system anymore.
- Flexible maturity and scalability: Kinaxis allows customers to start from anywhere they need and grow the way they want. Their single platform allows to add on applications and capabilities with ease. This results in the ability to mature and scale each customer's supply chain at their own pace and without the need of any custom code. However, as other companies in other sector, Kinaxis might deploy an ecosystem that best works with application made by themselves. This could ultimately lead to a need for having all the system made by the same software provider instead of choosing by economic reasons. All this can result in an overall bigger cost for the organization as well as developing a certain dependency for the software provider's solutions, which may not be bad by itself but may result in higher costs in the medium and long run.

4.4 Challenges for the future

After the implementation of the RapidResponse software, Anritsu is planning on adding additional functionalities to their system in the months and years ahead. After rolling out their implementation, they are already looking at capacity planning as one of the tools offered as well by Kinaxis that they will be looking at and most likely utilizing. They are also looking at supplier collaboration and how can they have this linked to their chain management. They believe they have many suppliers that would think would benefit by tightening the relationship, because one of the most critical areas in order to achieve success is responsiveness. So, the tighter the relationship a business has with its supplier, the more responsive that business can be to their customers and with leveraging tools that are a part of RapidResponse Anritsu feels it could give them a competitive advantage over the years to come. The ultimate goal is to use previous experiences and knowledge to get a better end-to-end view of the available inventory to ultimately become more responsive in a very complex operation industry.

Regarding the long-term vision behind Anritsu's supply chain, one of their top long-term strategies is, again, an improved responsiveness. Customers expect short delivery, they expected it even though in Anritsu's particular industry their products are highly configured and customized to that specific customer, but they still expect short delivery.

That's one of the organization's major focuses, which as earlier discussed some of their new tools have helped them support that. Another major focus is productivity of their supply chain people.

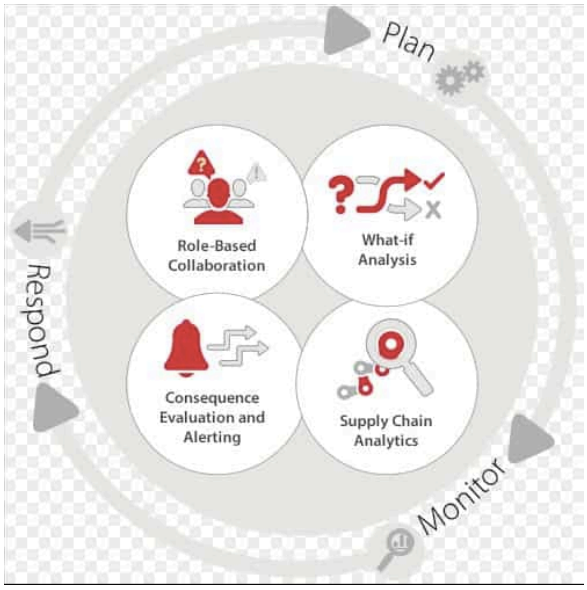


Figure 24 - Kinaxis RapidResponse® scheme of operation (kinaxis.com, 2017).

Anritsu wants them to continue to grow in their productivity, which is why it is so important. In the example of their shortage management, now, instead of their planners spending 50% of their time managing shortages, it is down to 10% and they could be doing more proactive things. They could be doing more continuous improvement activities so making their employees more productive. Thirdly is cost. Cost is critical to any supply chain organization. Customers continue to be more price sensitive and Anritsu needs to get their costs down and so, doing activities related to cost. And then, the last one is best practices. Anritsu is humble enough that they know they do not have all the answers of doing everything in the best way possible. So, they are eager to learn from other companies, they are eager to learn from other organizations, from supply brain, of all the different ways other companies are doing things and put them into best practices and so, those are things that are really important to Anritsu. They want to learn and grow in that area and kind of wrapping it all together as continuous improvement.

CHAPTER 5

SUSTAINABILITY ANALYSIS

The relationship between sustainability and supply chain is playing an increasingly important role both for an operation and, naturally, an environmental point of view. All aspects concerning a business have to be taken into account, not only environmental operations and policies. As sustainability is being considered at an ever-growing rate by policymakers, the media and the academic world, it seems important to take this aspect into how globalization and climate change are shaping the supply chains of the organizations in the industry object of study, as well as that of Anritsu.

The term sustainability is commonly defined as being able to use the available resources to meet the needs of today, without compromising the ability of generations to come to meet their own needs as well. However, as it can be seen, this definition is quite vague, and it is not surprising that different and diverse interpretations have evolved around this definition. It is still hard today to give an answer to questions such as: what kind of resources and in what amount will the generations to come need? What is the maximum amount of pollutants that can be released into the environment without having a negative impact on the generations to come? How can new resources be identified as depletable in the future? To what extent can renewable energies be exploited making sure that these resources remain available, and therefore, renewable? How can technology maintain a sustainable use of resources when we increase the material wealth? How do market forces enhance sustainability? Do our current lifestyles need to change now? If so, how should we change them? From a political point of view, what kind of policies are required to achieve true sustainability?

It might seem that the importance of this issue is just relative and there is no real point on operationalizing sustainability. It is true that over the past years, environmental and public health concerns that were controversial eventually were discounted or seen as a reduced threat as further evidence proved it was not as important of an issue. However, other environmental concerns about product pollution or processes sustainability have included quick substantive changes. For instance, countries worldwide adopted very strict legislation fairly rapidly in order to abolish the use of chemicals with ozone depleting potential. As a matter of fact, there is increasing concern and recognitions in both the public and the private

sectors regarding global warming as a societal issue. Sustainability is gaining importance over time, as new initiatives are being proposed and adopted by the public and private sectors. The European Union (EU) has proven to be an important influential proponent of the concept of sustainability. In fact, the European Parliament believes this concept to be so critical for current and future generations that present and future legislation has to involve sustainability into the implementation orders. For instance, the EU has passed a European Directive on Waste and Electronic Equipment that enhances sustainability in the union. Furthermore, EU's strong support for sustainability is increasingly likely to lead others, as many more nations and jurisdictions worldwide are introducing legislation addressing similar issues as the EU.

As it can be seen, there is increasing implication, support and development in the area of sustainability. Regarding operations management, it is vital for operations management researches and other practitioners to consider both the implications and impacts on sustainability that traditional assumptions and practices might have. Several crucial questions have already been addressed, such as: green design, technologies for cleaner processes, extension of products' life or systems for environmental management. Nevertheless, these issues have not been taken into account from a sustainability point of view.

It seems important to note at this point that a profound research has recently been conducted on industrial ecology (field that considers industrial processes as if they were a biological ecosystem), offering very useful insights on the use of by-products (politically correct term for 'wastes') generated along a supply chain. Having shown what sustainability is, why it is important and discussed about current policies, limitations and questions posed on sustainability, it is important now to understand the interaction between sustainability and supply chains.

Relationship between sustainability and supply chains

In the recent decades, a shift has been made from focusing on optimizing operations of a single facility to the whole supply chain. This is due to the fact that if an optimization is conducted along the entire supply chain (including all the processes and steps involved), then the production of a product (good or service) will maximize its value while reaching the lowest possible cost. This focus on the supply chain can and should lead to an adoption

and development of sustainability and sustainable operations, as supply chain actually considers the product from the initial processing of raw materials to the ultimate delivery of the final product itself to the customer. Sustainability must add issues and flow that go beyond the core of supply chain management, such as: the design of the product, the manufacturing of by-products, the production of by-products during the usage of the product itself, the extension of product life and recovery processes when the product comes to the end of its life.

- Product design: Life cycle assessment and other such techniques are being used in order to assist in designing a product to minimize its environmental impact both over its life and afterwards at its end-of-life. It is important to consider not only environmental impact, but also resource depletion.
- Manufacturing by-products: Cleaner and more efficient process technologies are required in order to reduce and eliminate by-products. Therefore, the extended supply chain has to be considered and important aspects such as quality and lean production techniques have to be evaluated and put into practice. For instance, and as appointed by industrial ecology, by-products can be used again in the process, like using waste heat to condition a space or using food waste for new food products. All these are examples of continuous improvement as well as sustainable process design.
- By-products that are produced during the usage of the product: In order to achieve full sustainability, it is crucial to bear in mind that sustainable practices do not only apply to product design but product management as well. Extended producer involvement and responsibility can lead to a great potential from a sustainability point of view, as many opportunities and benefits arise from this idea. For example, the provision of a product as if it was a service, or the provision of services to supplement as well as support the sale of the original product.
- Extension of the product life: In order to extend the product's life, there are several techniques that can be implemented. If the usable life of a product is extended, organizations can avoid the depletion of resources as they will avoid having to produce new products. In order to do so, the current consumption-oriented mindset has to change, and companies have to work against the common design for obsolescence, typical nowadays. This will ultimately increase the valued created by each individual product. Now, the organization has to focus on offerings that allow

them to increase the product value. Some manufactures have already made profits through extending their products' lives, but others have made extraordinary profits in other fields such as remanufacturing, as a consequence of original equipment manufactures' failure to make profit of product life extension opportunities.

- The product end-of-life: When the life of a product comes to an end, being able to correctly dispose the product itself depends primarily on decisions made at earlier stages. As commented above, correctly designing the product with an aim for sustainability has a great impact on the extent to which the product can be reused, remanufactured, recycled or disposed of. In the case of electronics, main area of discussion in the present project, phase-out of lead use in solders during the processes have made extremely difficult to dispose these items. Sometimes, even jurisdictions and regulations have to be placed to divert these products from landfills with the aim of integrating the lead into new products. However, it is true that policies introduced to make more environmentally favorable modes of end-of-life disposal have had some negative effects, such as more storage of product and a lower rate of redeployment of inner parts and materials to create new products. It is important, not only to meet desired goals (environmental policies, regulations and incentives), but also to take into account the operational aspects (forecasts, logistics, processes and other operations).
- Recovery processes at the end-of-life: This has become an increasingly growing field, gaining a lot of importance in the recent years. Many studies and research have been conducted on how to design recovery networks for all sorts of products. Related to those, studies have found that if emphasis is increased on supply chain sustainability, there tend to be lower costs and a neutral or even positive effect on value. Naturally, if supply chain is expanded to include these items, additional levels of complexity will be added to an already complex supply chain, in addition to new strategic and operational issues, which, of course, can increased costs in the short term. However, if the bigger picture is observed, sustainability opens the door to a larger set of opportunities and improvements that might require a short-term investment but that may lead to great gaining and benefits.

Generally speaking, it is a combination of changes in policies and profitability considerations that drive manufacturers and researches to find new options in order to improve the supply chain sustainability from and operations point of view. However, it is

true as well the flow of command can also go in the opposite direction, being practice and research the ones that affect policies through their supply chain management experience. They are the ones that are able to present alternative scenarios for the development of sustainable supply chains for the benefit of science and society. The concept of sustainability forces supply chain management to find new ways, options or possibilities to optimize operations from a broader point of view (that of the entire production system, together with post-production management). Just producing a good or service is no longer an option if organizations want to become sustainable. Although it is true that pursuing sustainability through optimization will increase the complexity of supply chain management and the complexity of coordinating stakeholders, it is an important step to take as it will report benefits in the long run, as it was earlier discussed. In addition, the concept of sustainability takes into account other considerations relating to the natural environment (or even social issues too) that tend to be less quantifiable – Business ethicists and other finance professionals refer to this as the triple bottom line. For instance, the interaction between economy with social and environmental issues in logistics, such as noise, pollution, congestion or carbon dioxide emissions.

As it was earlier discussed, there is trend towards the implementation of sustainable concepts and measures into legislation, which change the way in which firm operate as their environment changes as well. This also shapes the nature of competition as studies in competitive strategy in remanufacturing and the impact of take-back laws show. Naturally, these changes require that management not only addresses these new issues (for instance, the reverse supply chain), but also it requires that management tightens and changes its existing practices in order to create a brand-new production and management systems, in a more sustainable fashion. These issues have to be considered when linking forward and reverse supply chain investments, together with business uncertainty.

After discussing the effects that the implementation of sustainable practices might have when trying to achieve a sustainable supply chain policy, competitive environment as well as strategy, it seems important to consider that other critical tactical and operational issues may arise as a consequence of this process. Examples include decentralized collection and consequent processing of end-of-life products as well as how to obtain a better use from those used products through remaining life estimation of its used components in consumer products (data analysis of life cycle by using Weibull and artificial neural networks). Of

course, given the nature of sustainability (closed-loop system nature of sustainability), and according to studies and research on the issue, new opportunities to modify operations or other changes in tactics may have substantial effects on future policies, firm strategies as well as shape the competitive environment.

As it can be seen, sustainability goes beyond current and common practices while providing a fresh framework for past and ongoing environmental research in the operations area. In order to do so, supply chain must be extended in an explicit way to include those by-products produced during the production of goods, as well as consider the whole lifecycle of the product itself. It is important to optimize the product design and to shape the organization's supply chain not only from a current cost standpoint but also to consider the total cost standpoint. In fact, total cost has to include those effects that are consequence of resource depletion and consequence of the generation of by-products that are not used or capture in any way (that is to say, pollutants and waste). Finally, it is important to note that further research into what the implications are from an operational point of view of the implementation of various policies and how can businesses integrate sustainable practices. This is due to the fact that legal trends nowadays will actually force various of these changes whether or not organizations and practices are prepared. That research requires many questions to be answered, but they also require a variety of new approaches, very recently introduced. Among them, case study analysis, statistical testing of hypotheses, multiple case modeling, model development and machine learning.

5.1 Before the Kinaxis implementation

In the year 2014, the year Anritsu began implementing the RapidResponse software, the organization highlighted and incorporated measures to boost human rights issues as well as the promotion of the environment, thereby establishing four goals. These goals are:

- Contribution to build a safe, secure, and comfortable society.
- Maintain harmony with the global socio-economy.
- Promote global environmental protection.
- Promote communications.

Figure 25 - 2014's goals of Anritsu (anritsu.com, 2014).

The third goal is the main focus of this section of the project. In this part, the organization's performance previous to the implementation of the Kinaxis' solution from a sustainability point of view will be analyzed, whereas in the following part the very same analysis will be undertaken but after the implementation. The main objective is to address the issue of whether or not third-party solutions can help increase supply chain sustainability.

If a look is taken to the previous year, the 2013. Anritsu made the following breakthroughs in the following environmental areas:

- Waste reduction and recycling: In Japan, the total emitted wasted was 125.3 tons, whereas in the United States, the volume of landfill was reduced in 22% compared to the year 2010, achieving therefore their targeted goal of a 20% reduction. For the year 2014, they established a target amount of industrial waste emissions that were 58 tons or less for the Atsugi and Hiratsuka sites and nine or less for the Tohoku site. As for the general waste emissions disposed in Atsugi City, they targeted it to be at 40 tons or less. In addition to that, they intended to maintain a zero emissions target in the country of Japan, as well as reduce by at least 13% the waste to landfill emissions compared to the previous year, 2013.

- Resource and energy conservation: Regarding this item, in Japan, the equivalent crude oil of the reduced energy consumption went down by 11.5% if compared to the previous year, 2012. However, in the United States, Anritsu did not achieve its goal of reducing the basic unit of energy consumption per sale, when compared to the results of the year 2010. They fixed a target of 5% reduction, but they ended up reducing it by 0.9%. As for the targets for 2014, they established an energy consumption reduction of at least 1% and be able to reduce, or at least maintain, the basic unit of energy consumption per sale at the levels of the previous year, 2013.
- Eco products (for Anritsu Group companies in Japan): In this case, Anritsu did achieve its goal of developing at least four target products as environmentally conscious products. In the same regard, they achieved a total resource conservation of at least10% for at least three out of the four targeted products, and finally, they achieved an improvement of at least 30% in power efficiency for at least two of their targeted products. Regarding the year 2014, their goals were to convert all targeted products into products that were environmentally conscious; achieve, at least, a 10% resource conservation for all targeted products; and achieve, at least, a 30% improvement in power efficiency for all targeted products.

In the year 2014, and prior to the Kinaxis implementation, Anritsu made the commitment to focus on designing and developing environmentally friendly products, considering the entire product life cycle. This process was meant to take into account everything from parts procurement, design and manufacturing, shipping, customer use and finally recycling. Being their primary goal to maintain their efforts to enhance the quality if their audits to enhance environmental consideration, they have been actively taking actions to reduce their environmental impact in the years before the Kinaxis implementation.

Anritsu has been striving to give consideration the environment in both the development and design as well as the manufacturing and production of their products. That is the reason why in the year 2014 they developed the ‘eco-management, eco-mind’ strategy in order to develop the corporate environmental management. The action guideline of this strategy can be observed in the following figure:

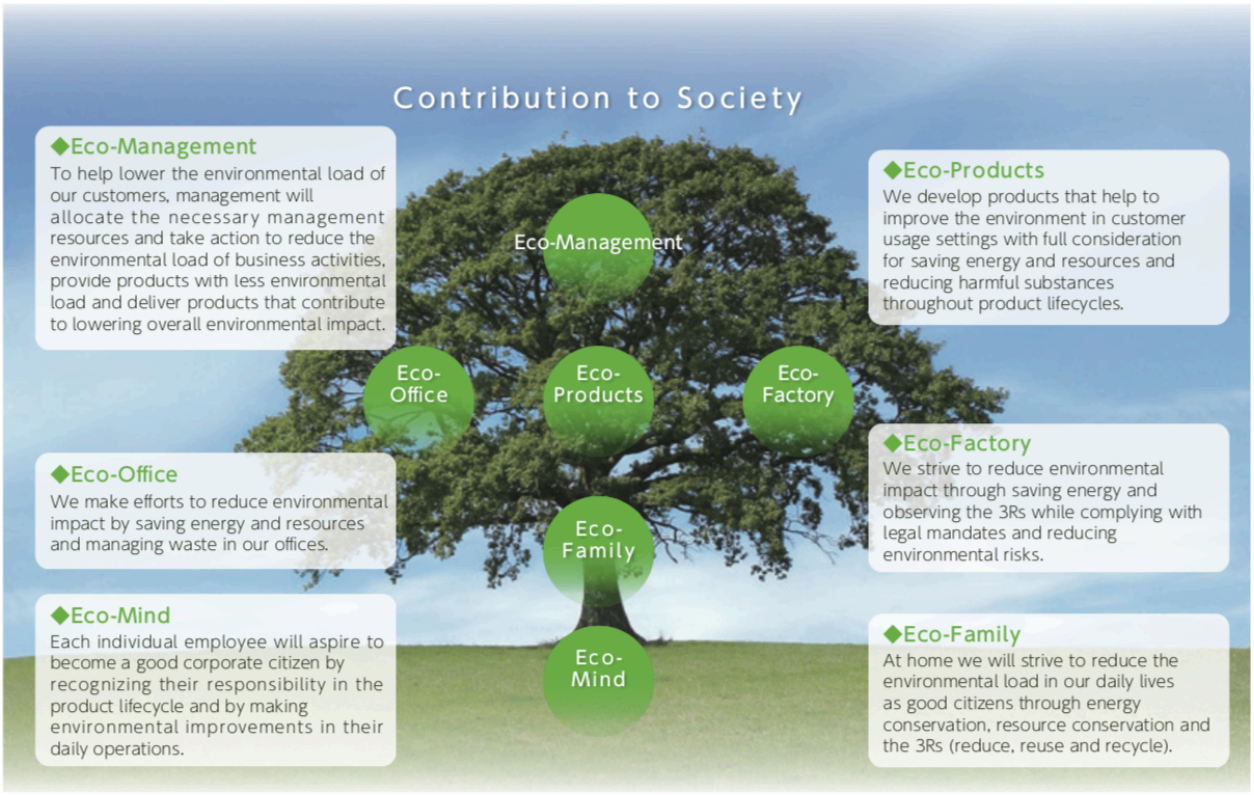


Figure 26 - Action guidelines for Anritsu's 2014's environmental strategy (anritsu.com, 2017).

Regarding Anritsu's environmental management, it has to be said that in the year 2014, they first took into account the entire product lifecycle. More concretely, they focused on four key policies: provision of energy/resource-saving products; provision of products with reduced harmful substances in product development; promotion of energy conservation in all their operations; and the strengthening of eco-mind and environmental communication. They also continued to improve and maintain their previous efforts of promoting the 3Rs (Reduce, Reuse, Recycle). All this led to the final establishment of their Basic Rules of Biodiversity Conservation, with the aim of helping mitigate climate change, the increasing loss of habitat due to overexploitation and to reduce pollution. Moreover, as discussed earlier, Anritsu started applying life cycle analysis approach to its global environmental management, with the final goal of reducing their environmental impact and to design and develop environmentally sound products that take into account the entire product life cycle. In fact, they had identified several items in which improvements could be made so as to become more sustainable. The data can be seen in the following diagram:

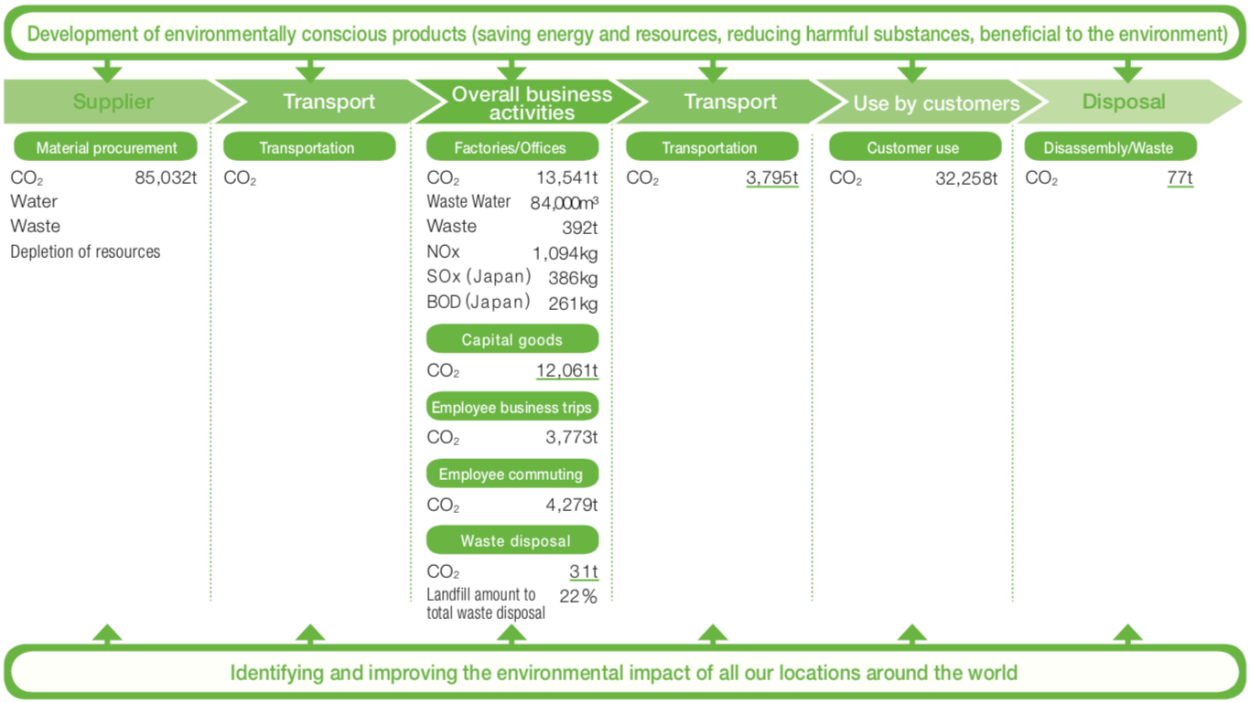


Figure 27 - Items in which improvements could be made for Anritsu to become more sustainable as of 2014 (anritsu.com, 2014).

It seems important to note at this point that in the fiscal year 2013, the year before this analysis is being conducted, Anritsu received the ISO 14001, as well as a combined assessment of the ISO 9001 and ISO 27001, all of them environmental audits that found Anritsu to be in compliance. In addition to that, the organization itself conducted two more internal audits related to environmental analysis to show the organization's effectiveness and conformance. One of them, regarding their environmental management system and performance, conducted in July, resulted in 35 indications of nonconformance. The second one, conducted in October, analyzed the Anritsu's compliance status and showed eight indications of nonconformance. After these two audits, they reported on and improved their environment management.

As earlier discussed, Anritsu developed in the year 2014 a basic policy for conserving biodiversity. This effort to preserve biodiversity affect all business operations and benefit as well as influence the ecosystem supported by diverse organisms at the same time. Anritsu believes it is a vital concern for environmental management to preserve the biodiversity which is the foundation of the ecosystem. The main aim of this basic policy is to encourage and support activities that ultimately reduce their environmental impact associated with their business operations and to presser biodiversity in such a fashion that includes social

contribution and efforts to protect the natural environment at all levels. In fact, in order to raise the environmental awareness of Anritsu's employees and to encourage them to actively engage in environmental activities, they launched an environmental education program for employees. This general education, implemented through e-learning, is actually adapted and designed for each job type and rank, including supply chain managers and analysts. Furthermore, these programs are available and attended by employees of all Anritsu's business partners under consignment. Among other things, the programs include sections related to internal auditor training programs, education for technology departments, chemical substances manager training or onsite consignment worker education.

As of 2014, energy conservation activities at factories, offices and the supply chain itself have played a key role to reduce CO_2 emissions, associated with global warming. In fact, Anritsu has actively been trying to reduce its electric power (which actually account for about 95% of its energy consumption, in crude oil equivalent). As a matter of fact, for the years previous to the Kinaxis implementation, there has been a constant reduction of Anritsu's electric energy use, as represented in the following chart (Anritsu Group companies established in Japan), Figure 28.

However, after this energy usage is transformed into its equivalent CO_2 emissions, some years show an increase in emissions, despite the fact that every year there has been a reduction in electric energy consumption. This is due to the fact that emissions are calculated using the emission basic unit that was adopted by the Law Concerning the Promotion of the Measures to Cope with Global Warming. This law associates CO_2 emissions with electric power through the CO_2 emissions basic unit (t- CO_2 /MWh) published by the Federation or Electric Power Companies of Japan for each year. This CO_2 emission basic unit actually varies every year depending on the supply situation of each electric power company in Japan, explaining therefore why even though there is a reduction each year in electric energy consumption, the equivalent CO_2 emissions vary. The CO_2 emissions from total energy use can be seen in the following chart, Figure 29.

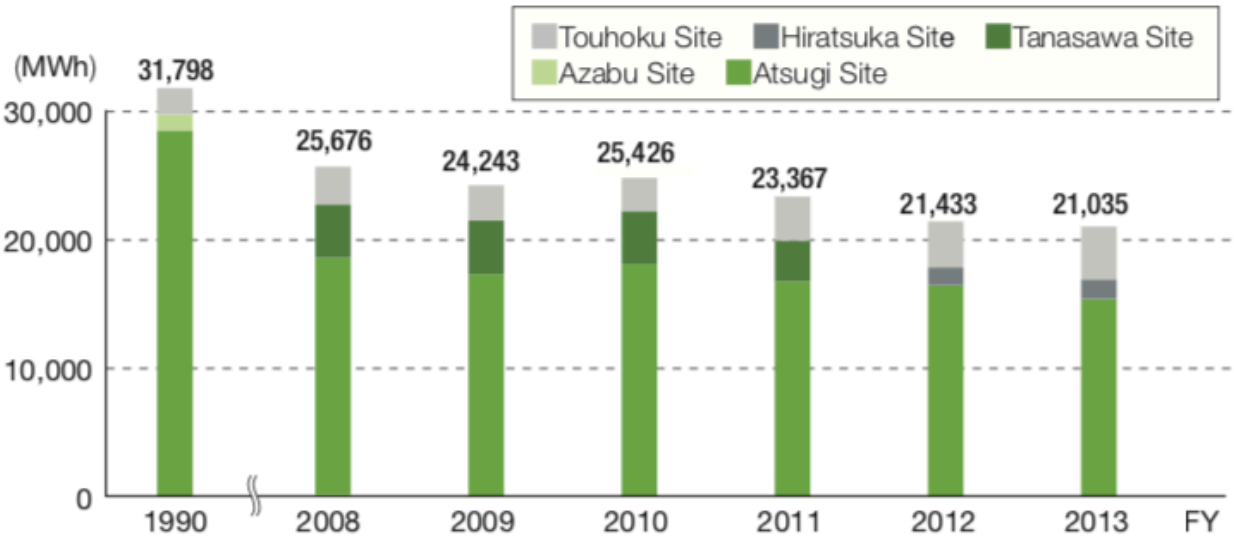


Figure 28 - Change in electric energy use for Anritsu Group in Japan (1990-2013) (anritsu.com, 2014).

Regarding the wastewater discharge from operation (which include all the supply chain-related activities), it is important to note that Anritsu used to use large volumes of water in order to manufacture and ship their products, due to the processes used. However, in the year 2002, they totally discounted these processes therefore reducing the industrial effluent of harmful substances. Ever since Anritsu has been able to reduce its wastewater discharge as a trend, even though some years those volumes augmented due to an increase in Anritsu's activity.

Regarding the water resources, over the previous ten years to 2014, the Anritsu Group in Japan has been able to effectively reduce water use by nearly 50%. They have been reducing water use at the Atsugi site over the years due to efforts such as monthly leakage inspections, upgrading to water-saving toilets and using circulated water in facilities. They have as well analyzed all activities regarding their operations to ensure water is preserved, including logistics and supply chain departments, object of study in this project.

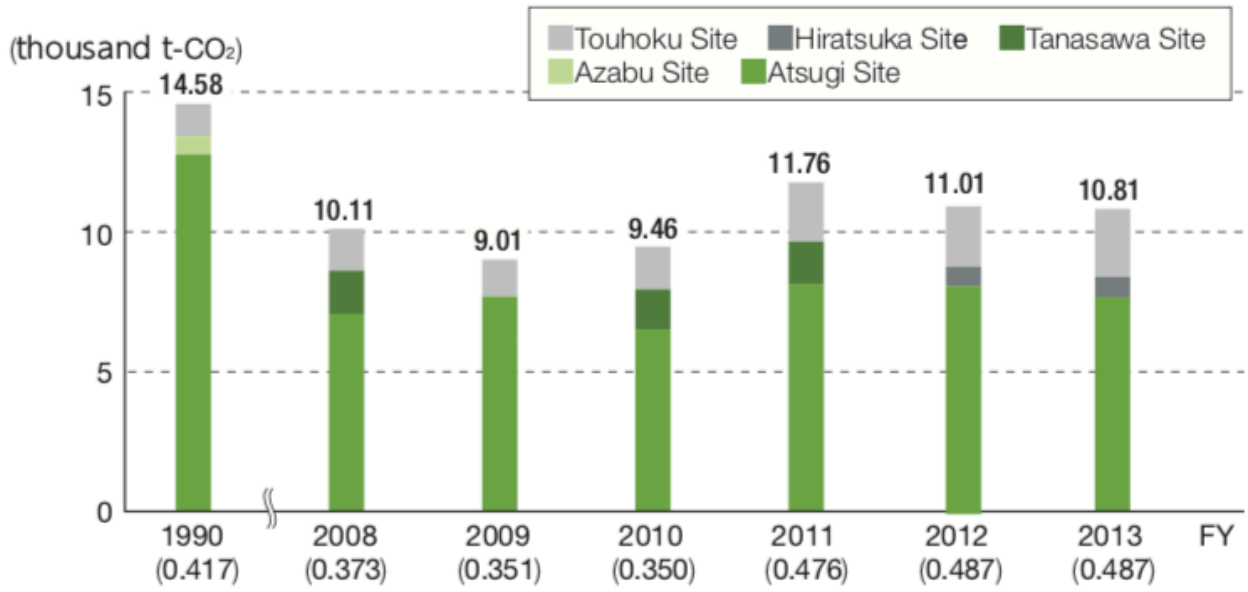


Figure 29 - CO2 emissions from total energy use for the Anritsu Group in Japan (anritsu.com, 2014).

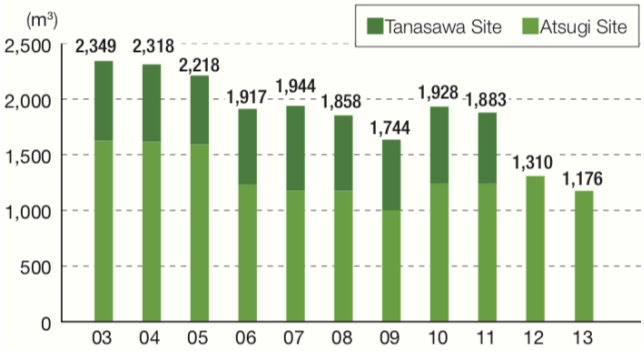


Figure 31 - Wastewater discharge from operations (anritsu.com, 2014).

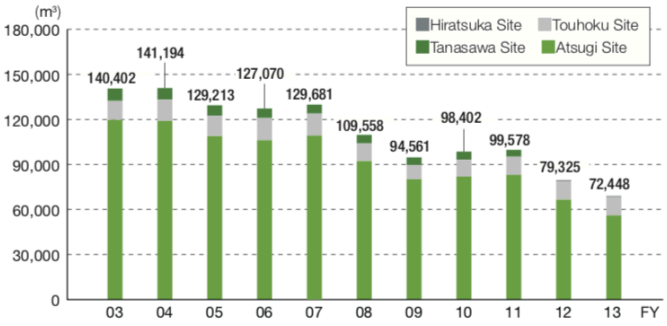


Figure 30 - Water Consumption (anritsu.com, 2014).

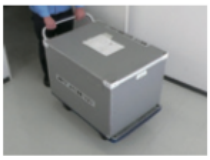
It is worth mentioning the strategy Anritsu developed for the logistics (not part of supply chain, but interesting for the overall analysis of Anritsu's sustainability). In the years previous to the Kinaxis implementation, Anritsu has developed what they call 'eco-logistics'. This is how it works:

- Delivery: The carrier takes the product out of a returnable box and delivers the product to the place designated by the customer.
- Pick up: The carriers pick the product up after it has been wrapped with the packaging materials they brought by themselves.
- Response to the carrier: Anritsu maintains high transport quality by conduction discussions between carriers and Anritsu in order to build a safe system of transport.

The following sequence depicts an example of delivery:

The product is first covered with polyethylene bag to prevent from scratches and dust, and then packaged in returnable box.

The product and attached equipment box are packaged as in the left picture.



Carrier removes the product from the returnable box.

The product and attached equipment box are delivered to customer, covered with polyethylene bag for protection. Invoice is attached to the product. After delivery, carrier brings back the returnable box and packaging materials.

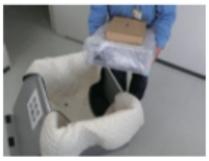


Figure 33 - Diagram showing an example of Anritsu's delivery (anritsu.com, 2014).

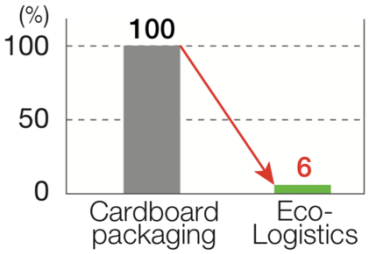


Figure 32 - Reduction of packaging material waste due to eco-logistics (anritsu.com, 2014).

The consequence of this eco-logistics strategy is a significant reduction of packaging material waste, as for the returnable box, the customer only actually needs to dispose the plastic bag that overs the product. In fact, if traditional cardboard packaging is compared to returnable containers, waste emissions will be greatly improved, representing about a 94% reduction by weight (assuming a 20 times rate returnable box used).

As for supply chain management itself, Anritsu believed that in order to provide environmentally sound products and materials (to reduce the environmental impact), it was important to have an environmentally conscious supply chain management. In order to do so, they believed practicing green procurement and conducting research and studies on chemical substances contained in purchased parts from supplier was the best way to do it. Regarding the green procurement, Anritsu has been undertaking its procurement according to its Green Procurement Guidelines that were established in 1999 and that state it is preferable to procure environmentally sound parts and materials. In the same fashion, in the year 2001, Anritsu Corporation launched its environmental partner company certification. This program has allowed the company to evaluate the status of Anritsu suppliers' environmental management systems (EMS) as well as product assessment procedures by ranking them at three different levels and encouraging environmental initiatives of suppliers. Later on, in 2019, they incorporated a new means of assessing the management status of chemical substances in products into their system. Check sheets have been provided to suppliers as well as audits have been conducted in order to strengthen the

reliability of information that suppliers provide on chemical substances in products. Finally, in the year 2011, as they introduced the concept of preserving biodiversity in their operations and activities, they began as well to implement initiatives to broaden and deepen supplier understanding of biodiversity preservation. In fact, as of 2013 151 of Anritsu's suppliers were certified as environmental partners.

5.2 After the Kinaxis implementation

Now, continuing with the analysis of Anritsu's sustainability, the years after the Kinaxis implementation of RapidResponse will be evaluated. That is to say, this section will look at the years between 2014 to 2018 (last year with full available data as of the date of writing this project) and will compare the results to that of the years prior to the RapidResponse implementation to evaluate if this third-party tool has substantially helped regarding supply chain sustainability.

To begin with, it is important to conduct an overall analysis of the supply chain management objectives for the 2018 and see if Anritsu was able to achieve the proposed goals:

- (1) Entrench CSR procurement and create the right climate for increased use: In this regard, Anritsu held procurement policy briefings for all their business partners during the months of May and November of the year 2017. In these briefings they explained their CSR (Corporate Social Responsibility) procurement policies as well as their ESG (Environmental, Social and Governance) developments to a total of 266 companies and organizations and Anritsu requested their cooperation in these fields. Furthermore, the organization has performed human rights due diligence through CSR procurement survey which was given to a total of 116 domestic as well as international partner companies. The results show that the are no significant issues regarding ethnicity, or the risk of ethnic issues in the supply chain, as those risks have been judged to be low compared to other organizations across the industry.
- (2) Establish and operate a global governance system: in this regard, Anritsu has conducted operations aligned with its Global Procurement Guidelines (GPGs) and they have been able to confirm that there are no outstanding or relevant issues to be

concerned about. In addition, they have been reviewing their risk management schedule on a quarterly basis and they have been making all decision according to their procurement risk management guidelines. They have put their focus on high-risk projects, and they have ensured PDCA (Plan, Do, Study & Act) cycle is followed in all their supply chain activities. Finally, it is important to mention that credit management tools have been established and monthly monitoring of high-risk partners has been implemented. All this in order to lower the associated risk of partner bankruptcy, business withdrawal or continuity issues.

- (3) Establish and deepen a BCP system across the entire supply chain: A secured and updated BCP (Business Continuity Plan) has been implemented for plants and business locations from partner firms. Data has been updated as of March 2019.

Briefly, some of the objectives for the following year in the supply chain management field are to establish new human rights due diligence methods and to implement human rights due diligence for partner companies, including those overseas.

As in the analysis before the Kinaxis implementation, if a look is taken to the previous year, the 2017. Anritsu made the following breakthroughs in the following environmental areas:

- Energy and CO_2: In the year 2017, Anritsu's objectives were to reduce energy consumption (again, in crude oil equivalent) by at least 3.0% for the Anritsu Group compared to the year 2014 and by at least 3.94% for the Domestic Anritsu Group compared to the year 2013 (in order to correct the error due to energy consumption-related disturbance factors such as ambient temperature, total floor area, operating time or days worked). These goals were largely achieved by Anritsu in this year, were the reduction was 3.3% compared to 2014 and an incredible 13.7% reduction compared to the 2013. As for the 2018, the objective is for the Anritsu Group to cut CO_2 emissions down by an average of 2% every year, until reaching a 26% reduction by the year 2030.
- Water: Regarding water, Anritsu's goals for the 2017 were to reduce their water consumption by at least 3% when compared to the year 2014 and to maintain a voluntary management standard of excess inorganic wastewater at zero for the Atsugi site. Both of these goals were again achieved in the 2017, with a water consumption reduction of 25.4% compared to that of 2014 and in fact maintaining

the zero excess voluntary management limit. As for the 2018, the target is to maintain a water consumption below 60,000 m^3 for the Domestic Anritsu Group (about the same volume of water consumed in 2017).

- Development of environmentally friendly products: Finally, regarding environmentally friendly products, the only target was to develop new products that could be considered environmentally friendly. The results were five new products developed in this year that were considered to be environmentally friendly. As for the year 2018, the objective is to keep developing new products environmentally friendly.

Regarding supply chain management itself and as described above, Anritsu's procurement and operation activities are global in scope and they aim to give equal opportunities to every company they work with through fair assessment practices. In this regard, they maintained in the year 2018 the commitment to respond not only the demands but also the expectation of society as a whole in their supply chain. In order to do so, they develop new partnerships as well as strengthen older partnerships through involving both suppliers and partners in various activities.

As of the year 2018, Anritsu has procurement bases mainly in the United States, Europe, China and Japan. They are working very hard to establish a unified set of assessment criteria that can be used globally and that can be approved by each location to optimize mutual use of the supply chain. In fact, they intend to promote parts and accessories procurement through a global collaboration. Furthermore, and as a means of recognizing business partners, Anritsu still offers what they call mutual approval. They particularly use this with partners that commonly provide Anritsu with products they very often use, being called Global Preferred Supplier (GPS). Regarding this particular group of partners, Anritsu is intending to shorten their time to market for product development by using common roadmaps and by sharing technological issues with these partners. In addition, they use a common standard for assessing suppliers between their operations both in Japan and the United States. Finally, Anritsu still selects eight companies to their GPS list to enhance mutual interests as well as building stronger relationships.

As for their medium to long-term goals in the year 2018, again, the are still working to achieve all those objectives stated in the GLP2020 business plan. Those goals are summarized in the following:

- Promote global CSR procurement: Anritsu is actively promoting CSR procurement protecting human rights, labor, safety as well as health throughout the entire supply chain. This includes overseas business partners. In order to do so, they work to strengthen their global supply chain. This is done by promoting their CSR procurement activities based on CSR surveys and by visiting their business partners regularly. For instance, their aim is to increase their CSR survey assessment scores in the upcoming years.
- Promote global green procurement: Anritsu is actively promoting an environmentally friendly and green procurement throughout the supply chain as a whole, including here once again their business partners overseas. This all goes again by strengthening their global supply chain. For instance, they survey the environmental initiatives of their business partners, as well as undertake activities to increase the quality of the environmental initiatives of them. This all pursues the ultimate goal of enhancing the ratio of certified Environmental Partners among Anritsu's business partners.

Further detailing Anritsu's initiatives for CSR procurement, as of the year 2011, the organization received many letters of consent as they asked for cooperation in promoting CSR procurement by their business partners. They also were able to conduct those CSR surveys explained before. The main aim of these surveys was to review the CSR initiatives undertaken by their business partners. All this resulted in positive results for the fiscal year 2017. In this year they obtained responses from 116 of their primary business partners. They are constantly increasing this number by seeking cooperation from suppliers on clean and green procurement in order to achieve full transparency in their transactions as Anritsu practice compliance.

After reviewing some of the aspects in which Anritsu's supply chain has changed over the course of the years after the Kinaxis implementation, it now seems important to focus on Anritsu's environmental management and how it has evolved after the RapidResponse software implementation.

The years after the implementation have been marked by an increased interest by Anritsu's investors and stake holders in environmental, social and governance issues, as well as in sustainable development. In the year 2018, Anritsu firmly believes in a balance between protecting the global environment and developing our societies and economies. In fact, so as to promote sustainable growth, Anritsu has been working to firmly apply environmental compliance. Their business activities and products address issues such as climate change, creating a recycling-oriented society, and environmental pollution prevention. Furthermore, they believe that Anritsu's administration has to be conducted in such a way that discloses information in such a fashion that it is easy for all stakeholders to understand. In fact, in the year 2018 Anritsu started a brand-new three-year mid-term environmental business plan that operates within the above-explained GLP2020. This does not only identify materiality within environmental management but also to the challenges of the GLP2020 framework.

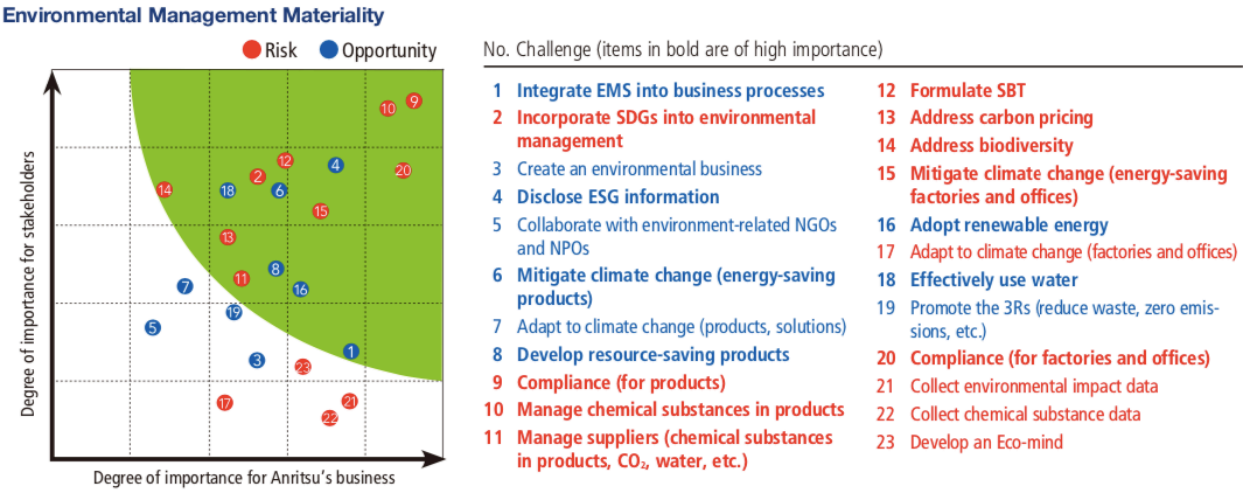


Figure 34 - Environmental Management Materiality as of 2019 for Anritsu (anritsu.com, 2018).

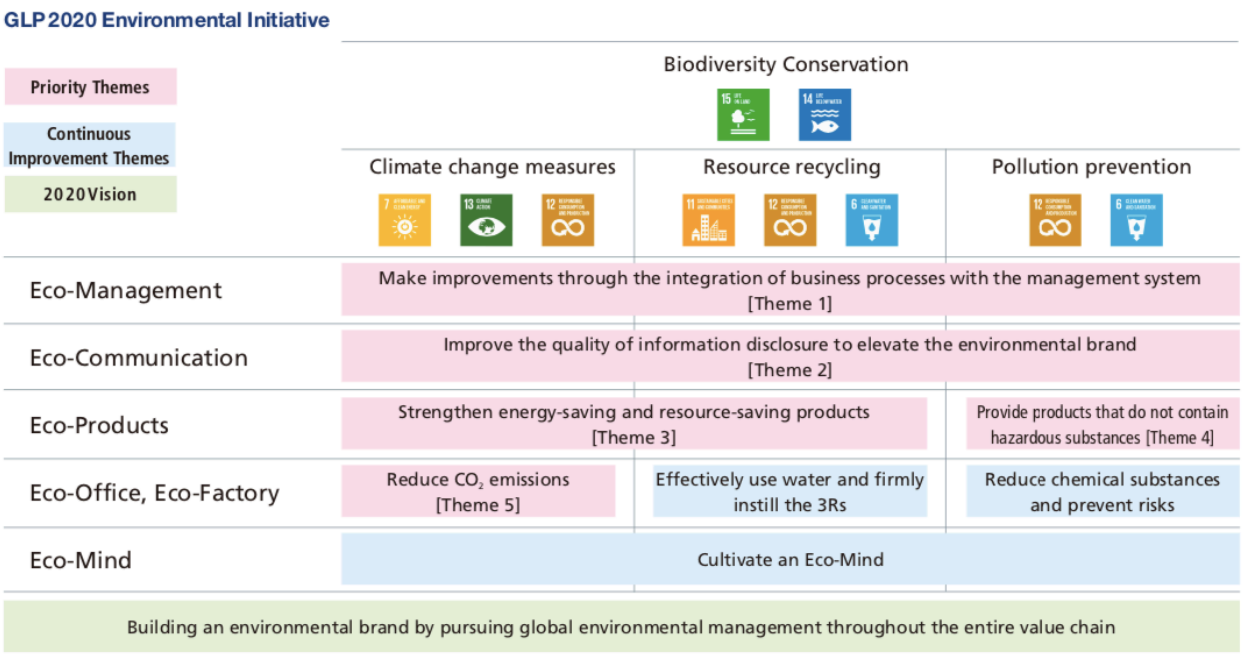


Figure 35 - Anritsu's GLP2020 initiative (anritsu.com, 2018).

As of 2018, Anritsu has established a body within the company that delivers and executes to promote environmental management with an officer of environmental management as chairperson. This body is composed of:

- Global environmental management meetings: This body addresses all those challenges Anritsu must get involved in as a single and global entity. This is composed by all responsible officers from all major locations in Japan, the United States, and the United Kingdom.
- Environmental management committee: the main mission of this body is to promote systems for the environmental management of the Domestic Anritsu Group (Japan). This body is composed by all those division officers responsible for the environment (environmental management activity unit), as well as those officers responsible for internal control, legal affairs and the sustainable promotion center.
- Promotion of RoHS group meeting: The main objective of this body is to promote the development as well as production of products and equipment that does not contain substances hazardous in any way. For instance, those banned by the RoHS directive approved by the European Union. This body is composed by representatives of the development, the SCM, the IT and the environmental departments.

Figure 36 - ISO 14100 certification acquisition status as of 2018 (anritsu.com, 2018).

After the Kinaxis implementation, Anritsu has been able to construct a system for the environmental management which has ultimately led the organization to acquire the ISO 14001:2015 certification both for their core development as well as manufacturing bases of Japan and the United States. In fact, as of the year 2018, that system has a coverage rate of 70% when based on the number of employees.

As a comparison to the year 2014, Anritsu's medium- to long-term goals have evolved to promote environmental management so the organization can move forward to the realizing its 2020 vision goal. This not only includes building a green and environmental brand, but also pursuing a global environmental management throughout the whole value chain. Beginning in the year 2018, Anritsu has actively been taking action in order to achieve the GLP2020 initiative. This can be seen in the new mid-term business plan Anritsu Approved in the year 2018:

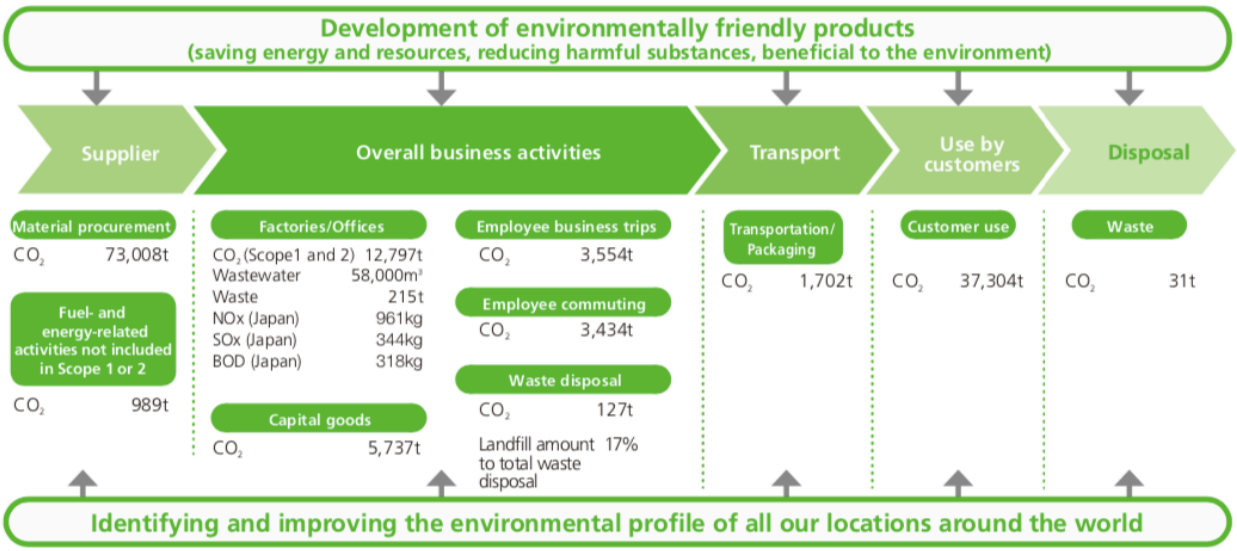


Figure 37 - Items in which improvements could be made for Anritsu to become more sustainable as of 2018 (anritsu.com, 2018).

As for the progress and challenges in the year 2018, as well as priorities, it has to be said that in the previous year, 2017, Anritsu was able to complete their three-year GLP2017 initiative for the environment. This was their second phase in order to realize the before-mentioned 2020 vision. It has to be noted that the 2017 plan went as expected generally speaking, however those challenges that could not then be addressed as well as the newer challenges will be taken into account in the GLP2020 initiative. Some of the priority themes of the GLP2017 initiatives as well as new objectives for the GLP2020 initiative are:

- Improve through the integration of the management system: Anritsu was able to expand their initiatives from an environmental point of view within their operations and was able to pass the assessment in order to obtain the ISO 14001:2015. Objectives for GLP2020 are the construction and administration of a mechanism able to review compliance with environmental laws and regulations at a global level.
- Provide information that helps elevate the environmental brand: The organization was able to draw up environmental information disclosure regulations and guidelines. Anritsu was as well part of the 'Environmental Reporting Platform Development Pilot Project' guided by the Japanese Ministry of the Environment and was able to conduct productive dialogues with their investors in this regard. Objectives for the GLP2020 include the improvement of the quality of the

information disclosure as well as the continuation of the organization in the ministry's above-mentioned project and the revitalization and improvement of the communication with investors.

- Provide energy-saving and resource-saving products: In 2017, Anritsu was able to certify three models of their products developed in the U.S. as excellent eco-products. Their goals now are to reduce the CO_2 emissions related to products.
- Provide products that do not contain hazardous substances: In this year, did not only the organization certify their compliance with RoHS but also achieved zero RoHS as well as other product and environmental regulation violations. Now their objectives are to address additional products and regulations (RoHS2, for instance). Other objectives are to develop and provide products that do not contain any hazardous substances.
- Effectively use energy and water: Compared to the year 2014, Anritsu reduced their energy consumption by 3.3% and their water consumption by 25.4%. Objectives for the GLP2020 are primarily to reduce CO_2 emissions: on the one hand, the first objective is to reduce CO_2 emissions by 2% per year if compared to the year 2015 (which means a 26% reduction by the year 2030) and on the other hand, to set a long-term CO_2 emissions target for the years 2030 and 2050.

On another note, it seems important to comment on the environmental audits Anritsu has get involved in as well as those environmental education programs the organization has been conducting over the years. Regarding the first topic, in the year 2017 did not only Anritsu transition to the ISO 14001:2015 in their bases of Japan and the U.S. (as stated earlier), but they also conducted internal environmental audits so as to review conformance, effectiveness and performance of their environmental management system. In addition to that, the organization conducted audits to review legal compliance of that system as well as audits to generate proposals for initiatives to comply with newer regulations and legislations. All these opportunities for improvement are directly reported to the above-mentioned Environmental Management Committee as well as shared throughout all the management organizations allowing this to face the issues more effectively and so activities can be undertaken in the next years to mitigate the issues. On the other hand, regarding the environmental education topic it has to be said that although this project started even before the Kinaxis implementation, it has changed since it was created. The e-learning program in the year 2017 already complies with the RoHS Directive of the European Union. This is

due to the fact that Anritsu's test and measurement equipment and other products are subject to this regulation in the European Union. The e-learning program is designed to fit any job type as well as rank within the Anritsu organization.

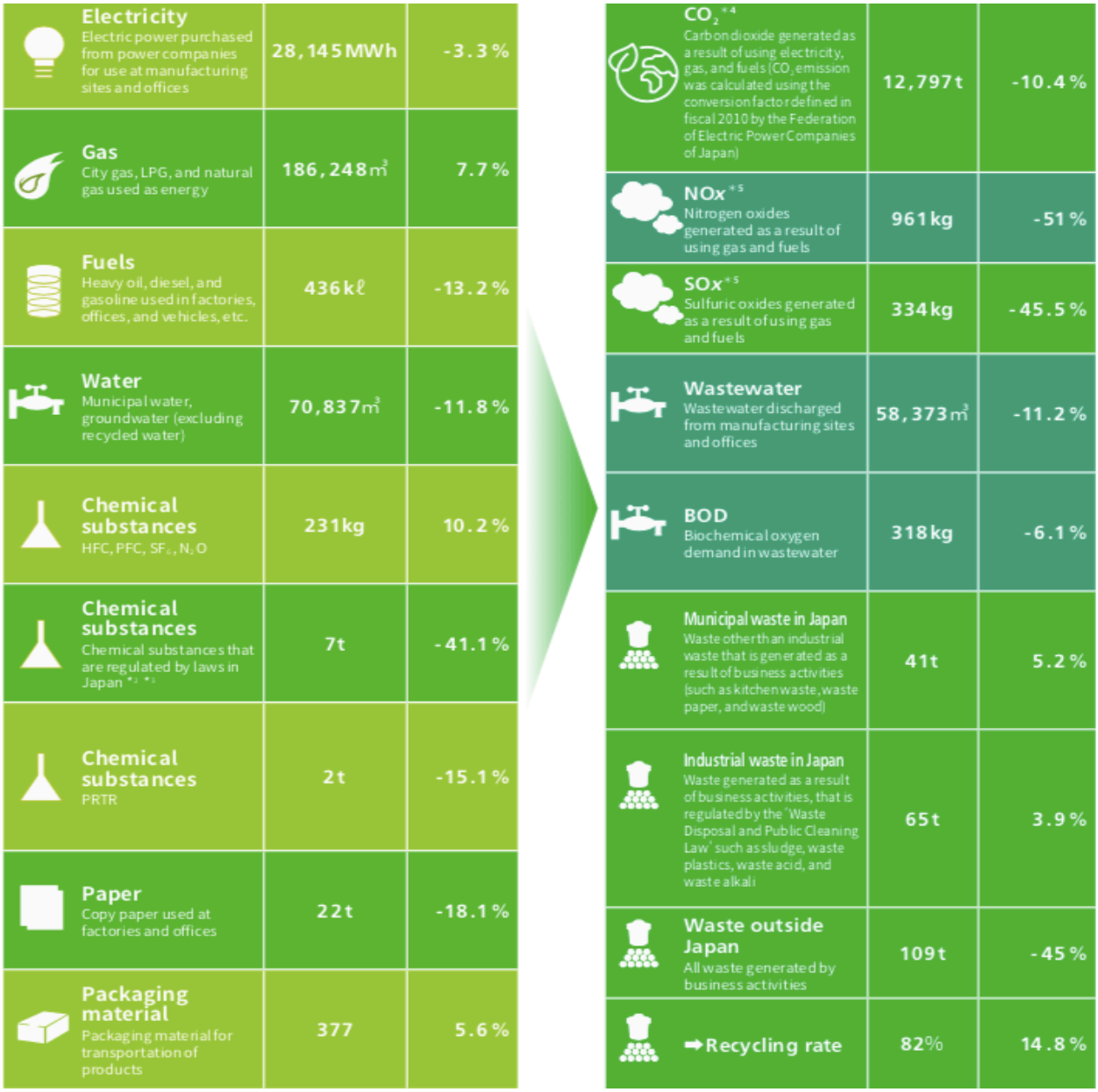


Figure 38 - Environmental impact mass balance as of 2018 (anritsu.com, 2018).

Serve the previous graph as a clear overview of the year 2018. This is an impact mass balance, which shows substances entering the organization, identified by name and mass, in one column and substances and mass leaving the organization in the other column. This

allows to clearly display that relationship existing between business activities and environmental impact.

Another way of showing the environmental impact of Anritsu in the year 2018 is through environmental accounting, that is, attaching an economic value to the environmental conservation cost versus that of the environmental conservation benefit. The following table shows these values for the year 2018 and compares them to the year 2017. Even though environmental accounting is conducted for all activities involved in Anritsu's operation, only those related to supply chain will be taken into account for the purposes of this project.

Table 6 - Environmental accounting for Anritsu as of 2018 (anritsu.com, 2018).

Upstream/ downstream cost	Green purchasing/procurement cost	0.0	24.9	62.7	*	1,604.4t-CO_2	*
		0.0	24.8				
	Design of environmentally friendly products	0.0	20.7				
		0.0	21.6	73.6	*	2,161.5t-CO_2	*
	Recycling and treatment of products, containers, and packaging	0.0	0.0				
		0.0	0.0				

Finally, this project will analyze progress and challenges Anritsu has been facing during the years of the Kinaxis implementation. First of all, it is important to note that Anritsu's goal for the GLP2017 initiative was to reduce its energy consumption by 3% compared to the year 2014 (year in which the Kinaxis implementation began). The fact is that Anritsu achieved a 3.3% reduction in the year 2017. Now, they are working on updating their goals for their GLP2020 initiative. What is more, they are shifting their attention from reducing energy consumption to actually including a CO_2 emissions reduction too.

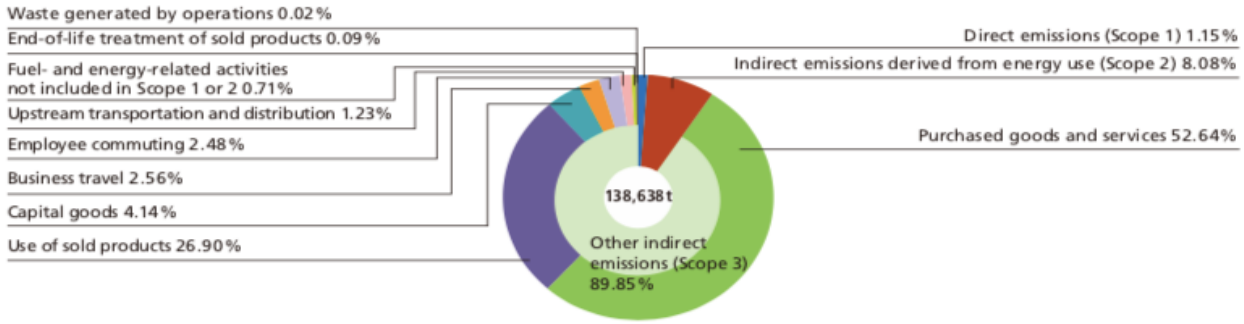


Figure 39 - Value chain CO2 emissions by scope as of 2018 (anritsu.com, 20118).

Regarding CO_2 emissions throughout the entire value chain of Anritsu, an overview of the amount of CO_2 emissions by activity conducted within Anritsu can be seen in the following figure. Note that this calculated emissions values have been verified by third-party organizations.

If these values are compared to that of previous years, including three years before the Kinaxis implementation, the results are the following:

Table 7 - Value chain CO2 emissions volume by scope as of 2018 (anritsu.com, 2018).

CO_2 emission volume	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017
Total CO_2 emission volume	129,251	158,900	155,941	162,957	141,906	138,683
Scope1	3,124	2,376	1,669	1,722	1,698	1,591
Scope2 (Market based)	12,259	11,045	13,396	13,387	12,581	11,206
Scope2 (Location based)	14,276	14,174	14,262	15,310	14,741	12,354
Scope3[*1 *2 *3]	113,867	145,479	140,876	147,848	127,626	125,885

As for energy-saving activities within Anritsu's factories, offices and supply chain, it is important to remark that about 99% of Anritsu's CO_2 emission volume comes from the use of energy. Therefore, in their focus to reduce their energy used, the organization has been able to drop their energy consumption by about 22% within ten years.

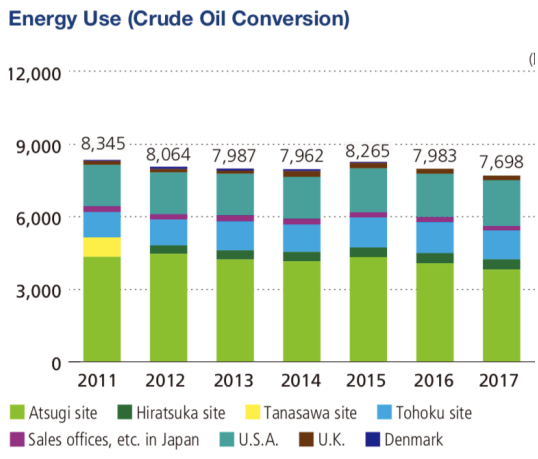


Figure 40 - Evolution of energy use in crude oil as of 2018 (anritsu.com, 2018).

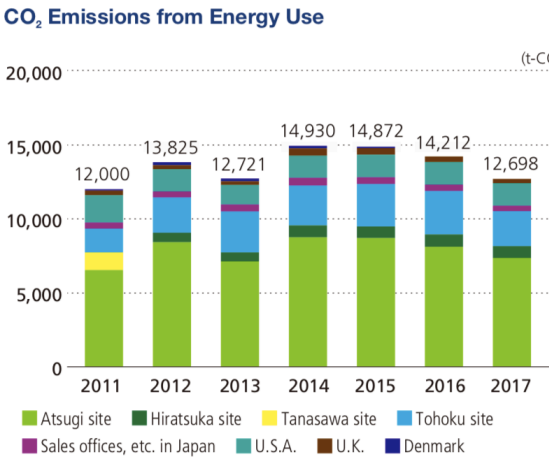


Figure 41 - Evolution of CO2 emissions from energy use as of 2018 (anritsu.com, 2018).

As for the year 2018, Anritsu has seen an 8.3% improvement since the year 2012 regarding their basic unit of energy. This goes beyond their targeted goal of a 1% improvement every

year toward the year 2020. Moreover, Anritsu target of an annual reduction of at least 1% in the basic unit of energy consumption per sales was too effectively achieve, reaching 1.4% in 2018.

Regarding water usage, Anritsu aims to maintain water utilization this year 2019 at a level below or at least equal that of the year 2018. If a look is taken to Anritsu's GLP2017 target goal, the organization aimed to reduce its global water use by at least 3% by 2017 when compared to that usage they did in the year 2014. During the course of these three years, Anritsu has been able to achieve an incredible reduction of 25.4% and they keep controlling water use so that it does not increase in the future. If a look is taken to water usage for the Anritsu group over the years, the following graph is obtained, where it can be seen how Anritsu has been able to constantly reduce their water consumption over the years, even before the Kinaxis implementation.

As for their waste reduction initiative, in the year 2018 Anritsu is still promoting 3R initiatives and activities, as well as the separation of different wastes both in offices and production lines. For instance, closely related to supply chain, Anritsu replaced their wooden frames with rented plastic frames to ship components to Japan that are produced overseas. This change has allowed for a reduction of wood waste in comparison to previous years. The evolution of the volume of waste for the Japanese Anritsu Group is shown below:

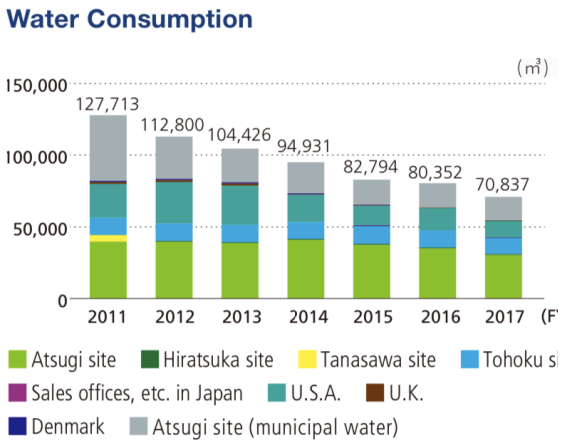


Figure 42 - Evolution of water consumption as of 2018 (anritsu.com, 2018).

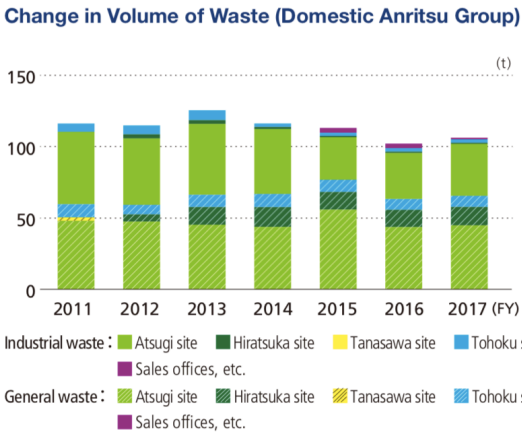


Figure 43 - Evolution of change in volume of waste as of 2018 (anritsu.com, 2018).

As earlier discussed, Anritsu continuously seeks to take environmental considerations into their packaging, being that the reason why they try reducing the amount of packaging materials they use. To further accomplish their objectives, the organization is closely working with their packaging subcontractors to discontinue the use of the so-called 'shock-absorbing' materials for their packaging, which are heavily regulated as they pollute the environment. Some of the eco-friendly measures they have undertaken are:

- Polyethylene foam packaging (PEF packaging): This is used for the desktop measuring equipment Anritsu produces. They use this plastic foam as a means of cushioning the equipment. This action has resulted in a volume reduction of 40% and a total discontinuation of the urethane foam (a shock-absorbing material).
- Cardboard as cushioning material for packaging: This kind of packaging is used for the handheld measuring equipment. The objective is to use corrugate cardboard as a means of cushioning the equipment. Standard attachments and other optional parts are as well placed in carboard cushioning material gaps. Again, this measure has led to a reduction of 40% in volume and the discontinuation of urethane as cushioning material.
- Eco-logistics: Those products sold in Japan are placed in reusable boxes both for delivery and for pickup. The material used for protection is polyethylene and this has result in an overall simplification of the packaging as well as it allows for reuse and a reduction of waste emissions by 94% compared to regular packaging (this

measure was introduced before the Kinaxis implementation, it was earlier discussed in the project).

- No packaging: For large products, Anritsu has removed all packaging and now uses reusable pipe frames, which allows to shift from crates (disposed after use) in order to achieve zero waste emissions.

5.3 Analysis of the advantages/disadvantages

Nowadays, it is clear that sustainability is increasingly becoming a key and integral part of any organization's business strategy. In fact, performance indicators and dashboards are being increasingly used to measure whether or not an organization is being successful in key areas of their business. Sustainability indicators can be either quantitative or qualitative but what is a fact is that sustainability touches a wide variety of functional groups, including supply chain management, logistics, internal operations or product development. This is the reason why being able to streamline an organization's supply chain with a focus on the customer while paying a big deal of attention to sustainability can improve supply chain performance, can positively impact the above-mentioned measurements, can improve resource use and ultimately employment stability.

Transitioning a supply chain like Anritsu's through a third-party software such as Kinaxis' RapidResponse is not an easy task. It is clear that there are benefits and drawbacks. From a sustainability point of view, it is clear that being able to operate within the ISO 14001 (Environment Management System), a fairly systematic framework, allows Anritsu to easily adapt their operations to comply with international environmental requirements and standards. This turns as well to a more convenient way of approaching continuous improvement as it sets Anritsu's operations in the plan-do-check-act mindset. Furthermore, being sustainable allows organizations to relieve pressure coming from a number of fronts:

- Regulatory pressure: Manufacturing is increasingly being regulated and legislated. Supply chain is being impacted by regulation in aspects such as carbon emissions, energy footprint, RoHS or chemical products regulations. In addition, laws and requirements are not the same in one region to another, as aspects that may be unregulated in the United States may be strictly controlled in the European Union, for instance. This added complexity is what differentiates organizations' supply

chains. This not only affect supply chain themselves, but also organizations selling to a supply chain or organizations receiving from a supply chain might as well be impacted by these regulations. What is more, these laws, requirements, standards and regulations change at a very rapid rate. Being the rate of change so significant, supply chains are becoming increasingly volatile.

- Supply chain pressure: Not only laws and regulations but also big, large and influential corporations are setting their own rules in order to comply with their efforts towards good corporate citizenship. For instance, IBM or Wal-Mart both are demanding their suppliers to not only track but also report all their environmental performance. The ultimate goal of this is to be able to provide the public with information about the environmental impact of their products so clients can make informed choices. However, this brings to the supply chain a pressure (the buying public) characterized for being potentially disruptive and unpredictable. Third-party tools such as Kinaxis' RapidResponse can help with this. Being able to manage a great deal of information and data so seamlessly and rapidly can definitely make a difference. At some point, society will hit an inflection point where people will take green tags and other sustainability indicators as very important part of their purchasing decision. At that point, if an organization is not able to provide green alternatives and their competition is, that organization will find its market share shrinking at a fast rate.
- Financial pressure: In the same fashion as customers, investors, shareholders and analysts are beginning to take sustainability as a key and leading indicator of an organization's overall efficiency as well as risk exposure. A not efficient organization cannot be sustainable which means it can be profitable in the long term.

In order to face these issues, organizations can wait for those regulations, market forces or financial analysist to force them to respond or they can take action and implement sustainability as an added value to their operations. The first is a certainly risky approach as changes in regulations can result in the redesign of a product from the ground up, forcing companies to design a new product to replace an old product that can no longer be sold due to its incompliance with newer regulations and standards. This can drastically affect a company's performance. However, the second option allow for the implementation of third-party tools that cannot only improve supply chain performance, but also add

sustainability and transparency as an added value. Some of the advantages of the use of these third-party tools are:

- Improve the understanding of the issue: Kinaxis' RapidResponse allows officials and supply chain analysts to quickly become aware of potential issues that might impact a product. The sooner these issues are spotted, and the sooner operators understand how they impact products, the sooner a solution can be put together and actions can be taken to respond. This does not only apply to supply chain sustainability but any other issues that may cause supply chain disruption.
- Involve other industry groups: By closely working with other entities and by collaboration and the sharing of information, industry groups can tackle issues in a more efficient way. Tools like RapidResponse allow all this sharing and connectivity to happen so whenever an organization becomes aware of a problem, other entities and third-parties can participate with their knowledge to help mitigate the issue.
- Engagement and assemble the organization: RapidResponse allows to quickly and effectively inform other departments within the organization to ensure everyone is aware of an issue and to allow collaboration between different parts to ensure potential responses have the buy-in of every department involved.
- Assessment of IT landscape: Parameters such as carbon footprint, energy consumption or usage of chemicals have to be documented throughout the supply chain as part of regulations and other of the above-mentioned supply chain pressures, however, generally speaking, ERP packages do not have the ability to track these. The use of third-party software and applications such as RapidResponse allows for the required tracking of these parameters throughout the entire supply chain or even value chain within an organization.
- Simulation of responses: Finally, third-party tools allow to simulate initiatives and responses so that officials and other supply chain professionals can be sure a certain response or action will work in the desired way and what the cost of that response or action will be. Being able to simulate does not only assure an organization that they are on the right track from a sustainability point of view, but also, they can identify the changes and adjustments they need to implement to assure compliance with regulations and standards.

Aside from environmental or social reasons to undertake environmental initiatives, regulatory requirements and their geographic nature, as explained above, can be challenging for supply chain professionals. No matter what leads organization to take sustainability initiatives, those need to be fully integrated in all the activities an organization gets involved in, due to the fact that they significantly impact every aspect of the operations. RapidResponse has definitely helped Anritsu with this over the years since its implementation. It did not only help with becoming more sustainable but also with managing quick responses to all unexpected events or the introduction of new regulations and standards either from the environment or within the organization itself.

In order to illustrate how RapidResponse helps with supply chain sustainability and supply chain responsiveness, serve as an example the following: for instance, let's say there is an increase in demand for Anritsu's products in the United States. The natural reaction would be to satisfy this demand, which results in an increased revenue and therefore an increased profit. However, this increase in demand had never been planned, so in order to profitably meet this new demand, officials might decide to re-allocate supply that was meant to be delivered somewhere else, let's say from the European Union, to the United States. However, sustainability requirements or standards vary from region to region, therefore a 'European' product is not really the same as the equivalent 'American' product. In order to avoid this situation, Anritsu has to take a more global view from a sustainability point of view. That is to say, bring consistency across all regions to where they operate. This is where RapidResponse intervenes, as the advantage of bringing this consistency to all regions makes Anritsu to be ahead based on the fact that requirements will increasingly be adopted everywhere where Anritsu operates. Although regional differences will always exist, third-party tools allow to raise the bar so organizations with these tools can be ahead and, therefore, better off.

This example shows how environmental issues need to be addressed and shows the impact that sustainability decisions have on responsiveness. However, third-party tools allow this to be an opportunity rather than a barrier. Proactively making sustainability laws, requirements and standards a core part of Anritsu's business allows them to retain responsiveness while still being able to differentiate themselves from their competition in a very positive way.

5.4 Challenges for the future

Customers are increasingly paying attention to green labels, earth-friendly products and sustainable operations. Nowadays it is hard to read or watch the news without encountering something about the environment and business practices. Organizations have to increasingly focus on the complex world of sustainability as default to do so may cost them more them they would like to think. Today's marketplace is that of environmentally aware customers.

Although Anritsu has been doing an extraordinary job regarding supply chain sustainability in particular but sustainable management in general, there are still some challenges for the future. Given the complexity of sustainability, the most obvious challenge for the future is strong leadership. Being able to implement all what is required to keep improving sustainability parameters and to achieve full sustainability requires strong leaders that can undertake all actions required. Best-in-class companies are continuously boosting their procurement talent efforts to meet this challenge. Processes that support design and management of a sustainable supply chain are increasingly becoming critical for providers of any good or services.

On a special note, it is important to know that regarding sustainability, any supplier's issue in this aspect is actually the organization's issue too. A supplier not being sustainable, means the organization it provides to is not sustainable either. As sustainability becomes an increasingly important metric for supply chain analysts, it is no longer possible to look only at your own company's operation sustainability but suppliers' operations too. Sustainability will inevitably become way more than just a green label or environmental packaging to affect wider aspects such as social corporate responsibility, postponement or better use of logistics and transportation.

How can companies have the necessary expertise to manage this complex issue? Again, investing in human capital is key to success. All across functions, industries and geographies, companies need to hire new staff to support all their environmental activities, reassess existing staff for the purpose and employing a combination of those two options. In fact, it is believed that environmental efforts are not going to take a back seat to profitability in the economic downturn so experienced executives in sustainability will be

needed more than ever. Sustainability in supply chain creates opportunities of great value which offer a very significant competitive advantage for early adopters as well as innovators. Strong leadership and expertise are required so as to avoid that sustainability and profitability becomes an either-or problem.

Some of the trends and examples of drivers of sustainable supply chains are the following:

- Closed-loop supply chain: Or cradle-to-cradle supply chain, it describes the ideal od a zero-waste supply chain. This supply chain would ideally reuse all the materials entering the system, including as well corporate programs with manufacturers so they assume responsibility to dispose all those goods already used by customers. Production-logistics-recovery models have been demonstrated to have a very high potential added value.
- Thinking global: Nowadays, supply chains must consider all activities involved, such as logistics, content verification, energy used, product integrity and transport costs at a global scale. Regardless of the location, supplier's supply chain must be monitored as well. Cost, risk and availability have to be weighted differently in order to avoid cost inflation.
- Certify suppliers' supplier sustainability: This is very time consuming and requires a great deal of effort to ensure the selection of the right certification system, but uniform standards would definitely ease the pain to check and ensure suppliers of suppliers comply with each organization's sustainability standards.
- Resource base expertise: The ability to understand as well as interpret resources trends is becoming a critical skill as organizations are increasingly sourcing globally. Executives require a wide knowledge into various resources issues. For instance, alternative energy sources, substitution of oil-based plastics with renewable plastics, consolidation of metals output or demand patters from emerging markets.
- Commodities trading: For instance, the European Union manages and operates the world's largest emissions trading system (ETS), being the first to trade and limit CO_2 emissions. Procurement professionals in supply chain have to become conversant in commodities trading. Executives must understand how these markets work and how they impact their businesses.

Other sustainable supply chains challenges are the following. They depict trends required to assess the creation of more sustainable supply chains in the future along with the explanation of those required competencies managers must have in order to deal with these new trends.

1) Cultural sensitivity and global awareness: continuing education requires a learning agility to be able to deal with new lexicon regarding standards, certifications and requirements

2) Flexible commodities trading and procurement agreements: professionals must be competent in negotiating complex and dynamic agreements

3) Corporate and global citizenship: the sustainability of the corporate supply chain is part of the CSR reporting picture

4) Innovative thinking: executives and entrepreneurs need to design programs and strategies that utilize the internal supply chain to deal with customer needs and green interests

5) Communication abilities: to move sustainable supply chain forward, executives must communicate affectively internally and externally to manage certification processes and to meet standards and new strategies.

Operating at a global level requires that organization understand that society is facing a new global economy where energy costs are increasing so renewable energies become an option. Procurement must considerate more sourcing options and market factors than ever. And supply chain leaders must change the way they have been operating to compete in this new playfield. Organizations looking to become more sustainable must ensure their leaders have the skills that are now needed and demanded. Through assessments, organizations can now evaluate the competences of current employers to be able to design efficient and effective programs to update them, and through new recruitment plans, organizations can ensure that their skill gaps are filled. The most important challenge for the future of supply chain is strong leadership. As this is the only ingredient that will allow organizations to succeed in the complex and ever-changing world of sustainability.

Figure 44 - Challenges for a more sustainable supply chain (Open source, 2019).

CHAPTER 6

RISK MANAGEMENT ANALYSIS

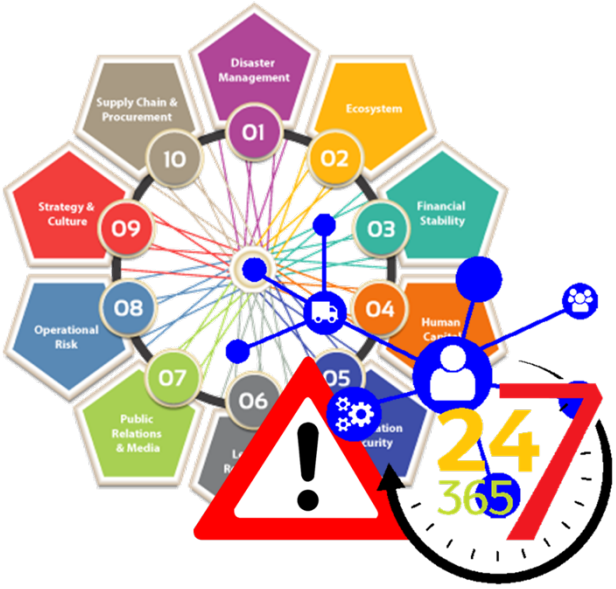


Figure 45 - Business activities where risk can arise (enterrasolutions.com, 2017).

Due to the increasing levels of globalization, our world is both physically as well as virtually interconnected. Although this opens the door for a great amount of benefits, positive aspects and advantages (free movement and circulation of goods, money labor and services, together with the expansion of the global economy), it also means an increased risk that can cause supply chain and transport disruptions. These risks are becoming increasingly acute and they affect economics, security and even geopolitical interests, as outsourcing is being increasingly used and new open standards are being developed every day. As both big and small organizations seek to extend their global influence, vast and wide transportation networks are continuously being developed to span the globe and they are optimized to eliminate inefficiencies, delays or slacks so as to achieve lower overall costs. Organizations that enter new markets need to establish new supplier relationships, deal with new state entities and adapt both local laws and culture. All these result in large and complex supply chain that deal with a large number of financial, regulatory or even legal risks. However, are these supply chain optimizations for higher efficiency actually developing robust transport and supply chain networks? This section will analyze some of the most critical threats and risks that supply chain and transport professional face, afterwards, the Anritsu case will be analyzed and finally this project will look at how a third-party tool like Kinaxis' RapidResponse can help promote efficiency regarding risk management, security and resiliency for Anritsu's supply chain.

Definition of supply chain risk management

Supply chain risk management is the discipline that analyses, addresses and solves threats, vulnerabilities and other exceptional risks along the supply chain based on continuous risk assessment with the ultimate objective of minimizing those risks and vulnerabilities to finally ensure continuity, just in time/sequence values and brand reputation within the value chain. In other words, it is an activity that manages risks in a very complex and dynamic networks using tools to deal with uncertainties affecting supply chain-related activities or resources. These risks can occur both upstream and downstream the supply chain, being upstream suppliers and other business partners who deliver raw components and materials and facilitate the organization's operations and downstream the distribution network for goods and services to be delivered to customers. Ideally, if risk management is properly conducted, nothing should occur that results in a negative impact on operations or profitability for an organization, however, that is only theoretically, as in reality to truly eliminate all risk organizations would be required to never use suppliers or conduct any procurement activities at all, which is unrealistic. On the contrary, supply chain professionals must focus on creating a high-performing supply chain that is secure and resilient. Risk management is the one that minimizes risk while value-added business and contractual relationship can flourish.

As reliable and secure supply chains and transportation systems assure the prosperity of international trade and economies around the world, being able to detect, assess and address supply chain risks play a key role. These risks are characterized for continuously evolving, becoming increasingly complex and damaging, therefore, organizations have to respond 1) mapping their key risks (to create a risk profile), illustrating how these risks might unfold and what blind spots there might be in their supply chains and transportation networks in order to address their causes and to identify possible solutions. This is the first phase in the risk management lifecycle, which also includes active monitoring to keep up to date; 2) sharing approaches and insights on how to mitigate them not only with suppliers and stakeholders (because of their significant impact on sales, margins or even profit), but also other partners and policy-makers. This also includes understanding the extent to which these risks might affect the business; and 3) evaluating any protection tools together with identifying possible interventions and policies, so as to design preventive as well as reactive plans, which are the only way to address risk to secure and protect the supply chain.

These risks range from unpredictable natural disasters or political uprisings to world economic crisis or counterfeit products, together with financial risks, reputational risks, man-made risks, geopolitical risks or cybersecurity risks. All them have the potential ability to reach anything from product quality or organization security to economic resiliency or product integrity. These risks pose supply chain vulnerabilities that involve all stakeholders and can ultimately suppose emergence of failure points throughout the supply chain that can finally cause a supply chain disruption. In order to mitigate the risks, aspects such as logistics, cybersecurity or finance, as well as other risk management disciplines are involved. All this has the ultimate goal of making sure that the supply chain is able to have a continuity in the event of an abnormal scenario that would otherwise have interrupted the normal operation of the business and so, affect the profitability of the organization. Generally speaking, through supply chain optimization techniques, organizations can evaluate contingency planning that can reduce the overall risk level for each particular supply chain. However, it is becoming increasingly common to use third-party software, specially a supplier quality management one, able to integrate all phases of the supply chain cycle. Using this specialized software has been proven to increase transparency as well as operational efficiency and to reduce overhead costs.

Of course, given the complexity of many supply chains, the identifying-assessing-controlling-monitoring cycle to address risks might not be enough to ensure that the supply chain is prepared for all eventualities. This is where the concept of *resilience* comes into play. Unlike risk management itself, which is cause-oriented, resilience focus on ensuring that the supply chain is able to deal with eventualities by itself and is able to resist risks irrespective of their cause. This capability to prepare for unexpected eventualities, respond to disruptions and recover from them without losing continuity plays a very important role in supply chain risk management, as it assures a minimum level of connectivity, control and function even when unfortunate events happen.

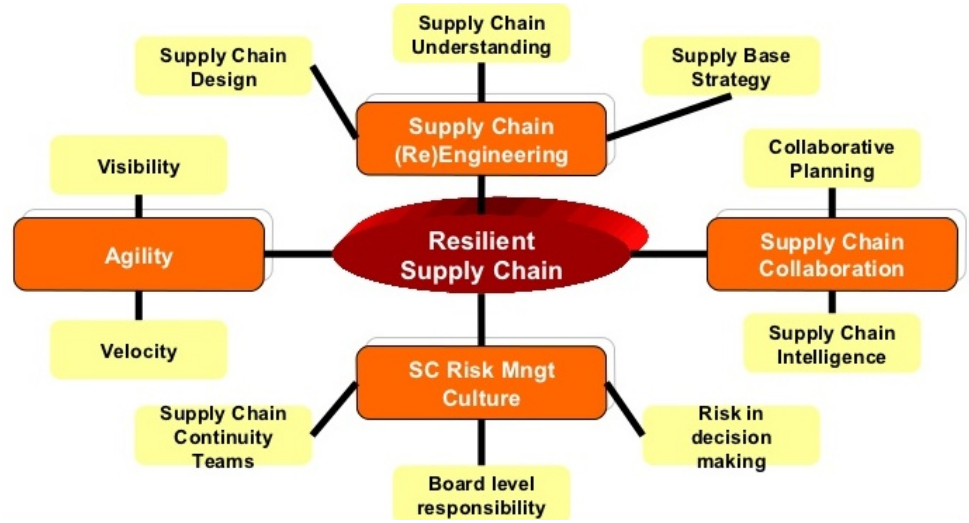


Figure 46 - Schematic representation of supply chain resilience (researchgate.net, 2017).

In addition, and closely related to this concept, a very important metric first introduced by Cisco Systems (a worldwide reference in IT, networking and cybersecurity solutions provider) is *time to recover*. This by the definition is the time it takes, after a major supply chain disruption, to restore the 100% of the operational level assuming the supply chain remains unusable. This concept includes the idea of repairing, reconstruction, resourcing and requalifying all that required equipment to operate a supply chain.

Mathematically speaking, the most popular way to quantify risk is the one that defines risk as a function of likelihood that looks at an event's occurrence and the impact that event has, in this case, in supply chain. However, using this methodology is very time consuming and computationally intensive, as it assesses probability for a big number of events for each supply chain location. This method results in a wide number of different possibilities, which usually makes it appropriate for smaller number of options (smaller size of the supply chain). Generally, large organizations prefer to measure risk using what is called *risk scores*. A number of metrics can be used, among them, financial risk score, operational risk score or resiliency score are the most popular. These risk measurements are typically easy to acquire, analyze and calculated, allowing for an effective understanding of the overall supply chain risk at any given moment. A comprehensive approach to the supply chain risk management takes into account all types of risk as well as all tiers for all risk objects, not only suppliers, but also locations and ports too. Finally, it seems interesting to note that according to a 2011 research conducted by the Business Continuity Institute and the Zurich Financial Services Group, over 85% of companies have had at least one supply chain-

related disruption during that same year. What is more, that for 40% of them, that disruption did not originate in a direct supplier but in a sub-tier supplier. This research was conducted using data from around 600 organizations across 65 countries.

Some of the available solutions engineered to minimize risk to an acceptable level are: the right management of stock; using alternative sourcing routes; contracting insurances for the business interruption or business contingency (indemnification and limitations of liability too); hiring specialized companies to conduct risk assessments and audits; require a visibility for supplier financial stability; undertake training programs for employees as well as awareness campaigns; make use of big data analytics and other business intelligence alternatives to monitor and take predictive security measures; and make use of redundancy optimization, innovation and efficiency in contract managing, postponement and collaboration with other partners. All these can mitigate risks so that business continuity, supply chain visibility, CSR or compliance with existing regulations and good supplier relationship are guaranteed.

Just to show how important supply chain risk management is, here in the United States several measures have been undertaken to review and refine supply chain risk management procedures and practices, and to make of supply chain risk management a national priority. For instance, the National Security Presidential Directive 54, the Homeland Security Presidential Directive 23, the Defensive Authorization Act 254 are some examples of these measures. Furthermore, the United States Department of Defense and the Department of Homeland Security, among others, have been working on a Comprehensive National Cyber Initiatives to provide a robust toolset of supply chain defense methods and techniques, containing a wide set of practices to mitigate supply chain risk. Some of the key analysis and measures the United States government uses to mitigate the risks are: determine both system criticality as well as supply chain threats, primarily select build over buy and use key practices to determine sufficiency and analyze likelihood and consequence of insufficiency.

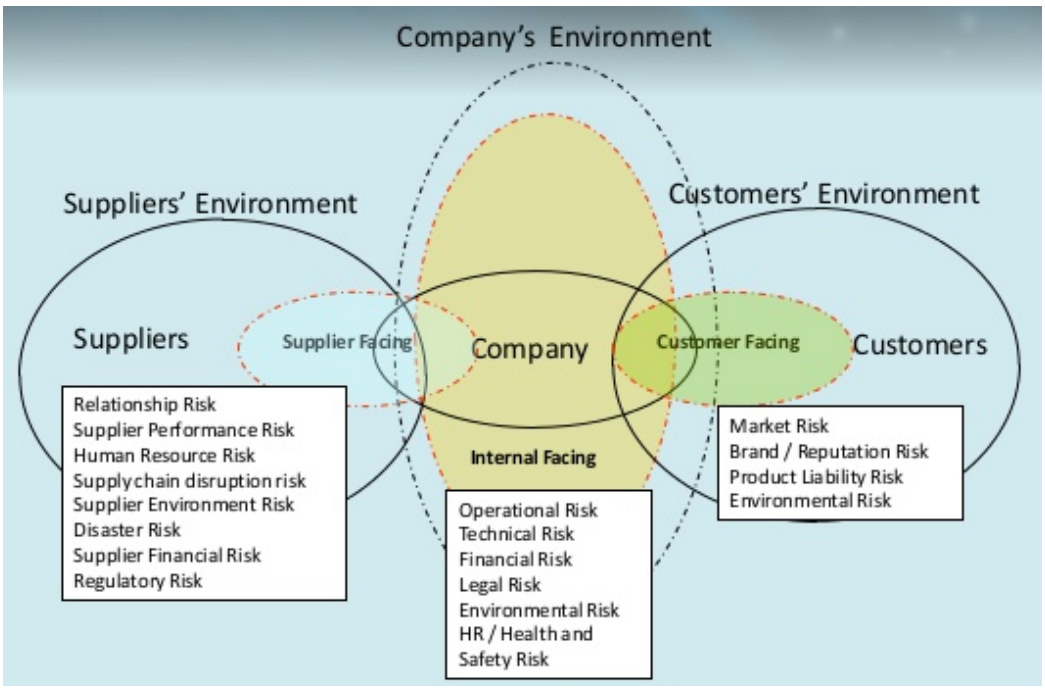


Figure 47 - Representation of various risks associated to supply chain (slidesharecdn.com, 2016).

As business critically rely on the suppliers they work with, supply chain executives and analysts have to understand those factors that promote risk management. Not only is this important to ensure that goods are delivered on time, competitive advantage is gained, or brands are protected but also to establish good vendor relationships, to build strong payment protocols or to completely understand those geographic challenges that can influence growth. All these can help mitigate or keep risk under certain levels. In fact, proactive risk management has been proven to be a very cost-effective approach as research shows that organizations that use this approach on a standard basis spend 50% less in supply chain disruption management than those that do not. In this regard, proactive solutions to manage supply chain are:

- Closely working with and knowing potential suppliers: It is important to be able to answer questions about suppliers and other business partners regarding their practices as from a supply chain point of view, it also will affect the organization itself. Aspects such as being able to meet contractual obligations, having relationships that can potentially create conflicts of interest, or maintaining the same level of standards regarding safe work conditions and environmental protection, all play a very important role at keeping risk low. Furthermore, it is important to consider whether or not the existing supply chain network can actually meet any

new needs before bringing on new suppliers. This is important as if organizations can establish good partnerships with a small group of suppliers, extra benefits can be obtained such as priority service or scale advantages.

- Ensuring the quality of the orders: It is vital to monitor and control all goods and services that enter the organization for quality and quantity. In order to maintain risk at certain levels, it is important to ensure all what suppliers provide adheres to that specified in the contract. This is the only way for an organization to meet their own standards for products and services offered to their clients.
- Ensure payments are only made of what is received: Obvious as it seems, a supplier's invoice must correspond to those goods or services that have precisely been received. It is easy to duplicate bills, make inappropriate markups or make wrong payments when an organization has a complex network of suppliers and contractors. All these increments the overall supply chain risk, as it potentially harming from a supply chain waste, fraud or abuse perspective. In fact, according to a survey made by Deloitte to 2,660 corporate professionals, almost 30% indicated that their organizations had experienced this kind of added risk in a year.
- Effectively preventing or resolving disputes: Each stage of a supply chain is a point where potentially conflicts and disputes may arise. In order to mitigate those dispute-related risks, it is important to promote a proactive prevention of disputes and resolving them in an amicable way in case they happed. Processes and technologies are essential to identify any source of disagreement that might prevent operations from running smoothly and can ultimately cause supply chain disruption. Good communication skills within an organization is important for associated risk reduction. Mutually beneficial resolutions of conflict will not only mitigate risk, but also increment the value of the organization.
- Watch for risks in sales: Another source of risk for supply chain are sales operations. In fact, sales play such an important role in linking suppliers with demand that it can greatly affect supply chain and purchasing requirements. As sales evolve, they can introduce potential new risks. For instance, organizations that start business in a new market or in a new geography where they have never provided goods or services into have to rearrange their procurement-supply dynamics, ultimately increasing the overall risk. In order to mitigate these new risks, it is important for

an organization to understand the liability sales suppose and to act accordingly. Higher revenue growth should not be at the expense of a higher supply chain risk.

Finally, in order to mitigate risk and to increase the value of supply chain, all actors and stakeholders have to be coordinated, including supply chain and procurement executives and analysts, legal personnel, compliance workers and finance professionals. By working closely and together, they can build new strategies to increase the value of the supply chain while maintaining a low risk. This is the key to success, brand protection and business growth. However, third-party software can more effectively help to mitigate risks associated to supply chain breakdowns, global corruption or world crisis, financial crime, business fraud, cybercrime or other vulnerabilities (generally speaking, financial, confidentiality, operational, reputational and legal risks). This specialized software is usually able to anticipate emerging threats and using edge-cutting technology in order to uncover possibilities hard to find, helping businesses to become more transparent, resilience and with a long-term advantage leading, ultimately to growth.

6.1 Before the Kinaxis implementation

Figure 48 - Anritsu's main goals in the year 2014 (anritsu.com, 2014).

In the year 2014, Anritsu made a commitment to promote their global CSR activities therefore aligning their business strategies with these activities. As explained before throughout this project, this 2020 vision was a plan started in 2014 with several goals, one of them, "maintaining harmony with the global socio-economy", actually including the idea of risk management and its promotion. According to Anritsu, they have identified seven different risk categories: 1) management decision-making and business operations; 2) legal violations; 3) environmental preservations; 4) quality of product and service; 5) import/export management; 6) information security; and 7) disaster. In order to mitigate them as much as possible, in 2014 Anritsu had designated a chief administrator for each category. Their tasks were to conduct periodic analysis and evaluations as well as

to establish rules and guidelines to better address each of them. Furthermore, they were required to conduct education and training programs to rise employees' awareness and increase the effectiveness of Anritsu's risk management with the ultimate goal of ensuring business development.

Table 8 - Anritsu's risk categories and related rules as of 2014 (anritsu.com, 2014).

	Risk Categories and Related Rules		Responsibility for Risk Management	Committees and Other Organizations
1	Business risks associated with management decision making and execution of operations		Executive officers in charge of each business division, presidents of subsidiaries and executive officers in charge of operations	Executive organ of each business division and the corporate division
2	Risks associated with legal violations	Anritsu Group Charter of Corporate Behavior Anritsu Group Code of Conduct	Executive officer in charge of compliance	Corporate Ethics Promotion Committee (Committee for Promoting Fair Trade in Sales Activities) (Committee for Promoting Fair Trade in Procurement)
3	Risks associated with environmental preservation	Basic Rules of Environmental Systems	Chief officer in charge of environmental management	Environmental Management Committee
4	Risks associated with product and service quality	Rules on Quality Management Systems	Chief quality officer	Quality Management System Committee
5	Risks associated with export/import management	Rules on Security Trade Control	Chief officer in charge of trade control	Export Control Committee
6	Information security risks	Basic Rules on Information Management	Chief officer in charge of information management	Information Management Committee
7	Risks associated with disasters	Basic Rules on Disasters and Emergency Response	Chief officer in charge of disaster prevention	Disaster Prevention Headquarters

For the year 2014, Anritsu's risk management can be divided into three major topics: internal controls to enhance corporate value, business continuity management and finally, information security management. These are described below:

Internal controls to enhance corporate value

In order to efficiently and effectively control all those factors that can result in the incapability of Anritsu to attain its goals, the organization believes that reinforcing collaborative relationships within the Group companies at an international level plays a key role in this regard. This did not only require improving their internal control system but also, they had to upgrade their risk management so as to enhance corporate vale, leading not only to a business development, but also allowing Anritsu to transform risks into sources of competitive advantage.

In that year, Anritsu established and developed an internal control system and regulations together with the creation of an Internal Control Committee. This body is directed by an executive officer that is directly appointed by the President of the organization. His or her main task is to improve and apply those internal controls, especially those concerning the financial reporting of the different Anritsu groups around the globe. In addition to this body,

the division in charge of Anritsu's internal audits, the Global Audit Department, actively promoted risk management by conducting business audits in 2014. In fact, in that very same year, Anritsu conducted a survey analyzing how executives and officials of all subsidiaries were able to evaluate the status of risk management. This was part of Anritsu's plan to establish an enterprise risk management. Furthermore, they began training management-level employees on practical aspects of risk management. All these efforts were made to develop and increase the practical skills of these employees which are responsible for Anritsu's operations. During the evaluation process, several potential risks were identified and in order to mitigate them, various strategic improvements were implemented. In fact, in April that year, Anritsu went through a fairly big audit that included: Anritsu's philosophy and ethics, accounting policies and procedures controls, IT infrastructure and business processes controls, especially those related to financial reporting. This audit concluded that as of 2014, Anritsu's internal controls were effective.

Business continuity management

In 2014, each division within Anritsu created a business continuity plan that would allow them to maintain smooth operations even in the event of any disaster or emergency. The main objectives of these plans are to minimize the potential damage of these events and to resume all operations and full business activities in the least possible time. In fact, in order to guarantee a stable procurement of all necessary materials for the production of different parts, the Koriyama Business office of Anritsu in Japan (which is the primary manufacturing base of the organization) has developed very strict business continuity plans. These plans, by identifying natural risks as material risks, allow them to quickly respond in the event of earthquakes or other natural tragedies. The plans incorporate very concrete and clear steps for each of the processes in the manufacturing facility in the event of any disaster, natural or human-made.

In the year 2011, one of the most destructive earthquakes that Japan has suffered in modern times, known as the Great East Japan Earthquake, occurred in the coast of Tohoku. Years before that, the division of Anritsu operating in that area already recognized the great risks and potential damage natural disasters, specially earthquakes, suppose for the Anritsu business. Years before that earthquake, they had already a business continuity plan, which was updated after that earthquake. After that tragic event, the criteria for establishing the plan in case of an emergency were revised, as well as more and better ways to prepare for

such an event and the procedures for response were refined. The years after the earthquake, Anritsu began annual education plans that included trainings for employees. The officer in charge of the continuity plans actively participates in these education programs to determine if the plans require review and to revise them as needed.

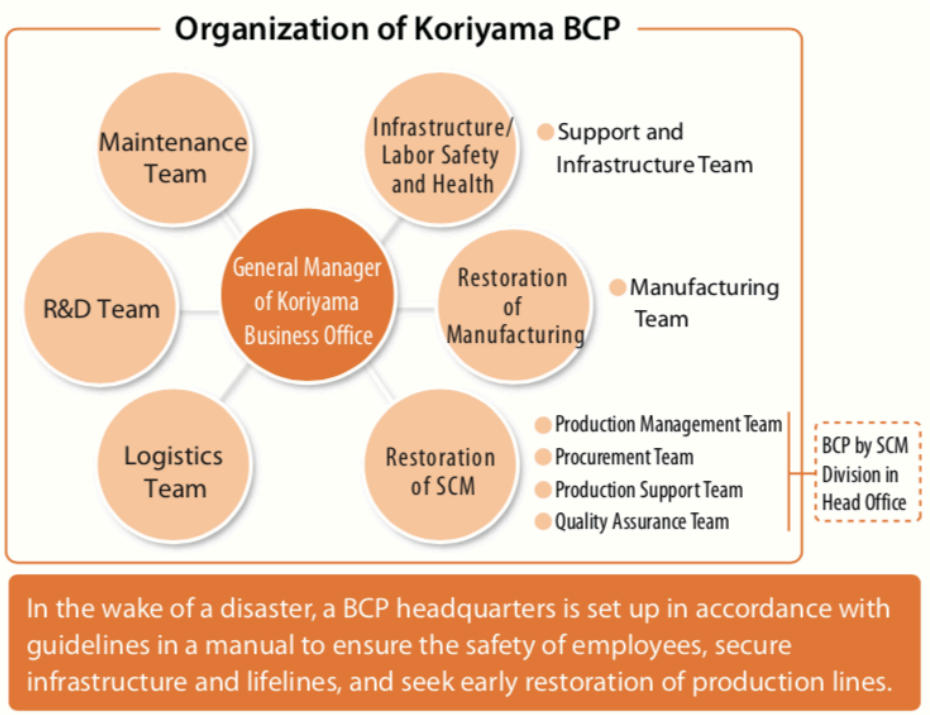


Figure 49 - Organization of the Koriyama business continuity plan as of 2014 (anritsu.com., 2014).

In order to guarantee a stable supply and to minimize their exposure to risk, Anritsu opened another manufacturing plant in Japan in the year 2013. Both located in Tohoku, production is distributed between the two plants. Moreover, Anritsu started enhancing their R&D capabilities by the construction of a worldwide headquarters that could be used as head office and R&D location. This building was designed to be able to resist major earthquakes by using the latest technologies by that time. As for key information systems, Anritsu established a secure structure that replicates data across three different sites within Japan (Osaka, Atsugi and Koriyama). These systems include vital systems such as mission-critical systems and e-mail communications. Since its introduction in 2014, this structure allows Anritsu to have full control of the systems, even in the event that anyone fails due to a disaster. Systems can continue to be operated form alternate sites thanks to this structure. To improve these systems, since the implementation of the structure, Anritsu

conducts regular assessments of the effectiveness of the structure itself and correct any problems that there might be. In addition, they keep improving their response to disasters by developing emergency procedures and by improving their time for recovery.

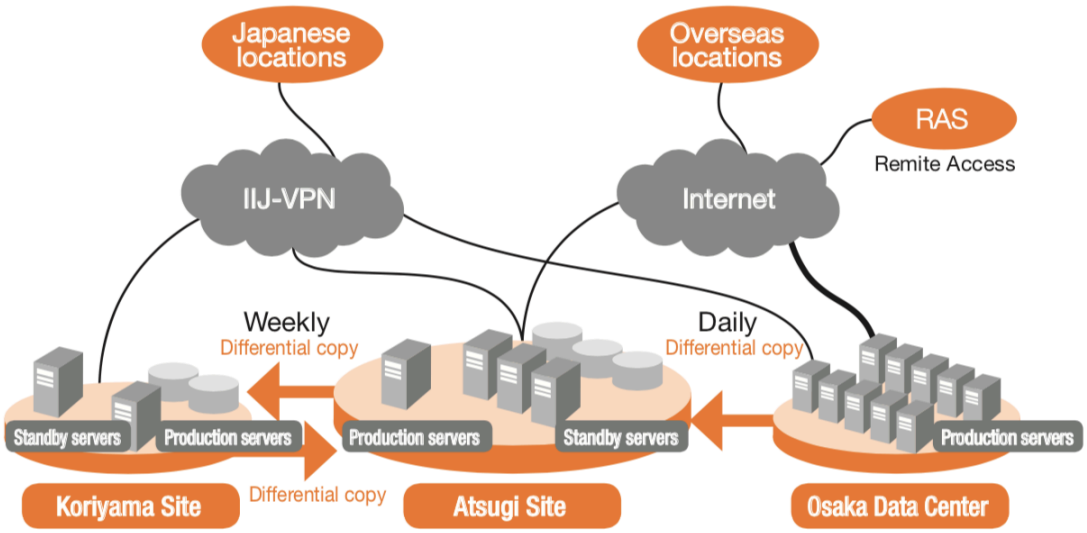


Figure 50 - Diagram of Anritsu's structure to secure the information system as of 2014 (anritsu.com, 2014).

In 2014, Anritsu created a database containing the statues of around 2,000 sites operated by their partners. The objective of this measure is to be able to fully visualize Anritsu's supply chain by understanding their partners' standards and alternative transporting routes to the organization. This did not only minimize any risks emerging from a disaster, but also minimized supply chain disruptions so supplying products to their customers could be conducted in a more secure way. Furthermore, in this same year Anritsu started requesting business partners all available information about their business partners up in their supply chain. This, together with the fact that they actively worked on strengthening their relationship with partners by exchanging information through an in-house system has allowed Anritsu to maintain a stable supply chain even during emergency events and situations from 2014 up until today.

Information security management

From 2014 on, Anritsu has been taking information security very seriously, making continuous efforts to maintain and enhance security by using an information security management system.

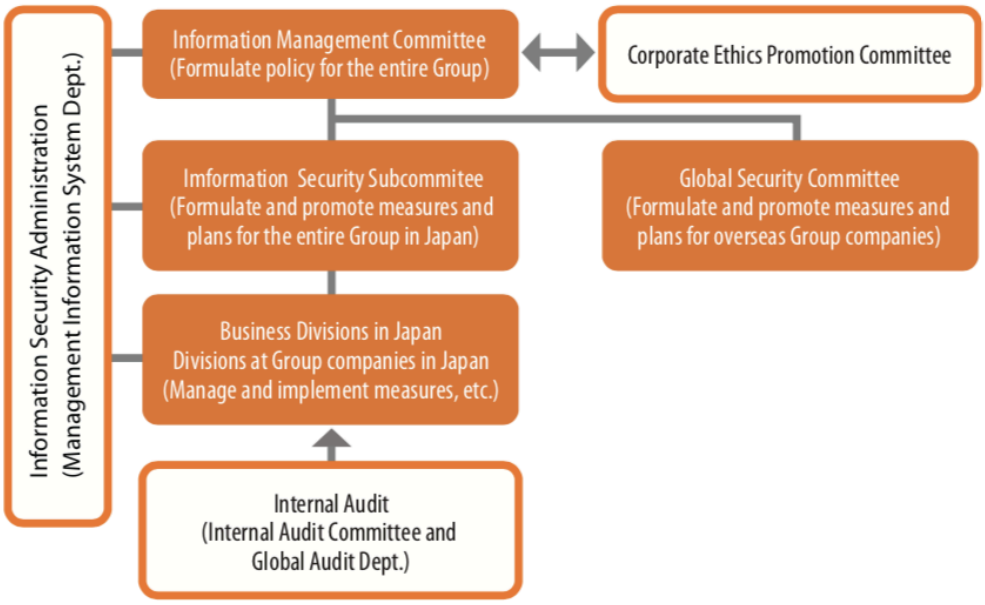


Figure 51 - Anritsu's information security management system as of 2014 (anritsu.com, 2014).

This system consists on an Information Management Committee (composed by executives from each of Anritsu's divisions and companies), an Information Security Subcommittee (composed only by Japanese division representatives), and a Global Security Committee (composed only by IT representatives from overseas departments). On the one hand, the Information Management Committee establishes and develops basic policies regarding information management. On the other hand, both the Information Security Subcommittee and the Global Security Committee outline annual actions plans and concrete measures for those policies. Those plans and measures are implemented by each department through concrete actions they undertake. A diagram of how this process work can be seen in the following picture.

As for the major activities Anritsu undertook during 2014, it is important to note the following. To begin with, Anritsu actively tracked all those new and ever-changing threats to their IT systems. In order to do so, they conduct annual risk assessments. This allowed them to address the information security risk they face and to develop countermeasures to protect themselves. Two of them are worth mentioning:

- Encryption of material information: Beginning in 2012, Anritsu implemented a site for several departments to use that used rights management and file encryption so as to avoid leaks. This site was further expanded in 2013, making it available to all

departments within Japan. In 2014, however, Anritsu unified all policies among departments and introduced an automatic encryption tool to handle confidential sales information. This protects confidentiality even in the event that a confidential file leaves the company. This is due to the fact that only the department responsible for that information has the decryption rights to access the file.

- End of support to Windows XP: In April 2014, Microsoft ended all support for the Windows XP OS. However, as of the same month one year earlier, about 2,000 PCs operated using that system in Anritsu. In order to mitigate the associated risk, prior to the loss of support Anritsu installed Windows 7 on 700 PCs for general use, and also strictly prohibited the access to the Internet of any PC still running Windows XP.

Apart from these measures, employees at Anritsu are required to watch videos on security every year and to later discuss these videos with peers to confirm their understanding on security issues. Defending Anritsu's systems from cyber-attacks required from Anritsu to minimize damage and strengthen recovery operations. It is so vital, that starting in 2014, the organization started educational programs for system administrators on incident response. All this with the objective of developing employees response capabilities and to develop and implement effective countermeasures that can minimize the overall risk of information management.

6.2 After the Kinaxis implementation

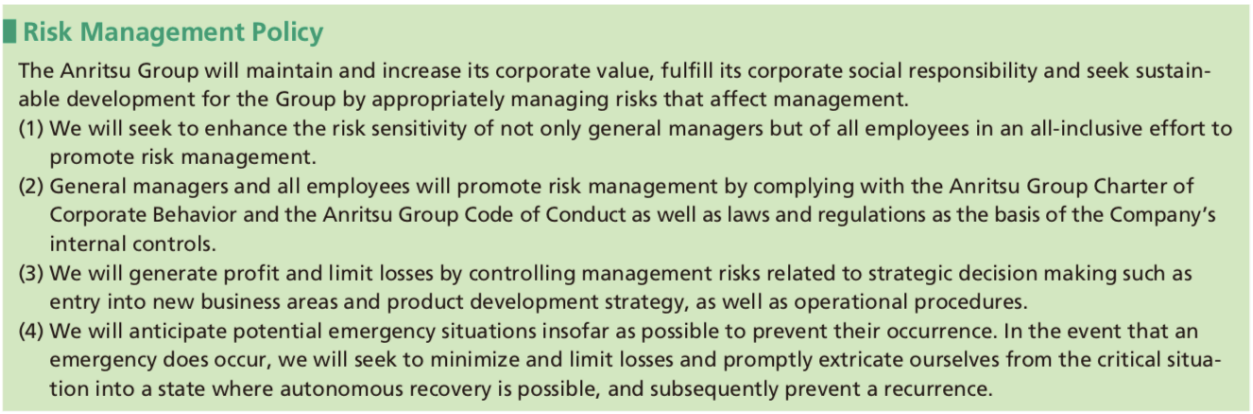
Now, continuing with the analysis of Anritsu's risk management, the years after the Kinaxis implementation of RapidResponse will be evaluated. That is to say, this section will look at the years between 2014 to 2018 (last year with full available data as of the date of writing this project) and will compare the results to that of the years prior to the RapidResponse implementation to evaluate if this third-party tool has substantially helped regarding supply chain risk management.

As of 2018, Anritsu understands risk management as any uncertain event that can potentially affect corporate values, including organizational profit and social credibility. However, instead of seeing risk as a negative aspect, they believe risk can have a positive side if properly managed. This is due to the fact that Anritsu understands risk as being

framed within the organization's 2018 vision: achieve growth with sustainable profits while using innovation and the knowledge of all parties. Therefore, risk management is believed to be another means of creating a society that is considerate and sustainable. In the year 2018, Anritsu recognizes that risk management is a critical part of their business and has developed and established a system for the whole corporation to address the issue. By creating initiatives that promote risk sensitivity both for top management and employees, as well as by making all-inclusive efforts to expand Anritsu's value, the organization is able to properly manage risk while fulfilling their social responsibility and developing their business in a sustainable fashion.

An extract of Anritsu's risk management policy can be seen below, Figure 52.

Although risks are still divided into the same categories as in 2014 (see Table 8), when compared to that year, Anritsu's risk management structure has evolved and grown considerably. Instead of having a chief administrator for each category, now Anritsu has brought that position to the category of executive officer, with many more responsibilities, duties and power than before. Each executive officer is still responsible for the management and administration of each category; however, they now supervise a committee composed with all heads of relevant divisions and management officers of other Anritsu groups.



Risk Management Policy

The Anritsu Group will maintain and increase its corporate value, fulfill its corporate social responsibility and seek sustainable development for the Group by appropriately managing risks that affect management.

(1) We will seek to enhance the risk sensitivity of not only general managers but of all employees in an all-inclusive effort to promote risk management.

(2) General managers and all employees will promote risk management by complying with the Anritsu Group Charter of Corporate Behavior and the Anritsu Group Code of Conduct as well as laws and regulations as the basis of the Company's internal controls.

(3) We will generate profit and limit losses by controlling management risks related to strategic decision making such as entry into new business areas and product development strategy, as well as operational procedures.

(4) We will anticipate potential emergency situations insofar as possible to prevent their occurrence. In the event that an emergency does occur, we will seek to minimize and limit losses and promptly extricate ourselves from the critical situation into a state where autonomous recovery is possible, and subsequently prevent a recurrence.

Figure 52 - Anritsu's risk management policy as of 2018 (anritsu.com, 2018).

In addition, they control any group company involved in managing risk and are required to report to the Management Strategy Conference regarding measures, plans, implementations and results throughout the year. Finally, each division is responsible for education and training so as to maintain risk management at a good level and to ensure business

development. Regarding overseas companies, they are supported by each risk management officer, with the exception of the headquarters in the Americas, which conducts its own activities. As for compliance risk, the issues are assessed annually, through action plans developed by each regional headquarter. An organigram of Anritsu's risk management structure can be seen below. Regarding that education and training, Anritsu still conducts workshops on business risk management for all newly appointed managers and officers as well as general risk management workshops for employees in software.

Because of the increasing levels of globalization, a section called Risk Management Promotion Division has become an administrative office that addresses the most important global risks and that has created a series of measures to deal with risk within Anritsu. What is more, in the year 2018, Anritsu established a mechanism by which they regularly check different aspects of the organization's business, such as all those above-mentioned competencies of each responsible department or new emerging risks. They select the most important risks and develop all kinds of risk reduction activities. This mechanism is expected to be reviewed this year together with the implementation of a new plan-do-check-act cycle with the objective of ensuring that all global risks brought because of globalization are properly managed by the end of 2019.

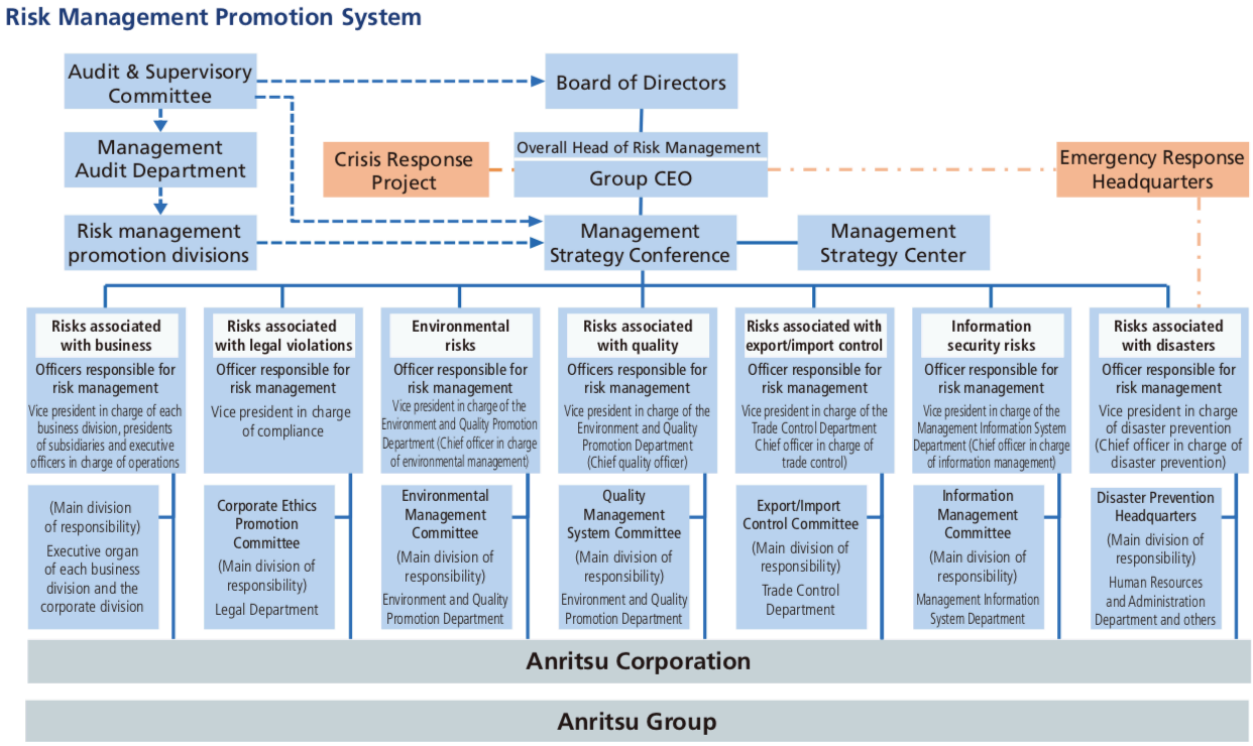


Figure 53 - Anritsu's risk management promotion system as of 2018 (anritsu.com, 2018).

As it happened in the year 2014, Anritsu still focuses on two main issues: information security risk and business continuity management. Therefore, Anritsu places in 2018 on the background the internal controls issue that was explained in the previous section.

Information security risk

More than ever, cyber-attacks are an increasingly present, more potentially damaging and more diversified and malicious. 2018 has been the year when attacks became broader in reach and characterized by the fact that any organization, regardless of size or industry in which it operates, is a potential target of these attacks. In addition to that, Anritsu believes it is its social obligation to protect all information concerning all stakeholders (customers, shareholders, investors, suppliers and employees).Given all these facts, Anritsu sees information security as one of the main issues in risk management and continuously develops and implements measures to deal with that issue and to maintain information security through a better information security management system that the one described in 2014.

As of 2018, the information security management system is still composed of an Information Management Committee (key executive officers from different business divisions). However, operating below this body, two bodies coexist: An Information Security Subcommittee (representatives of the Japanese group) and the Global Security Subcommittee (chief regional officers). These three bodies seek to maintain and promote information security. Their roles are still the same as they were in 2014, with the sole exception that the Global Security Subcommittee is now audited by the Internal Audit department within Anritsu. This was not the case in 2014. An organigram of the current structure of the information security management system can be seen below, as of 2018.

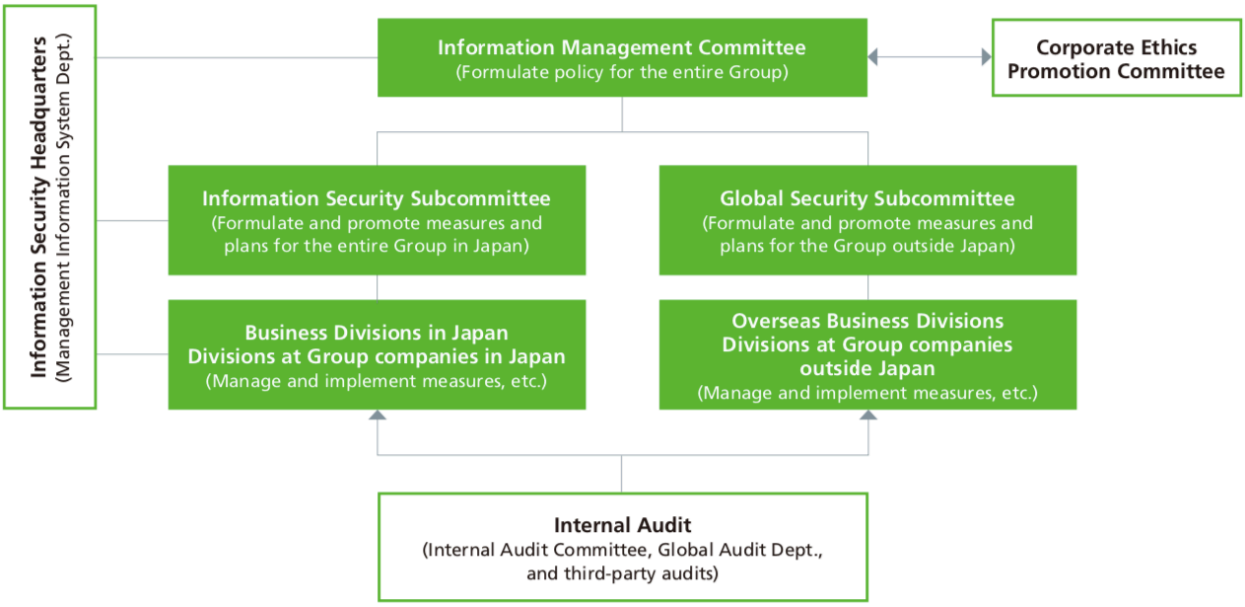


Figure 54 - Anritsu's information security management system as of 2018 (anritsu.com, 2018).

Due to the increasing levels of operations, for Anritsu to run globally it is necessary that all offices around the globe are connected through a network that allows them to share information. However, if an office suffers a vulnerability, Anritsu's entire security level will be affected. In 2018, one of the primary goals of the organization is to correct regional disparities regarding security level standards, as there are different standards within the Anritsu group depending on the location. This correction resulted in a global information security policy. After this policy was established, several risk assessment and reduction activities were carried throughout the year, however, risk has remained high outside Japan

due to delays in implementing measures given their reduced investment because of insufficient resources in those locations.

Anritsu has conducted the following activities in 2018, in order to cope with cyber-attacks:

- Higher restrictions on employee's internet access: Sites that are not work-related suppose a potential threat, as there can be viruses present. In order to reduce those threats, Anritsu blocks access to sites and platforms that are not work-related.
- Improved countermeasures against spam: As what happens with the internet in general, misusing email is another source of potential threats. Scam-related emails and other damaging activities are growing fast and to face those threats, Anritsu has in 2018 transitioned to a check tool with AI technology that checks any email coming or going through Anritsu's servers for potential threats.
- Education on information security: In order to eliminate the above-mentioned disparity between different regions regarding information security, education programs have been implemented. These programs use a e-learning system that adapts for each position and circumstance so as to facilitate the learning process. These programs were available for 95% of Anritsu's employees in Japan and around the globe.
- Network monitoring business and ISO 27001 certification: As customer information data is increasing, it has been important for Anritsu to protect that information which is managed by the network monitoring business. Anritsu's head office in Japan acquired the certification ISO 27001 which enhances data security and this certification is expected to be adopted by overseas divisions in the short run.

Regarding key information, it is stored in Anritsu's core systems located in a data center in Nagoya district. The way in which the securing of information works has changed sin 2014 due to the implementation of Kinaxis' RapidResponse software. Now, all data is backed in a data center located in Tokyo. CAD systems used to develop products are located in Atsugi and all data is backed through Anritsu's private network to Koriyama. If Nagoya or Atsugi are ever hit by a natural disaster or other unpredictable event, Anritsu can still operate all the information through the other two sites which contain all the backup data. Finally, same as in 2014, the organization actively redefines emergency procedures so as to achieve a

targeted recovery time and to be prepare in event of a disaster. This is achieved by conducting simulations to disasters and to train employees in the recovery operations. All these simulations and trainings are continuously evaluated to analyze their effectiveness and to correct any issues that there might be. A scheme on how the information securing system works can be seen below.

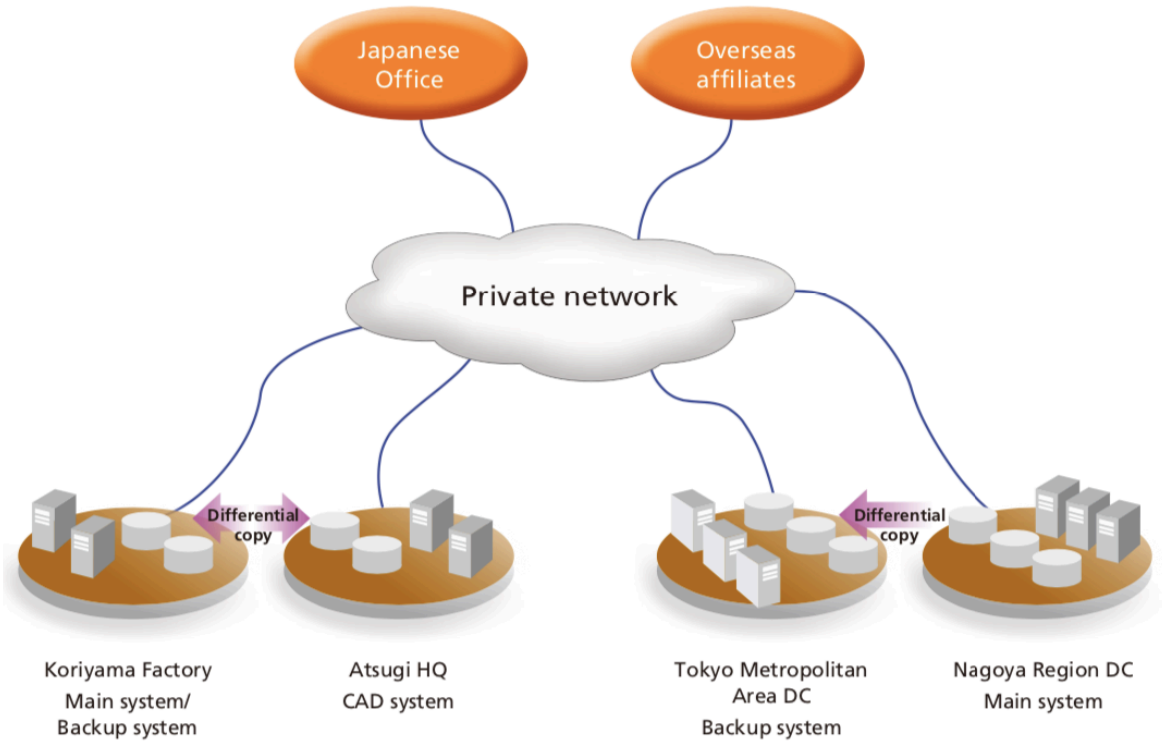


Figure 55 - Scheme of Anritsu's information securing system as of 2018 (anritsu.com, 2018).

Business continuity management

As commented above, Anritsu takes very seriously its business continuity management to be able to maintain operations even in the event of a disaster by minimizing damage and continue with all business activities as fast as possible. In contrast with that of 2014, in the year 2017 Anritsu first introduced a disaster recovering planning together with their business continuity plan. This recovery plan was based on the 2016 earthquake that was as damaging as the Kumamoto earthquake. This plan is under continuous development to make it better for future events.

Apart from the disaster recovery plan, business continuity plans have not changed much since 2014 as they serve for the same purpose as back then and have not evolved much since then. It seems important to note that in 2015, Anritsu opened a global headquarters office building in the location of Atsugi City. This was planned in the previous year's business continuity plan as a countermeasure to maintain business core function running in the event of a disaster. The building is fully prepared to adopt all functions if anything happened to the head offices. This is due to that fact that it has been built in steel with seismic base isolation so when an earthquake occurs, personnel safety is guaranteed, and the building can provide an emergency power supply up to 144 hours capable of coping with all the energy needed to conduct all activities.

Kinaxis' RapidResponse has been able to provide Anritsu with the necessary tools to support its business growth, promoting overall optimization of its management, and providing safe and secure IT services for Anritsu's supply chain. This is achieved by using the platform able to reunite all stakeholders in the same place. This software allows to contact customers and suppliers along with all the needs and interactions between them an Anritsu. The RapidResponse tool allows Anritsu to operate its supply chain with the latest technologies, including cloud computing and Artificial Intelligence. Moreover, optimization is achieved thanks to the unification of ERP (Enterprise Resource Planning) of all Anritsu groups, allowing to automate activities like transactions, internal controls, business continuity plans for the supply chain and visualization.

6.3 Analysis of advantages/disadvantages

It is clear that the last few years have seen significantly disruptive events around the world that have only heightened and increased the level of awareness of how potentially damaging risk can be to any business. This is the reason why supply chain and more concretely supply chain risk management has become the front and center of the organizations' minds.

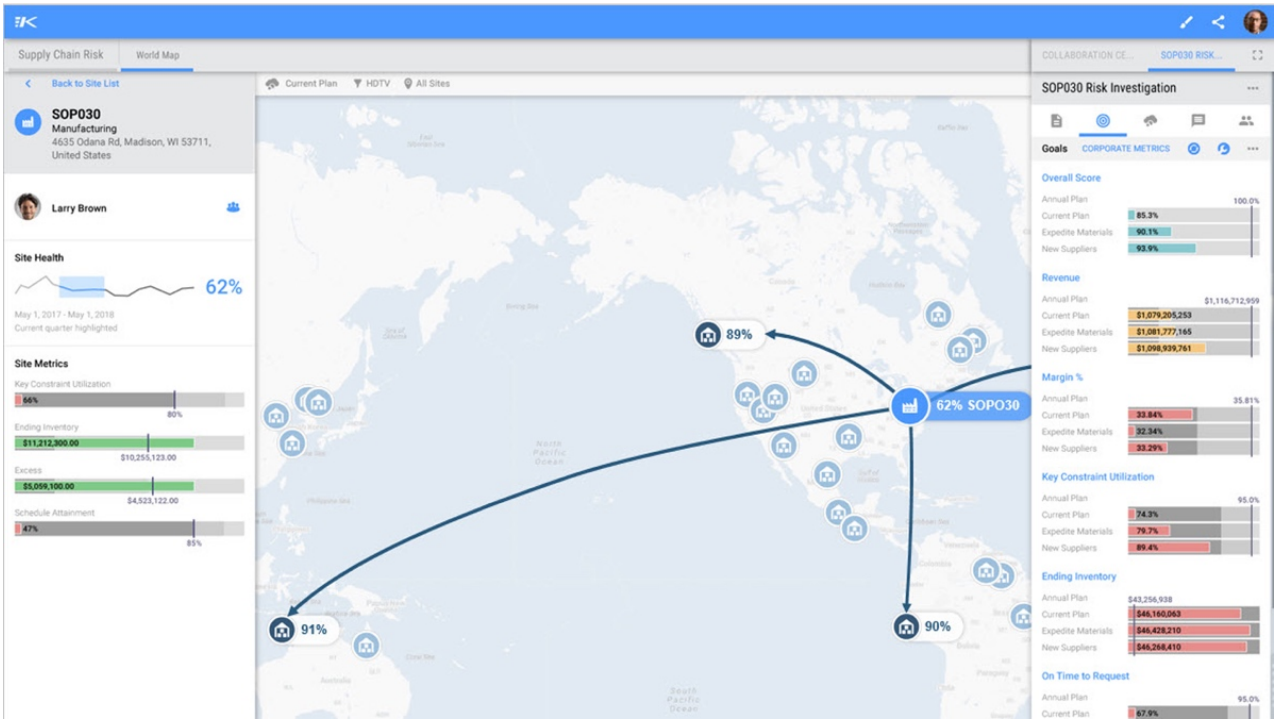


Figure 56 - Screenshot of Kinaxis' RapidResponse software (kinaxis.com, 2017).

Kinaxis' RapidResponse has the ability to predict when disrupting conditions may appear and can evaluate and alert of the possible damages. RapidResponse allows Anritsu to take a more 'event-based' approach to monitor for potential consequences and alert based on projections and if-case scenarios. This allows supply chain professionals to know whenever a situation presents a true risk of disrupting the supply chain, and therefore, the business. In addition, the software analyzes and presents what the operational and financial consequences are if that event happens. What is particularly interesting is the fact that alerts can be configured according to the needs of the organization. For instance, one organization might be interested in certain risks or conditions, while other might be more interested in knowing a specific change in a key metric or a late supply due to a certain event.

RapidResponse is able to automate all responses and can start contingency processes after alerting the required supply chain officer.

Supply chain risk management is about identifying and quantifying risks, but also, and maybe even more importantly is the ability to respond. This is a key component in supply chain risk management. RapidResponse goes through typical analysis and mitigation planning strategies, to new risk management approaches. These are key aspects that make RapidResponse the perfect ally for Anritsu to combat supply chain risk:

- Identification: In order to manage supply chain risk, RapidResponse creates a risk registry which is synchronized with Kinaxis available data and that allows supply chain professionals within Anritsu to collaborate and to identify all risks to which Anritsu's supply chain is exposed. The software can as well apply data analytics and the Pareto principle to prioritize all those risks that are especially harmful and potentially disruptive to Anritsu's supply chain.
- Quantification and mitigation: RapidResponse is able to assess the probability of any event to occur and build those probabilities into Anritsu's business justification as they make decisions. For instance, the tool allows organization to quantify the risk of an earthquake to happen if a key supplier is located in an area prone to this kind of disaster. If that ever happens, it addresses the time as well to recover through the use alternate sources or the very same supplier, as well as the revenue and cost impacts the organization would face during that recovery time. Although this does not eliminate the risk itself, having a well informed and documented contingency process as well as business continuity plans help mitigate the risk, lowering the potential damage and fastening the time to recover when impacted by a disaster.
- Monitoring: Although earthquakes and tsunamis do not happen every day, other disrupting events are more common and can cause issues in the suppl chain. For instance, quality issues, missed deliveries or customer order cancellations, when not addressed properly can have a cumulative effect and end up being just as damaging as any natural disaster can be. This is why RapidResponse monitors those metrics as key part of having a good risk management strategy. This tool can process real world events in order to provide organizations with the needed visibility to see risks in their supply chains. The software evolves and redefines itself through actualizations that include the latest improvements in big data analysis or machine

learning, providing more and better contextual information to supply chain professionals.

- Response: As explained earlier, risks cannot be eliminated at all, the only thing organizations can do is to mitigate them to protect themselves. From natural disasters to the bankruptcy of a business partner, supply chain has to be resilient in order to cope with these issues. However, RapidResponse allows Anritsu to also be able to speed up the response and collaboration processes to address and face these issues and disruptions. The tool allows to quickly identify and evaluate the impact of any issue downstream in the supply chain (its impact in orders or forecasts, for instance), and to create custom contingency plans according to Anritsu's business continuity plans. In order have supply chain visibility, RapidResponse provides Anritsu with a holistic way to plan and execute its operations in its supply chain.
- Learning and improvement: Finally, RapidResponse allows for continuous improvement, helping Anritsu understand how the company responds to risks today and how these reactions can be refined and improved. Then, these new learnings can be introduced into new contingency plans and business continuity models.

RapidResponse provides Anritsu with the specific capabilities required to succeed. The Kinaxis software helps Anritsu to be more prepare and to handle disruptions effectively and efficiently, coming out ahead than competitors. As Anritsu's supply chain operates globally, the next disruptive event does not have to be in Japan, it can very well be in America or in Europe. It does not even have to be in Anritsu's own supply chain but in a supplier's one. RapidResponse allows Anritsu with its task of leveling standards among all Anritsu groups around the world so all offices are equally prepared to the worst. The tool also allows the organization to connect with suppliers and other stakeholders to address risk management issues directly with them. Through practical and technical contingency plans, recommendations and active monitoring, RapidResponse allows Anritsu to undertake measures to minimize and manage risk and the impact of disruptive events.

However, supply chain risk management is not only about facing big environmental disasters, there are many other risks associated with the business itself: daily fluctuations in demand and supply which can be very severe can cause inventory to increase and become obsolete and customer service to be poor and ineffective; rapid growth which can negatively impact production, quality, corporate reputation and ultimately profit; changes

in the supplier base, as suppliers can go out of business, cost structures change, and performance for delivery and quality degrade; changes to IT systems, which was earlier discussed; and counterfeit or contaminated products, just to mention some risks. All these are risks that can potentially have a great impact in Anritsu's business. However, in order to mitigate them, Anritsu has benefited from the use of Kinaxis' RapidResponse tool, which has brought visibility to its supply chain through event detection and alerting, analyzing all available information with Artificial Intelligence, conducting simulations and scenario comparisons and finally, through collaboration between all stakeholders involved.

Anritsu's supply chain is exposed to more risks than ever. Some of the risks have been mitigated through a better supply chain design, assessing supply chain flaws and through redundancy. However, other risks have only been mitigated through the use of RapidResponse. This tool has given Anritsu the ability to quickly respond to unpredictable events and that has meant the difference between profit and loss. By the use of this tool, Anritsu has embraced risk as a key element of the ongoing management of its business operations.

6.4 Challenges for the future

When it comes to risk and to managing supply chain risk on a global basis it seems like every year is the most challenging year ever, due to the fact that globalization and the level of interconnection between different parts of the world keep rising, risks evolve and technologies are becoming increasingly used with more and more applications and tools. However, there are three areas that really suppose a challenge for the future:

- Cybersecurity: Being able to protect not only corporate information but also clients' or suppliers' is becoming an increasingly difficult task. For instance, very often it can be seen on the news about companies and organizations worldwide being hacked. Companies try they best, but they cannot really predict what the future of hacking will be. A major credit agency, Equifax was recently hacked, and millions of identities and sensible information were released. This will only get worse as hacker refine and improve their tactics to steal very valuable information. This supposes a very big risk as well for supply chain management, as not only sensitive

data about sales and clients can be obtained, but also it can cause major supply chain disruptions.

- Natural disasters: Regardless of climate change, global warming or climate disruption, it is fact that not only there are more natural disasters worldwide, but also, they are more damaging than ever. The reason for this is not only that the disasters themselves are more powerful, but more and more organizations are becoming global in scope and therefore, increasingly affected by natural disasters. For example, two years ago, 2017, Hurricane Maria brought a lot of destruction to Puerto Rico, where a many pharmaceutical companies from the U.S. have established their production. This resulted in a lot of infrastructural damage ultimately causing a shortage for many pharmaceutical products. Maximizing and optimizing a supply chain by going to a concrete location can result in better quality and tax incentives, but natural events might cause major issues in the long run.
- Globalization: This process is increasingly growing and gaining importance. However, while new international or even intercontinental trade pacts are being signed, others change at a very fast pace. Companies do not know whether new agreements or changes will be favorable or unfavorable for them. Organizations operating at an international level might see that their business continuity are at risk, when new trade agreements are introduced, or older agreements are being changed.

In all these cases, it is important for companies to map, monitor and then proactively take measures to start putting mitigation in place. Running what-if scenarios ahead plays a very important role in this regard. Third-party software such as RapidResponse undoubtedly helps put organizations in a position where from a data perspective, they are able to utilize the available tools to proactively mitigate these risks. For instance, if a hurricane were to cross through an area were a company has production facilities, that company can know this event beforehand it happens. Even though the level of devastation is not totally known, that company can run what-if scenarios and use other technology tools to identify key suppliers and sub-tier suppliers. This allows them to be able to rearrange and get ready before the hurricane hits the location. Having this visibility and ability to response quickly is a challenge for the future, as current systems can be improved with new advancements in technology. This will allow organization to proactively make decisions around risk before the impact has even occurred.

Many companies are maturing their risk management processes and now are looking for new alternatives and options. Businesses like Kinaxis have the challenge to keep up to date with newer demands for an increasingly more complex software solution. While trying to mitigate newer risks from a cybersecurity point of view, they also have to look ahead and predict what other unpredictable risks companies are facing to be able to provide a useful tool that can help them mitigate those risks as much as possible. Talking about cybersecurity, it seems like companies are using a corrective strategy. When a hacking happens, they mitigate it, they learn from it and they make sure it never happens again. However, they next hacking will be something different and this whole process has to start again. The challenge now is to proactively be able to secure information and develop tools that can actively reduce risk in this regard. It is important to note that concern among supply chain professional regarding cybersecurity has be rising over the last years, as shown in the following graph.

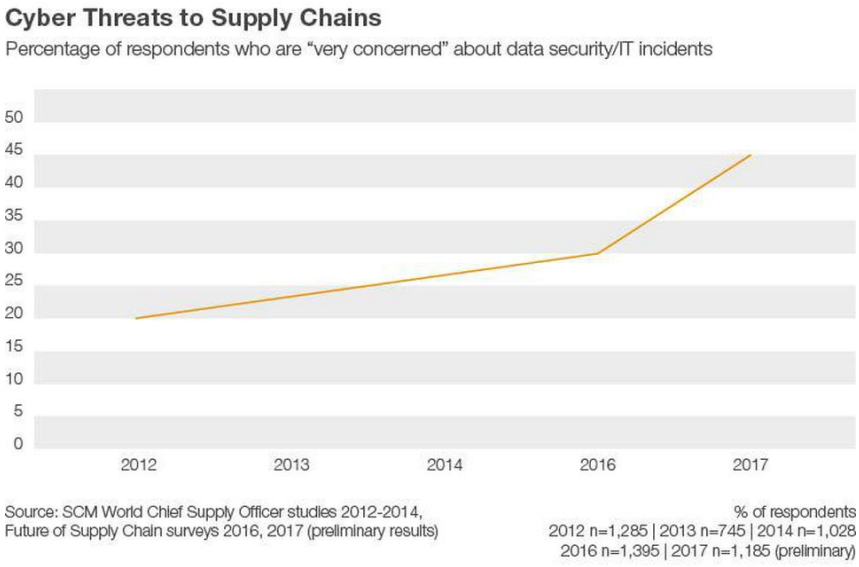


Figure 57 - Number of supply chain professional that are 'very concerned' about cybersecurity (forbes.com, 2017).

Moreover, in order to fully address risk management in supply chain, it is important knowing the standards and strategies of all stakeholders involved. As a breach in the supplier's systems might suppose a breach in the company's data itself. What about the supplier's supplier? A tool that is able to manage not only first tier information, but also second and third tier information is really valuable in this regard and could mean the difference between secure data and a breach in information. This is one of the main issues

in which supply chain risk management has to work in the future. It is worth noting at this point that the ability to share information, not only within different departments in an organization but also between organizations and suppliers or other stakeholders, this interconnectivity has allowed companies to operate their supply chain more effectively and efficiently and has ultimately reduced their carbon footprint. However, this same interconnectivity is the one responsible of the majority of the vulnerabilities that organizations face. The main objective for the future is to be able to secure these communications without giving up to the interconnection that has allowed business to grow and to be operated in a much optimized and smoother way.

Some decades ago, supply chain risk management was primarily concerned with issues such as supplier failure, prices volatility or shortages and how to mitigate those. That was made through cooperation between stakeholders, good planning and multi-sourcing. However, in order to maintain good levels of risk in a supply chain this is no longer enough. Apart from cyberattacks and natural disasters, another big issue for the future of supply chain risk management is war. In fact, in the year 2017 nearly one out of five supply chain professionals are 'very concerned' about devastating issues such as war, terrorism or other such geopolitical threats. In order to put this into context, it is important to note that the same professionals feel exactly the same way about issues such as financial failures of a supplier, counterfeit products or breach of intellectual property.

The number of professionals concerned with war has risen drastically from the 8% that was in 2013, only four years before. This fear is not by chance, as although security levels are generally increasing in the globe, terrorism and wars are also becoming more destructive than ever. Examples include assaults, mass shootings or cyberattacks. These do not have the power to cause supply chain disruptions by themselves unless it happens in a head office or manufacturing facility. However, over time they can cause the loss of interest by organizations to operate in a certain region, which can complicate geopolitics. Wars and conflicts have the power to change trade rules, freedom of movement or currency exchange rates. Although business executives do not usually comment on these issues, they are well aware of the different situations around the world and work on contingency plans and business continuity plans that include these types of events. As geopolitics are a complex topic and is likely to become even more complex in the future, supply chain has to evolve and improve to become resilient to these kinds of conflicts.

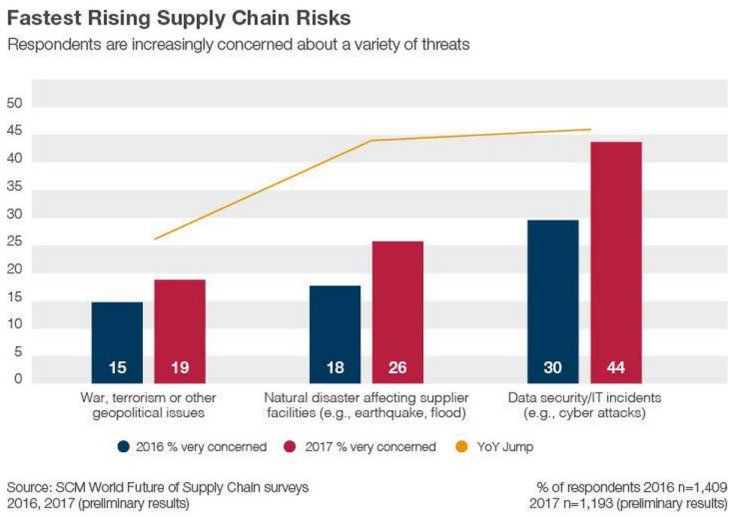


Figure 58 -Supply chain professionals' top concernings and its percentage change between 2016 and 2017 (forbes.com, 2017).

Today, supply chains are becoming increasingly complex and businesses continue to struggle to keep them under control at all times. Old, new and hidden risks suppose significant threats to any organization. Even with all the new technologies and advancements, business must be aware of all potential threats and invest to mitigate them and to react to them properly. Organizations should maintain good levels of supply chain visibility and keep cyberattacks, natural disasters and conflicts in mind together with more classic risks such as suppliers going out of business, counterfeit products or imbalances between supply and demand. All these factors by themselves suppose a significant risk and the challenge for the future is to be as well prepared as possible for all of them.

Advances in technology are increasingly making its way into the supply chain, helping deal with some of those issues, however they force businesses to constantly change their systems to adapt to new trends or tools. This has an overall impact on supply chain as organizations ae required to hire talents able to adapt to these new digital disruptions. Not only the Internet of Things or Artificial intelligence are transforming supply chain end to end but all processes and operations are utilizing technologies in one way or another and the challenge here is to make managers and other supply chain professionals to keep up to date with all advancements.

As supply chain continues to become increasingly complex, it is important to bear in mind that training, planning and making good use of available tools and software that can make

supply chain decision agile and dynamic, while mitigating risks as much as possible. Changes in the world and events such as cyberattacks, natural disasters or even conflicts should be used to prepare the supply chain for future disruptions and to develop a proactive and engaging plan that allows professionals to face them before they have an impact on the people, on profit or on reputation.

CHAPTER 7

ECONOMIC ASSESSMENT OF THE IMPLEMENTATION

In order to be able to analyze how the implementation was from an economic perspective, it is important to first be able to address supply chain performance itself. As there is a direct relationship between economic success (from a supply chain performance point of view) and supply chain performance, conducting an analysis on supply chain performance is basically the same as conducting an analysis of supply chain economics. Said otherwise, the better the performance is, the better the economic and financial data of the supply chain will be. Once the performance analysis is conducted, then the rest is a matter of adding money ($) to the equation.

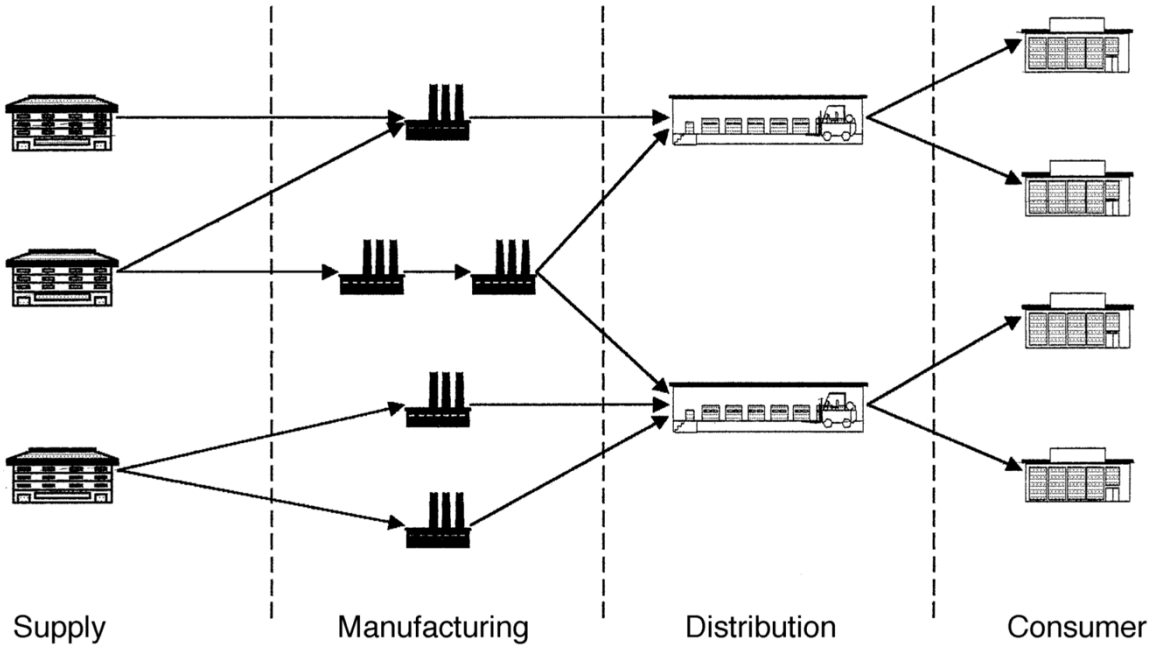


Figure 59 - Scheme of a typical supply chain (Beamon, 1999).

As it has been seen throughout the project, supply chain is essentially an integrated process where on the one side raw materials are manufactured to finally obtain products that can be sold, and on the other side these products are delivered to their buyers (customers). Typically, a supply chain if formed by four major steps: supply, manufacturing, distribution and finally, consumers. All of these four steps are usually conformed by various facilities. Therefore, it can be said that the more facilities at each step, the more complex the supply

chain will be. In the case of Anritsu, they are well established in Japan, the United States and Europe. All these three regions have their supply, their manufacturing, their distribution and they consumers, making Anritsu's supply chain fairly complex, compared to other smaller organizations. Because of this complexity and its large scale, being able to select the appropriate performance measures plays a critical role.

Typically, supply chain performance has been analyzed using two different measurements: cost and both customer responsiveness and cost (aggregated in a certain way or another so as to emphasize more one over the other). Generally speaking, costs usually include inventory ad operating costs. As for customer responsiveness, the measurement normally indicates how good lead time is, how much profitable is stockout and what the fill rate is. The main idea to successfully operate a supply chain is to minimize cost while maximizing customer responsiveness. Other ways to analyze supply chain performance are though the use of activity times or flexibility. Although each of these four measures can be used independently, normally, all four are used jointly to have a more realistic and accurate idea of what supply chain performance is. In fact, if any of the above-mentioned measures are used independently, the analysis extracted from that measure will be limited. Although the idea of using one single measure is very appealing given the simplicity and the fact that it is easy to use and to analyze, this might not be enough to describe the supply chain as a whole, and therefore, it might not be able to properly address its performance. Characteristics of a good measure of performance are universal (it can be used under any circumstance and in all cases), measurable (it must be quantifiable), consistent (it must not result in contradictions) and inclusive (it must include all relevant aspects). For instance, an organization might focus on keeping costs at a minimum, but this might result in poor customer response time or lack of flexibility to address sudden changes in demand. Although the cost is low, this does not indicate good supply chain performance.

Since one single measure is not suitable to perform a supply chain performance analysis given the fact that generally speaking it is not inclusive (ignoring important pieces of information and characteristics) it seems clear that in order to successfully conduct such an analysis, it is important to use an aggregation of different factors. As suggested by Beamon (1999), given the fact that commonly, strategic goals for organizations include key elements related to resources, output and flexibility, a good performance measurement for supply chain should include these three one way or another. For instance, resources are

normally related to costs, output are related to customer responsiveness and flexibility (in the sense of how well the supply chain can react to uncertainty, a measurement of supply chain resilience earlier discussed) is a characteristic that a good performing supply chain must possess. In other words, these three play a key role in supply chain success. Each of these components has different measures, different purposes and different goals. If a supply chain performs well in each of these components, then it will perform well as a whole and therefore it will be flexible, responsive and economically compliant. An explanation of each of the components is the following:

- Resources: Obviously, managing resources in an efficient way plays a key role in maintaining costs low and therefore, in profitability. Overall, the main aim of this component is to achieve high levels of efficiency.
- Output: If a given output is not acceptable, this will result in customers turning to other supply chains, therefore, this component evaluates the level of customer service a supply chain is offering.
- Flexibility: Closely related to supply chain resiliency, in any operating environment, supply chains must be capable of responding to changes in other parameters, for instance demand. This item analyzes the extent to which a supply chain is able to respond to a changing environment.

Of course, each of these three items can be measured in many different ways, but a good supply chain perform measure must contain at least one measure of each of these components. If the measures for each of them are aligned with the organization's strategic goals, then the overall measure can guarantee a minimum level of performance in each of the items, making the organization's supply chain well performing according to its strategic goals. It is important to highlight the fact that all three components are interrelated, affecting one the other two.

7.1 Resources

Some of the items included in this component are, for instance: inventory, personnel, equipment (and its utilization), energy or cost. It is important to know both, the minimum quantity required to successfully operate and the efficiency with which current resources operate. Both of them are important because if an organization does not operate with

enough resources, then output and flexibility will be negatively affected. However, it is important to minimize the amount of resources being used, given a certain output level and a desired level of flexibility. For a given demand, supply chain must be adjusted to use as little resources as possible but without affecting output and flexibility. Generally speaking, supply chain resource performance can be measured with any of the following measures:

- Total cost: The aggregated cost of all used resources.
- Distribution costs: Aggregated cost of all the activities required to distribute the products, including both transportation and handling.
- Manufacturing costs: Aggregated cost of all the activities required to manufacture a product, which include labor, maintenance or re-work costs.
- Inventory: All costs related to inventory, among them the investment (invested value of the inventory), obsolescence (cost of obsolete or spoiled inventory), work-in-progress, and finished goods.
- Return on investment: The ROI, ratio of profit versus assets gives an idea of the profitability of the organization.

7.2 Output

Some of the items included in this component are: responsiveness for variability in demand, quality or quantity required for the final product. These items can be easily quantifiable such as number of products, time to produce a certain product or number of deliveries on time. But there are other ways to analyze these factors that are much less quantifiable or easy to work with, such as customer satisfaction or quality from a satisfaction perspective. However, as it was mentioned before, the number of resources and their efficiency affect the output of a supply chain. What is more, this output (and its measurement) plays a key role in determining if a supply chain is flexible or not. Generally speaking, output links both the organization's and the customers' goals. This is due to the fact that companies' strategic goals include meeting customers' goals one way or another. Output can be measured with any of the following measures:

- Sales: Aggregated economic value (total revenue) of everything sold.
- Profit: Difference between the aggregated economic value of the sales less the aggregated economic value of all the expenses required to obtain those sales.

- Fill rate: Among all the orders, amount of those filled with immediate character as a proportion of the total orders. If an aggregated rate is calculated and divided by the total number of items, then the average fill rate is obtained. Organizations might fix a targeted fill rate and analyze the extent to which this target was achieved.
- On-time deliveries: Measure that addresses order delivery performance. If the date in which an order is delivered is subtracted from the date that same order was due, then order lateness is obtained. Again, if an aggregate of all latenesses are divided by the total number of orders received, then the average lateness is calculated. However, if on the contrary the date that an order is due is subtracted from the date that that same order is received, then the order earliness is obtained. In the same fashion as before, an average of the earliness can be conducted. Finally, if the number of orders received before or on the expected date are expresses as ratio of the total number of orders, then the percentage of on-time deliveries is obtained. A very useful measurement.
- Backorder/stockout: This parameter essentially measures order availability performance and can be expressed in several different ways. On the one hand, if the probability of a product to be out of stock is calculated for a given order, then the stockout probability is obtained. On the other hand, other measures to be considered are the number of backorders and number of stockouts, both quite self-explanatory. Finally, if the total number of backordered orders are divided by the total number of orders, then the average backorder is obtained.
- Customer response time: By definition, this is the time it takes for an order to be delivered after it was requested.
- Manufacturing lead time: Total time required to produce a specific product.
- Shipping errors: Total number of errors made in shipments.
- Customer complaints: Very self-explanatory, total number of complaints made by customers.

7.3 Flexibility

This component of a healthy supply chain offers multiple advantages, among them: reductions in all, backorders, lost sales and late orders; and increased overall customer satisfaction; and ability to effectively respond to periods of fluctuations in demand, poor manufacturing, bad supplier performance or bad delivery performance, together with an

increased capacity to include new products in the supply chain, start business in new markets or even face more efficiently new competitors. Given the fact that the environment around any supply chain is by definition uncertain, this component plays a critical role in supply chain performance and economic success. This is the reason why it will be the primary analysis of this economic study. In 1991, Slack identified that flexibility could be separated into two types: range (the extent to which operation could be changed) and response (cost and time required to change operations). Understandably, these to types of flexibility are limited and cannot be infinitely improved, but supply chains can be redesigned to gain flexibility to face uncertain events.

However, measuring flexibility is not an easy task, being that the main difference between flexibility and resources or output. That is the reason why several measurements were proposed by Slack in that same year. This flexibility measures apply for the supply chain as a whole and evaluate the extent to which supply chain is flexible in certain ways. As earlier discussed, these measures can be analyzed both in terms of response and in terms of range. He proposes four measures, which are the following:

- Volume flexibility: Extent to which a supply chain is able to modify its level of output for the different products being manufactured. This addresses the response for variable demands and the associated costs of not meeting the new demand.
- Delivery flexibility: Extent to which a supply chain is able to modify already planned delivery times or dates. This addresses the response to delivery times and dates being changed regularly and the associated costs of not meeting the new conditions.
- Mix flexibility: Extent to which a supply chain can modify the variety or offer of products being manufactured. This addresses the response to a stationary demand for various product types.
- New-product flexibility: Extent to which a supply chain can incorporate new products into its network, including the modification of already existing products. This addresses the response to operating with products with short life cycles.

As it can be seen, depending or the organization being studied, it might be more interesting to analyze one or another supply chain flexibility. This will also depend on the available historical data. It is important to note that given the volatility and uncertainty of the

environment in which today's supply chains operate, even with stationary demands, a certain degree of volume flexibility is always desired. According to Beamon (1999), they are defined as follows:

Volume flexibility

As pointed out by Sethi and Sethi in 1990, volume flexibility can be considered to be the measurement of the extent to which the range of volumes can be run profitability by an organization. Particularly, in supply chain this analyzes the amount of demand that can be met only if profitable range of volumes are considered. Basically, volume flexibility (F_v) is the amount of demand that a given supply chain can meet. Assuming the volume of demand (D) to be a random variable following a normal distribution $D \sim N(\mu_D, \sigma^2_D)$, then an upper and a lower value for profitable output volume can be defined at given period (O_{max} and O_{min}). If the supply chain being studied has enough available data for the volumes of the demand, then the distribution of the demand $D(\mu_D, \sigma^2_D)$ can be used to effectively calculate the mean ($\overline{D}$) and the variance (S^2_D) of the demand. Those would be calculated as follows:

$$\overline{D} = \frac{\sum_{t=1}^{T} d_t}{T}$$

Equation 1 - Mean of the demand.

$$S_D^2 = \frac{\sum_{t=1}^{T} \left(d_t - \bar{d}\right)^2}{T - 1}$$

Equation 2 - Variance f the demand.

Where,

$$\begin{cases} d_t = Actual\ demand\ during\ period\ t. \\ t = Actual\ period\ being\ considered. \\ T = Number\ of\ periods\ considered. \end{cases}$$

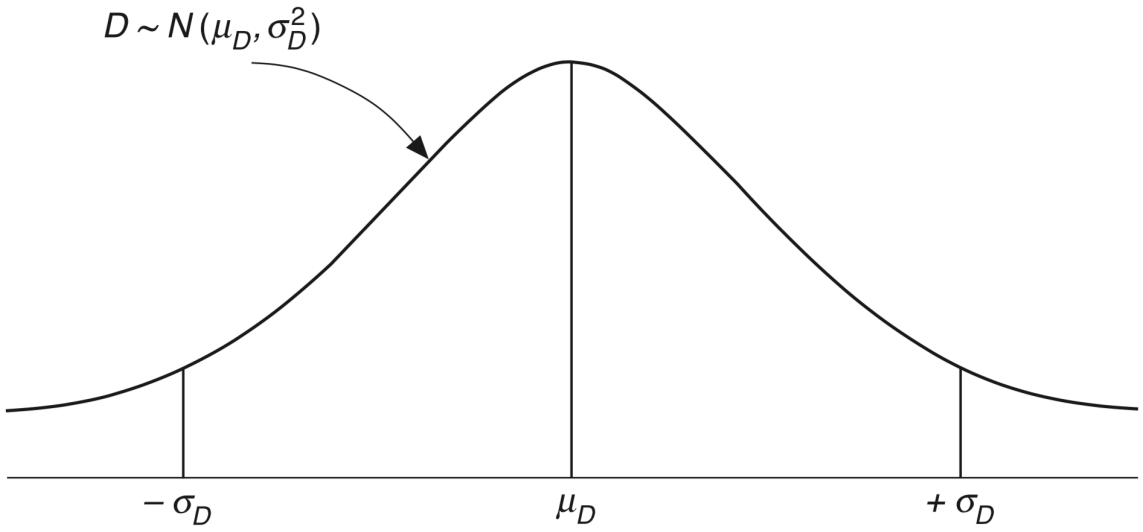


Figure 60 - Standardized normal demand distribution (Beamon, 1999).

Finally, volume flexibility can be defined as:

$$F_V = P\left(\frac{O_{min} - \overline{D}}{S_D} \leq D \leq \frac{O_{max} - \overline{D}}{S_D}\right)$$

Equation 3 - Volume flexibility I.

Or, what is the same:

$$F_V = \Phi\left(\frac{O_{max} - \overline{D}}{S_D}\right) - \Phi\left(\frac{O_{min} - \overline{D}}{S_D}\right)$$

Equation 4 - Volume flexibility II.

The result of this equation is a value ranging between 0 and 1, $F_V \in [0,1)$, showing the proportion of the demand that can be met with the actual supply chain (in the long-run). It is important to note that demand is represented as a standard normal function and it is standardized, being its mean μ_D and its standard deviation σ_D.

Unfortunately, at the time of writing this project Anritsu has not disclosed the data for its demand during any time period, due to the fact that this is treated as confidential data for the company as well as they work with very customized products, not being two products

exactly the same. Were there have been available actual data, it would have it used at this point. However, in order to show how this works, an example will be shown.

Assume these are demand volumes for a certain year considering each week to be the period:

Table 9 - Weekly demand volume.

Period (t)	Demand Volume (units)	Period (t)	Demand Volume (units)	Period (t)	Demand Volume (units)	Period (t)	Demand Volume (units)
1	17	14	6	27	8	40	13
2	14	15	17	28	21	41	27
3	26	16	8	29	28	42	7
4	3	17	15	30	4	43	14
5	19	18	22	31	23	44	6
6	2	19	30	32	17	45	29
7	24	20	27	33	26	46	1
8	28	21	16	34	2	47	18
9	16	22	5	35	5	48	12
10	7	23	29	36	20	49	11
11	14	24	2	37	16	50	22
12	4	25	9	38	30	51	19
13	17	26	26	39	3	52	15

For this data, it can be effectively calculated the mean ($\overline{D}$) and the variance (S^2_D) of the demand:

$$\overline{D} = \frac{\sum_{t=1}^{T} d_t}{T} = 15.13\ units$$

$$S_D^2 = \frac{\sum_{t=1}^{T}(d_t - \bar{d})^2}{T-1} \rightarrow S_D = \sqrt[+]{\frac{\sum_{t=1}^{T}(d_t - \bar{d})^2}{T-1}} = 9.16\ units$$

Once obtained the mean and the variance, and assuming for the purpose of this example that maximum profitable output is 48 units (O_{max}) and the minimum profitable pout put is 1 unit (O_{min}), then, applying equation 4, the following volume flexibility is obtained:

$$F_V = \Phi\left(\frac{48 - 15.13}{9.16}\right) - \Phi\left(\frac{1 - 15.13}{9.16}\right) = 0.9998 - 0.0614 = 0.9385$$

$$F_V = 93.85\ \%$$

In other words, in the long-run, 93.85 % of the demand can be met by the supply of this organization. In the case of Anritsu, although at the time of writing this project no demand volume data was available, it seems clear that using the RapidResponse tool has risen this number from before the Kinaxis implementation to after the Kinaxis implementation, seeing Anritsu an increase on its volume flexibility, as available data suggest. Undoubtedly, this has very positively affected the economic assessment of the implementation, as more volume flexibility means Anritsu is able to successfully deal with variable demands (uncertainty) in a very positive economic fashion.

Delivery flexibility

As pointed before, delivery flexibility measures the extent to which a supply chain can push delivery dates forward, including rush orders or special orders. This ability plays an important in today's supply chain environment, as even greatly customized products such as Anritsu's are still required to be rushed shipped or customers may require special orders from the organization. Delivery flexibility (F_D) is measured as a percentage of the slack time that the delivery can be reduced. In order to calculate the delivery flexibility, two other parameters have to be first calculated, the total slack time for all jobs within the supply chain and the minimum delivery time for all those jobs:

$$\sum_{j=1}^{J}(L_j - t^*)$$

Equation 5 - Total slack time.

$$\sum_{j=1}^{J}(E_j - t^*)$$

Equation 6 - Minimum delivery time.

Where,

$$\begin{cases} t^* = Current\ time\ period. \\ L_j = Due\ date\ period. \\ j = actual\ job. \\ E_j = Earliest\ time\ period. \\ J = Number\ of\ jobs\ in\ the\ system. \end{cases}$$

Finally, the delivery flexibility reflects the proportion of excess slack across all jobs within the supply chain and is expressed as:

$$F_D = \frac{\sum_{j=1}^{J}\left(\left(L_j - t^*\right) - \left(E_j - t^*\right)\right)}{\sum_{j=1}^{J}\left(L_j - t^*\right)}$$

Equation 7 - Delivery flexibility I.

Which, applying mathematics theory can be simplified to:

$$F_D = \frac{\sum_{j=1}^{J}\left(L_j - E_j\right)}{\sum_{j=1}^{J}\left(L_j - t^*\right)}$$

Equation 8 - Delivery flexibility II.

The result of this equation is a value ranging between 0 and 1, $F_V \in [0,1)$, showing the percentage of slack delivery time that can be reduced.

Again, and unfortunately, at the time of writing this project Anritsu has not disclosed the data for its current orders or delivery times, due to the fact that this is treated as confidential data for the company. Were there have been available actual data, it would have it used at this point. However, in order to show how this works, an example will be shown.

Assume the actual current time period is week 32 and these are scheduled jobs together with their due week and the earliest week it can be delivered:

Table 10 - Job schedule (earliest and due weeks).

Job	Earliest Period (Week)	Due Period (Week)	Job	Earliest Period (Week)	Due Period (Week)
A	37	42	G	43	46
B	47	48	H	50	52
C	49	51	I	41	44
D	38	40	J	48	50
E	36	37	K	40	41
F	39	43	L	42	45

According to this that, being the due period L_j, the earliest period E_j and the actual current period t*, the total slack time for all jobs and the minimum delivery times for all jobs are, respectively:

$$\sum_{j=1}^{J}(L_j - t^*) = 155\ weeks$$

$$\sum_{j=1}^{J}(E_j - t^*) = 126\ weeks$$

The delivery flexibility is therefore, for this supply chain:

$$F_D = \frac{\sum_{j=1}^{J}(L_j - E_j)}{\sum_{j=1}^{J}(L_j - t^*)} = 0.1871$$

$$F_D = 18.71\ \%$$

As the delivery flexibility assess the extent to which a supply chain can modify already planned delivery dates, this number indicates the percentage of the slack time by which the delivery time can be reduced. Again, available data suggests that after the RapidResponse

implementation, Anritsu has seen its delivery flexibility increased, meaning their supply chain is more capable of dealing with changes in delivery times.

Mix flexibility

Mix flexibility (F_m), or process/job flexibility is the measurement of the extent to which a supply chain can modify the offer of products it deals with. This can be measured as the number of different products being produced at the same time for a given amount of time (mix flexibility range, very self-explanatory) or the time required to get everything ready to start manufacturing a new product mix (related to mix flexibility response).

The first one of the above-mentioned measures is very self-explanatory and is a characteristic of the supply chain itself. The mix flexibility range can be calculated applying the following equation:

$$F_m = N(t)$$

Equation 9 - Mix flexibility range.

Where,

$$\begin{cases} N(t) = Number\ of\ diff.\ products\ produced\ in\ period\ t. \\ N(t) \in I^+. \\ t = Time\ period\ being\ considered. \\ t > 0. \end{cases}$$

As for the second one, the mix flexibility response is given by:

$$F_m = T_{ij}$$

Equation 10 - Mix flexibility response.

Where,

$$\begin{cases} T_{ij} = Changeover\ time\ from\ product\ mix\ i\ to\ mix\ j. \\ T_{ij} \geq 0\ for\ any\ i,j. \end{cases}$$

As these operations are very simple and straightforward, no example is given.

New product flexibility

As it was earlier mentioned, new product flexibility (F_n) measures the extent to which new products can be fit in the existing supply chain. Of course, introducing new products means some time will be required to develop and set the new supply chain up. According to Sethi and Sethi (1990), this measurement can be expressed either in terms of time or in terms of cost. This is the reason why new product flexibility is determined applying the following equations.

New product flexibility in terms of time:

$$F_n = T$$

Equation 11 - New product flexibility (in terms of time).

Where,

$$\begin{cases} T = Time\ required\ to\ add\ new\ products. \\ T \geq 0. \end{cases}$$

New product flexibility in terms of cost:

$$F_n = C$$

Equation 12 - - New product flexibility (in terms of cost).

Where,

$$\begin{cases} C = Cost\ required\ to\ add\ new\ products. \\ C \geq 0. \end{cases}$$

Again, as these operations are very simple and straightforward, no example is given.

As it has been seen throughout this section, the economic assessment of the implementation can be addressed in several different ways: resources, output and flexibility. During all this project, both resources and output have been analyzed one way or another, being that the reason why the section was reserved for flexibility. The above-mentioned measures only need to be multiplied by the economic value ($) to obtain the benefits this implementation

has meant for Anritsu. However, the same conclusions can be obtained without adding the economic value. What is more, if the same studied was to be conducted with economic value, this would have to be adjusted over time. As a dollar today is not a dollar tomorrow, in order to be able to analyze the data, it would be first necessary to express all the parameters in the same value frame, according to tine value of money theory. The analysis presented in the present project is believed to be handier and more intuitive as no adjustments are required over time. That is to say, different values for different time periods of the parameters shown in this study can be compared without any additional calculations or adjustments.

CHAPTER 8

POSSIBLE EXTENSION TO OTHER INDUSTRIES

As it has been seen throughout the project, Kinaxis' RapidResponse is a software that allows companies to plan, monitor and respond quickly whenever an issue happens. This helps with current supply chain problems, such as, increasing costs and their associated pressure, ever growing customer expectations and expanding globalization. RapidResponse allows companies operating in all sectors to plan, make confident decisions and monitor all required data to maximize profit and business performance. This is due to the fact that RapidResponse uses machine intelligence together with data analytics to help supply chain professionals improve revenue, cut costs and ultimately, reduce risks. In fact, RapidResponse can be implemented in a customized way so companies can pick among their options the ones that best suits them and then build up from there if necessary. Among the possibilities are:

- Sales and Operations Planning: Allows for the creation and analysis of sales and operations scenarios in a matter of minutes. It also defines collaborative processes, weighs options and associated trade-offs and align plans with each organization financial goals.
- Demand panning: This option is able to assess any change to a demand plan in a matter of minutes, allowing for the creation of demand plans that actually combine available historical data with statistical forecasting.
- Supply planning: With this option organizations can align their supply to match demand at all levels. It also helps identify gaps and collaborate with stakeholders involved to avoid excess or shortage conditions. This option can cut an organization's buy expenses by a quarter.
- Inventory planning: With this tool, organizations can determine what inventory strategy best suits them in order to better support customer service at all levels across the supply chain. This tool is capable of reducing by a third the finished goods inventory.
- Capacity planning: This tool is able to analyze any change in build plans in a matter of seconds, to better address changing conditions. This is possible thanks to its

ability to work with model constraints and fine-tune capacity simultaneously with ease.

- Machine learning: This tool analyzes complex dependencies and patterns so performance can be driven. It automatically closes the gap between actual and expected performance.

Kinaxis' RapidResponse software is so flexible and customizable that organizations from very different industries have changed their approach to supply chain planning and now operate this software. It has become one of the most important supply chain planning and analytics systems. In fact, many manufacturers in the automobile, consumer goods, high-tech or life sciences have adopted this tool for the operation of their supply chains. Among them: Unilever, Nikon, Ford, Asics, Dyson, Jabil, NCR, Santen, Schneider Electric, or Nissan Motor Corporation. In fact, Kinaxis conducted a customer survey in the year 2013 with over 150 organizations and every single one of them stated they have benefited from using this software and they particularly mentioned the following items to be the ones that helped them the most: supply chain flexibility, visibility, planning, what-if analysis, response management, alternative technologies and competitive advantage. Probably, the most valuable benefit organizations can get from using RapidResponse is a decrease in decision latency (measure of supply chain efficiency and effectiveness). The tool allows supply chain professionals to make good decisions quickly, therefore making the physical supply chain much more agile, aligned and adaptable, thereby increasing efficiency in both processes and finances.

These are the steps that organization in other industries need to follow to adopt Kinaxis' RapidResponse and to ensure the implementation is optimal and smooth:

1) Prioritizing: Adopting a complex software such as RapidResponse, which is a comprehensive solution for supply chain sales and operations planning, cannot be done at once. This software contains many tools and applications and deploying all of them at once is probably not the best approach. Even with just one single tool there will be decisions to be made regarding what, among all requirements, should be first implemented. In order to best prioritize and to save efforts, it is important to understand the interdependencies and the time it is going to take to fully implement the tool. It is important to assess, set a roadmap and review all

requirement definition phases before starting the actual implementation. Making all these decisions beforehand certainly can make the implementation process a lot smoother for the organization.

2) Data wrangling: Or in other words, collect, organize and clean up the organization's data before starting any analysis. In order to fully support the RapidResponse implementation it might be necessary for the organization to change the way data is capture and stored as well as how both master and transactional data are maintained. This includes aspects such as bills of materials, lead times or sourcing rules. These planning parameters are vital for RapidResponse to operate at its best. Having good data quality is important to avoid any project overruns and the only way to achieve the RapidResponse implementation.
3) Process redesign: RapidResponse is a software that requires processes to be streamlined in a certain way to operate at its best. This software can run both, the long-term sales and operations planning as well as what-if scenario simulations. All this requires the process to be integrated by bringing all stakeholders together. This also includes information and analytics, as well as roles and responsibilities. All them need to be clearly identified and defined for the RapidResponse software to optimally operate. The time to implement the tool can be used to get people to embrace the change and to redefine the way activities have been conducted. Of course, during the implementation processes must be redesigned and integrated several times and at different planning levels. Adopting the RapidResponse software must not be seen as an IT project but it must involve all business sides.
4) Change of mindset: According to the previous point, RapidResponse is an innovative platform able to make easier cross-function and inter-organization collaboration. This tool offers the capability to revolutionize the way supply chain is planned. Although collaboration within the organization, breaking silos and incorporating trading partners is not something new, implementing these can be hard. RapidResponse is the right tool to change this mindset, as its technology operates at all levels within the supply chain and this makes collaboration platforms easier and more convenient to use than other communication channels.

Kinaxis' RapidResponse has the capability to gain a competitive advantage for organizations using it. It helps them roadmap their strategies, redesign their processes, integrate functions and promote a change mindset throughout the organization. This allows

companies to achieve end-to-end visibility, build an integrated planning program and ultimately, construct a responsive and resilient supply chain that is strong enough to successfully operate in today's volatile and complex environment.

The RapidResponse software can make its way into any supply chain management department within any organization, big or small. Regardless of the situation of the organization, this tool is capable of giving the required information to the required person in time to make a difference on how planning can be conducted. In order to balance supply and demand in a continuous and instant way, RapidResponse gathers and synchronizes data across the corporate network. This allows supply chain professionals to know exactly where the company stands with just one look and can respond accordingly to the concrete situation. In fact, this comprehensive approach ultimately allows employees and executives to devise better plans, monito the results to those plans in real time and the capability of responding to any minor issue that might occur before it becomes a major problem capable of damaging the supply chain. Overall, RapidResponse solves complex planning problems for big and small businesses operating in any industry. The Kinaxis approach uses the best of both the human and machine intelligence to perform advanced analytics and develop algorithms to solve those complex planning problems. This software, however, does not intend to replace people, but rather support employees to deliver the confidence and necessary information to achieve new levels of performance, accuracy and, of course, results. A fully automated supply chain that does not required any planner to conduct its planning activities is not likely any time soon. Decision makers are still a key part of the equation. Technology has a lot of power and potential in this regard, but it should consider people as well.

As it was said earlier, RapidResponse has been helping various organizations in very different industries. Companies such as Lockheed Martin, Ford, Asics or Jabil are now performing much better than before and taking much sooner and more informed decisions than before. All this results in a 20% reduction in lead time for manufacturing, a 33% reduction in inventory for finished goods or a 15% increase in efficiency regarding supply chain overall planning. It is both technology and people that bring these results and successful outcomes for the organizations. Issues such as increased complexity and volatility, geopolitical instabilities, changes in regulations or tariffs, personalization or cost pressures can be managed by technology. However, software does not completely

understand the consequences of the actions it takes. That is why RapidResponse is able to break down all the incoming information and then present it in a clear, easy and convenient way to the supply chain professional working with it. Decision makers can then see the bigger picture, understand the situation and make the right choices.

In closing, RapidResponse automates the following functions to help assure a successful supply chain management:

- Performance enhancement by automatically correcting inaccurate supply chain designs.
- Risk avoidance by interpreting the overall impact of wrong assumptions like lead times.
- Improve productivity by focusing planners' attention to what really matters, alerting them about discrepancies between actual and design supply chain performance.
- Automatic and continuous improvements to improve the accuracy of the planning design phase, increasing therefore business growth and boosting profitability.

CHAPTER 9

CONCLUSIONS

As it has be seen throughout this project, Globalization has changed the way business operate all over the world. These changes have also touched supply chains, making them more complex and unpredictable than ever. Issues like disruptions, unexpected threats, or last-minute opportunities make supply chain volatility even stronger and more potentially damaging. It seems obvious that in a time when everything moves so fast and expectations grow at a very high rate, it is extremely hard to keep customers happy. This project studies how globalization affects two fields: supply chain sustainability and supply chain risk management. Afterwards, the idea of using a tool to mitigate the effects of globalization was introduced. In order to conduct the study, the Japanese company Anritsu was used as case study and the software they use is Kinaxis' RapidResponse.

As proved throughout the project, Kinaxis has added a lot of value to Anritsu, from a quick response to issues on its supply chain to end-to-end visibility. Kinaxis has given Anritsu the assurance that any time a problem arrives, they are able to make the best decisions to, not only correct the issue, but to make a difference in the process. RapidResponse allows Anritsu to use what-if scenarios so the organization can plan for any future it might arrive. The software does not only monitor for risks, but also opportunities are highlighted so overall supply chain performance can be optimized. This tool has proved to provide organizations with the ability to respond to any change faster than before and to help supply chain professionals solve very complex supply chain problems in an easy way using both human and machine intelligence.

Kinaxis' customers are numerous and very different among them. They operate in very different industries and their sizes vary a lot from small national companies to international corporations operating all over the globe. Kinaxis' staff and other partners have been shown to be passionate and willing to help organizations that used their software. They have created a community with all supply chain professionals that are like-minded and willing to create a new future for the supply chain planning process. Using Kinaxis' tools does not only mean the ability to use a certain software, but it also opens the possibility to call on experts from Kinaxis or even outside the company itself so that organizations can optimize their processes, ultimately succeeding in overcoming supply chain problems, creating profit

and improving their business practices. Kinaxis uses technology that optimizes concurrent planning, delivering a connected supply chain that is always synchronized with all parties involved. This tool is capable of bridging the gap between supply chain planning and supply chain execution and operation. It balances the end-to-end network instantly and continuously. In fact, whenever a change is made by a planner, immediately everyone else across the supply chain can see its impact. Kinaxis offers several packages that are completely customizable and adaptable to each organization's needs. Sales and operations planning, demand planning, supply planning, inventory planning or capacity planning, all are tools offered by Kinaxis' RapidResponse software. All these platforms are cloud-based and seek to be integrative supply chain planning. In fact, once a tool is implemented, then the RapidResponse software is easily scalable and is capable of incorporating all the tools an organization might need as it grows. This is possible without the trouble of writing custom codes and with the convenience or being able to work on any device the organization uses. Thanks to this responsive and people-first design, RapidResponse offers the possibility to make decisions, even critical decisions, on the go. Some of the data that shows how RapidResponse is able to improve supply chain performance are: reduction of about 33% in average for finished goods inventory, reduction in about 20% in average for manufacturing lead times, reduction of about 57% for planning cycles times and finally, sales and operations scenario creation and its analysis that goes from an average of 48 hours to only 30 minutes. All these facts are why RapidResponse is the trusted software by some of the top manufacturers in multiple industries across the globe and why it has been recognized by analysist and experts for all its capabilities and flexibilities.

Regarding supply chain sustainability, although Anritsu was already taking this aspect seriously, it is fair to say that the Kinaxis tool has certainly helped in this regard. For the organization, sustainable business practices have always been a top priority as reflected on its corporate social responsibility and green procurement guidelines. Anritsu has always recognized the importance of protecting the environment and the value of trying to leave a cleaner planet that the one we found. During its recent history, it does have analyzed the advantages and tradeoffs of greener policies, not only from a business point of view, but also from a human perspective. They have always believed the cost of pollution is much more expensive that conducting business at any price. The organization has always believed economic benefit and sustainability can go hand in hand and organizations do not really have to hose between one or the other. Building a sustainable supply chain has been a top

priority for Anritsu and in fact, this has resulted in an increase in profits. What is more, other companies using the Kinaxis' RapidResponse software and also focused on supply chain sustainability, such as Unilever, have also seen an increased revenue by up to 20%, together with a supply chain cost reduction of as much as 16% as a result of their green practices.

Many studies and other research have already shown several times the positive aspects of implementing green policies within an organization. All these policies can potentially have the same results as the one mentioned before. The idea is simple: work and conduct business in such a way that profitability is achieved through measures that not only benefit the business, but also society and the environment. These include, but not limited to collaboration both with suppliers and even competitors so as to implement new and innovative technologies to enhance savings. This is in fact what Kinaxis proposes with its RapidResponse software. Keeping all stakeholders involved in the operation and management of the supply chain has been proven to play a critical role in business success. Serve as an example the case of Nestle and PepsiCo. In Belgium, these two companies, which are actually rivals, came together with the idea of combining parts of their fresh and cooled products' supply chains. In fact, they combined their warehousing activities, as well as packaging and distribution. They even synchronized all their deliveries to fill the truck they used. This idea resulted in a reduction of about 44% for their transportation costs, as well as an impressive 55% reduction in carbon emissions. Both of the companies even reported higher customer satisfaction and better service quality levels. The truth is that RapidResponse has the ability to make these types of collaborations faster, more convenient and even more efficiently. Bringing the idea of implementing green policies one step further, another example would be that of DHL. When the organization started using trucks that were much more aerodynamic than the previous ones they were using, this resulted in an average reduction of fuel use and CO_2 emissions that could be as high as 12%. What is more, research shows that companies as a result of reducing their carbon footprints can see a clear and direct increase in their profitability. Studies suggest that in average, being able to reduce this footprint between 13 to 22% actually results in an increased revenue of 5 to 20%, increasing brand value as a consequence by about 15 to 30%. The software by Kinaxis supports and promotes this sort of changes and optimizations for the supply chain.

Taking advantage of RapidResponse's capability to implement sustainable policies and guidance, allows organizations to drive the following factors:

- Reputation: Customers expect more every day and they submit companies to growing scrutiny regarding sustainable practices. This pressure is even reinforced by investors and the media. They all expect to see sustainability efforts, and this results in higher brand reputation. RapidResponse, through increased supply chain visibility can help build up brand reputation.
- Risk: as later on it will be reassessed, environmental factors can result in risk that can potentially impact the supply chain in a negative way. Throughout the project, extreme weather vents such as natural disasters can cause big loses to the companies if operations have to be paused for some time. RapidResponse helps mitigate this risk.
- Opportunity: RapidResponse allows to quickly spot and pinpoint areas in which there are hidden inefficiencies. This allows to reduce costs which can be associated to sustainable factors, such as the cost reduction due to the reduction of the carbon footprint.

Even if before the RapidResponse existence it was not a matter of sustainability versus profitability, Kinaxis' tool makes it even easier to have both.

Regarding supply chain risk, it is important for organizations to make good supply chain decisions. However, if the information used is outdated or based on inaccurate data, decisions and tradeoffs will not as good as they could be. In order to make sure that the information used to make the best supply chain decisions is accurate and up to date, organizations are increasingly relaying on third-party software, such as Kinaxis' RapidResponse.

Supply chain planning actually has a big deal of room for uncertainty. While isolated and sequential pieces of information about metrics or processes do not provide with the required visibility, disconnected and outdated systems do not provide with the required flexibility. These two factors combined, result in a slow and suboptimal decision-making process, which ultimately results in poor decisions regarding supply chain risk management. As it was commented throughout the risk management section in this project, making the right

decisions at the right time does not only have an impact in supply chain efficiency, but it also means a reduction in risk to costs, revenue or even customer satisfaction.

Kinaxis' RapidResponse reshapes the supply chain, uses real-time and updated data and allows for monitoring so that the best decisions can be made regarding supply chain planning. The three key areas in which RapidResponse adds value to the organization that uses it are:

- Visibility: Having good visibility into the supply chain means seeing the bigger picture anytime and from any device the organization uses. This allows the organization to make confident and good decisions, as they will have the capability of having fast and accurate insights into the most critical metrics and areas of the supply chain network. The software also for the rapid viewing of trends regarding important metrics or key performance indicators (KPIs), for instance, revenue or gross margin. What is more, RapidResponse does not only show the information in a convenient and clear fashion, but it also allows supply chain professionals to actually drill into the details of the information to see, for instance, contributing factors or to be able to quickly collaborate and be in touch with the supply chain professional responsible for a certain piece of information.
- Flexibility: Having good supply chain flexibility means having not only the right information, but also being able to see and understand the data according to what is required or what best suits each particular position. RapidResponse allows for the ability to create personalized reports, custom made for each management level, as well as incorporates dashboards with intuitive and responsive data discovery. This ultimately allows employees to quickly spot issues and opportunities at any level. What is more, RapidResponse has a clear and convenient interface that allows for dragging and dropping capabilities, so professionals can spend less time creating reports which allows them more time to analyze them.
- Agility: Having supply chain agility means to be able to respond and react to any change that happens. This is key to make confident and good decisions as soon as issues appear. RapidResponse allows for the creation and quick analysis of what-if scenarios, see previous actions (what was done when in a similar situation in the past) and to be ahead of any shifting situation by being able to get instant alerts custom made for each position.

Throughout this project, the role of globalization on supply chain and particularly its effect on supply chain sustainability and supply chain risk management. RapidResponse has particularly been helpful for Anritsu in this second regard. Although it has. Enhanced Anritsu sustainability values and policies, RapidResponse has been able to connect Anritsu's regional operations under the same platform, which has improved collaboration and ultimately driven global efficiency. This has been done through data transparency so planning activities have become more effective. Finally, it has allowed Anritsu to accelerate the decision-making process and has made a lot easier to connect with all stakeholders involved in supply chain management.

RapidResponse has been proven to successfully deal with any supply chain related topic, from supply assurance, to revenue risk or strategic product transitions. Central to globalization, the software allows for the automation of non-value-added work, multiple MRP standardization, the management of product portfolio or reginal variations. This tool improves planning and operations activities, and certainly helps improve sustainability performance and risk management. Visibility, flexibility and agility have been proven to be a key part of RapidResponse's success.

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IMPACT OF GLOBALIZATION ON SUPPLY CHAIN SUSTAINABILITY AND RISK MANAGEMENT

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