

Organizational Drivers of Effective Crisis Management

Analysis based on Supply Chain Disruptions in the Electronics Industry

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Abstract

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The control measures for the COVID-19 pandemic, early 2020, caused a chain reaction that eventually led to a shortage of components in the electronic manufacturing industry. A lack of components meant that the production and sales were interrupted or even stopped. For many electronic manufacturing firms, this was seen as a crisis. A crisis is mostly divided into three phases called the pre-crisis phase, crisis management and post-crisis phase. The pre-crisis phase involves an environmental assessment and setting up of crisis management teams, and plan. The crisis management phase has to do with the collection and interpretation of information and the mitigation of the crisis. The post-crisis phase looks at learnings from the crisis.

In this paper it was investigated how the electronic manufacturing firms in Vorarlberg managed the crisis in the period between 2020 and 2022. The overall aim was to get a full understanding of how it affected the operations regarding the respective crisis teams and which factors were considered most important for setting up the teams. Two basic criteria which had to be overcome was the uncertainty and lack of time.

It was seen that even though the fundamental structure did not change, crisis teams were added in the form of a crisis management team and task forces. The task forces played a major role in getting an understanding of the problem and the effect it has on the business. The crisis management team, which includes high level managers from all affected functional areas, had to re-evaluate the high level strategy and decide what needs to be done, and who will be doing it. In order to do so, they needed to understand what the priorities are regarding components and products and then decide on the priorities regarding affected business. The new strategy was then handed down to the task forces for implementation. A major focus of this paper was also on decision making and how everything contributed to making decisions that had the right effect in resolving the financial crisis for the organizations.

Keywords: Crisis management team, task force, uncertainty, lack of time, fast decisions, priorities, information, effective decision making, strategic decisions, operational decisions

Kurzreferat

Organisatorische Faktoren für ein effektives Krisenmanagement

Analyse anhand von Unterbrechungen der Lieferkette in der Elektronikindustrie

Die Bekämpfungsmaßnahmen für die COVID-19-Pandemie Anfang 2020 lösten eine Kettenreaktion aus, die schließlich zu einer Verknappung von Bauteilen in der elektronischen Fertigungsindustrie führte. Ein Mangel an Bauteilen bedeutete, dass die Produktion und der Verkauf unterbrochen oder sogar gestoppt wurden. Für viele Unternehmen der Elektronikindustrie wurde dies als Krise empfunden. Eine Krise wird meist in drei Phasen unterteilt: die Phase vor der Krise, das Krisenmanagement und die Phase nach der Krise. Die Vorkrisenphase umfasst eine Umweltbewertung und die Einrichtung von Krisenmanagementteams und -plänen. In der Krisenmanagementphase geht es um die Sammlung und Auswertung von Informationen und die Abschwächung der Krise. In der Nachkrisenphase geht es darum, aus der Krise zu lernen.

In dieser Arbeit wurde untersucht, wie die Vorarlberger Unternehmen der Elektronikindustrie die Krise im Zeitraum zwischen 2020 und 2022 bewältigt haben. Ziel war es, ein umfassendes Verständnis dafür zu erlangen, wie sich die Krise auf die Arbeit der jeweiligen Krisenstäbe auswirkte und welche Faktoren für die Einrichtung der Stäbe als besonders wichtig erachtet wurden. Zwei grundlegende Kriterien, die es zu überwinden galt, waren die Unsicherheit und der Zeitmangel.

Es wurde festgestellt, dass sich die grundlegende Struktur zwar nicht geändert hat, aber Krisenteams in Form eines Krisenmanagementteams und von Task Forces hinzugekommen sind. Die Task Forces spielten eine wichtige Rolle dabei, ein Verständnis für das Problem und seine Auswirkungen auf das Unternehmen zu entwickeln. Das Krisenmanagementteam, dem hochrangige Manager aus allen betroffenen Funktionsbereichen angehören, musste die übergeordnete Strategie neu bewerten und entscheiden, was zu tun ist und wer es tun wird. Dazu mussten sie die Prioritäten in Bezug auf Komponenten und Produkte ermitteln und dann die Prioritäten für die betroffenen Geschäftsbereiche festlegen. Die neue Strategie wurde dann an die Task Forces zur Umsetzung weitergegeben. Ein Schwerpunkt dieses Papiers war auch die Entscheidungsfindung und wie alles dazu beigetragen hat, Entscheidungen zu treffen, die den richtigen Effekt bei der Lösung der Finanzkrise für die Organisationen hatten.

Schlüsselwörter: Krisenmanagementteam, Task Force, Unsicherheit, Zeitmangel, schnelle Entscheidungen, Prioritäten, Informationen, effektive Entscheidungsfindung, strategische Entscheidungen, operative Entscheidungen

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List of Abbreviations and Symbols

CMT	Crisis Management Team
CMP	Crisis Management Plan
OEM	Original Equipment Manufacturer
EMS	Electronic Manufacturing Services
VUCA	Volatility, uncertainty, complexity, and ambiguity
ERP	Enterprise Resource Planning
PCB	Printed Circuit Board
PCBA	Printed Circuit Board Assembly

1 Introduction

Supply chain disruptions started due to COVID-19 control measures between January and March 2020, but factories have mostly been back to production from about the middle of 2020 (McKay, 2023). The disruptions in the first half of 2020 almost led to a stop in production of the automotive industry which caused an abnormally fast ramp up and growth in the second half of 2020. This incredibly fast increase in demand from the automotive industry, in turn led to an over demand, specifically with micro electronic parts in the world economy. The raw material production and electronic parts manufacturing couldn't keep up with the sudden increase in demand thus causing shortages of electronic components all across the globe (Frieske, 2022). This increase in demand caused the Bullwhip Effect (Mooney, 2022). Also having adopted, early on, a 'just in time' strategy caused manufacturers to only be able to produce to current demand (Burkacky et al., 2022). So, the industry was already quite sensitive to increase in demands. In a struggle to get components, many firms had production delays or even production stops that prevented them from keeping to delivery dates and in some cases not being able to deliver at all ("Versa Electronics," 2023). It was seen as a crisis, because non-deliveries and no sales, result a negative impact on the business and therefore on the financial well-being of an organization.

The overall objective of this thesis was to find out how the Electronic Manufacturing firms organized themselves in order to successfully get through the shortages crisis. In other words which teams they formed, who they included in the teams and how the respective teams related to each other. A crisis brings with it a lot of uncertainty and urgency which need to be resolved as fast as possible. These teams therefore need to be organized in such a way as to create an environment where clarity is found regarding the crisis problems and solutions are found in resolving the problems. Decisions are needed on how it will all be done. All in all, the overall objective was driven by the main research question.

Which organizational factors did the electronic manufacturing firms in Vorarlberg consider important for effective decision making in the shortages crisis during the COVID-19 pandemic?

The question was answered by following a qualitative approach. And in order to do so, five electronic manufacturing firms in Vorarlberg were interviewed. The questions asked and the method used, was done in such a way, to enable the reconstruction of the teams and structure that was necessary for making decisions that effectively resolved the impact of the crisis on the organization.

1.1 Background

According to Carmeli & Schaubroeck (2008, p. 1), an organizational crisis “is a low-probability, high-impact event that threatens the organization’s survival and is characterized by ambiguity of cause, effect and means of resolution, as well as by a belief that decisions must be made swiftly.” According to Christensen et al. (2016a, p. 6), a crisis situation is “...where there is a serious threat to the basic structures or fundamental values and norms of a system and where critical decisions have to be made quickly under highly uncertain circumstances.” Furthermore, Crandall et al. (2021, p. 109f) states that crisis management requires managers to understand the threat/s or crisis source/s and then knowing which strategy to follow. But, in some cases the crisis is not identified until it is too late because they were not aware of it or because of the way it was interpreted, or it was simply ignored. Mossa-Basha et al. (2021a, p. 3f) supports the fact that the source of the crisis might not be fully known at the start of the crisis, and that it is important that they are able to address uncertainty and quickly decide/respond with sometimes incomplete information.

All four sources argue that, in a crisis situation, decisions need to be made quickly and that these decisions, most probably, need to be made under highly uncertain circumstances. Therefore time and information are very limited and that the decision makers need to make the best with what they have or get.

King (2002, p. 1) states that, “Being able to effectively respond in the event of a crisis is relevant to an organization’s survival.” And according to AccountingTools (2023), effectiveness is “...considered to be ‘doing the right thing.’” And, “It is an essential element of corporate success.”

In order to do the right thing, the organization needs to respond effectively which means they have to organize themselves in order to make effective decisions.

According to Fener & Cevik (2015a, p. 4), “Leaders shall overcome the state of crisis where there is a chaos environment in the organization, they shall restructure the organization and adapt it to the changing environmental circumstances.” In a study by Christensen et al. (2016b, p. 13), they looked at the organizational structures regarding better collaboration in the public sector of 6 countries with the sole purpose of crisis management. They couldn’t establish one single structure as a solution but they did see a trend where all were making structural changes for instituting a main administrative body that coordinates other administrative bodies. Even though mostly centralized, the organizations relied on networks and matrixes in the crisis to form an overall coordination, with each having their own respective hybrid solution. Also interesting to see in Christensen et al. (2016b, p. 7), but which is not explicitly mentioned by the researchers, is that each country had different initial key institutions which shows that they had different organizational base structures to start off with. This would also be an important

factor to consider in further research, when looking at if and how the organizational structure was adapted for more effective decision making under uncertainty and lack of time.

According to Heath (1998b, p. 7), delegating work and certain decisions, generates more time and information for decision making. James & Wooten (2005, p. 8) supports this by saying that leaders will often rely on expert opinion during crises because of their extensive subject knowledge which can drastically reduce the uncertainty regarding the problems that arises from the organizational crisis. And according to King (2002, p. 6), a diverse team in skills and background are more creative in finding solutions and are therefore better at making decisions. It is relevant in any organizational situation, but even more so in a time of crisis.

The above discussion shows that the following two organizational elements are constant in all crises: uncertainty and lack of time. Subsequently, organizational and teams structures play a key role in setting up effective crises coping strategies.

1.2 Research Setting and Objectives

It has been established that organizational structures play an important role in the performance of an organization in times of crisis. But, there are also a lot of variations to how different institutions decide on how to set it up, and different theories on what types of organizational structures facilitate effective collaboration. It is a fact that the effect of a crisis on an organization needs to be resolved and decisions need to be made on how it is to be resolved. More effective decisions lead to better performance of the resolution.

This paper aims to consolidate two basic concepts namely Crisis Management and Organizational/Team Structures with effective decision making at the center. It will be done by looking at the way the Electronic Manufacturing firms organized themselves in order to successfully get through the component shortages crisis. By reconstructing the happenings of each firm during the crisis, has created an understanding for why they did, what they did, in order to facilitate more effective decision making with the purpose of solving problems. And how they managed to do it faster under uncertain conditions.

The objectives are:

- to better understand the basic factors of organizational crises response/adaptation
- to better understand relevant adaptations towards resilient organizational/team structures
- to establish a roadmap for future organizational adaptations in crises situations

1.3 Research Question

Considering all beforementioned aims and objective, the following research question was defined:

Main research question

- Which organizational factors did the electronic manufacturing firms in Vorarlberg consider important for effective decision making in the shortages crisis during the COVID-19 pandemic?

With supporting sub questions

- In what way did the firms adapt or add to the existing organizational structure for more effective decision making?
- How does the normal operations structure differ from the structure during the crisis?
- Which factors did they consider in setting up the crisis management teams for effective decision making under both uncertainty and time pressure?

2 State of the art

The concept is framed around the basic crisis management process due to the fact that crisis management forms the research environment. The following three elements are then also integrated where relevant:

- Organizational structures
- Teams Structures
- Decision-making processes

2.1 Introducing the phases of crisis management

“Crisis management is the whole of activities applied in a planned, systematic and rational way in order to eliminate the state defined as a crisis. Its systematicity enables initiation of the step-by-step decision making process and formation of the team to apply these decisions and taking new decisions according to the results of the practice.” (Fener & Cevik, 2015a, p. 699)

According to Fener & Cevik (2015b, p. 699), there are three phases for managing the whole crisis management process, called the Pre-Crisis, Crisis and Post-Crisis management. In the pre-crisis phase, the aim is to detect the signals in either preventing the crisis or in some cases to use it to the organization’s advantage. Crisis management is the phase where the crisis is analyzed for type and severity and managed for a best possible outcome. And lastly the post-crisis phase is where lessons are learned in order to improve on future crisis management procedures.

Another principle for addressing the management of a crisis is the Four-Stage principle from Crandall et al. (2021, pp. 12–14). The four stages are Landscape Survey, Strategic Planning, Crisis Management and Organizational Learning. Landscape Survey and Strategic Planning are part of the pre-crisis phase and Organizational Learning refers to the post-crisis phase.

The dimensions to consider for all four stages are the Internal and External Landscape. Internal landscape refers to the employees and the external landscape refers to all external stakeholders. Below you will see a two by four matrix stating the most important question to be answered for each of the four stages.

	Landscape Survey	Strategic Planning	Crisis Management	Organizational Learning
Internal Landscape	What crisis threats exist inside our organization?	How can our organization plan for potential crisis events?	How should we manage our internal stakeholders during a crisis?	What can our organization learn from this crisis?
External Landscape	What crisis threats exist outside of our organization?	What planning has been done outside of our organization to help us prepare for potential crisis events?	How should we manage our external stakeholders during a crisis?	What learning is taking place outside of our organization in relation to the type of crisis we have just experienced?

Table 1: A framework for crisis management. (Crandall et al., 2021, p. 14)

2.2 Pre-crisis

2.2.1 Landscape survey

The information in this section was not actively used in the investigations for answering the research questions but rather as an overall understanding of the causes thereof.

A landscape survey is a task or activity, where one looks at the type of crises or trend towards one, which could occur and which could end up affecting your organization negatively. Even though our main focus is on the negative impact it could have, it should also be noted that in some instances or for some organizations it could lead to an advantage. The two trends that are most relevant to the global supply chain disruptions during the COVID-19 pandemic are Transboundary Crisis and Globalization (Crandall et al., 2021, p. 27f).

2.2.1.1 Transboundary Crisis

A transboundary crisis which is more related to the external landscape and has a low amount of controllability, is extremely difficult to manage due to its complexity having many stakeholders involved and being affected by different factors. Such a crisis causes a lot of uncertainty and takes time to clarify which makes it difficult to mitigate internally (Crandall et al., 2021, pp. 34–38).

Factors are

- 1) Crosses geographical boundaries: Natural disasters in one part of the world could cause a crisis in other parts of the world. (Crandall et al., 2021, pp. 34–35)
- 2) Crosses functional boundaries: It affects multiple companies, systems and/or infrastructures. Some are involved directly and some indirectly. (Crandall et al., 2021, p. 34,36)

- 3) Crosses time boundaries: A crisis event that occurs now, could have repercussions over years to come. It is therefore sometimes not that clear to why a problem occurs because it is difficult to link it to a crisis that happened years before and had an indirect effect. (Crandall et al., 2021, p. 34,37)

2.2.1.2 Globalization – organizational supply chain

“Globalization refers to the growing interdependence among nations.” (Crandall et al., 2021, p. 50)

It is unavoidable for organizations to source globally due to the increased need for decreasing costs in order to be more competitive. This is one of the positive effects of globalization but there are also negative effects which arise from two trends in globalization called outsourcing and lean management in global sourcing.

- 1) Outsourcing production to other organizations, and then even other countries, increases the risk of a crises because you are giving away direct control. The organization leaves itself open to political, legal and cultural influences. (Crandall et al., 2021, pp. 50–51, 71–72)
- 2) Lean management which focuses on removing waste, incorporates the principle of just-in-time which focuses on only producing and stocking what is required. Thus only keeping stock of raw material for what is needed in the ‘short term’. This increases the risk of a production stop in the case of supply chain disruptions. (Crandall et al., 2021, pp. 52–53; *Just-in-Time Manufacturing: The Path to Efficiency*, 2022)

2.2.2 Strategic planning

Referring back to section 1.1, where it was mentioned that a crisis brings a lot of uncertainty which requires managers to get clarity on. Managers should then use the information in order to create a strategy that would guide the organization in the right direction for solving the problems generated by the crisis.

According to Christensen et al. (2016a, p. 6), crisis situations are “...where there is a serious threat to the basic structures or fundamental values and norms of a system and where critical decisions have to be made quickly under highly uncertain circumstances.” Furthermore, Crandall et al. (2021, p. 109f) states that crisis management requires managers to understand the threat/s or crisis source/s and then knowing which strategy to follow.

It was also mentioned by Crandall et al. (2021, p. 114), that understanding and managing the uncertainty is a critical step in planning the strategy. And one way of strengthening the crisis management process is by creating a crisis management team and plan (Crandall et al., 2021, p. 123). It is the purpose of the crisis management team to manage a crisis of which managing

the uncertainties are an important part. And the crisis management team, together with the crisis management plan represents the core of the crisis planning process (Crandall et al., 2021, p. 138).

2.2.3 Setting up the crisis management teams

It was mentioned earlier, that a team with the right background, experience and skills is required for making effective decisions. Going forward, we will be looking at the needed skills, the required abilities and expected goals of crisis management teams. The type of decisions needed, also plays a big role in who are part of the teams.

2.2.3.1 Needed skills

According to Crandall et al. (2021, p. 205) the needed skills of a CMT leader are:

- Getting a clear understanding of the situation
- Make effective decisions
- Coordinate the team
- Monitor progress
- Delegating tasks to other members from what was decided
- Effectively prioritize information handed over to the CMT
- Plan the process and the tasks

And according to Fener & Cevik (2015a, p. 698f), the required qualifications of leader managers in a CMT are – the ability to:

- Catch the signals of crises.
- Prepare and protect against crises.
- Make efficient decision throughout the crisis management process.
- Use power throughout the crisis management process.
- Plan the crisis management process.
- Organize the crisis management process.
- Ensure communication throughout the crisis management process.
- Ensure coordination throughout the crisis management process.
- Supervise the crisis management process.
- Shift to normal state.
- Learn and assess throughout the crisis management process.

And according to Tokakis et al. (2019, p. 38) effectiveness is dependent on the skills of the CMT, for example

- Situation assessment
- Teamwork and communication
- Decision making

2.2.3.2 Goals

Crandall et al. (2021, p. 138f) refers to 5 goals of the CMT for managing the crisis

- 1) They need to identify the crisis threat. They need to therefore provide the ways and means for acquiring the required information in order to get clarity.
- 2) Develop the crisis management plan which contains the threat identification, from the first step, and the stakeholders to be involved.
- 3) Facilitates crisis management training.
- 4) Actively manage the crisis when it occurs. Refer to section 2.3
- 5) Facilitates learning from the crisis. Refer to section 2.4

And according to Tokakis et al. (2019, p. 38) the CMT needs to:

- Respond immediately and communicate clearly and honestly.
- Manage the crisis in order to take control and limit the duration.
- Transform the data into something useful.
- Analyze the data.
- Make decisions.

2.2.3.3 Stakeholders

Alexander et al. (2020, p. 3) mentions that during uncertain times people tend to want to limit the amount of people involved in the bigger decisions. Instead they should be going the other way by including more people, with diverse backgrounds which would generate better decisions faster. Minciu et al. (2020, p. 17) also mentions that in a VUCA (volatile, uncertain, complexity and ambiguity) environment which relates to a crisis situation, decision making is much more efficient when representatives from all departments are consulted.

King (2002, p. 5) confirms this by listing 5 factors for team effectiveness, especially in the time of crises, namely:

- 1) "Prior interactions": When they already know each other, they would feel more comfortable challenging each other's view point, learning from each other, generating new ideas, and therefore be more productive (King, 2002, p. 6)

- 2) "Team composition": The more diverse the members of a team are the more creative they are and therefore make better quality decisions (King, 2002, p. 6)
- 3) "Task knowledge": When members have prior knowledge or experience of a task, then they generate better ideas. (King, 2002, p. 7). Thus, prior knowledge would enable the members to make faster decisions as they do not have to go and first learn what is needed to understand the problem in order to decide on a solution or a way to go forward.
- 4) "Leadership ability": Charismatic leaders are better at managing a crisis, holding it all together and encouraging all to work together. (King, 2002, p. 8)
- 5) "Organizational culture": The beliefs and values of the members influence the way they make it through the crisis. Teams that support the crisis planning and strategy are more likely to be effective. (King, 2002, p. 9)

Although leadership types/styles and culture are mentioned in this paper, it is not actively pursued and not in focus but rather seen as an interesting sub note.

It is therefore not just about incorporating people in the team that have different backgrounds but what is more important is the different perspectives in combination with a deep knowledge of the respective disciplines and ideally having vast experience of a subject.

According to Crandall et al. (2021, p. 141), "crisis management teams are cross-functional that includes top managers with strategic vision and authority to make decisions and render resources when a crisis strikes."

Important factors to be taken from this statement are:

- As mentioned before. Members need to be from all functional areas of the business: Crandall et al. (2021, p. 141) talks about including marketing, production, finance and other functional areas. But considering the fact that this paper is related to supply chain disruptions which has an influence on production and in turn the customer as well, other departments would be relevant here. For example supply chain, purchasing, and sales. The CEO should also be involved in the process, directly or indirectly, thus delegating the executive position to someone else in case he is not active in the team.
- The managers need to be capable of making strategic decisions: Thus, the big decisions with higher risk, that point the organization in the right direction. Smet, Jost, et al. (2019, p. 2f) talks about three types of decisions to be made (table 2), of which two are relevant here: 1) Big-bet decisions that are more infrequent and future shaping, and made by top management (CEO or c-level involvement) and 2) Cross-cutting decisions that are more frequent and require collaboration amongst department heads.
- The managers need to have authority over resources: Strategic decisions have to be implemented for which the resources are needed. This work should be delegated to project teams or specialists, who according to Smet, Jost, et al. (2019, p. 7f), are delegated in making decisions on how the work will be done. The delegated decisions are low risk and frequent and are related to everyday work. Giving full authority to "those

that are closest to the work”, means faster and better implementation of the work. One way of keeping delegated decisions from unnecessary escalation, is to set a threshold for decisions that require approval. (Smet et al. 2017, p. 11)

Key practices by decision type	Who makes it	How to make it better
Big-bet decisions Infrequent, high risk, future shaping (eg, M&A)	Top team; board	Spur productive debate— eg, assign someone to argue the case for and against a potential decision
Cross-cutting decisions Frequent, often high risk, collaborative (eg, operations planning, pricing)	Business-unit heads; senior managers	Double down on process— one that helps clarify objectives, measures, and targets
Delegated decisions Frequent, low risk, day-to-day (eg, hiring, marketing)	Individuals; working teams	Ensure commitment— not just consensus

Table 2: The three decision categories (Smet, Jost, et al., 2019, p. 3)

The roles need to be made clear, before convening a meeting with CMT members. McKinsey Explainers (2023, p. 4) mentions that the participants need to be divided into four roles

- 1) “Decision makers”: Who is responsible for which decision. For example, who is making the decision regarding finance and who is deciding regarding production etc. If the CEO is present (or the delegate), he/she would be the executive decision maker. But in general the team needs to be able to solve disagreements and commit on the decision otherwise the decision would lead to split strategy and loose its effectiveness.
- 2) “Advisors”: The other top management members or delegates that have a big stake in the outcome and the business impact of the decision. That is why it is critical that all top or main department managers are involved where the decision could have an impact. They will know best because they have the knowledge and experience related to their respective department or business functions. It could also be that an advisor is a decision maker as well.
- 3) “Recommenders”: The group or individual specialists who have the knowledge regarding the topic on which a decision needs to be made. They would normally “conduct analyses, explore alternatives, illuminate pros and cons, and ultimately recommend a course of action to the advisers and decision makers.” In other words, they bring clarity for a situation by investigating it on a functional or operational level in order to bring the facts to the table. Having the facts together with the available and viable options, simplifies the decision process. Which in turn means better quality and faster decisions. The person/s do not necessarily sit in on the meeting.
- 4) “Execution partners”: The group or individual specialists who are responsible for implementing the task which is related to the decision that is made by the decision makers in the management team meeting. Here it is important that the group or responsible

person sits in on the meeting when the decision is made in order to speed up the process by not needing to convey the information and also ensuring clarity.

2.2.3.4 Effective structures

It was mentioned earlier that leaders need to re-organize the collaborating structure of the workforce in order to manage the effect of the crisis on the organization. The newly structured collaboration can then facilitate more effective decision making that leads to more effective problem resolution.

According to Mossa-Basha et al. (2021b, p. 3), all efforts and goals should be aligned with decisions from the main and central leader crisis management team (CMT). Fener & Cevik (2015, p. 5) supports this by saying that the best way to solve a crisis is with team work of the managers. Heath (1998a, p. 3) mentioned that, "Fast decision making usually comes from single decision makers who exert authority in centralized structures. Crisis situations tend to require a central commander to whom (and through whom) all information and attention is placed." The CMT fulfills the role of such a central commander indicating that strategic decisions need to be made in a centralized way. These decisions are made with all affected business unit representatives together in one meeting. Therefore ensuring decision making that considers the whole organization.

From Heath (1998a, p. 3) it can be concluded that crisis management requires the input from experts and teams by decentralizing operational decisions in order to take full advantage of all stakeholders. In hierarchical and top-down oriented organizational structures this means: decentralization of a structure ending up with a flat structure where work and certain decisions are divided among the crisis management team managers which are passed on to their respective teams. Dhillon et al. (2020, p. 26) confirms this by referring to the effectiveness of a team based approach in a VUCA environment, during the execution phase. Delegation is therefore permitted at teams level which ensures faster and more effective implementation of the strategy.

As mentioned in 2.2.3.3, that management needs to accommodate a two-step decision making process where strategic decisions can be made on a management level and delegated decisions on an operational level. And according to Heath (1998a, p. 3), "...crisis management requires decisive action due to the limited time in which to respond, the threat of losses, and the uncertainty of available information." Considering the fact that decisions need to be made fast, means that the path between the two levels need to be short as possible. This ensures fast communication for sharing information regarding the situation, possible solutions or what needs to be implemented.

Also mentioned in 2.2.3.3, that the 'execution partners' who are responsible for completing the task, related to the strategic decision made in the CMT meeting, also sits in on the CMT meeting. Alexander et al. (2020, p. 3) also talks about a fishbowl model where 'the executer of the

decision' sits in on the meeting together with the decision maker, expert and other relevant stakeholders. Here they again mentioned the big advantage of management being able to simply turn to the 'executer' in order to clearly explain the task, the timeline and answer any questions. Thus ensuring a flatter structure for more direct communication which saves time and ensures clarity. In normal circumstances, tasks are handed down to the employees by their direct managers which evolved from an initial decision higher up and then filtered down through the ranks. Collaboration in such a hierarchical structure takes more time which is not a problem, as situations outside of a crisis is not time critical.

Consultation is therefore required from both levels; management level, in order to make big-bet and cross-cutting decisions, as well as from an operational level in order to make delegated decisions. Thus, have a team of management level members from different functional areas in a centralized crisis management team, together with supporting specialist teams or groups in a decentralized structure which ensures better and more effective collaboration.

2.3 Crisis Management

The first step of crises management is to convene the crises management team that has ideally been established in the pre-crisis. It is expected of the CMT to perform tasks like "...fact finding, analysis, damage control, and communication" (Heath, 1998a, p. 2). In order to do that they need effective leadership, an appropriate structure and resources, and support from all functional areas (Crandall et al., 2021, p. 204).

The following sub sections explain the tasks to be performed by the CMT when managing a crisis (Crandall et al. 2021, p. 206f). Only the three most relevant tasks were taken for framing the crisis management phase.

2.3.1 Situational assessment

One of the first tasks of the crisis management team is to assess the situation in order to get an understanding of the environment and the problem, before making any decisions on how to manage the crisis. It is here where most of the "information processing" and "knowledge creation" takes place (Crandall et al., 2021, p. 206). It is also important that the information gathered in the crisis is processed and transformed into something that describes the situation as accurately as possible (Tokakis et al., 2019, p. 38).

Knowing what is coming to you, leads to more appropriate decisions that improves the effectiveness of your actions. Which is why this is probably one of the most important parts of crisis management.

2.3.2 Mitigation strategies

Only when the situational assessment is done, can the CMT start to strategize on how to mitigate the crisis (Crandall et al., 2021, p. 209). The data needs to always be up to date in order to effectively react to the constant changes caused by the pandemic (Mossa-Basha et al. 2021a, p. 4).

But, sometimes the situation is not so clear due to incomplete information, which is why the process needs to be repeated in cycles. A cycle would normally consist of: 1) collecting the data, 2) interpreting the data, 3) deciding on a strategy and 4) implementing the strategy. The next cycle is then started with reviewing the work result from the implementation and its effect. And then possibly require an adjustment of the strategy. The strategy therefore needs to be continuously adjusted to always be in line with the needs of the situation. (Mossa-Basha et al., 2021a, p. 4)

The decision making process plays an important role in mitigating a crisis.

2.3.2.1 Crisis Decision Making

A decision can only be a good decision when it has been followed through all the way to the end, and has been effectively and fully implemented as intended. This requires the commitment from everyone, even when not all agree. Strategic decisions made in the management team need to therefore be accepted by everyone in the team and then communicated by all members to their respective departments or business units (Smet, Jost, et al., 2019, p. 9).

It also requires clear communication of the strategy to all parties responsible for the implementation of the strategy and the work behind it. If everyone knows and understands what management is trying to achieve, the operational work would be more effective (Smet, Hewes, et al., 2020, p. 5).

Below is a 7 step example of a crisis decision making process.

Decision-Making Step	Action plan
Step 1: Alert and assemble the crisis management team.	As soon as the crisis has been detected the CMT should be activated.
Step 2: Collect all the relevant information.	Learn as much about the situation, including what happened, who was involved, where it took place and the current status of the crisis.
Step 3: Assign tasks and continue fact finding.	The crisis management team should delegate duties as a project management team would. Literature added by author: <i>“While it’s important to devote enough resources to help propel follow-through, and it’s also important to assign accountability</i>

	<i>for getting things done to an individual or at most a small group of individuals, the biggest challenge is to foster an “all-in” culture that encourages everyone to pull together.” (Smet, Jost, et al., 2019, p. 9)</i>
Step 4: Develop solution alternatives	Identify feasible solutions.
Step 5: Implement the chosen solution(s).	Implementation is often the most challenging part of the process. It requires competent and sufficient people, time and money. Literature added by author: <i>“One of the most important characteristics of a good decision is that it’s made in such a way that it will be fully and effectively implemented. That requires commitment, something that is not always straightforward in companies where consensus is a strong part of the culture (and key players acquiesce reluctantly) or after big-bet situations where the vigorous debate we recommended earlier has taken place.” (Smet, Jost, et al., 2019, p. 9)</i>
Step 6: Communicate with the media	The organization should be proactive in meeting with the media and presenting its side of the story. Added by author: Communication to the media is not as relevant for a supply chain crisis as would be for an internal company scandal or a tragedy related to customers.
Step 7: Review what happened.	Evaluate the decisions and the outcome. What was learned, and how might a similar crisis be handled in the future.

Table 3: Crisis Decision-Making – modified by author based on (Crandall et al., 2021, p. 211)

Minciu et al. (2020, p. 3) also refers to a 4 stage decision making process in a VUCA world. There are a lot of similarities to the crisis decision making steps shown in table 3.

Stage 1: Here again stating the importance of first getting an understanding of the situation. Thus getting an understanding of the problem and its severity, and what needs to be solved.

Stage 2: Looking at what options the organization has for solving the problem.

Stage 3: Getting an understanding for the impact each possible decision has on the business.

Stage 4: The process of implementing the decision by delegating it to the operational teams who will do the work.

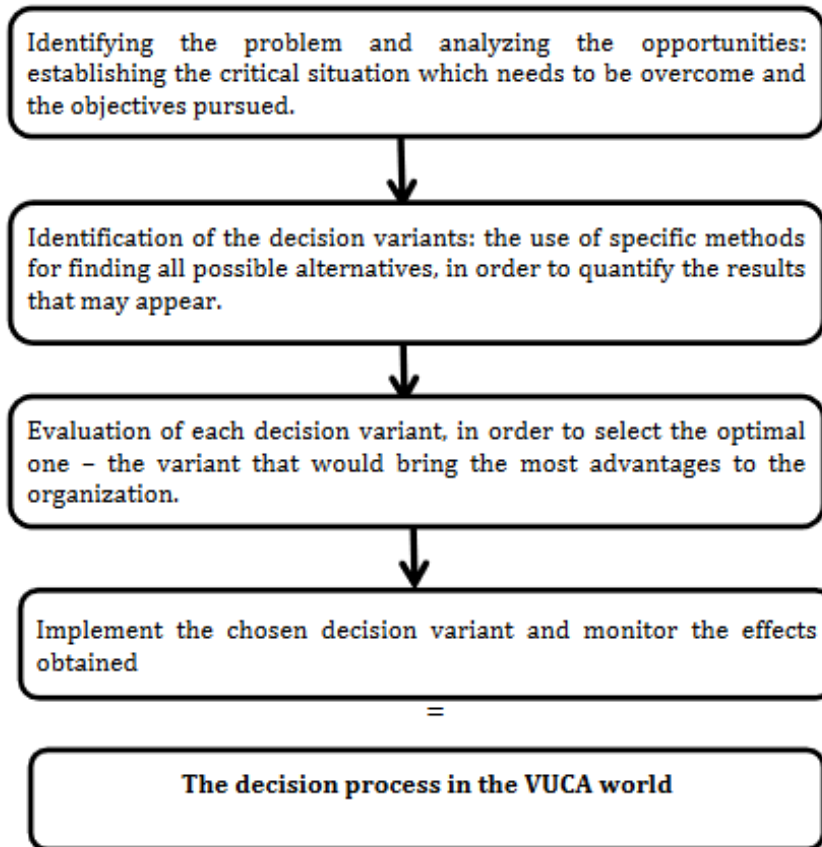


Figure 1: The process of adopting decisions in the VUCA world (Minciu et al., 2020, p. 3)

2.3.3 Evaluating the crisis status

According to Crandall et al. (2021, p. 213), three possible scenarios may be seen any time during the course of the crisis, namely:

- 1) The assumption that the crisis is under control and management can start with preparations and the process of getting the organization back to the normal state of operations.
- 2) The crisis still poses a threat to the organization and they have to continue with the cycles of assessment and mitigation. At this point they have either found a momentum and strategy that works for containing the damage or they keep on readjusting it in order to minimizing the damage as much as possible.
- 3) The impact of the crisis is catastrophic and the 'ship is sinking'.

It is important that the CMT understands in which of the 3 scenarios the organization finds itself in, all the way through the organizational crisis.

2.4 Post-crisis

For the post-crisis phase, only organizational learning is addressed. Even though it was not the main focus of this paper, learnings still had a small part to play. It was also important to give an overview here in order to close the loop.

2.4.1 Organizational learning

According to Crandall et al. (2021, p. 265), "Organizational learning is the process of detecting and correcting errors. It seeks to improve the organization's operation by reflecting on the past experiences." The idea is to understand what went well, in order to incorporate it into the process, and what didn't go well, in order to prevent this from being done again.

Facilitating a learning environment and providing the tools and methods necessary to do that, is the last management task. The best time to do this is directly after the crisis has been resolved, but all events and occurrences are still relatively fresh in everyone's minds. Also, because the more time that passes, the less motivated people become to go through the learnings process (Crandall et al., 2021, p. 273). But the effectiveness of the learning also depends on the type of method used.

Carmeli & Schaubroeck (2008, p. 5) mentions that the detection and correction of an error could come in two forms: Single Loop Learning and Double Loop Learning. Single loop learning is when the error is corrected without making any fundamental changes to the processes and policies. On the other hand, with double loop learning the organization would have a deeper look into the root cause of the error and then fix it in order to make sure it doesn't happen again. The double loop learning would therefore be the more effective and sustainable form of learning.

A good learning process would ensure that the organization is better prepared for a similar crisis, in case it happens again.

3 Research methodology

An explorative approach was taken to answer the questions. Therefore doing qualitative research in order to generate a theory about how the firms acted in the seemingly unique case of the COVID-19 pandemic. Foreseeable outcome would be for organizations to know which factors to consider regarding decision making to be able to establish a holistic and well-informed future crises management strategizing plan.

3.1 Research philosophy

The philosophy for the research that was conducted and laid out in this paper is called interpretivism. According to “Research Methodology” (current, sec. Research Philosophy) this philosophy “integrates human interest”, and are more focused on qualitative based analysis. Also that “interpretive researchers assume that access to reality (given or socially constructed) is only through social constructions such as language, consciousness, shared meanings, and instruments.” The research has therefore a more personal way of data collection such as with interviews.

“Disadvantages associated with interpretivism relate to subjective nature of this approach and great room for bias on behalf of researcher. On the positive side, thanks to adoption of interpretivism, qualitative research areas such as cross-cultural differences in organizations, issues of ethics, leadership and analysis of factors impacting leadership etc. can be studied in a great level of depth.” (“Research Methodology,” current, sec. Research Philosophy)

3.2 Data collection and analysis

3.2.1 Sampling

Sampling Method

Sampling technique is purposive sampling because it is used for information rich cases, and the method of purposive sampling is expert sampling (*Big Enough? Sampling in Qualitative Inquiry*, 2021). The reason for using expert sampling is due to the assumption that the target population to be leaders/managers, from electronic manufacturing firms, that were part of the crisis management teams or at least had a part to play in the crisis management process. They are ‘experts’ in the sense that they know how the crisis was handled in their respective organizations during the component shortage situation. Departments that were targeted are purchasing and R&D. The primary target population was the purchasing department due to the fact that they are the link between the component suppliers and the rest of the firm, and they are the requester of help regarding component approvals. It was therefore assumed that they would know who were involved in managing the crisis.

Sampling Size and Population

The goal of purposive sampling, and more specifically expert sampling, is to generate rich and focused information, which means that a smaller sample of approximately 6 is enough (*Big Enough? Sampling in Qualitative Inquiry*, 2021).

Electronic manufacturing firms, situated in the Vorarlberg region were explored regarding their experience of managing the crisis during the pandemic. Eventually five electronic manufacturing firms agreed to take part in the research from which six interviews were conducted. Two of the interviews came from one firm which consisted of someone from R&D and the other from the Purchasing department. All the other interviews were with people from the Purchasing department. It was important that the interviewees are on a management level which meant that the chances should be high that they were part of the management team responsible for the crisis management setup. The management levels of the six interviewees varied between 'head of' and vice president. Information also relevant and seen in the table below is the relevant size of the company, the company type (4* OEM and 1*EMS), whether they produce internally or externally and finally whether the person was part of the crisis management team and/or task force/s. In order to keep the companies anonymous but still be able to coordinate the data, the 5 companies were referenced as C1, C2, C3, C4 and C5.

Reference	Size of Company (€)	Industry	Electronic assembly	Interviewee position	Part of the CMT	Part of a Task Force/s
C 1	XL	Original Equipment manufacturing (OEM)	External Production Partner	Head of Purchasing	No	Yes
C 2.1	L	Original Equipment manufacturing (OEM)	Internal Production	Director of Technology	Yes	Yes
C 2.2	L	Original Equipment manufacturing (OEM)	Internal Production	Director of Operations	Yes	Yes
C 3	M	Original Equipment manufacturing (OEM)	External Production Partner	Director of Purchasing	Yes	Yes
C 4	M	Electronic Manufacturing Services (EMS)	Internal Production	Head of Purchasing	Yes	Yes
C 5	L	Original Equipment manufacturing (OEM)	Internal Production	SVP Global Purchasing	Yes	No

Table 4: Company information matrix related to the interviews ¹

One limiting factor of the sample size was the willingness of some organizations to take part in the research. Three more firms were asked to take part, but they rejected the offer or simply refrained from answering.

¹ Revenue: M = 30M€ to 90M€, L = 150M€ to 500M€, XL > 1 billion€

3.2.2 Data collection

Collection Method

The primary method used for collecting the data was by means of conducting interviews.

According to “Research Methodology” (current, sec. Interviews), there are three interview formats, called: Structured, Unstructured and Semi-structured. With structured there are a fixed set of questions, with unstructured no questions are prepared, and with semi-structured some questions are prepared but some additional questions might be asked during the interview in case further elaboration is needed in supporting the basic questions. Or new concepts became apparent during the interview and needed further probing.

A semi-structured format was chosen mainly due to the uniqueness of the COVID-19 pandemic in having a global effect for both supply and demand. Nobody in the modern industrial era has ever experienced this type of crisis to such a degree. Even though the basic frame was based on the crisis management literature, it was assumed that there might be more to come out of the interviews than what was found in the literature.

It was important to have the interviews face-to-face in order to have a better and more personal connection with the interviewee. Having both audio and visual (body language), made it easier to judge a person’s emotions and motivations towards a topic which indicated a sense of personal importance regarding a topic. That also helped in conducting and leading the meeting.

Interview tools for data collection

It was decided to use Microsoft Teams as the main tool for facilitating the interviews in order to meet face-to-face but also to be able to record both audio and video. Having the video recorded meant that the interview could be replayed for a much richer analysis than with audio alone.

The “happyscribe” software tool was used for transcribing audio to text. It is quite an accurate tool which achieves an accuracy of more than 95% leaving the other 5% to be corrected and confirmed by using the audio recording.

Miro, which is a digital whiteboarding or brainstorming platform, was used interactively together with the interviewee for mapping the crisis management teams and task forces. Having the interview over ‘Teams’, enabled the interviewer and interviewee to both view the Miro board, while working together on reconstructing the different types of collaboration during the crisis.

The principle which this process is based on is called Cognitive Mapping. According to “Cognitive Mapping” (2021), cognitive mapping “is a set of techniques for studying and recording people’s perceptions about their environment. These perceptions are recorded graphically in the form of a “mental map” that shows concepts and relationships between concepts.

“Cognitive mapping techniques consist of three major steps: (1) eliciting concepts, (2) defining concepts, and (3) identifying assertions that concepts are connected by causal relationships.” The specific type of cognitive mapping is called Concept Mapping which, according “Conjointly” (2023, p. Concept Mapping), is “a general method that can be used to help any individual or group to describe their ideas about some topic in a pictorial form.”

With this in mind, using Miro, helped the interviewee to recall the processes and events as well as stimulate a conversation in order to answer the relevant questions. This also ensured more accurate reconstruction of the events because it made it possible for the interviewee to request a correction of a possible misinterpretation of an illustration. It was also assumed to prevent bias that would skew the results. Refer to figure 2 for an example of an illustration made in Miro.

Interview Framework

The purchasing department was targeted for the first interview for reasons mentioned above. The purpose of the first interview was to possibly but slightly re-adjust the target population and use any new insights (not considered in the original literature review) to expand or re-evaluate the current literature in order to generate more focused and relevant questions for the following interviews. The process was repeated after each interview unless no new concepts came up from a respective interview.

Factors of organizing/arranging structures (organizational and teams level) was collected in order to compile various organizational behaviors and on the other hand have them evaluated by the same experts regarding effective decision making under uncertainty and lack of time.

Structured part was started with getting an understanding of the current organizational structure needed for collaboration in ‘normal’ circumstances. Which was followed by looking at what structural changes were made, if any. Find out who all were involved in managing the crisis. And then it was broken down to the teams structure before and during the crisis management.

The Miro board structure and Questionnaire:

The structured part were questions which were based on the crisis management principles in combination with building up the teams structures on Miro reflecting the Pre-pandemic and Pandemic environments.

The main theme of the interview was introduced as:

Collaboration for effective decision making during the shortages crisis under both uncertainty and time pressure. What are the factors?

The original Questionnaire that accompanied the Miro illustrations:

1. What does the structure look like that you are normally working in? The departments you are working with or interacting with.

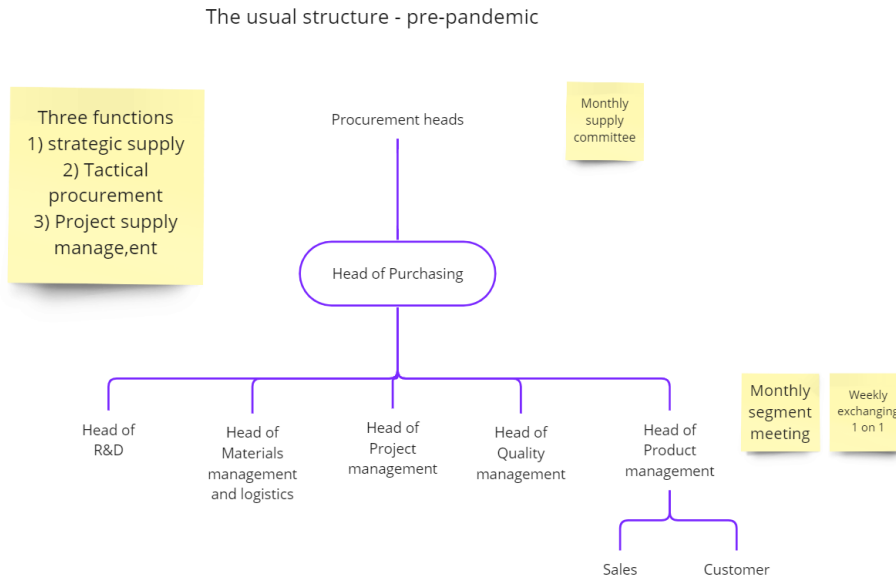


Figure 2: Structure before the pandemic – Example from one of the organizations

2. The structure during the pandemic

- What did the structure look like during the shortages crisis for more effective decision making?
- Who was in the driving seat in managing the crisis?
- How did you organize or re-organize yourselves for better collaboration?
- What was the biggest challenges or problems to overcome in the last two years?
- Which factors were important for overcoming the uncertainties? Why?
- Which factors were important for faster decisions? Why?

3. Crisis management team – for effective decision making

- Which factors did you consider in setting up the crisis management teams for effective decision making under both uncertainty and time pressure?
- One central team for the crisis management, or divided into different teams?
- Why was that important?
- Which factors were important for overcoming the uncertainties? Why?
- Which factors were important for faster decisions? Why?

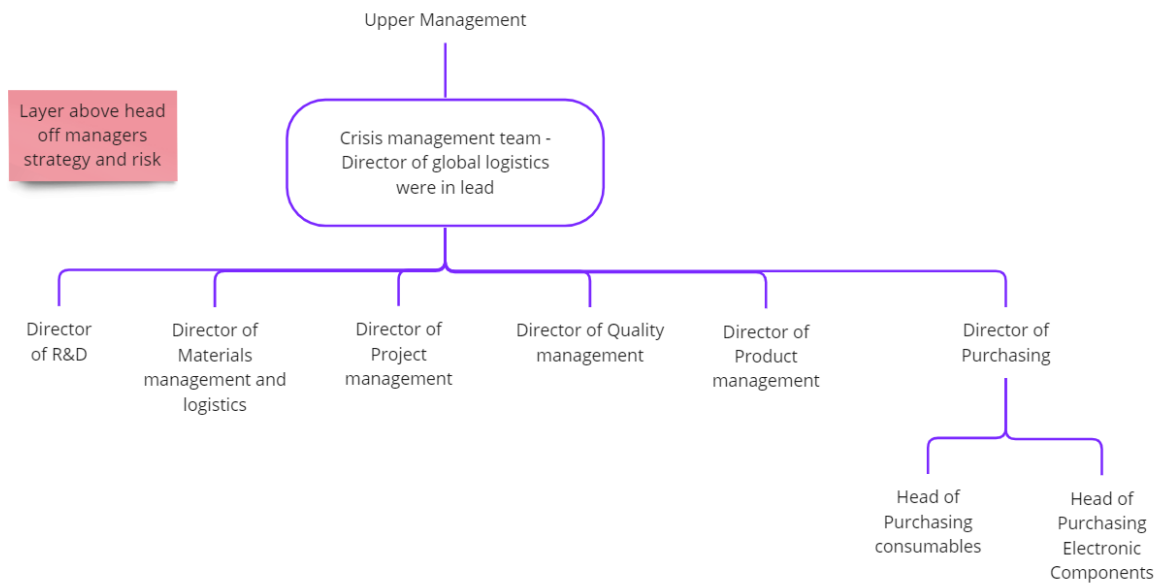


Figure 3: Crisis management team during the pandemic – Example from one of the organizations

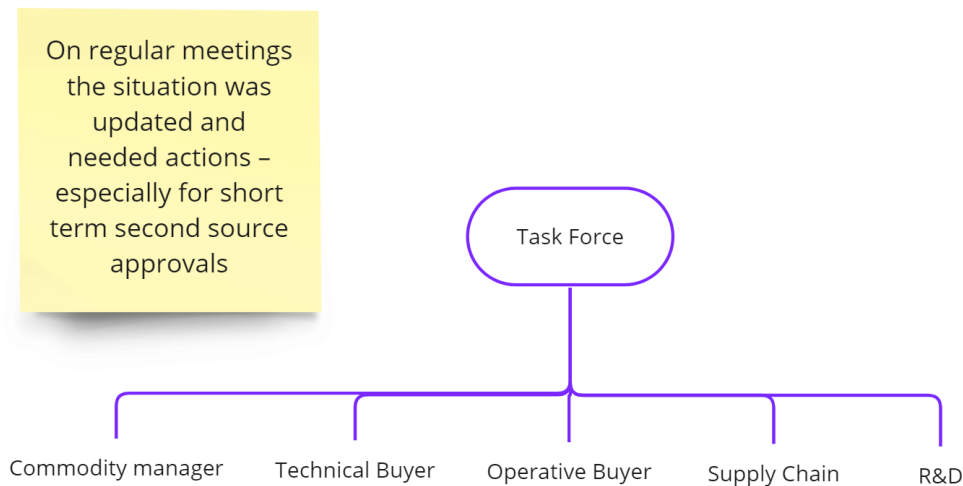


Figure 4: A Task Force during the pandemic – Example from one of the organizations

The following Questions were added to the original Questionnaire after the first and second interviews:

- What determines decisions on different levels?
- What was needed for more clarity on how to go forward?
- On what basis did you prioritize tasks and projects?
- How did you establish the level of risk decision allowed on different levels?
- Biggest challenges in managing the crisis management team, and how were they overcome?

- What did you need as an input to the crisis management team regarding decision making (speed and uncertainty)?
- Did you establish any task forces?
- What did the task forces need regarding information in order to do their job?

These questions were then also sent to the first and second interviewees via email.

3.2.3 Method for data analysis

The technique used for analyzing the data is called Content Analysis. According to “Content Analysis” (n.d.), content analysis is a method or technique used to “determine the presence of certain words, themes, or concepts within some given qualitative data (i.e. text).” In this case it would be the transcribed audio data. The text was analyzed by first dividing it into two separate categories called: Pandemic and Pre-pandemic, then it was broken down into themes as a first coding round, and finally it was further broken down into codes as a second coding round. There were no special analyzing SW tools used during the analysis process. The analysis was done with an old fashioned method of reading and coding the text manually. The process was quite time consuming in the sense that the text had to be re-read multiple times and the interview recording re-watched repetitively with every coding layer. Manual coding was thought to be better in the sense that a concept or theme might be explained explicitly, implicitly or simply in a different way from one interview to the next.

Coding categories

Primary aspects that were considered: crisis management team, structures, teams, meetings, fast decisions, information, uncertainty, decisions under uncertainty. During the analysis these basic aspects were used while other aspects became apparent when the relationship between people, teams, functions and processes became clear and were understood. By getting familiar regarding the story about how they collaborated and what was seen as important, the themes and codes developed further. The three layers of coding are laid out below.

Two main categories: Pre-pandemic and Pandemic

Themes: Meetings, Structure - Crisis Management Team, Meeting - Crisis Management Team, Structure - Task Force, Meetings - Task Force, Business focus, Uncertainty – getting clarity, Decisions - Risk level, Information needed - Crisis Management Team, What came out of the crisis

Codes: Task forces, Fundamental structure did not change, Business decisions, Fast decisions, Stakeholders, Steps to get clarity, More frequent meetings, Business priority, CMT has full authority, Supply chain for information, Suppliers for information, Escalations, Better collaboration, First layer of decision making, Decision makers and advisors, Options, Strategic decisions, Commitment, Tactical and operational decisions

Cross analysis

Each respective interview was separately analyzed and then compared to all of the previous interviews. Thus repeating the process in iterative steps. Previous interview texts were therefore repetitively reviewed by comparing them to the following interview texts, in order to see if some of the new concepts became apparent in the following round. And vice versa. This was needed because not all concepts became apparent in the first round, mainly due to the way an interviewee would answer a question or describe a situation varied between the respective interviewees. In some cases a concept was explained or mentioned implicitly and could only be understood or recognized later on as a basic pattern were formed between interviews.

Decisions - Risk level

Escalations

Absolutely. Okay, plan delivery tomorrow is not coming. Delay it again, two weeks. But I have at a broker market, the spot by cost me 10,000 euro more. But escalating finance PM decided yes, no, go.

Task force – led by purchasing

Okay. So it's also in this meeting, it was purchasing, who was managing it?

Yes.

Page 7

Task force – led by purchasing

Okay. Because you have the best understanding of where the problem is coming from the information. Exactly.

Structure - Task force

Meeting - Task force

Information needed CMT

It was the team approach, definitely. Just the roles, the commodity manager was orchestrating that. So really having this updated information from the market. Technical buyer was more in regards of second sourcing samples? Do we have it already or not? Are there any alternative? Operative buyer was really okay. Updating always the full delivery scheduling from the supplier. Do we have any update here? And supply chain then the planning, what are the demands? Do we have over planning or not, etc. And R&D, of course, the status of second source approvals.

Figure 5: Interview text coding example - blue=theme and green=code

Consolidating the data

And finally, the data from all interviews were consolidated in a table and categorized under the shared themes and codes which was then referenced and described.

Ref.	Theme	Code	Description
C 1 C 2.1 C 2.2 C 3 C 4 C 5	Organizational Structure	Fundamental structure did not change	All: Only added Crisis management team and task forces C 4: Only added task forces
C 1 C 2.1 C 2.2 C 3 C 5	Crisis management team	Existing	C 4 did not have a crisis management team. Because they are a EMS that produces assembled PCBs for electronic manufacturing companies. They are a production partner for electronic manufacturing companies. They are the supplier and the crisis management team sits by each respective customer. This was seen because they were also referring back to the customer making the decisions that are normally made in the CMT
		Reason	The crisis threatens the company's financial wellbeing Business/financial, Executive, Strategic decisions to be made What needs to be done, where to focus the resources, which resources and the cost approvals
C 1 C 2.1 C 2.2 C 3 C 4 C 5	Task force teams	Existing	Various purchasing and R&D Task Forces
C 1 C 2.1 C 2.2 C 3 C 4 C 5		Reason	Very high frequent changing of the delivery situation and the availability and the impact to the product. Creating transparency What is the situation? What is changing? What product will be not available? So that PM was informed. What does it mean? Operationalize the decisions made in the CMT
C 1 C 2.1 C 3 C 4 C 5	Meetings	More frequent meetings	Increased frequency of decision making, faster response needed with higher flexibility Looking at different options/solutions and the progress thereof
C 1 C 2.1 C 3 C 4 C 5		Frequency CMT meetings	C 1: Once a week (from Once a month) C 2.1: Once a week (the same) C 3: Bi-weekly (don't know) C 4: Once a week (from bi-weekly) - they work different not having a CMT and this is compared to the normal purchasing/sales meeting C 5: Once a week (from Once a month)

Table 5: Part of the table from consolidated coding data

4 Results and Findings

It is now in this section where we are getting to the point in starting to develop a better understanding of the data collected. And because the data collection was based on the original research questions it only seems right that we familiarize ourselves again regarding the research questions.

The research question together with the supporting sub questions:

Which organizational factors did the electronic manufacturing firms in Vorarlberg consider important for effective decision making in the shortages crisis during the COVID-19 pandemic?

- RQ1.1: In what way did the firms adapt or add to the existing organizational structure for more effective decision making?
- RQ1.2: How does the normal operations structure differ from the structure during the crisis?
- RQ1.3: Which factors did they consider in setting up the crisis management teams for effective decision making under both uncertainty and time pressure?

In order to systematically answer the research questions, the results and findings were categorized and presented in three main sections which aims to give an understanding and explain the three sub questions.

All the way through this section, the aim was to give an understanding for both, 'what was done by the organizations' as well as 'why it was done that way'. 'What they did' is of equal importance to 'why they did it'. It is only through knowing the reason for what was done that one can start to fully understand the situation and then be able to achieve external validity through generalization. According to "Conjointly" (2023, p. External Validity), "external validity is the degree to which the conclusions in your study would hold for other persons in other places and at other times." If people know why something is needed, they can adapt the said function or process to their specific needs so that it can also work for that 'new' environment.

4.1 Results and findings for sub RQ1.1

RQ1.1: In what way did the firms adapt or add to the existing organizational structure for more effective decision making?

All of the companies that were interviewed, clearly stated that their fundamental structure did not change, before, during or after the crisis.

Ref.	Theme	Code	Description
C 1 C 2.1 C 2.2 C 3 C 4 C 5	Organizational Structure	Fundamental structure did not change	All: Only added Crisis management team and task forces C 4: Only added task forces

Table 6: Fundamental structure unchanged

Crisis management teams (CMTs) added

What they did in fact do, was add Crisis Management Teams of different forms and functions. Four of the five companies referred to as C1, (C2.1, C2.2), C3 and C5, who are all Original Equipment Manufacturers (OEMs), had a main Crisis Management Team and various Task Forces. The one company C4, that is an Electronic Manufacturing Services (EMS) business only had multiple Task Forces who worked together with the respective customers. It is assumed that their customers were taking the role of the CMT, due to the reported relationship and expectations between them. Reason being, that this relationship and expectations showed a lot of similarities to that of C3 and its Production Partners (EMS). As well as the relationship between the task forces and CMTs of the respective companies in general. We will further elaborate on this later.

The reason for adding the two types of teams was due to the need for answering various questions regarding: what is going on?, how does it affect us?, what are we going to do about it?, and how will it be solved?

Ref.	Theme	Code	Description
C 1 C 2.1 C 2.2 C 3 C 4 C 5	Task force teams	Existing	Various purchasing and R&D Task Forces

C 1 C 2.1 C 2.2 C 3 C 4 C 5		Reason	C1: Increase decision making efficiency. Operationalize the decisions made in the CMT C2.1: "Build dedicated project teams" right group of specialists together on solving that issue for head of technology. "purchasing department how critical they see the situation and of course" C3: Purchasing-Information regarding supply situation, R&D-re-designs C5:What is the situation? What is changing? What product will not be available? So that PM was informed. What does it mean? C5: Very high frequent changing of the delivery situation and the availability and the impact to the product. Creating transparency
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Table 7: Task Force teams and the reason

Started with a purchasing Task Force team

It all started with assembling the first task force team in the Purchasing department. Reason was that the purchasing department started to realize that there is a very rapid and continuous change in the delivery situation and availability of the components. This in turn caused a chain reaction where they saw that it would also have an impact on the production of the finished goods in the near future. In turn, this phenomena would then also affect sales and therefore threaten the financial well-being of the company. One of the big uncertainties was that they couldn't see how long the situation would carry on and when it would stop. This critical situation was then escalated to upper management within Purchasing, Supply Chain and Operations. In need of transparency of the problem, a Task Force was assembled in order to investigate the situation further so as to get a better understanding about what is going on in the supply industry of components. In the first round, their aim was to answer some questions like: what is the situation?, what is changing?, which components will not be available?, and which products will be affected, in what way? All of this information was then gathered and handed over to upper management to decide what needs to be done about it.

Ref.	Theme	Code	Description
C 1 C 2.1 C 2.2 C 3 C 5	Crisis management team	Existing	C 4 did not have a crisis management team. Because they are a EMS that produces assembled PCBs for electronic manufacturing companies. They are a production partner for electronic manufacturing companies. They are the supplier and the crisis management team sits by each respective customer. This was seen because they were also referring back to the customer making the decisions that are normally made in the CMT
C 1 C 2.1 C 2.2 C 3 C 5		Reason	The crisis threatens the company's financial well-being Business/financial, Executive, Strategic decisions to be made What needs to be done, where to focus the resources, which resources and the cost approvals

Table 8: Crisis Management team and the reason

An Executive Task Force or Crisis Management Team

In parallel to this, also an upper management team was assembled, called the Executive Task Force or Crisis Management Team. The reason for starting the team at the higher level was because the initial information from Purchasing showed that the financial well-being of the organization is being threatened and something drastic needs to be done. They need to assess the risk, decide what needs to be done and where to focus the resources. These decisions would also then have current and short term high cost implications.

R&D Task Force

Certain situations also required R&D resources for example:

- 1) When an approval was needed for another component that was similar in form and function. Most of the time a formal task force was not needed. But rather a simple yes or no. And did not require an escalation to management.
- 2) When an approval was needed for another component that was NOT similar in form and/or function. This required much more resources in order to do a redesign and had to therefore be escalated to management.

Ref.	Theme	Code	Description
C 1 C 2.1 C 3 C 5	Structure – Task forces	Steps to get clarity	Whenever it cannot be solved within the boundaries of supply chain then an R&D Task Force is created in order to brainstorm different ideas and solutions. Parallel path to supply chain task force. Operationally there is then a direct path to supply chain/purchasing
C 1 C 2.1 C 3 C 5		Stakeholders - decision makers and advisors	Two different task forces: 1) Purchasing: Depending on the component or product - Technical buyer was more in regards of second sourcing samples? Do we have it already or not? Are there any alternative? Operative buyer was really okay. Updating always the full delivery scheduling from the supplier. Do we have any update here? And supply chain then the planning, what are the demands? Do we have over planning or not, etc. 2) R&D - status of second source approvals

Table 9: Task forces regarding the need for R&D

The two basic types of task forces from Purchasing and R&D were dedicated teams that were formed to fulfill a specific function related to resolving the critical component shortage issues that was caused by the Pandemic. Each had the operational responsibilities of gathering information or completing specific tasks that would lead to a solution for the component delivery problems. The whole process was led by the crisis management team in making strategic decisions and thereby guiding the task forces in the right direction by means of effective decisions. Figure 6 and 7 below, illustrate the relationship regarding information flow between the task forces and the CMT. The differences and the reasons thereof would be explained in detail in the following sub chapters of chapter 4.

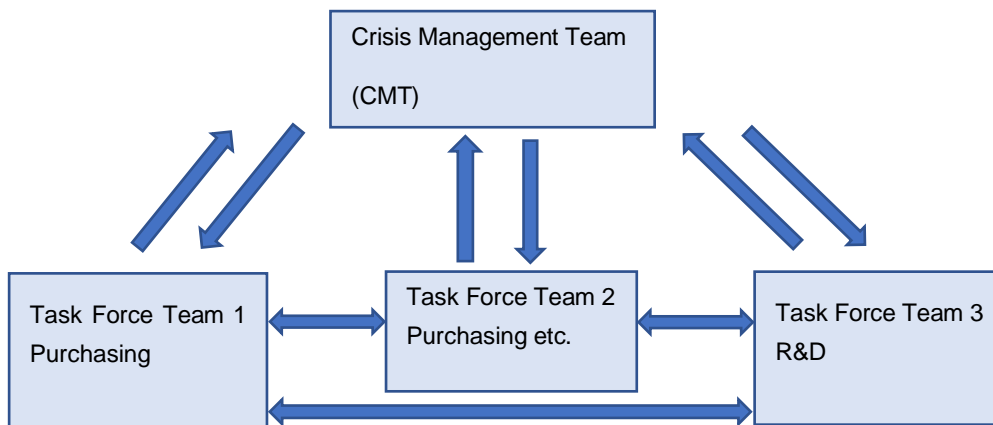


Figure 6: CMT and Task force relationship with OEMs – block diagram

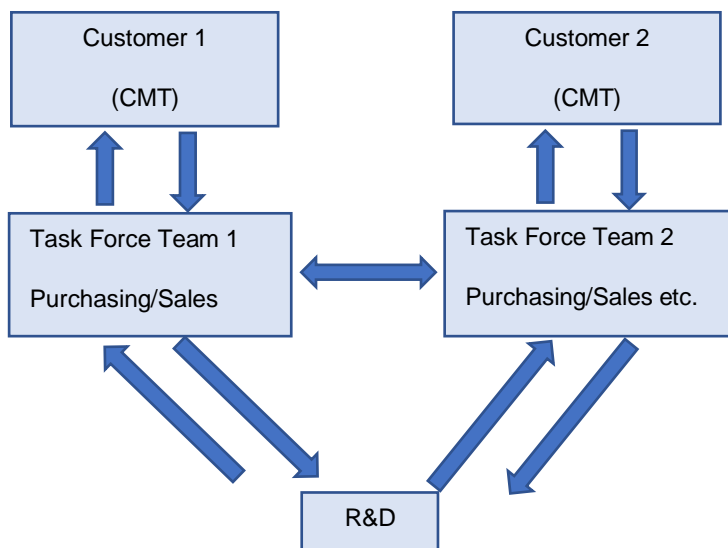


Figure 7: Customers and Task force relationship with EMSs – block diagram

4.2 Results and findings for sub RQ1.2

RQ1.2: How does the normal operations structure differ from the structure during the crisis?

As mentioned before, the fundamental structure did not change. They didn't go and change their disciplinary or functional reporting structure and they also didn't change their core functions and responsibilities. The difference was more in the way the respective project teams were setup regarding the stakeholders, the meetings that were scheduled and conducted, together with the meeting focus, the frequency of these meetings and the flow of information.

Ref.	Theme	Code	Description
C 1 C 2.2 C 4 C 5	Pre-pandemic: Strategic management meeting	Stakeholders	C 1: Upper management together with project representatives C 2.2: Executive management board only C 4: Management with CEO, CTO, CPO C 5: All executives and management
C 1 C 2.2 C 4 C 5		Frequency	C 1: Once a month C 2.2: Once a week C 4: Once a quarter C 5: Once a month
C 1 C 2.2 C 5		Focus	C 1: Steer strategic projects and define other strategic activities: new product developments C 2.2: Most important topics that we have to discuss C 5: Budget, big targets and strategy
C 1 C 2.2 C 4 C 5		Communication channels	C 1: Upper management directly with project leads C 2.2: Only C level with some directors C 4: C level with management C 5: C level with management
C 1	Pre-pandemic: Other meetings	One-on-one	Middle management more focused meetings - once a week
C 1		Supply Committee	Different business units from supply chain and purchasing - once a month
C 1 C 2.1 C 2.2 C 3 C 4 C 5		Purchasing team meeting	C 4: Team meeting - bi-weekly
C 1 C 2.1 C 2.2 C 3 C 4 C 5		Cross-functional team meeting	C 4: Responsible people for each department (assuming head-of or directors) - every 6 to 8 weeks

Table 10: Pre-pandemic situation

There were four different types of meetings mentioned which was the norm before the Pandemic as well as the norm after everything went back to (almost) normal.

- 1) Functional meetings where the members of the same department would meet up to discuss department only related issues to be answered or solved. Even though only C4 disclosed details regarding the frequency of this purchasing meeting, all of them mentioned that they do have this meeting.
- 2) Cross functional meetings where they reported back on the tasks done by each department for each project and then also the input needed from each other. (C1)
- 3) Strategic based meetings mentioned by C 1, where the project team leaders also take part in reporting back regarding the project progress and then also ask for guidance or decisions which has a large impact on the project or business in general. The focus here was to steer strategic projects and define other strategic activities for example new product developments.
- 4) Strategic based meetings mentioned by C2.2, C4 and C5, where only upper management is involved and no one from projects or product management are included. The focus here is mostly based on reporting back on financial results and larger budgets, big targets and strategy for mid to long term projects.

Ref.	Theme	Code	Description
C 1 C 2.1 C 3 C 4 C 5	Meetings	More frequent meetings	Increased frequency of decision making, faster response needed with higher flexibility C1: Task force frequency changes according to need C2.1: More frequent task force meeting at beginning C3: more frequent meeting with suppliers Looking at different options/solutions and the progress thereof
C 1 C 2.1 C 3 C 4 C 5		Frequency CMT meetings	C 1: Once a week (from Once a month) C 2.1: Once a week (the same) C 3: Bi-weekly (don't know) C 4: Once a week (from bi-weekly) - they work different not having a CMT and this is compared to the normal purchasing/sales meeting C 5: Once a week (from Once a month)
C 1 C 2.1 C 3 C 4 C 5	Business focus	Flexibility and time	C1: More flexibility needed and higher time pressure, task force per need C2.1: Driving more solutions in parallel C3: Quick informal meetings or unplanned called to CEO C4: Task forces on per case handling C5: The very high frequent changing of the delivery situation
C 1 C 2.1 C 3 C 5		Business priority	C1 and C2.1: High level decision by CEO: Serial production has higher priority (production stop is imminent due to safety stock running out) C3: R&D resources were used for technical changes instead of new development projects C1, C2.1 and C5: Sometimes new projects gets priority.

			C5: Key components and products C3: Priority, regarding which products and production, set by Purchasing
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Table 11: Meetings and business focus

Focus changed

The crisis management team and task forces, mentioned before, which were added during the crisis, did not necessarily replace these existing teams and meetings. Although they did affect these existing teams and meetings. They were mostly affected by the business focus. The business focus, priority and strategy changed from mid/long term running projects and new projects, to short term and current business:

- C1, C2, C3 and C5 mentioned that serial production had highest priority by default.
- C1 and C2.1 mentioned that all decisions that were made were to serve this top level priority.
- C3 mentioned that although they wanted to stay innovative by developing new products, their R&D was rather using their resources to adapt or change products in order to continue production.
- But, C1, C2.1 and C5 mentioned that new projects sometimes also got priority.
- C5 mentioned that they focused on the most important components and products that ended up bringing the biggest business.

More frequent and flexible meetings

The normal upper management strategic meetings before the pandemic, differed considerably in frequency between the respective companies:

- Management meeting interval before the pandemic varied between once a week (C2), bi-weekly (C4) and once a month (C1 and C5).
- During the pandemic it changed for most companies to 1 week intervals (C1, C2, C4 and C5). C3 had bi-weekly meetings.

Regarding the operational teams meetings which made up the task forces:

- C1 mentioned that also here the frequency increased but more importantly was the fact that it had to be flexible. The meetings and the intervals changed according to need. Even per day or sometimes on an hourly basis.
- C2.1 mentioned that more frequent meetings were held at the beginning of an investigation which reduced as things became more clear.
- C3 mentioned that the meetings with suppliers increased dramatically

More flexibility was needed from everyone involved:

- C1 mentioned that more flexibility was needed due to the time pressure and also the constant change of affected area and the criticality.
- C2.1 mentioned that having more resources available with more task forces working in parallel meant that more options could be explored.
- C3 reported that purchasing would walk over to R&D to informally discuss a technical option, assess the risk and make a decision in order to react faster. In some cases even the CEO was contacted directly per telephone to get a finance approval which couldn't wait. This was not done before the pandemic.
- C4 mentioned that task force teams, availability and intervals were handled on a per case basis.
- C5 mentioned that the flexibility was directly linked to the fluctuations in the deliveries.

Stakeholders involved

The stakeholders involved in the CMT also differed slightly. It was not only upper management present, seen with most of the companies before the pandemic, but also the Task Force leads or representatives and Product Management.

- C2.2 mentioned that the Head of Operation and SC (director) also did the job of the Purchasing team leader due to the position being open and it being the critical area that needs more help.
- C5 mentioned that purchasing and R&D task force leads also took part in the meeting in order to take instruction on what needs to be solved and report back on current running tasks.
- C1, C2, C3 and C5 all mentioned having the Product Managers in the CMT. They are the overall regulators of their products which means that they are the link to the respective project teams.

Ref.	Theme	Code	Description
C1 C2.1 C3 C5	Structure - CMT	Stakeholders - decision makers and advisors	C1: Reason is that Business/Financial/Executive decisions need to be made (What needs to be done regarding resources and costs involved) Diverse team was needed with people from all affected areas of the business C1: Directors or executive board: R&D, purchasing/supply chain, project management, quality, sales/product management, operations "And if that's already too much for them to decide, they (task force) can now come to the crisis management team where they would be steered in one way or another." C2.1: CEO, (actually directors) Head of technology (product management and R&D), Head of Sales, Head of operations and supply chain management

			<p>C2.2: Head of operations and SC also had the role of the purchasing task force lead.</p> <p>C3: CEO, CFO, COO, CSO (sales), R&D and product managers</p> <p>C5: The leaders of the various Task Forces were also in the meeting - Purchasing, commodity management and R&D</p>
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Table 12: CMT stakeholders, decision makers and advisors

4.3 Results and findings for sub RQ1.3

RQ1.3: Which factors did they consider in setting up the crisis management teams for effective decision making under both uncertainty and time pressure?

4.3.1 Task Forces

As mentioned earlier, the trigger for the first Task Force was the very rapid and continuous change in the delivery situation and availability of the components. This in turn affected the ability of the factories to produce complete products which meant that customer deliveries were affected and therefore the organization's core business. The fluctuations in the availability and delivery dates of components meant a lot of uncertainties regarding the supply of these components and what it meant for the organization. The first job of this Purchasing Task Force was to create clarity and transparency for the Crisis Management Team in order to decide what needs to be done. Repetitive cycles were needed.

Information needed from different areas of the supply chain and in some cases from R&D:

- Information regarding the components which are affected
- Information from suppliers: Delivery confirmation and dates
- Information regarding the products which are affected
- Information regarding production priorities
- Information regarding what is already done: status update
- Options already looked at regarding possible solutions together with recommendations
- The options available for purchasing were:
 - Broker material which was related to components already used
 - Second source components which has the same package but different supplier needed approval from R&D
 - Second source components which deviate from the original specification and requires R&D to make a redesign
- Info regarding the impact on the business and costs implications on all points above

Ref.	Theme	Code	Description
C 1 C 2.1 C 2.2 C 3 C 4 C 5	Information needed - CMT	Steps to get clarity (To make strategic decisions)	Clarity is needed due to frequent changing of the delivery situation and the availability and the impact to the product Clarity is needed on following points: Mostly from Purchasing/supply chain and task forces Where is the risk, where we have the resources, and where we need to focus. So really high level steering Info regarding where is the problem: Environmental issues, Supply issues - which component and products are affected Info regarding what are the options and recommendations (broker material, second sources-purchasing or R&D, redesigns - R&D etc.) Info regarding production priorities Info regarding affected products Info from suppliers: Delivery confirmation and dates Info regarding how far away from line stop or not fulfilling customer order Info regarding what is already done: status update Info regarding business impact and costs involved C 4 handed all of the information to the customer as the CMT together with their CEO

Table 13: Information needed for CMT decision making

Task force structures

Going further the findings are separated in this section regarding the build-up of the teams between the two type of organizations namely the Original Equipment Manufacturing companies (OEM) referred to as C1, C2.1, C2.2, C3 and C5, and the Electronic Manufacturing Services company (EMS) referred to as C4. Reason being, also mentioned earlier, is that all four OEM companies had both Task Forces as well as a CMT, but the one EMS only had Task Forces internally. Why that is, would be explained later.

Ref.	Theme	Code	Description
C 1 C 2.1 C 3 C 5	Structure – Task forces Electronic Manufacturing	Leading the Task Force	Task force was led by purchasing/commodity management
C 1 C 2.1 C 3 C 5		Stakeholders - decision makers and advisors	Two different task forces: 1) Purchasing: Depending on the component or product - Technical buyer was more in regards of second sourcing samples? Do we have it already or not? Are there any alternative? Operative buyer was really okay. Updating always the full delivery scheduling from the supplier. Do we have any update here? And supply chain then the planning, what are the demands? Do we have over planning or not, etc. 2) R&D - status of second source approvals

Table 14: Task force structures for OEMs

Purchasing Task force structure for OEMs

This section refers to C1, C2.1, C2.2, C3 and C5.

C1 reported to have had two different task forces, one for critical components and one for critical products. It is therefore divided into components and products. They also had task forces on two different levels. One on purchasing level and one on segment level that includes all the functions, as would be in the case of a project.

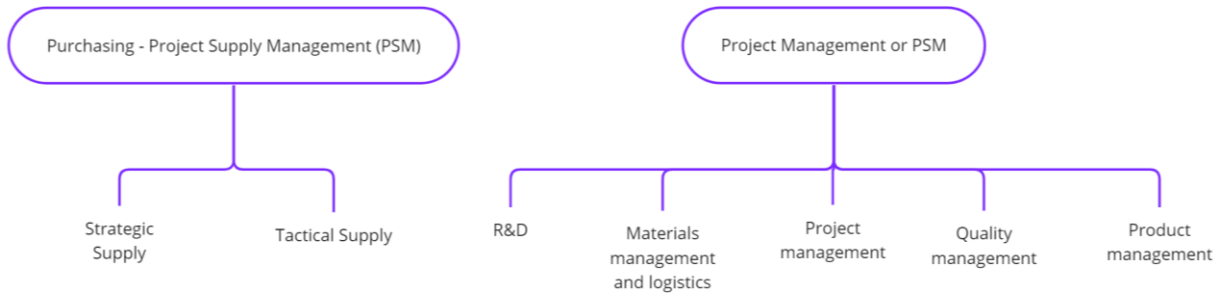


Figure 8: A task force representation of an OEM – ref. to C1

C5 reported to have the same roles for each task force but were divided regarding commodities. Therefore, each commodity had its own responsible team. Each task force was made up of a Technical Buyer who was responsible for component sourcing where second sourcing was an important factor, an Operative Buyer regarding the delivery schedule from the supplier, and the Supply Chain Planner regarding the demands. R&D was also involved regarding the technical advice or approvals needed for the second sources.

Led by Head of Commodity Management Division, Commodity Manager or Technical Buyer

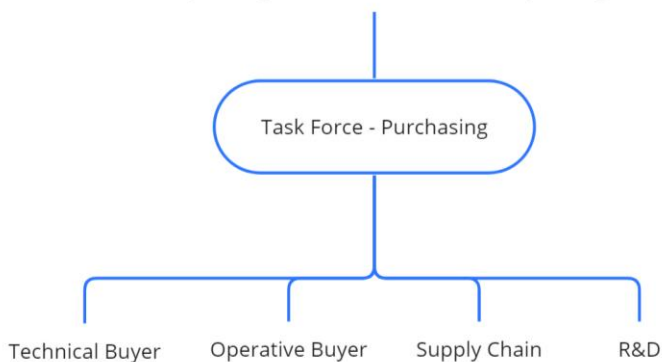


Figure 9: A task force representation of an OEM – ref. to C5

In order to get this information, mentioned above, different supply chain specialists had to be part of the purchasing task force. There were some differences to the means and ways of the different organizations to assemble the task forces. Reasons being that the different

organizations have different organizational structures in their Purchasing and Supply Chain departments. Also, as mentioned before, the fundamental structure did not change and the people's functional roles also did not change. The information listed above also isn't new. It is perhaps normally asked in different combinations, for different people and different reasons. Important thing is that they gather the needed information.

Ref.	Theme	Code	Description
C 1 C 2.1 C 3 C 4 C 5	Meetings	More frequent meetings	Increased frequency of decision making, faster response needed with higher flexibility Looking at different options/solutions and the progress thereof
C 1 C 2.1 C 2.2 C 3 C 4 C 5	Task force teams	Reason	C 1: Increased decision making efficiency Very high frequent changing of the delivery situation and the availability and the impact to the product. Creating transparency What is the situation? What is changing? What product will be not available? So that PM was informed. What does it mean? Operationalize the decisions made in the CMT
C 1 C 2.1 C 3 C 4 C 5	Business focus	Flexibility and time	C 1: More flexibility needed and higher time pressure C 2.1: Driving more solutions in parallel C 3: Quick informal meetings or unplanned called to CEO C 4: Per case handling C 5: The very high frequent changing of the delivery situation

Table 15: Meetings, task forces and business focus

Further important points to consider in setting up the task forces:

- C1 mentioned that the task forces were created to increase the decision making efficiency, hence the use of specialists in the task forces. Higher decision making efficiency was also a mechanism for coping with the increased time pressure.
- C1 also mentioned that more flexibility was needed in time, availability and combinations of people needed. It depended on which components or products are affected and what is the severity. C4 reported saying 'per case handling' where each case was unique.
- C2.1 mentioned that having multiple task forces enabled more solutions to be driven in parallel. This ensured more possibilities and options to be considered by the crisis management team.
- All mentioned that the very high frequency of changes of the delivery situation and availability of components meant that more decisions had to be made with a high urgency. Teams had to therefore meet more frequently.

Ref.	Theme	Code	Description
C 1 C 2.1 C 3 C 5	Structure – Task forces	Steps to get clarity	C 2.1: Whenever it cannot be solved within the boundaries of supply chain then an R&D Task Force is created in order to brainstorm different ideas and solutions. Parallel path to supply chain task force. Operationally there is then a direct path to supply chain/purchasing C 5: Major driver to have this task force was the very high frequent changing of the delivery situation and the availability and the impact to the product. So that means, okay, one driver was to create a transparency and say, okay, on which product we have a supply issue and how long to have that on a regular basis to have this transparency. And the task force which you have here, this is the Operative Task Force. Operative Task Force means really dealing with the suppliers and updating the figures, updating the delivery plans, et cetera

Table 16: Task forces – steps to get clarity

First layer of decision making

Operational decisions are made in the task forces where they have the needed knowledge to make the decisions or approval, and where the cost implications are not higher than what is normally expected of the job level. The risk is at an acceptable level. For example, if there are no questions or concerns regarding the technical aspect of a component, the procurement manager would make the decision by him or herself. But, if there are some technical questions or tests to be done in order to approve it, then the decision is handed over to R&D. These operational decisions between the different task forces are the first layer of decision making.

Escalations

Before any topics are escalated to management, purchasing tries to do everything they can to solve the problems on an operational level with a limited amount of resources from R&D. As soon as the cost implications become too high regarding the price of alternative components and sources, or the need for more resources from R&D, it is escalated vertically to the crisis management team.

Ref.	Theme	Code	Description
C 1 C 2.1 C 3 C 5	Meetings - Task forces	First layer of decision making	Operational decisions are made in the task forces where the risk is not too high and where they have the needed knowledge to make the decision or approval. The escalations are then done between the task forces horizontally
C 1 C 2.1 C 3 C 4 C 5	Decisions - Risk level	Steps to get clarity (Esca- lations)	Procurement manager can make certain decisions, but if too technical then it needs to be escalated to R&D in a task force, but then again if the business impact is too high then it is escalated to the CMT The reason is that purchasing department either tried everything to get it under control and was not able to, or broker material is very expensive and need to be decided in the crisis management team (too big effect on the business)

Table 17: Operational and risk level decisions

4.3.2 Crisis Management Team or Executive Task Force

As mentioned earlier, an executive management team was required for addressing the sudden increase of risk on the running operations and the possible high financial impact it could have on the organization. Steps for resolving some of the problems also had cost implications regarding either material/components or human resources.

Priorities and strategic decisions

C1, C2 and C3 mentioned that CMT needed the priorities from task forces regarding critical components and production. This information was required in order to decide on detailed strategy and therefore what the task forces need to do.

Ref.	Theme	Code	Description
C 1 C 2.2 C 3 C 5	Information needed - CMT	Priorities are needed (To make strategic decisions)	C 1: Priority set by Purchasing but sometimes by Sales when a big customer order or project comes up. Traffic light system giving an overview of all critical components. C 2: Info regarding production priorities C 3: Priority is always the availability of the components and if a line stop is possible C 5: Strategic products
C 1 C 2.1 C 3 C 5	Structure - CMT	Strategic decisions	C 1: Made in the CMT with executive members from all areas of the business as advisors and decision makers - due to risk and complexity. Decision handed down to be operationalized Refer to Business priority: C 3: All crisis management team members need to be on the same page, all need to commit and pull in the same direction C 4 the these decisions were made by customer and their CEO C 5: Information handed down to lower management level and task forces to be operationalized

Table 18: Business priority and strategic decisions

Risk management for options

Some basic supply chain principles were relevant during the crisis regarding risk management. For example

- C1 reported that the question was asked during the crisis (information for CMT in 4.3.1), whether there were any safety stock for the critical components. Having safety stock meant one more option. Even when only temporary.
- C2 mentioned that they started off quite well at the start of the crisis because they stocked up quite aggressively in the beginning. Later on the shortages became a problem.
- As mentioned before that C1 and C3 used production partners. C3 reported having multiple production partners for the same products. Therefore having more options from their supply. They could then balance the stock between them where each had different components as a shortage.

- C5 reported having a stocking policy where they would generate a critical parts list and then build up safety stock according to the priorities from the list.

Ref.	Theme	Code	Description
C 1 C 2.1 C 2.2 C 3 C 5		Risk Management (strategy)	C 1: Are there any safety stock? C 2: Stocked up at the start of the pandemic C 3: Multiple production partners C 5: Buffer/Safety stock of three months A certain stocking policy, a stocking, second source and stocking policy where we have so called aorta management. Very critical parts that are difficult to approve, source and which are used in big quantities and would therefore hurt the company if they were in shortage. What are the lead times and approval times

Table 19: Risk management for options

Information needed by the task forces

After exploring the options, the CMT needed to make decisions on what they would like the task force teams to operationalize. Clear instructions are needed from the CMT. The information that was handed down from the CMT to the Task Forces are divided into three sections:

1. What is the problem, on which component or product they needed more clarity and which they need to work on, and what is the timeline (C3)
2. An approval for one of the options presented to the CMT
 - a. Higher costs required for buying the broker material
 - b. R&D resources for a redesign of a product to be able to use an alternative component type or size. This also meant stopping some ongoing new development projects
3. High level strategy
 - a. All had the top level priority to not have any production stops
 - It was reported by C2 that all operational level decisions needed to serve this top goal
 - b. C5 reported to have the goal to define 'aorta' components which are the components that are not so common, thus not easy to find, or very complex, meaning they were difficult and time consuming to approve
 - c. C5 also reported to have strategic products that had to get priority which served a bigger part of the business or customers

Ref.	Theme	Code	Description
C 1 C 2.1 C 3 C 4 C 5	Information needed - Task forces	Info received from CMT	C 1: What needs to be done. What is the decided strategy in general as well as for the product or component they need to look at. When CMT needs an answer in order to make a decision C 2.1: Our highest priority is to have no interruption of production so that we can deliver to our customers on time. All the decisions made are serving to this top level goal. C 3: Problem description, what needs to be examined and the time line C 4: Received this information from the customer (Customer having the role of the CMT) C 5: Which direction you want the task forces to go

Table 20: Information needed by Task forces

CMT stakeholders or team members

All four OEM organizations, who had a CMT, reported in giving global logistics, supply chain or purchasing the lead of the crisis management team. The reason for that was mentioned to be, that they have the better understanding of where the problem is coming from. It is their business section of which they are competent professionals. They were therefore also best suited in gathering information and communicating the situation. It was also reported to have a combination of people that had a wide range of business understanding, knowledge and experience in order to understand the options that were made available by the purchasing, supply chain and operations teams. People were needed from all functional and business areas to assess the options, raise concerns of possible unforeseen risks and advise on best practices. In some cases also the Task Force leads joined the CMT who would then directly report on the information gathered as well as make some recommendations. In most cases the Purchasing Task Forces were involved and sometimes also an R&D Task Force when a design/product change was triggered.

Ref.	Theme	Code	Description
C 1 C 2.1 C 3 C 5	Structure - CMT	Leading the CMT	CMT was led by Global Logistics, Supply Chain department directors or Purchasing director or a delegate from one of the three
C 1 C 2.1 C 3 C 5		Leading the CMT Why?	They have the bigger clarity regarding the business situation. Refer to 'Steps to get clarity (To make strategic decisions)'
C 1 C 2.1 C 3 C 5		Stakeholders - decision makers and advisors	C1: Reason is that Business/Financial/Executive decisions need to be made (What needs to be done regarding resources and costs in-volved) Diverse team was needed with people from all affected areas of the business C1: Directors or executive board: R&D, purchasing/supply chain, project management, quality, sales/product management, operations

			<p>“And if that's already too much for them to decide, they (task force) can now come to the crisis management team where they would be steered in one way or another.”</p> <p>C2.1: CEO, (actually directors) Head of technology (product management), Head of Sales, Head of operations and supply chain management</p> <p>C2.2: Head of operations and SC also had the role of the purchasing task force lead.</p> <p>C3: CEO, CFO, COO, CSO (sales), R&D and product managers</p> <p>C5: The leaders of the various Task Forces were also in the meeting - Purchasing, commodity management and R&D</p>
C 1 C 2.1 C 3 C 5		Decision makers	<p>Reason is that problem always comes out of another angle with a different product</p> <p>CEO is executive decision maker also regarding finance (with C 1 (H) info about CEO is missing), CFO regarding the finance, Sales make decisions regarding influence on customers, Product Manager makes decisions regarding the product or customer, R&D makes decisions regarding alternative components usage and redesigns</p>

Table 21: CMT structure

CMT decision makers

It was important to define who was responsible for which decisions to be made, which slightly varied between the respective organizations. Where C1 and C2 mostly had director level members, C3 and C5 had mostly C level members. Most common decisions that had to be made were financial decisions, decisions regarding the customers and decisions regarding the changes on the product as well as the resources needed for it. For the three organizations C2, C3 and C5, all had the CEO in the team as the executive decision maker, but for C2 and C3, the CEO was also the decision maker for all financial topics. (Unfortunately the CEO was not mentioned with C1). With C5, the CFO was responsible for the financial decisions. For decisions regarding the customer, C1 and C5 had Product Management, C2 had the Director of Technology (also responsible for PM) and C3 had both Product Management and CSO (sales). For decisions regarding the redesign of the product and R&D resources, C1 had the director of R&D, C2 the director of Technology, C3 had a PM who had a link to R&D and C5 had the VP of R&D.

4.3.3 Uncertainties and faster decisions

Uncertainties – information from suppliers and purchasing/supply chain

There were different types of uncertainties and various ways of reducing the uncertainties. As mentioned in 4.3.1 that part of the job of the task forces were to get clarity on the situation. C2.1 mentioned that, in order to get clarity regarding the supply situation, they listened to what the suppliers had to say. Both C2.1 and C4 mentioned that also the meetings with the suppliers had to be more regular in order to get all relevant information. C3 reported saying that the job of one of the purchasing team members during the pandemic was purely to talk to the suppliers

by gathering information from them and to stay updated on changes on the supply situations. C5 mentioned that even the CMT with the CEO had direct meetings with the suppliers to state the importance of the business situation and therefore get the commitment from the suppliers on a higher level. But C2.1 mentioned that it needed to be understood, that even when you have a good relationship with the customer, the decisions are still made with some risk. In some situations, mentioned by C3, it was still not clear regarding deliveries and they had to simply wait for the components to arrive before planning any production.

According to C2.1 it was important through the whole process to listen to the supply chain/purchasing departments as they knew best regarding the situation.

Ref.	Theme	Code	Description
C 2.1 C 2.2 C 3 C 4 C 5	Uncertainty - getting clarity	Suppliers for information	C 2.1: Listened to the suppliers, if the deliveries are possible, but also understand that the decisions made are always under some risk. Frequent meetings with suppliers to make sure they are updated on all topics and changes. C 3: One colleague from purchasing had the responsibility to just do that. When not sure then wait for actual deliveries. C 4: Regular meetings to stay in close contact regarding changes so that you can know when you have to look at other options C 5: Also the CMT had meetings with the critical suppliers
C 1 C 2.1 C 3 C 5		Supply chain/purchasing for information	C 2.1: Listened to the people in purchasing department. They are responsible for putting all information together. Responsible for the priorities

Table 22: Suppliers and supply chain/purchasing for information

Faster decisions

Due to the fact that decisions needed to be made under time pressure, the question was asked what the organizations considered important for making decisions faster.

- What came up most, was the need for clarity and transparency. C1 explicitly mentioned the need for clarity and C5 mentioned that transparency was the first step before even starting to make any decisions. And C2.1 mentioned that faster decisions were possible when all information from purchasing/supply chain was clear with no uncertainties. As soon as all information regarding the supply, production and effect on the customer/business was on the table it was faster to assess the risk. All of the information that gave clarity to the priorities, and clarity of the high level strategy, made it easier to make a decision in the CMT.
- C2.1 and C5 mentioned that having all of the advisors and decision makers present, in both the CMT as well as the Task Forces, meant making faster decisions.
- Then having the commitment for both, being present as well as committing to the decision. All pulling in the same direction.

- And last, which was relevant for purchasing as mentioned by C3, was that decisions were made faster when the price for a component was at an acceptable level and therefore didn't need to be escalated to be approved.

Ref.	Theme	Code	Description
C 1	Meeting - CMT	Fast de- cisions	C 1: Pure clarity needed
C 2.1			C 2.1: All decisions made here with no postponements
C 2.2			All decision makers were present covering a wide area, and all are committed
C 3			All information are prepared by Purchasing/Supply chain - Clarity with no un- certainty
C 4			C 3: Not too high price and decided without escalation, short comms chan- nels. All pull in the same direction.
C 5			C 4: it was talking to the customer so that they can tell them which direction they want them to go C 5: Wide area, the transparency, top management involvement and commit- ment

Table 23: Fast decisions in the CMT

4.3.4 Task forces for EMS (production partner)

This section refers to C4.

Purchasing task force structure for EMS

As mentioned before, C4 is an Electronic Manufacturing Services (EMS) company that is mostly focused on the production of semi-finished electronic goods. Their main business is Printed Circuit Board Assembly (PCBA) where the production is set up for placing the electronic components onto the PCBs, which are then tested for functionality. The design of the PCBA belongs to their respective customers and is normally also designed by the customer, although they themselves have an R&D who can provide the added service. Their customers are OEMs like C1 and C3 who use these PCBAs in their own production, where all other parts are then being assembled and sold as a finished product. An important part to understand here, is that they are in fact an extension of the production for some OEMs that do not want to produce PCBAs themselves. They are in other words a Production Partner for these OEMs. Another important part to understand, is that their team structure for purchasing is also completely different from that of the 4 OEMs. Their sales, or key account managers, are integrated into the purchasing team. So every key account manager organizes both the sale and purchasing of a production build contract for each of their key customers.

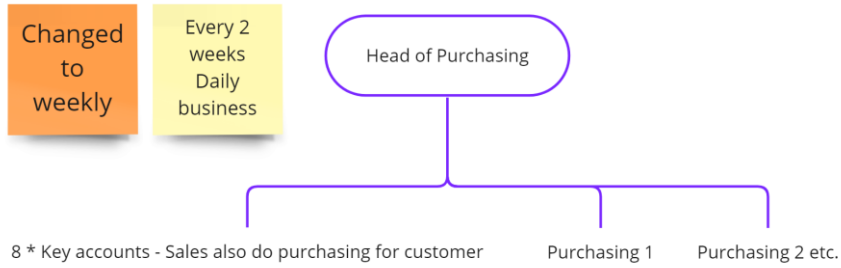


Figure 10: The normal structure for the purchasing department – ref. to C4

The normal collaboration with other departments, is very similar to the OEM companies where they also work together with R&D, quality and production.



Figure 11: The normal collaboration structure for the purchasing department – ref. to C4

Ref.	Theme	Code	Description
C 4	Structure – Task forces EMS	Leading the Task Force	Task force was led by one of the Key Account managers which is also in the purchasing department

C 4		Stakeholders - decision makers and advisors	<p>Done on case basis depending on the customer affected</p> <p>Key customer, key account A, probably included the R&D or probably included the quality so that we can find a solution for this specific problem</p> <p>Some cases the CEO</p> <p>Included R&D if we had to go for a second source, included the quality if we had to go for broker parts.</p> <p>Sometimes also included the CEO when bigger financial decisions had to be made</p> <p>Technical check – C 4 R&D or customer. And the next one was decision to go ahead - customer</p> <p>Final Ok always came from the Customer because it is the customer's design</p>
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Table 24: Task force structure for EMS

Task Force stakeholders and decision makers for EMS

The crisis management structure of C4 is quite unique when comparing them to the other four companies by having had only task forces. And the task force was led by a Key Account Manager instead of a Purchaser or Commodity Manager as in the case with the OEMs.

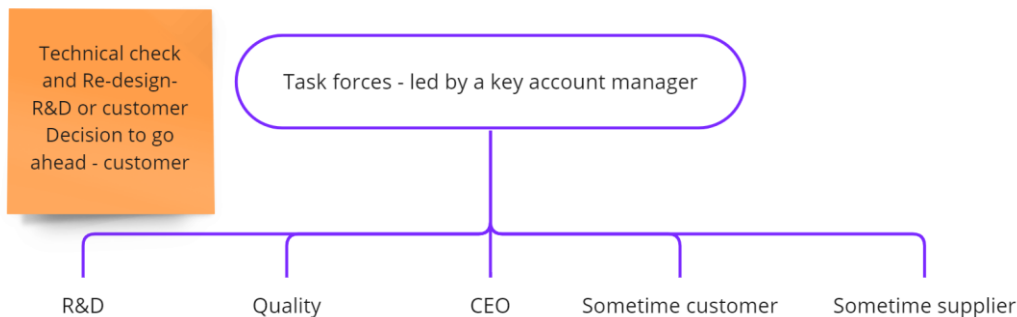


Figure 12: Task force representation of an EMS – ref. to C4

They reported that the teams were formed on a case basis, but a full team would normally consist of a member from R&D, someone from Quality and if needed the CEO. In some of the meetings the customer and a supplier also took part. R&D was involved when a second source approval was needed and Quality was involved when they had to look at buying Broker parts. Similar to some of the OEMs, the CEO was involved when bigger financial decisions had to be made. If an approval for a technical investigation had to be done, then it was either the R&D from C4 or the customer that gave the ok. The final decision to go ahead with an implementation or not, always came from the customer. The reason is that it is their product for which they will carry the risk and the cost.

Ref.	Theme	Code	Description
C 1 C 2.1 C 3 C 4 C 5	Information needed - Task forces	Info received from CMT	C 1: What needs to be done. What is the decided strategy in general as well as for the product or component they need to look at. When CMT needs an answer in order to make a decision C 2.1: Our highest priority is to have no interruption of production so that we can deliver to our customers on time. All the decisions made are serving to this top level goal. C 4: Received this information from the customer (Customer having the role of the CMT)
C 1 C 2.1 C 3 C 5	Structure - CMT	Strategic decisions	Made in the CMT with executive members from all areas of the business as advisors and decision makers - due to risk and complexity Refer to Business priority Information handed down to lower management level and task forces to be operationalized All crisis management team members need to be on the same page, all need to commit and pull in the same direction C 4 the these decisions were made by customer and their CEO
C 1 C 2.1 C 2.2 C 4 C 5	Meeting - CMT	Fast decisions	Pure clarity needed All decisions made here with no postponements All decision makers were present covering a wide area, and all are committed All information are prepared by Purchasing/Supply chain - Clarity with no uncertainty C 4 it was talking to the customer so that they can tell them which direction they want them to go

Table 25: Information for task forces – strategic and fast decisions

The following points form a list of reasons why it is assumed that the customer had the role of the CMT

- For the final ok for what needs to be done, came from the customer
- C4 mentioned that for fast decisions, they spoke to the customer so that customer could tell them in which direction to go
- The customer was therefore making the strategic decisions
- When referring to 'Information needed CMT' in Table 13, C4 handed over all of the information to the customer, where the OEM task forces were handing it over to their CMTs.

Uncertainty and fast decisions

In order to reduce the uncertainty, C4 took certain steps to get more clarity of the different situations.

- They standardized the process for dealing with the uncertain delivery dates, non-deliveries, acquiring second sources and taking the risk on buying from brokers. It was then clear to all regarding who should do what and in what way.

- They included the quality department more for risky broker material buys as well as the amount of external testing. This gave more certainty regarding the quality of the components.
- The customer was involved very early on in the process so that they could early on decide in which direction C4 should go and which options should be followed.

Regarding fast decisions, the following points were considered

- It was mentioned earlier from some of the OEMs, that a reduction in uncertainty was partly responsible for faster decisions. The clearer the situation, options or risk, the easier it was to make the decision which was then made faster.
- C4 reported having more short meetings to make more quick decisions in order to carry on.
- An interesting point which C4 mentioned, was the fact that the Key Account Manager had the 'double role' as sales and purchasing, meant that this person had an immediate overview of both functions. He/she was then always automatically updated which means no extra time was spent on information transfer and the decisions could be made faster because the situation was clearer earlier. It was also the case with C2 where the Director of Technology have both R&D and Product Management department under him. He has the background of both and can also decide for both.

Ref.	Theme	Code	Description
C 4	Uncertainty - getting clarity	Steps to get clarity	The process was standardized Get in contact with the customer as soon as possible so that they can decide which options they want to have pursued. Include customer in decision process as soon as possible. Go for redesign, second source or broker part. Minimize the risk internally by including the quality and have tests done at external test houses.
C 3 C 4 C 5	Decisions - Risk level	Fast decisions	C 3: Short distances between all crisis management team members, and direct contact: between task forces, and between task forces and CMT Quick risk and operational decisions C 4: it was the fact that the Key account manager has the double role of sales and purchasing so saving time on information flow C 4: Many short meetings C 5: Information quickly escalated from bottom to top and then down again

Table 26: Steps to get clarity and fast decisions

4.3.5 Lessons Learned

Two more questions developed through the course of the research where it was thought that;

- Maybe systems or SW tools could help or limit the process of finding, sharing or displaying information and,
- the companies might have learned something that would not only help them in better managing another similar crisis, but it might also even benefit them in general in making more effective decisions faster.

Systems and tools

The basic set of SW tools reported to have been used by all of the companies were Enterprise Resource Planning (ERP - SAP), which is the preferred tool for manufacturing industries, and 'Office Tools' like Word, Excel and One-Note for listing the critical components.

Ref.	Theme	Code	Description
C 3	Systems and tools	Cannot cope with changes or risk - Risk Management	The existing systems and SW tools could not always keep up with the changes: It gave delayed information or couldn't give the detail regarding the risk of components not being delivered
C 3		Changes made - for Risk Management	Adaptations were made to ERP (SAP) in order for the systems and tools to give a more accurate view of the delivery situation
C 3		New tool acquired	SW tool that gives you different options for components that are already used and which are very similar: for risk management
C 2 C 3 C 4 C 5		Tools for giving an overview of crisis	C 2: Generally ERP system, also Word/Excel for listing critical components C 3 and C 4: No special tools used. Word, excel and One Note. C 3: Should not take a lot of time to set up C 5: The ERP (SAP) system was the only source or truth, as all other editing tools might be outdated and not necessarily accessible by all

Table 27: Systems and tools during the crisis

C3 realized that their ERP system could not cope with the fast changes of the delivery situations as it always gave an outdated view of the deliveries and made it therefore difficult to judge the delivery risk. Changes were then made to the tool to improve it. C5 were reported to have no issues with the tool, but they rather saw the ERP system as the only source of truth, because all other tools used were not always centralized and then not always accessible by all.

Regarding SW tools that were used for collecting, sharing and displaying data during the crisis management meetings, C2, C3, C4 and C5 reported using basic 'Office Tools'. C3 reported that no special tools were needed and that it was important that it should not take long to set them up. There was not a lot of time for doing that.

C3 also mentioned that they bought a new SW tool during the crisis that helped them to find alternative components from stock, that could be used in place of the components for which they had shortages. This helped them to generate options for making decisions.

What came out of the crisis

C2.1 and C3 mentioned that with the many formal/informal meetings and close work meant that people came to know each other better which also improved their collaboration. Especially between the R&D and Purchasing departments. C2.1 said that R&D now also have a much better understanding for the need for second source components.

C3 actually decided to keep the crisis management meeting where the same topics are discussed but with bigger intervals between the meetings. C4 reported having learned how to better collaborate with the customer in communicating the right points, in the right way and that it is very important in being 100% transparent.

Ref.	Theme	Code	Description
C 2.1 C 3	What came out of the crisis	Better collaboration	C 2.1: Collaboration between hardware design and purchasing department got better because there was much more to work together. C 3: So I would say this is something positive in this crisis. People got to know each other better and stand by.
C 2.1		Risk Management (strategy)	Higher sensitivity in R&D regarding second sources - learned the importance of it
C 3		Management meeting with similar view	Management meeting was kept, discussing the same issues as experienced in the crisis. Just not so often
C 4		Talk to the customer as soon as possible	How to talk to the customers, how to get the problems across Be transparent as possible, especially with extra cost
C 5		Need more flexibility	How to have more options without adding more complexity in the system
C 5		Checklist for future crises	What was done. Set up the team, set up the frequency, set up the regular reporting, what kind of decision has to be done by whom, what is the interaction with the suppliers
C 5		Second sources for aorta parts: more options	More than one source for the critical and complicating parts. Get it approved already during development
C 5		Risk Management (strategy)	Invest in risk management: In safety stock as well as in R&D with second sources during development

Table 28: What came out of the crisis

5 Discussion

The discussion is broken down into two sections called 'An overview of the pre-crisis phase' and 'Answering the research questions'. The aim was to answer each of the following research questions in such a way that the factors become apparent. Following with the research questions:

Which organizational factors did the electronic manufacturing firms in Vorarlberg consider important for effective decision making in the shortages crisis during the COVID-19 pandemic?

- RQ1.1: In what way did the firms adapt or add to the existing organizational structure for more effective decision making?
- RQ1.2: How does the normal operations structure differ from the structure during the crisis?
- RQ1.3: Which factors did they consider in setting up the crisis management teams for effective decision making under both uncertainty and time pressure?

5.1 An overview of the pre-crisis phase

The reviewed literature did not specifically mention how long before the crisis, the pre-crisis tasks need to take place. Years before, months before, weeks before or simply border line at the beginning of a crisis.

For the landscape survey, where it has to do with evaluating the internal and external potential threats, it is clear that it is something that needs to be done quite some time before a crisis occurs. Reason being that in order to fix or prevent potential negative events, management needs to take certain steps that requires considerable time to implement. Important to be mentioned here again that the landscape survey was not actively explored in the data gathering but rather only mentioned in order to give full picture of the overall process.

For strategic planning of a crisis, it is required of management to create a crisis management team and a crisis management plan. Here it is not clear to how long before it needs to be done. It seems that all five organizations formed their crisis management teams round about the time they became aware of the crisis (and its possible effects it could have on the organization). Right at the end, interviewee from C5 was asked if he thinks it would be possible to now set up a CMP, after what they have learned from the crisis. Where he answered: *“Basically, I would just need to note down what we have done. Set up the team, set up the frequency, set up the regular reporting, what kind of decision has to be done by whom, what is the interaction with the suppliers. Finally, yes.”*

5.2 Answering the Research Questions

RQ1.1: In what way did the firms adapt or add to the existing organizational structure for more effective decision making?

Even though the fundamental structure did not change, they did in fact add a crisis management team and task forces for more effective decision making in order to resolve the crisis.

As mentioned earlier, it was important through the whole research process to understand why they did, what they did. So, by getting an understanding for why they added the crisis management teams, is key to getting an understanding of the important factors considered. Below, the reasons for each team are listed. It also supports the other research questions, especially RQ1.3.

Reasons for adding the crisis management teams

- The reason for adding the two types of teams was due to the need for answering various questions regarding: what is going on?, how does it affect us?, what are we going to do about it?, and how will it be solved?
- Information is required for answering the various questions which means the right people are needed for getting that information.
- Decisions that need to be made
 - Strategic – what needs to be done
 - Operational – how will it be done
- Eventually tasks need to be operationalized.

Reasons for adding a purchasing/supply chain task force

- Need for clarity on the situation or the source of the crisis
 - There is a very rapid and continuous change in the delivery situation and availability of the components.
 - They have the best understanding regarding where the problem comes from and the criticality of each situation
 - The criticality of each component and each supply chain situation
 - The effect on the business
 - What effect does the lack of a component have on the products to be produced and sold.
 - How does it affect the production orders and customer deliveries.
 - The potential cost implication of not getting the components.

- Need for clarity on the available options
 - Options that were listed as possible solutions for each component shortage are: safety stock, second source components, broker material, product re-design or simply removing the finished products from the market until the components were available.
 - The effect on the business for each of these options
 - Timeline, for example; How long will it take to get the components?
 - Cost implication, How much more would it cost and how does it affect the sales margins?
- Operational decisions need to be made
 - How will the problem be fixed or how will it be implemented for a specific component and/or specific product.
 - Most of the time they have purchasing/supply chain related decisions to be made. They are the experts that know best on how to answer these.
 - If there is an added cost related to the decision, which is above the maximum threshold allowed for the job level, then it is escalated to the CMT.

Reasons for adding the Crisis Management Team

- The financial well-being of the company is being threatened
 - The component shortages affects production, customer deliveries and therefore also sales.
 - The lack of the components eventually means a possible but drastic reduction in revenue.
- Strategic decisions need to be made
 - Strategic decisions need to be made on; What needs to be done, with which resources, regarding money and people.
 - Strategic decisions need to be made on; Which components, products, production orders and customers to focus on.
- Information needed for making these strategic decisions are:
 - Priorities that are being set on an operational level by the task forces
 - Criticality rating is set for each component, product and production order
 - The rating is related to the effect it has on the business
 - Priorities set on a management level
 - Main priority is to keep production running because that affects the current revenue.

- Priorities for some key projects related to key customers.
- Priorities set for products that have the biggest margin or contributes to the biggest part of the revenue.
- Priorities set for component types that are used in these key products or are simply more complicating in maintaining for change.
- Output from the CMT to the respective task forces
 - What is the problem.
 - What is the overall strategy.
 - What needs to be done for which components and products.
 - Cost approvals for one of the options.

Reasons for adding the R&D task force

- Needed for deeper technical knowledge regarding changes that are required for technical approvals or changes to products.
- Operational decisions need to be made
 - How will the problem be fixed or how will the approval or change be implemented for a specific component and/or specific product.
 - Most of the time they have technical R&D related decisions to make. They are the experts that know best on how to answer these.
 - As soon as a change is needed on a product that requires more resources from R&D, it is then escalated to the CMT. Reason is that in order for them to start this new project, other currently running projects would have to be placed on hold. A previously made strategic decision would need to be changed in order to be aligned with the new priorities. The new main strategy as mentioned before is to keep current production running.

Also listing the information requirements of the two types of teams. Seen in fig. 14 and 15

Information that is required by the CMT

- Situation from suppliers, production and customers
- Component, product, production and customer priorities
- Updates on projects/tasks

Information that is required by the Task forces

- What needs to be implemented – what to focus on
- Financial approvals

The block diagram illustrations below give an overview of effective organizational structures, that were constructed from the information gathered in this paper. It serves as a supplement for the factors listed.

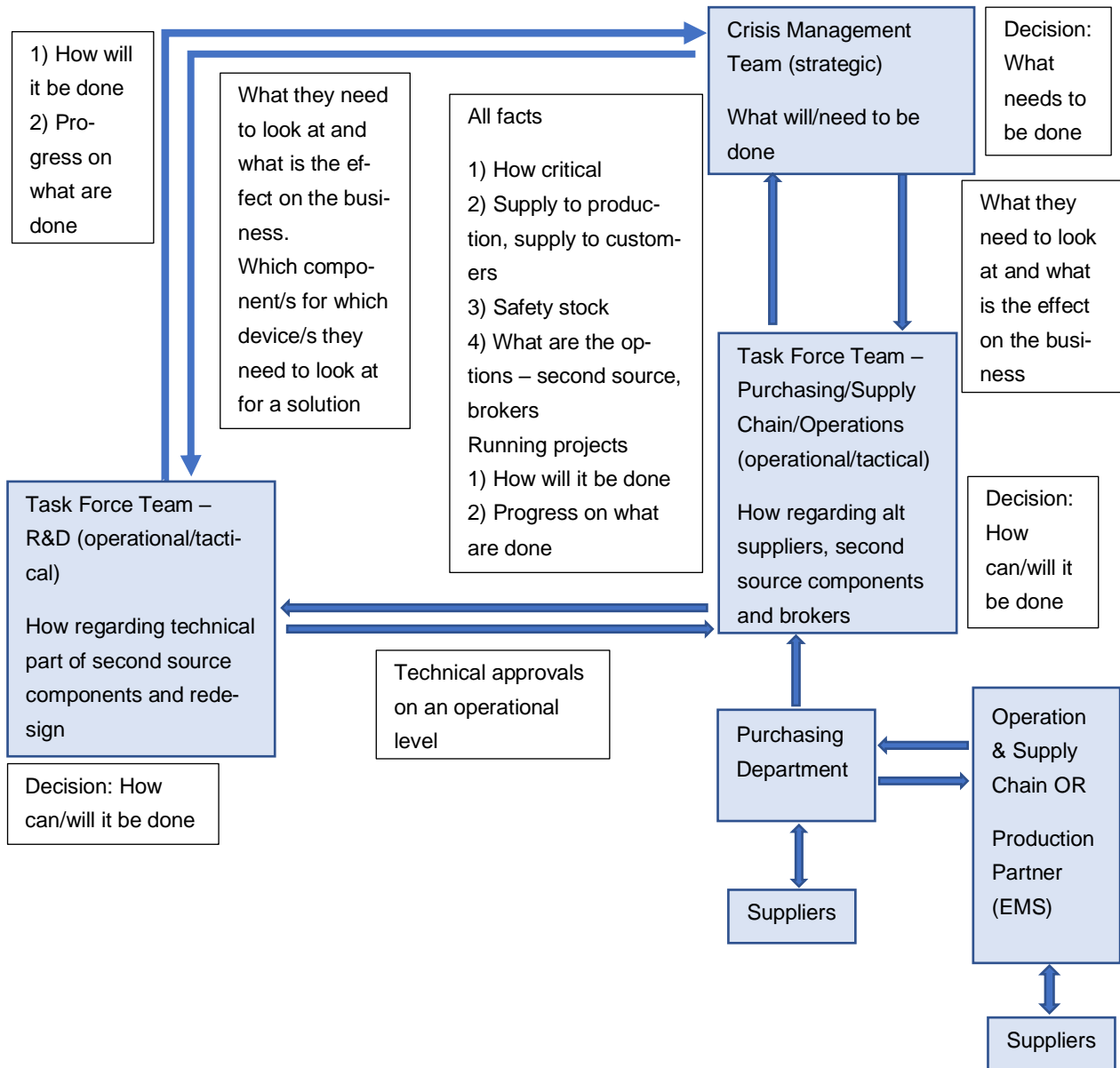


Figure 13: Overview of an effective crisis management structure – OEMs

The shaded blue blocks represent the teams, departments and companies dealt with internally and externally. The unshaded white blocks represents the expected information that needs to be gathered by the team or department (and for whom), which is indicated by the direction of the arrow. The general type of decision is also shown.

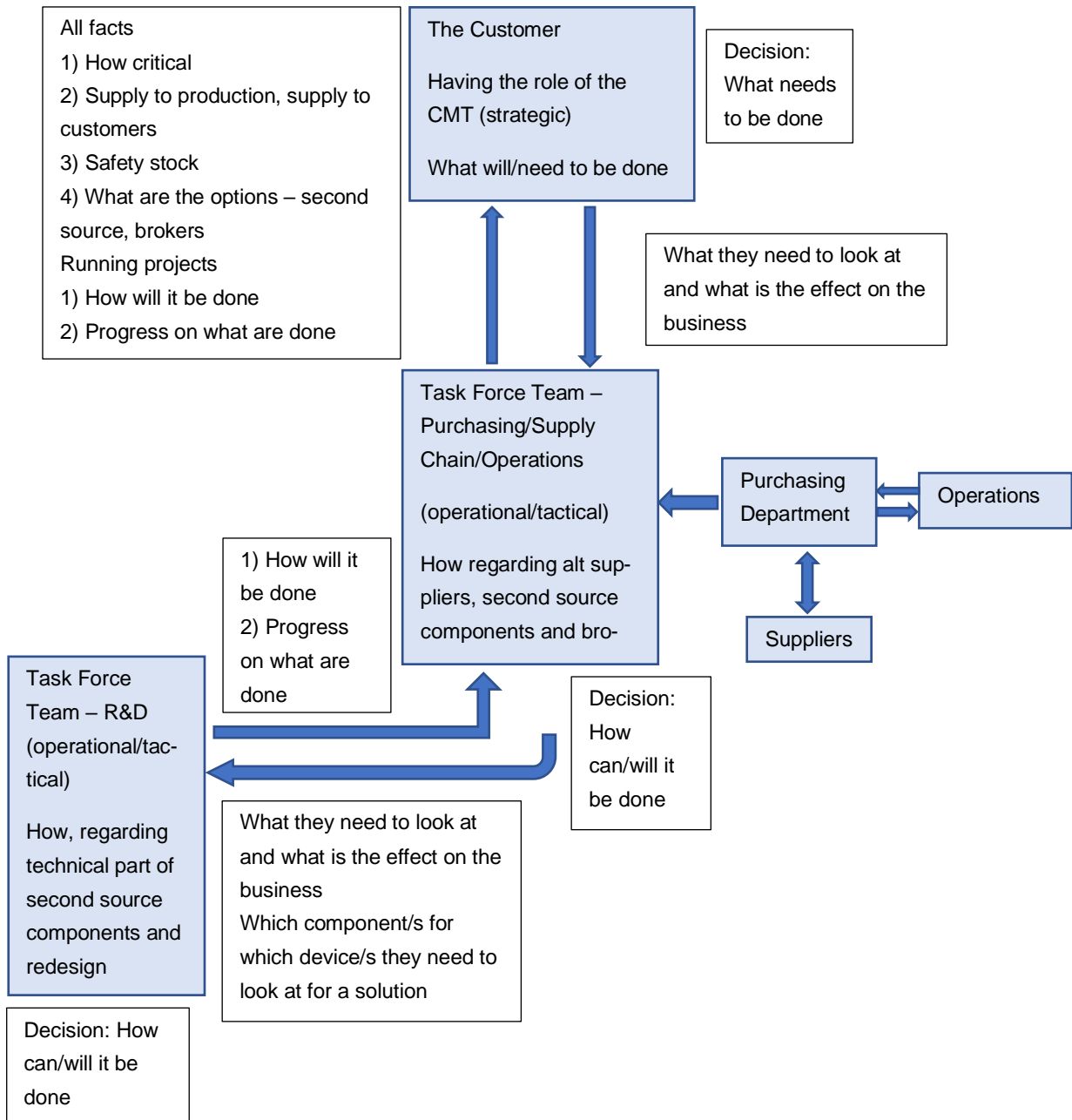


Figure 14: Overview of an effective crisis management structure – EMS

RQ1.2: How does the normal operations structure differ from the structure during the crisis?

As mentioned in section 4.2, the difference was more in the way the respective project teams were setup regarding the stakeholders, the meetings that were scheduled and held, together with the meeting focus, the frequency of these meetings and the flow of information.

Business focus

The existing structure, teams and meetings, were mostly affected by the business focus. The business focus, priority and strategy changed from mid/long term running projects and new projects, to short term and current business. Most of the financial and human resources were redirected to focus on the functions and areas which have the best financial gain, now and in the very near future. Daily supply, production, operations and sales details which were normally kept on an operational level due to an already predefined strategy from management and a stable supply, had to be rediscussed and replanned on a more frequent basis due to unstable supply.

More frequent meetings

- The constant and frequent change of delivery times and availability of components meant that previous decisions had to be re-evaluated regarding planning of production and customer orders.
- Much more changes meant more problems that were added regularly and which needed to be resolved. More frequent decisions had to be made in order to do so.
- The more frequent decisions and therefore more frequent meetings occurred on both operational as well as management level.
- That is also why the upper management stakeholders from the usual strategic meetings, had to meet more frequently in order to possibly redefine the business strategy and resource focus.
- Flexibility also played a big role in always being available for the purpose of resolving the crisis.

The stakeholders involved

The stakeholders involved in the CMT also differed slightly in a sense where it was not only upper management present, seen with most of the companies before the pandemic, but also the Task Force leads or representatives and Product Management. The reason was to flatten the operating structure between management and operational task forces in order to increase the speed and effectiveness of the communication flow between management and operations. Where the normal operating structure is more hierarchical with the information flowing in a timely basis between the different levels, the crisis required much faster reaction to problems which meant faster flow of needed information.

The lead for the crisis management team changed from one of the C level or director level managers to someone in purchasing or supply chain. Either upper management from these two departments or a representative thereof. They know best regarding the environment.

The CEO was also involved in informal meetings for fast decision making in order to exploit beneficial time limited pricing.

RQ1.3: Which factors did they consider in setting up the crisis management teams for effective decision making under both uncertainty and time pressure?

In the section for discussing the first research question RQ1.1, it was mentioned why the crisis management teams were needed and what was expected of them. The points mentioned in RQ1.1 therefore supplements the answers given here for RQ1.3.

It was mentioned in the literature that the crisis management teams must be able to deal with the uncertainties that come with a crisis. It was also mentioned by the interviewees, that the first task of the teams, was to get clarity of the new and critical situation. It was done on both an operational level as well as on a management level.

Information requirements

The information requirements was therefore one important factor for setting up the teams. It is mainly due to the fact that by getting information is a means of overcoming the uncertainties. On an operational level, two types of task forces were created namely a Purchasing Task Force and a R&D Task Force. The task forces basically consisted of the same people that normally worked on the same type of topics, for example the component supply topics related to purchasing, and the component approvals or design topics related to R&D. The task forces were assembled by combining the same specialists but with a special focus on resolving the problems related to the crisis. From the information requirements mentioned by the companies, it was clear that the members of the task forces were selected on the basis thereof. Some of the interviewees also mentioned that having more clarity meant being able to make faster decisions which was important due to the time pressure.

On a management level, a crisis management team was assembled. Due to the fact that the component shortages affected different functional areas of the business, the team also had to consist of managers from all the different functional areas. This enabled the team to assess the situation from all angles, when using the information from the task forces. Thus making sure that nothing is missed. Having all relevant members together in the team and meetings, meant that more clarity was achieved of the overall situation which in turn meant that decisions could be made faster.

Decision requirements

The decision requirements was another important factor for determining who should be part of the crisis management teams. The right knowledge and experience is needed in the right place for the right type of decisions, in order to give the organization the best chance on making the right decisions.

For the Task Forces, some mentioned that they trusted the expertise of the specialists to make the operational and technical decisions themselves. It is part of their everyday job of which they are professionals.

Regarding the CMT, it was important that it was made clear regarding who will decide for which affected area. All affected departments or business units had to have a representative in the meeting, with the total authority of that department or business unit. It was also important that, that person is present when a decision had to be made for the department or business unit. For example, the executive decisions or financial decisions were in most cases the responsibility of the CEO. And decisions related to product priorities or customers were either made by the product managers or sales. Some of the interviewees mentioned that by having all decision makers together in the meeting meant that decisions could be made faster.

Tasks required for implementing the strategic decisions

The people involved in the task forces as well as in the departments, where the task forces were formed, were dependent on the type of tasks required by the crisis management team. The teams were formed on an ad hoc basis whenever needed, for whatever reason. For reasons mentioned in the section for RQ1.1. The same as mentioned regarding the decisions to be made, it was also important here that the right people with the right skills and experience are assigned for the task in order to give the organization the best possible chance in implementing the decisions that were made in the CMT. The question about who is the best person/s for the job is not only related to crisis management but also to normal operations, and the respective department heads normally knows who can do what, and in what way.

Figure 15 below shows an overview of an effective crisis management team. It was constructed by considering what the 4 OEM organizations thought to be as best practice.

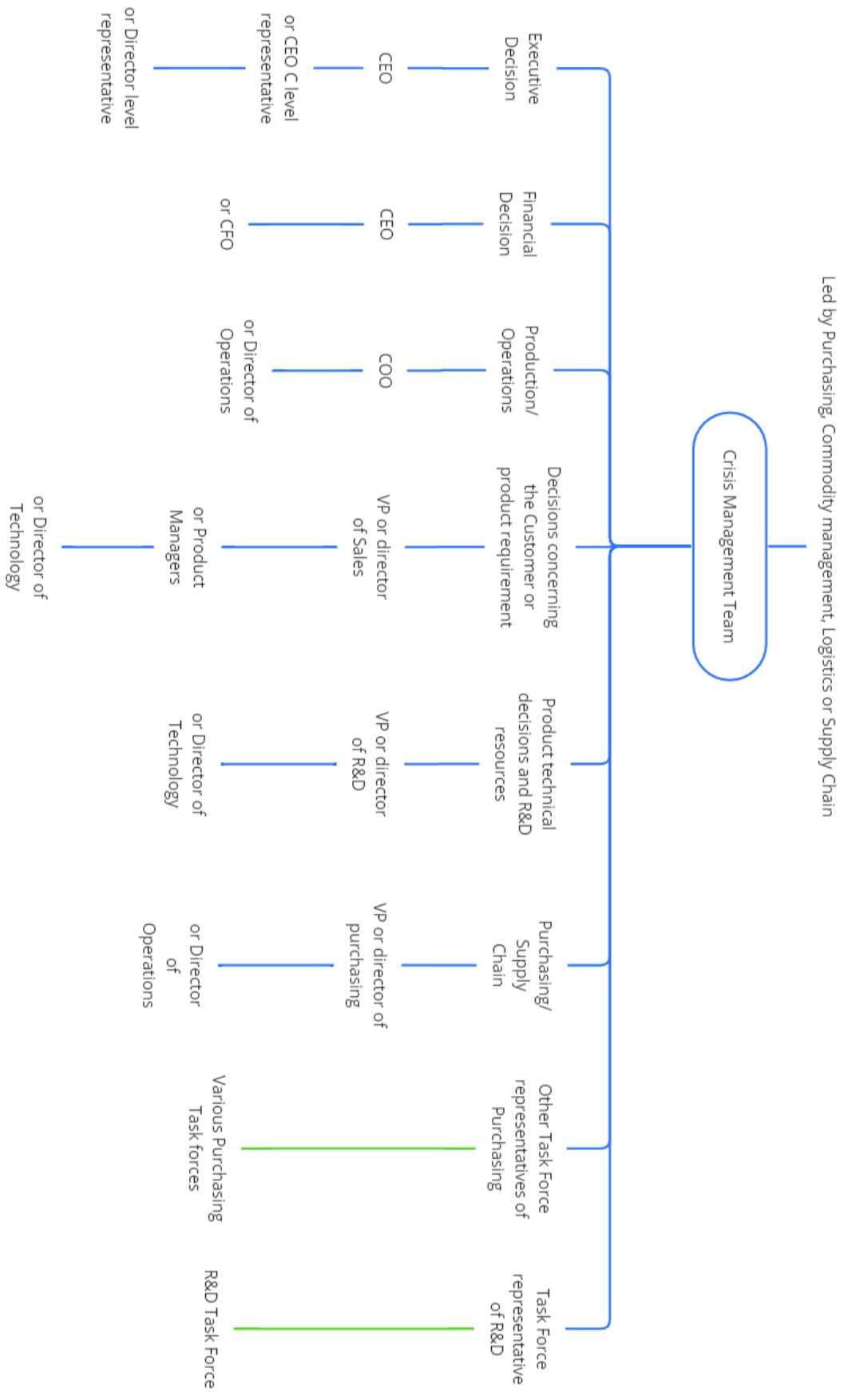


Figure 15: Illustration of an effective CMT - consolidated CMT build-up with listed decision makers - OEM

6 Conclusion

Looking back at the main research question:

Which organizational factors did the electronic manufacturing firms in Vorarlberg consider important for effective decision making in the shortages crisis during the COVID-19 pandemic?

Effective decision making is not just important during a crisis but also in everyday normal business administration. And, as mentioned before, in striving for more effective decision making in the organization, adds to the organization's ability to better manage a crisis. What was seen through the learnings of this research project was that; in order for a decision to be effective it needs to be successful or it needs to achieve the results that you want. For this to happen, the decision needs to be followed through all the way into implementation and must conclusively solve the problem. An effective decision is therefore not only relevant at the time it is made, but also beforehand with the work that is done in preparing the data which is needed for making the decision, as well as the work afterwards which is needed for making it a reality. It was also seen that the strategic decisions that were made in the CMT, should be clearly communicated from top to bottom, to ensure that everyone pulls in the same direction, thus being effective.

All five organizations stated that; they did a good job in managing the crisis. They therefore had everything in place, for making effective decisions that resolved the effects of the crisis on their organizations.

Quotes from two of the organizations:

"...I think regarding the circumstances, we did make a pretty good job most of the time."

"Only this is enough to explain that a lot of things went quite in the right direction during the last three years."

The following list shows the basic factors that were considered by the electronic manufacturing firms:

Information requirements

- What information is required and who can/needs to get the information

Clarity needed on:

- The crisis environment, the problems related to it and the interpretation of it
- Priorities on an operational and managerial level
- Which options are available for solving the problems

Frequency and flexibility of meetings and decisions

- Higher frequency due to more and faster decision requirements
- Higher flexibility needed due to the uncertainties and the environmental instability

Decision requirements

- Strategic and operational decisions
- What needs to be done, who will do it and how will it be done
- What needs to be answered and who needs to answer it
- Approvals

Task requirements

- Who can/needs to operationalize the strategic decisions
- Who has the right skills

Structure requirements

- All above makes up the criteria for structuring the teams
- Flatten the structure to ideally two levels – managerial/strategical and operational/tactical
- Simplify and shorten the line of communication

An interesting article was found on effective decision making (Kornmehl, current). It aligns quite well with the core principles shown in this paper. The three layers are listed below together with an interpretation from the findings gathered in this paper:

- “Identify what matters most to you (core priorities)”
 - As shown in this paper, it is important to first get clarity on the situation, the areas affected and the impact on the business.
 - Clarity is then needed on, which parts of the business, product or component needs urgent attention. And,
 - Clarity is then needed on which parts of the business, product or component that best contributes to the financial gain of the organization. In the short term.
- “Focus your energy (strategy)”
 - Only when you understand where an organization’s effort would bring the biggest gains, can you decide what is important to focus on.
- “Unleash your energy (tactics)”
 - A clear understanding is needed regarding the strategy and therefore the expectations in order to do the right thing.
 - The level of tactical skills and experience of the organization then also determines how well the expected task is done.

7 Further research and limitations

Risk Management: Even though risk management was mentioned a couple of times in this paper, it was not actively pursued. It is mainly due to the fact that risk management, on its own, is a large and extensive subject. Also covering it here would not have been manageable, considering an acceptable scope size and timeline for a master thesis.

With that said. Further research would be suggested in the area of risk decisions during crisis management. Two questions come to mind:

- What role does risk decisions play in effective crisis management?
- How it differs to risk decisions before and after a crisis?

The following limitations became apparent during the thesis:

- Only one Electronic Manufacturing Services company was available to be interviewed and analyzed. Even though a clear link was found between this type of organization and that of an OEM that uses production partners, it cannot be confirmed that most EMS organizations would follow the same principles.
- It was not possible to generate an overall or general structure for a purchasing or R&D task force that is needed for effective crisis management. Reason being, as mentioned before, that the operational structure for the various functional areas differed quite drastically. It is assumed that every organization is unique in their strategy regarding the tactical and specialized work.

8 Summary

Supply chain disruptions started due to COVID-19 control measures between January and March 2020 (McKay, 2023). The temporary closure of factories was followed by a spike in demand afterwards causing shortages of electronic components all across the globe (Frieske, 2022). The lack of components meant production stops for many OEMs which led to customer delivery problems and therefore a financial crisis (“Versa Electronics,” 2023). The overall objective was driven by the main research question: Which organizational factors did the electronic manufacturing firms in Vorarlberg consider important for effective decision making in the shortages crisis during the COVID-19 pandemic?

Background

According to (Carmeli & Schaubroeck, 2008, p. 1), an organizational crisis “is a low-probability, high-impact event that threatens the organization’s survival and is characterized by ambiguity of cause, effect and means of resolution, as well as by a belief that decisions must be made swiftly.” In a crisis situation it is important that decisions need to be made quickly and that these decisions, most probably, need to be made under highly uncertain circumstances. According to (Fener & Cevik, 2015a, p. 4), “Leaders shall overcome the state of crisis where there is a chaos environment in the organization, they shall restructure the organization and adopt it to the changing environmental circumstances.” Adapting the organizational structure in the form of teams, and the interaction between them, plays a key role in managing a crisis. The re-organization needs to therefore facilitate faster decision making under highly uncertain circumstances. Thus making it more effective.

Research setting, Objectives and Questions

This paper aims to consolidate two basic concepts namely Crisis Management and Organizational/Team Structures with effective decision making at the center. An objective would be to break the findings down to the basic factors with a clear understanding of why the respective factors are important during a crisis. Considering all beforementioned aims and objective, the following research questions were defined:

Main research question: Which organizational factors did the electronic manufacturing firms in Vorarlberg consider important for effective decision making in the shortages crisis during the COVID-19 pandemic?

With supporting sub questions: RQ1.1: In what way did the firms adapt or add to the existing organizational structure for more effective decision making? RQ1.2: How does the normal operations structure differ from the structure during the crisis? RQ1.3: Which factors did they consider in setting up the crisis management teams for effective decision making under both uncertainty and time pressure?

State of the art

The concept is framed around the basic crisis management process which also includes elements like organizational and teams structures, and decision-making processes. According to (Fener & Cevik, 2015b, p. 699), there are three phases for managing the whole crisis management process, called the Pre-Crisis: detecting the signals, Crisis: analyzing and managing the crisis and Post-Crisis management: Lessons learned. The Four-Stage principle from (Crandall et al., 2021, pp. 12–14), is the Landscape Survey and Strategic Planning as part of the Pre-Crisis phase, Crisis Management and Organizational Learning as the Post-Crisis phase.

Pre-crisis phase

The landscape survey is not actively pursued in this paper.

Strategic planning has to do with understanding and managing the uncertainty of a crisis by planning the strategy. And one way of strengthening the crisis management process is by creating a crisis management team and plan (Crandall et al., 2021, pp. 114, 123). The crisis management team, together with the crisis management plan represents the core of the crisis planning process (Crandall et al., 2021, p. 138).

For setting up the crisis management teams, the needed skills, goals and stakeholders need to be considered. The most important skills needed are, getting an understanding of the situation, making effective decisions, monitoring progress, delegating tasks, prioritizing and planning (Crandall et al., 2021, p. 205). The main goals consist of responding immediately, managing the crisis, making sense of the data, analyzing the data, and making decisions (Tokakis et al. 2019, p. 38). The stakeholders involved in a crisis management team should consist of a combination of people with diverse backgrounds (Alexander et al., 2020, p. 3). And according to (King, 2002, p. 5), there are five factors that make an effective team namely; 1) prior interaction, 2) team composition, 3) task knowledge, 4) leadership ability and 5) organizational culture (King, 2002, pp. 5–9). Another factor is that the member roles should be clearly defined. (McKinsey Explainers, 2023, p. 4) talks about 4 different roles namely; 1) decision makers - who decides on finance, products, customers etc., 2) Advisors - other management members with experience, 3) recommenders - specialists with subject related knowledge and 4) execution partners - the people that need to do the job from what was decided.

Effective structures accommodates a two-step decision making process: 1) strategic decisions like big-bet and cross-cutting decisions on management level and 2) delegated decision on an operational level (Smet, Jost, et al., 2019, pp. 2–7). An effective structure also calls for having a flatter structure that ensures faster communication between the two levels. For example (McKinsey Explainers, 2023, p. 4) mentioned including the “execution partner” in the management meeting to better understand the strategic decisions and speed up the process.

Crisis management

It is the first step of crisis management to convene the crisis management team (CMT) (Crandall et al., 2021, p. 204). The three most relevant tasks to be performed by the CMT during the crisis (Crandall et al., 2021, p. 206f).

- 1) Situational assessment is getting some clarity on the current situation as well as probable future developments of the crisis (Crandall et al., 2021, p. 206).
- 2) Mitigation strategies, is to strategize on how to mitigate the crisis when the situation is assessed. It is important to be flexible and to adapt to the crisis environment as it evolves (Crandall et al., 2021, p. 209). Everyone in the CMT needs to commit on the strategic decisions made (Smet, Jost, et al., 2019, p. 9), and then clearly communicate the strategy to the operational teams for more effective delegation (Smet, Hewes, et al., 2020, p. 5). Minciu et al. (2020, p. 3) mentions a 4 stage decision making process: 1) understanding the situation, 2) analyzing the options, 3) understanding the impact of each and 4) implementing the decisions.
- 3) Strategies during the crisis, is dependent on three possible scenarios that can be seen at any time during the crisis namely; 1) the crisis is under control, 2) it still poses a risk and 3) the impact is catastrophic. The strategy would therefore depend on the scenario at the given time (Crandall et al., 2021, p. 213).

Post crisis phase

According to (Crandall et al., 2021, p. 265), "Organizational learning is the process of detecting and correcting errors. Carmeli & Schaubroeck (2008, p. 5) mentions that the detection and correction of an error could come in two forms: Single Loop Learning and Double Loop Learning.

Research Methodology

Qualitative research was conducted in order to generate a theory about how the firms acted in the seemingly unique case of the COVID-19 pandemic. **Sampling:** The method of sampling used is expert sampling, due to the assumption that the target population are leaders/managers, from electronic manufacturing firms who were part of the crisis management teams. The purchasing department was the primary target population (1 from R&D). The 6 interviews came from 5 electronic manufacturing firms. The interviewees had to all be on a management level who were part of the crisis management setup. The management levels of the six interviewees varied between 'head of' and vice president. See table 6 for more information regarding the 5 companies C1, C2, C3, C4 and C5. **Data collection:** Semi-structured interviews were conducted remotely by using Teams as a main tool. Two other SW tools were used namely "happyscribe", for transcribing the interview audio, and Miro, as a brainstorming platform for interactively reconstructing the crisis management team's structures, together with the interviewee. With this in mind, using Miro, helped the interviewee to recall the processes and events as well as stimulate a conversation in order to answer the relevant questions.

Factors of organizing/arranging structures (organizational and teams level) was collected in order to compile various organizational behaviors and on the other hand have them evaluated by the same experts regarding effective decision making under uncertainty and lack of time. Structured part was started with getting an understanding of the current organizational structure needed for collaboration in 'normal' circumstances. Which was followed by looking at what structural changes were made, if any. Find out who all were involved in managing the crisis. And then it was broken down to the teams structure before and during the crisis management. **Method for data analysis:** The technique used for analyzing the data is called Content Analysis. The text was analyzed by first dividing it into two separate categories called: Pandemic and Pre-pandemic. It was broken down into themes as a first coding round, and then into codes as a second coding round. Primary aspects that were considered was: crisis management team, structures, teams, meetings, fast decisions, information, uncertainty, decisions under uncertainty. Further themes and codes were created as the process developed. Each respective interview was separately analyzed and then compared to all of the previous interviews. The data from all interviews were consolidated in a table and categorized under the shared themes and codes Refer to Table 7.

Results and Findings

The results and findings were categorized and presented in three main sections which aims to give an understanding and explain the three sub questions.

RQ1.1: In what way did the firms adapt or add to the existing organizational structure for more effective decision making?

All of the companies that were interviewed, clearly stated that their fundamental structure did not change, before, during or after the crisis. Crisis management teams (CMTs) were added. Four of the five companies referred to as C1, (C2.1, C2.2), C3 and C5, who are all OEMs, had a main CMT and various Task Forces. The one company C4, that is an EMS business only had multiple Task Forces who worked together with the respective customers. The reason for adding the two type of teams was due to the need for answering various questions regarding: what is going on?, how does it affect us?, what are we going to do about it?, and how will it be solved? The purchasing department formed a task force to address the rapidly changing delivery situation and component availability, recognizing the potential impact on production and sales. The task force provided information to upper management to guide decisions in mitigating the crisis. In parallel to this, also an upper management team was assembled, called the Executive Task Force or Crisis Management Team. The reason for starting the team at the higher level was because the initial information from Purchasing showed that the financial well-being of the organization is being threatened and something drastic needs to be done. Certain situations also required R&D resources for example: 1) When an approval was needed for another component, 2) When an approval was needed for another component that was

NOT similar in form and/or function. An R&D task force was then assembled. Refer to Figure 6 and 7 regarding the relationships between the various crisis management teams.

RQ1.2: How does the normal operations structure differ from the structure during the crisis?

The difference was in the way the respective project teams were setup regarding the stakeholders, the focus and frequency of the meetings and the flow of information. The business focus, priority and strategy changed from mid/long term running projects and new projects, to short term and current business. Serial production was the main priority. The management meeting frequency with the CMT was shortened to 1 week intervals. The stakeholders involved in the CMT also differed by also including the Task Force leads and Product Management. It was due to the need for increasing the speed and effectiveness of the communication flow between management and operations.

RQ1.3: Which factors did they consider in setting up the crisis management teams for effective decision making under both uncertainty and time pressure?

The Task Forces for OEMs: The first job of this Purchasing Task Force was to create clarity and transparency for the Crisis Management Team in order to decide what needs to be done. The information that was needed for this purpose was; components which are affected, delivery dates, products affected, production priorities, status updates, available options and the impact on the business related to all. Regarding the purchasing task force structure of the OEMs. C1 reported to have had two different task forces, one for critical components and one for critical products. C5 reported to have the same roles for each task force but were divided regarding commodities. In order to get this information, mentioned above, different supply chain specialists had to be part of the purchasing task force. Different companies had a different setup for their task forces which is mainly due to the fact that the companies in general have a different organizational structure. Other points are; task forces were created for increasing the decision making efficiency (C1), flexibility was needed in time, availability and combinations of people needed (C1), per case handling (C4), multiple task forces enabled more solutions to be driven in parallel (C2.1), and all mentioned that more decisions had to be made. Operational decisions are made in the task forces where they have the needed knowledge to make the decisions or approval, but further tests are handed over to R&D. High cost decisions are escalated to the CMT. **The Crisis Management Team:** The crisis management team was required for addressing the sudden increase of risk on the running operations and the possible high financial impact it could have on the organization. Priorities regarding critical components are needed from the task forces. Risk options are available, for example safety stock. The outcome from this team should be; what's the problem and what to focus on, option approval and the high level strategy. Purchasing and logistics had the team lead. Stakeholders were from all functional areas and in some cases also the task force team leads took part. Regarding the decision making, it was important to define who was responsible for

which decisions, which slightly varied between the respective organizations. **Uncertainties:** In order to get clarity regarding the supply situation they listened to the suppliers (C2.1). They also reported having more regular meetings with the suppliers (C2.1 and C4). One person was even dedicated to only gather information from the supplier (C3). **Faster decisions:** Clarity and transparency meant that decisions could be made faster (C1, C2.1 and C5). Having all of the advisors and decision makers present in the crisis management teams also meant fast decisions (C2.1 and C5). As well as when a decision could be made without escalating it. **Task forces for EMS (production partner C4):** An EMS company is focused on producing semi-finished goods which in this case is PCBAs. They are production partners that is a production extension for OEMs, who do not do their own electronic assembly like C1 and C3. Their purchasing team structure is unique in the sense that their sales and key account managers are integrated into the purchasing team. The EMS only had task forces which were led by the key accounts managers and included members from R&D and the CEO. The CEO and customer were the executive decision makers. But, the final decision to go ahead with an implementation or not, always came from the customer. The reason is that it is their product for which they will carry the risk and the cost. It was assumed that the customer had the role of the CMT. In order to overcome uncertainties, C4 took the following steps; standardized the process, included quality in risky decisions, and they involved the customer early on. Regarding fast decisions; they reported having short meetings and that the key account have the double role which reduced information transfer and which made the situation clear earlier. **Lessons learned:** SW tools used by the companies are SAP which related to manufacturing, and office tools like Word, Excel and One Note. C3 had changes made to its SAP due to the limitations in dealing with the fast changes. Most teams reported using basic Office Tools for collecting, sharing and displaying data. C3 bought a special SW tool for selecting alternative components. C2.1 and C3 said that people got to know each other better in the crisis and C2.1 said that R&D now has a better understanding for alternative components.

Discussion

The aim was to answer each of the following research questions in such a way that the factors becomes apparent.

An overview of the pre-crisis phase: All four OEM organizations did in fact have a CMT and the one EMS did have crisis management teams in the form of task forces, but it seems more like they were formed right at the start of becoming aware of the crisis, rather than before. No one mentioned anything about ever putting a 'Plan' on paper before the crisis, but they all seemed to have made a plan at the start and during the evolvement of the crisis.

Answering the research questions:

RQ1.1: In what way did the firms adapt or add to the existing organizational structure for more effective decision making?

Even though the fundamental structure did not change, they did in fact add a crisis management team and task forces for more effective decision making in order to resolve the crisis. The reasons for adding these teams are key to understanding the factors that were considered.

Reasons for adding the crisis management teams; need for answering various questions (what is going on, its effect, what to do and the solution), information needs and the right people for it, strategic and operational decisions needed, tasks need to be done. Reasons for adding the purchasing task forces; need for clarity on the situation and the available options and operational decisions to be made. Reasons for adding the Crisis Management Team; threat to the company, strategic decisions to be made and the information needed for it, instructions to the task forces in what needs to be done. Reasons for adding the R&D task force; need for deeper technical knowledge, operational decisions to be made regarding approvals and redesigns.

Refer to figure 13 and 14 for an overview of effective crisis management structures.

RQ1.2: How does the normal operations structure differ from the structure during the crisis?

What did change was: The business focus, priority and strategy changed from mid/long term running projects and new projects, to short term and current business. More frequent meetings were needed due to; frequent change of delivery times, more frequent decisions had to be made, re-evaluation needed of strategy and need for flexibility. Stakeholders involved in the CMT were not just upper management but also task force leads in order to improve the speed and effectiveness of information flow. CEO was also available for ad hoc fast decisions.

RQ1.3: Which factors did they consider in setting up the crisis management teams for effective decision making under both uncertainty and time pressure?

The reasons mentioned for adding the teams with RQ1.1, contributes to answering RQ1.3.

The 'information requirements' were one important factor for setting up the teams, mainly due to the fact that by getting information is a means of overcoming the uncertainties. Each task force was being setup for gathering specific information. They were assembled by combining the same specialists but with a special focus on resolving the problems related to the crisis. Regarding the CMT: due to the fact that the component shortages affected different functional areas of the business, the team also had to consist of managers from all the different functional areas. This enabled the team to assess the situation from all angles, when using the information from the task forces. The 'decision requirements' was another important factor for determining who should be part of the crisis management teams. The right knowledge and experience is needed in the right place for the right type of decisions. For the Task Forces, some mentioned that they trusted the expertise of the specialists to make the operational and technical decisions themselves. Regarding the CMT: it was important that it was made clear

regarding who will decide for which affected area. All affected departments or business units had to have a representative in the meeting, with the total authority of that department or business unit. **The tasks required** for implementing the strategic decisions was an important factor for who needs to be involved in the task forces. It was also important that the right people with the right skills and experience are assigned for the task.

Conclusion

What was seen in the paper, is that a decision needs to be followed through all the way into implementation and must conclusively solve the problem. An effective decision is therefore not only relevant at the time it is made, but also beforehand with the work that is done in preparing the data which is needed for making the decision, as well as the work afterwards which is needed for making it a reality. The basic factors answering the main RQ is as follows-

Information requirements: What information is required and who can/needs to get the information

Clarity needed on: The crisis environment, Priorities on an operational and managerial level, Which options are available for solving the problems

Frequency and flexibility of meetings and decisions: Higher frequency due to more and faster decision requirements, Higher flexibility needed due to uncertainties and environmental instability

Decision requirements: Strategic and operational decisions, What needs to be done, who will do it and how will it be done, What needs to be answered and who needs to answer it

Task requirements: Who can/needs to operationalize the strategic decisions, Who has the right skills

Structure requirements: All above for structuring the teams, Flatten the structure to two levels – managerial/strategical and operational/tactical, Shorten the line of communication

The basic three layer decision making structure from (Kornmehl, current), has a strong relation to the work done in this paper namely (refer to section 7 for further interpretation):

- Identify your core priorities
- Form a strategy
- Implement the strategy

Further research and limitations

Further research would be suggested in the area of risk decisions during crisis management.

Two limitations noted: Only one EMS organization was analyzed and it was not possible to generate an overall or general structure for a purchasing or R&D task force.

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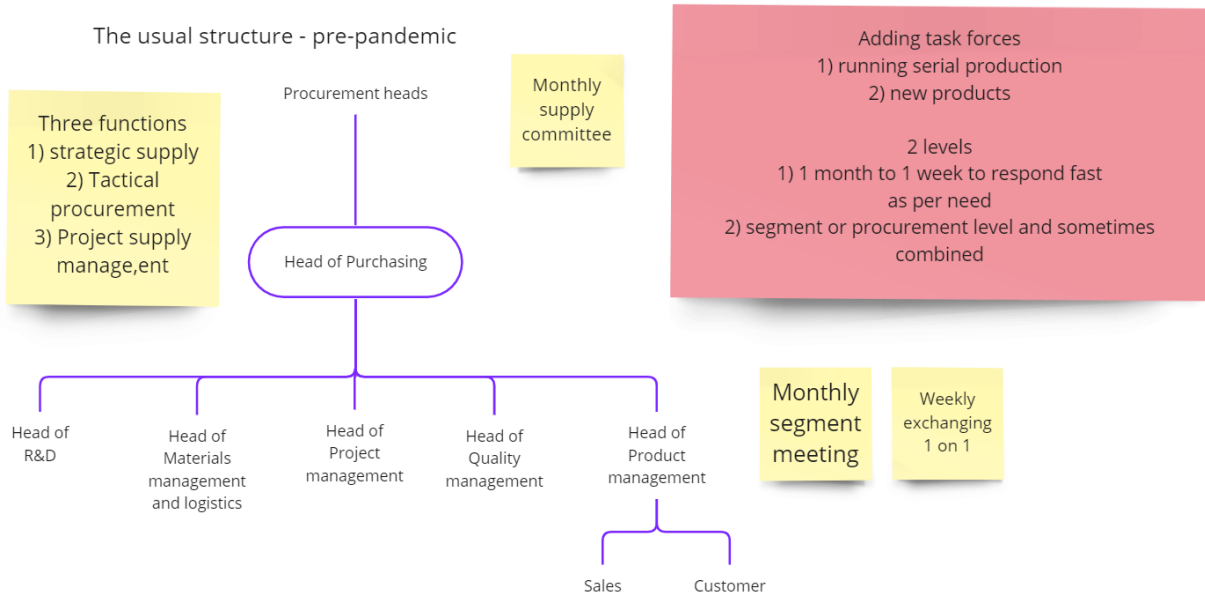
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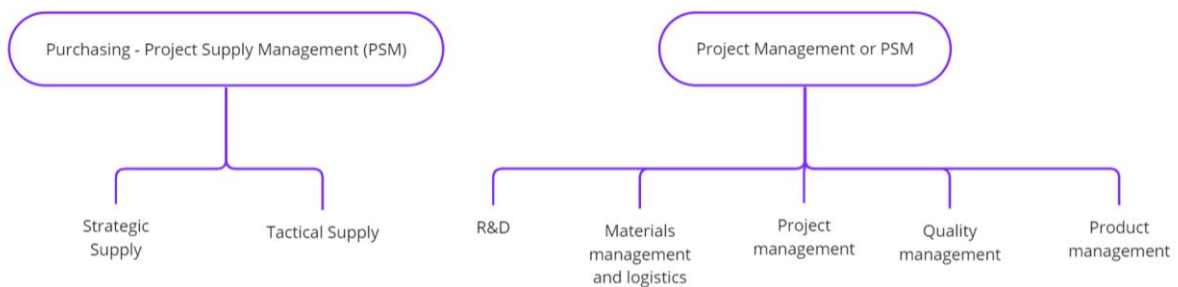
Appendix

Miro board – Mind Maps

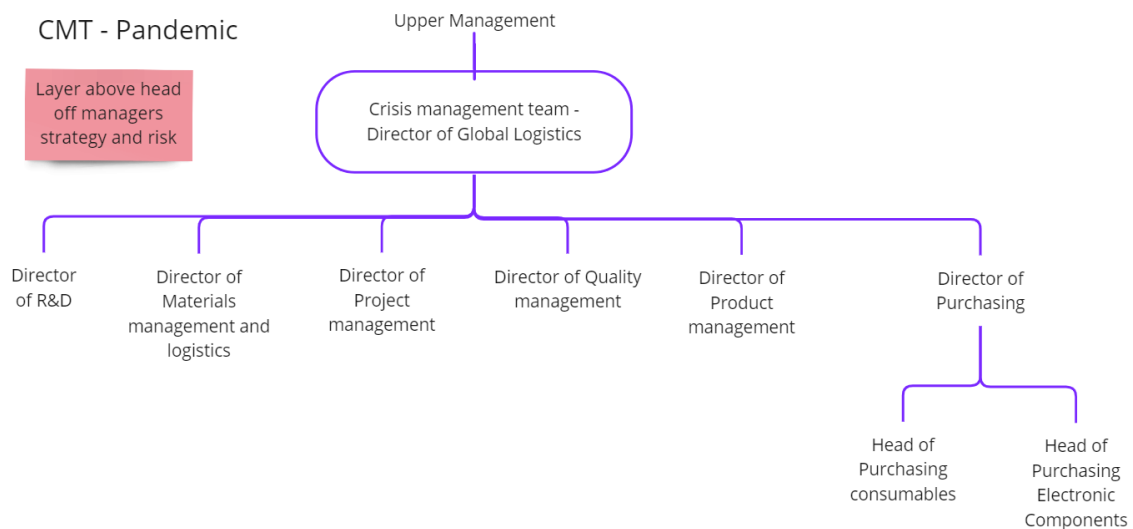
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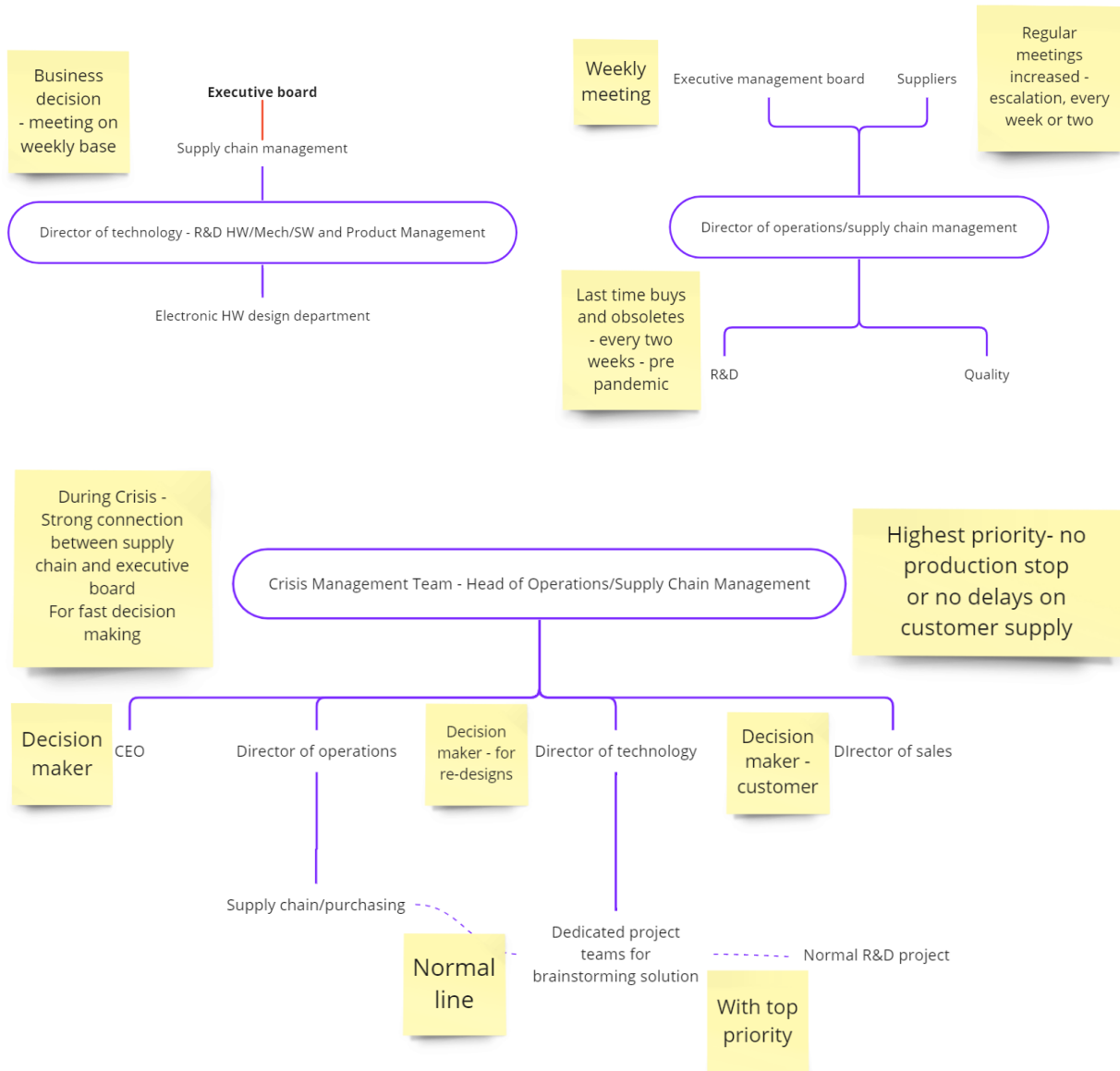
The usual structure - pre-pandemic



CMT - Pandemic

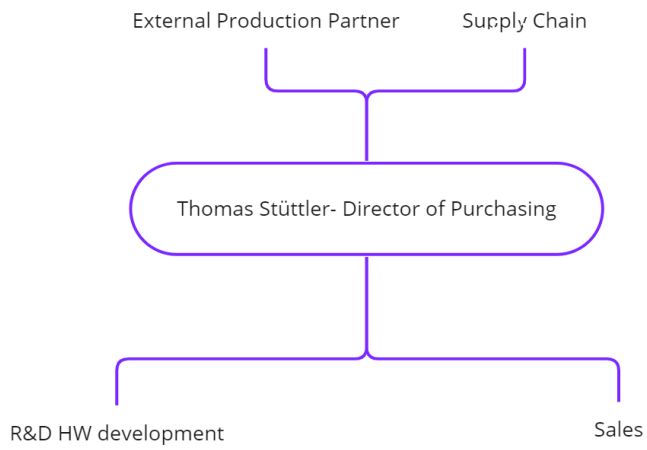


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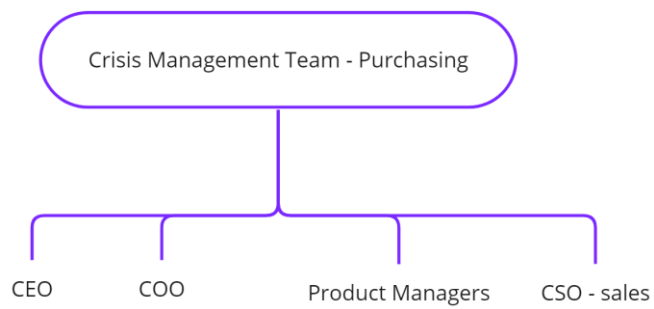


Company C3:

The usual structure - pre-pandemic

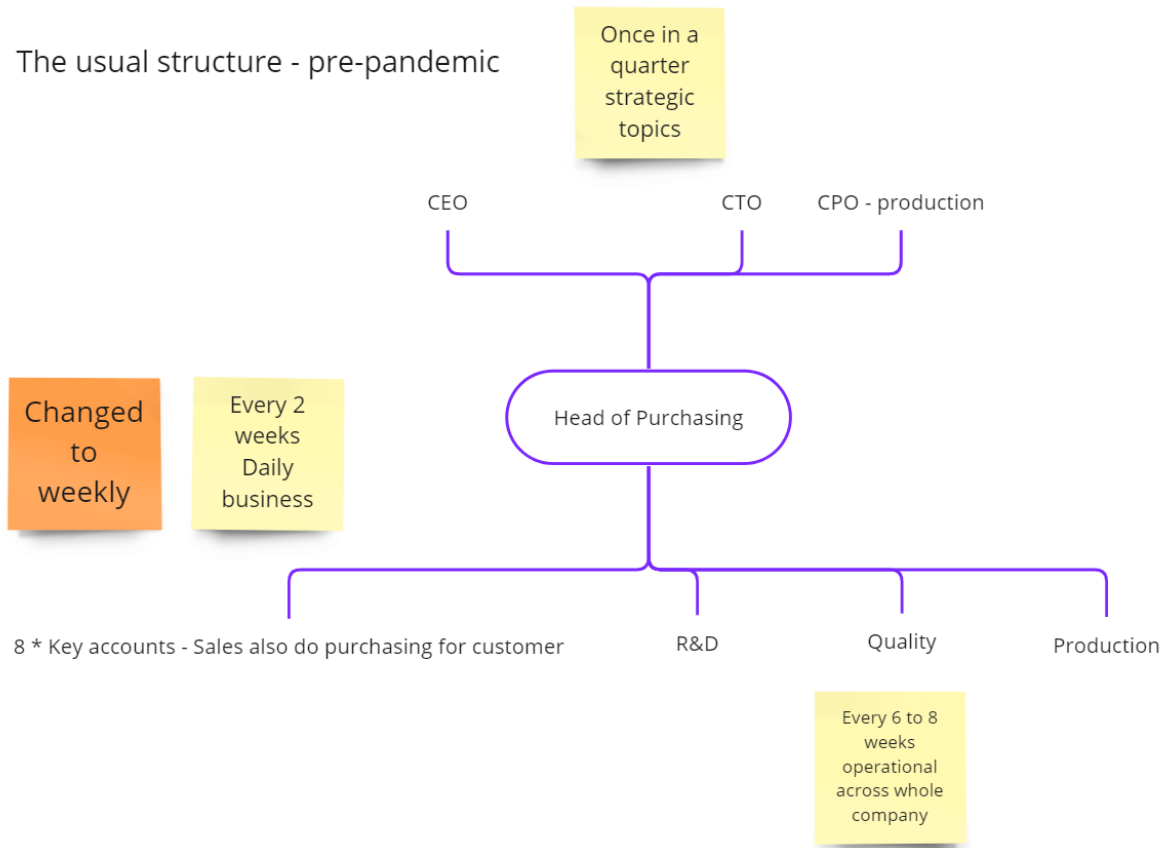


CMT - Pandemic

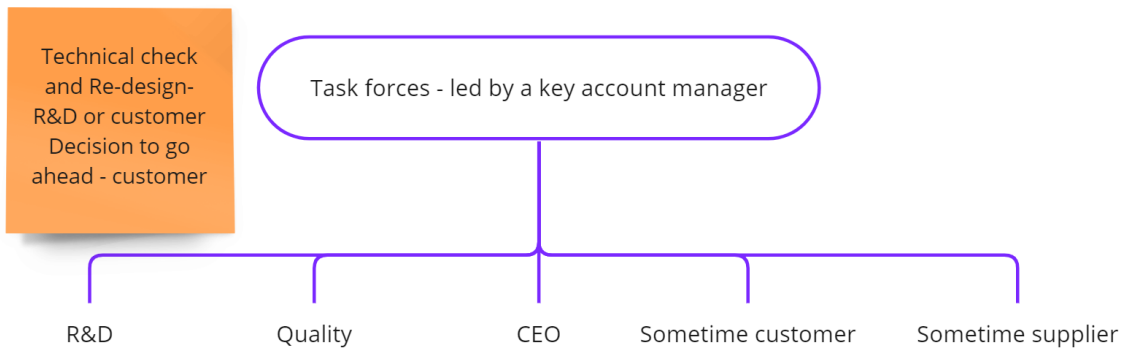


Company C4:

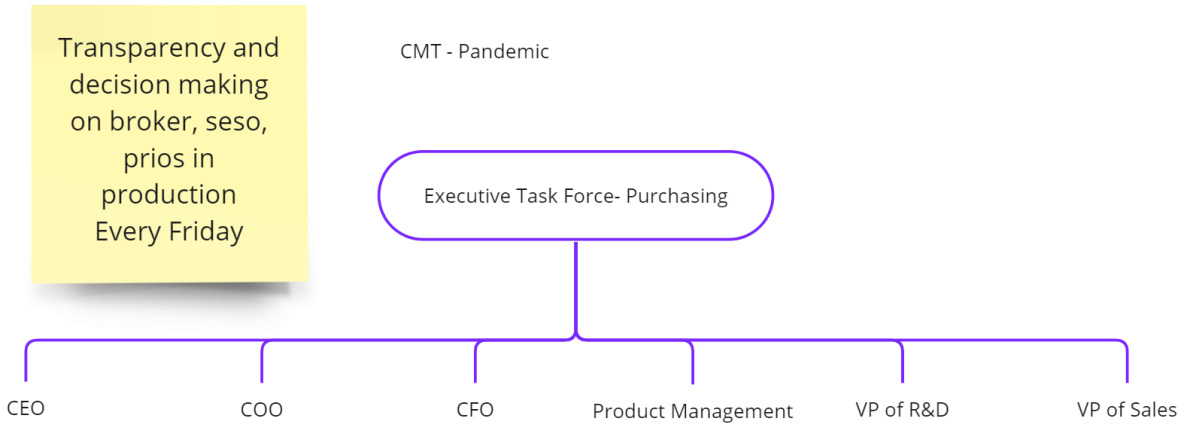
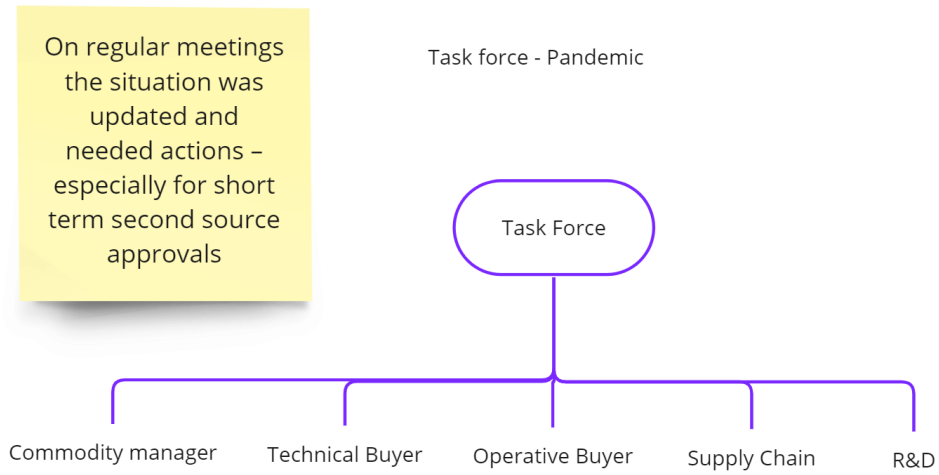
The usual structure - pre-pandemic



Task force - Pandemic



Company C5:



Coding Analysis

Ref.	Theme	Code	Description
C 1 C 2.2 C 4 C 5	Pre-pandemic: Strategic man- agement meeting	Stakeholders	C 1: Upper management together with project representatives C 2.2: Executive management board C 4: Management with CEO, CTO, CPO C 5: All executives and management
C 1 C 2.2 C 4		Frequency	C 1: Once a month C 2.2: Once a week C 4 : Once a quarter C 5 : Once a month
C 1 C 2.2	replace	Focus	C 1 : Steer strategic projects and define other strategic activities: new product developments C 2.2 : Most important topics that we have to discuss C 5 : Budget, big targets and strategy
C 1 C 2.2 C 4		Communica- tion channels	C 1 : Upper management directly with project leads C 2.2 : Only C level with some directors C 4 : C level with management C 5 : C level with management
C 1	Pre-pandemic: Other meet- ings	One-on-one	Middle management more focused meetings - once a week
C 1		Supply Com- mittee	Different business units from supply chain and purchasing - once a month
		Purchasing team meeting	C 4 : Team meeting - bi-weekly
C 4		Cross-func- tional team meeting	C 4 : Responsible people for each department (assuming head-of's or directors) - every 6 to 8 weeks
C 1 C 2.1 C 2.2 C 3 C 4 C 5	Organizational Structure	Fundamental structure did not change	All: Only added Crisis management team and task forces C 4 : Only added task forces

C 1 C 2.1 C 2.2 C 3 C 5	Crisis management team	Existing	C 4 did not have a crisis management team. Because they are a EMS that produces assembled PCBs for electronic manufacturing companies. They are a production partner for electronic manufacturing companies. They are the supplier and the crisis management team sits by each respective customer. This was seen because they were also referring back to the customer making the decisions that are normally made in the CMT
		Reason	The crisis threatens the company's financial well-being Business/financial, Executive, Strategic decisions to be made What needs to be done, where to focus the resources, which resources and the cost approvals
C 1 C2.1 C2.2 C 3 C 4 C 5	Task force teams	Existing	Various purchasing and R&D Task Forces
C 1 C 2.1 C 2.2 C 3 C 4 C 5	Task force teams	Reason	C 1 : Increased decision making efficiency Very high frequent changing of the delivery situation and the availability and the impact to the product. Creating transparency What is the situation? What is changing? What product will be not available? So that PM was informed. What does it mean? Operationalize the decisions made in the CMT
C 1 C 2.1 C 3 C 4 C 5	Meetings	More frequent meetings	Increased frequency of decision making, faster response needed with higher flexibility Looking at different options/solutions and the progress thereof

C 1 C 2.1 C 3 C 4 C 5		Frequency CMT meetings	C 1 : Once a week (from Once a month) C 2.1: Once a week (the same) C 3 : Bi-weekly (don't know) C 4 : Once a week (from bi-weekly) - they work different not having a CMT and this is compared to the normal purchasing/sales meeting C 5 : Once a week (from Once a month)
C 1 C 2.1 C 3 C 4 C 5	Business focus	Flexibility and time	More flexibility needed and higher time pressure Driving more solutions in parallel Quick informal meetings or unplanned called to CEO Per case handling The very high frequent changing of the delivery situation
C 1 C 2.1 C 3 C 5		Business priority	High level decision by CEO: Serial production has higher priority (production stop is imminent due to safety stock running out) R&D resources were used for technical changes instead of new development projects Sometimes new projects gets priority Priority regarding which products and production, set by Purchasing
C 2.1 C 2.2 C 5		Risk Management (strategy)	C 2 & C 5 : Buffer/Safety stock of three months C 5 : A certain stocking policy, a stocking, second source and stocking policy where we have so called aorta management. Very critical parts that are difficult to approve, source and which are used in big quantities and would therefore hurt the company if they were in shortage. What are the lead times and approval times
C 1 C 5	Structure – Task forces	On two levels	In purchasing: coordinate and also execute

C 1 C 2.1 C 3 C 5		Steps to get clarity	Whenever it cannot be solved within the boundaries of supply chain then an R&D Task Force is created in order to brainstorm different ideas and solutions. Parallel path to supply chain task force. Operationally there is then a direct path to supply chain/purchasing Major driver to have this task force was the very high frequent changing of the delivery situation and the availability and the impact to the product. So that means, okay, one driver was to create a transparency and say, okay, on which product we have a supply issue and how long to have that on a regular basis to have this transparency. And the task force which you have here, this is the Operative Task Force. Operative Task Force means really dealing with the suppliers and updating the figures, updating the delivery plans, et cetera
C 1 C 2.1 C 3 C 5	Structure – Task forces Electronic Manufacturing	Leading the Task Force	Task force was led by purchasing/commodity management
C 1 C 2.1 C 3 C 5		Stakeholders - decision makers and advisors	Two different task forces: 1) Purchasing: Depending on the component or product - Technical buyer was more in regards of second sourcing samples? Do we have it already or not? Are there any alternative? Operative buyer was really okay. Updating always the full delivery scheduling from the supplier. Do we have any update here? And supply chain then the planning, what are the demands? Do we have over planning or not, etc. 2) R&D - status of second source approvals
C 4	Structure – Task forces EMS	Leading the Task Force	Task force was led by one of the Key Account managers which is also in the purchasing department

C 4		Stakeholders - decision makers and advisors	Done on case basis depending on the customer affected Key customer, key account A, probably included the R&D or probably included the quality so that we can find a solution for this specific problem Some cases the CEO Included R&D if we had to go for a second source, included the quality if we had to go for broker parts. Sometimes also included the CEO when bigger financial decisions had to be made Technical check – C4 R&D or customer. And the next one was decision to go ahead - customer Final Ok always came from the Customer because it is the customer's design
C 1 C 2.1 C 3 C 4 C 5	Information needed - Task forces	Info received from CMT	C 1 : What needs to be done. What is the decided strategy in general as well as for the product or component they need to look at. When CMT needs an answer in order to make a decision C 2.1 : Our highest priority is to have no interruption of production so that we can deliver to our customers on time. All the decisions made are serving to this top level goal. C 4 : Received this information from the customer (Customer having the role of the CMT)
C 1 C 2.1 C 3 C 4 C 5	Meetings - Task forces	Fast decisions	Purchasing: the buying price is within certain boundaries enabling them to make the decision themselves without escalating R&D: When it is just a technical approval with not much cost or function change effect All decision makers are present
C 1 C 2.1 C 3 C 5		First layer of decision making	Operational decisions are made in the task forces where the risk is not too high and where they have the needed knowledge to made the decision or approval. The escalations are then done between the task forces horizontally

C 1 C 2.1 C 3 C 4 C 5	Decisions - Risk level	Steps to get clarity (Escalations)	Procurement manager can make certain decisions, but if too technical then it needs to be escalated to R&D in a task force, but then again if the business impact is too high then it is escalated to the CMT The reason is that purchasing department either tried everything to get it under control and was not able to, or broker material is very expensive and need to be decided in the crisis management team (too big effect on the business)
C 3 C 4 C 5		Fast decisions	Short distances between all crisis management team members, and direct contact: between task forces, and between task forces and CMT Quick risk and operational decisions C 4 : it was the fact that the Key account manager has the double role of sales and purchasing so saving time on information flow C 4 : Many short meetings Information quickly escalated from bottom to top and then down again
C 1 C 2.1 C 3 C 5	Structure - CMT	Leading the CMT	CMT was led by Global Logistics, Supply Chain department directors or Purchasing director or a delegate from one of the three
C 1 C 2.1 C 3 C 5		Leading the CMT Why?	They have the bigger clarity regarding the business situation. Refer to 'Steps to get clarity (To make strategic decisions)'
C 1 C 2.1 C 3 C 5		Stakeholders - decision makers and advisors	Reason is that Business/Financial/Executive decisions need to be made (What needs to be done regarding resources and costs involved) Diverse team was needed with people from all affected areas of the business Directors or executive board: R&D, purchasing/supply chain, project management, quality, sales/product management, operations CEO, CFO, COO, CSO (sales), R&D and product managers The leaders of the various Task Forces were

			also in the meeting - Purchasing, commodity management and R&D
C 1 C 2.1 C 3 C 5		Decision makers	Reason is that problem always comes out of another angle with a different product CEO is executive decision maker also regarding finance, CFO regarding the finance, Sales make decisions regarding influence on customers, Product Manager makes decisions regarding the product or customer, R&D makes decisions regarding alternative components usage and redesigns
C 1 C 2.1 C 3 C 5		Business/Financial decisions	Big purchasing items under discussion from Purchasing/Supply chain with executive board (CMT)
C 1 C 2.1 C 3 C 5		Strategic decisions	Made in the CMT with executive members from all areas of the business as advisors and decision makers- due to risk and complexityRefer to Business priorityInformation handed down to lower management level and task forces to be operationalized. All crisis management team members need to be on the same page, all need to commit and pull in the same directionC 4 the these decisions were made by customer and their CEO
C 2.1		CMT has full authority	That all decisions which need to be made are made instantly in this meeting and the relevant people are involved and no one needs to ask anyone else and to back up and so on

C 2.1 C 3		Risk Management (strategy)	Increased their safety stock - no KPI Had to wait for components to physically arrive or product was temporarily removed from the market
C 1 C 2.1 C 2.2 C 4 C 5	Meeting - CMT	Fast decisions	Pure clarity needed All decisions made here with no postponements All decision makers were present covering a wide area, and all are committed All information are prepared by Purchasing/Supply chain - Clarity with no uncertainty C 4 it was talking to the customer so that they can tell them which direction they want them to go
C 1 C 2.1 C 2.2 C 3 C 4 C 5	Information needed - CMT	Steps to get clarity (To make strategic decisions)	Clarity is needed due to frequent changing of the delivery situation and the availability and the impact to the product Clarity is needed on following points: Mostly from Purchasing/supply chain and task forces Where is the risk, where we have the resources, and where we need to focus. So really high level steering Info regarding where is the problem: Environmental issues, Supply issues - which component and products are affected Info regarding what are the options and recommendations (broker material, second sources-purchasing or R&D, re-designs - R&D etc.) Info regarding production priorities Info regarding affected products Info from suppliers: Delivery confirmation and dates Info regarding how far away from line stop or not fulfilling customer order Info regarding what is already done: status update Info regarding business impact and costs involved C 4 handed all of the information to the customer as the CMT together with their CEO

C 1 C 2.2 C 3 C 5		Priorities are needed (To make strategic decisions)	Priority set by Purchasing but sometimes by Sales when a big customer order or project comes up Info regarding production priorities Priority is always the availability of the components and if a line stop is possible Traffic light system giving an overview of all critical components.
C 1 C 2.1 C 3 C 5	Uncertainty - getting clarity	Supply chain/purchasing for information	Listened to the people in purchasing department. They are responsible for putting all information together. Responsible for the priorities
C 2.1 C 2.2 C 3 C 4 C 5		Suppliers for information	Listened to the suppliers, if the deliveries are possible, but also understand that the decisions made are always under some risk. Frequent meetings with suppliers to make sure they are updated on all topics and changes. C 3 : One colleague from purchasing had the responsibility to just do that Regular meetings to stay in close contact regarding changes so that you can know when you have to look at other options Also the CMT had meetings with the critical suppliers
C 3		A lot of communication	A lot of informal meetings and alignments
C 4		Steps to get clarity	The process was standardized Get in contact with the customer as soon as possible so that they can decide which options they want to have pursued. Include customer in decision process as soon as possible. Go for redesign, second source or broker part. Minimize the risk internally by including the quality and have tests done at external test houses.
C 3 C 5	Systems and tools	Cannot cope with changes or risk - Risk Management	The existing systems and SW tools could not always keep up with the changes: It gave delayed information or couldn't give the detail

			regarding the risk of components not being delivered
C 3		Changes made - for Risk Management	Adaptations were made in order for the systems and tools to give a more accurate view of the delivery situation
C 3 C 4		Tools for giving an overview of crisis	No special tools used. Word, excel and One Note. Should not take a lot of time to set up
C 2.1 C 3	What came out of the crisis	Better collaboration	Collaboration between hardware design and purchasing department got better because there was much more to work together. . So I would say this is something positive in this crisis. People got to know each other better and stand by.
C 2.1		Risk Management (strategy)	Higher sensitivity in R&D regarding second sources - learned the importance of it
C 5		Risk Management (strategy)	Invest in risk management: In safety stock as well as in R&D with second sources during development
C 3		Management meeting with similar view	Management meeting was kept discussing the same issues as experienced in the crisis. Just not so often
C 3		Adaptations to SW tool	Changes were made to SAP to give a better overview regarding production orders in order to better prioritize regarding supplies and production orders
C 3		New tool acquired	SW tool that gives you different options for components that are already used and which are very similar: for risk management
C 4		Talk to the customer as soon as possible	How to talk to the customers, how to get the problems across Be transparent as possible, especially with extra cost

C 5		Second sources for aorta parts: more options	More than one source for the critical and complicating parts. Got it approved already during development
C 5		Check list for future crises	What was done. Set up the team, set up the frequency, set up the regular reporting, what kind of decision has to be done by whom, what is the interaction with the suppliers
C 5		Need more flexibility	How to have more options without adding more complexity in the system

Statement of Affirmation

I hereby declare that all parts of this thesis were exclusively prepared by me, without using resources other than those stated above. The thoughts taken directly or indirectly from external sources are appropriately annotated.

This thesis or parts of it were not previously submitted to any other academic institution and have not yet been published.

Dornbirn, 5 July 2023

Trevor Howard