True Demand-Driven Semiconductor Supply Chains for Europe

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Publishable Executive Summary

The overall objective of WP7 is the incentivisation of participants to participate in the survey and in this way to obtain enough and qualitative good data. The set of participants should in any case consist of companies covering the whole semiconductor supply chain while being sufficiently representative and in sufficient numbers (text from call). As a first step (task 7.1) the idea is to create awareness and attract participants to build a community of first-time users who provide first data both on demand and supply. Those first-time users should be representative of the semiconductor supply chain including semiconductor manufacturers, Tier 1, Tier 2 and OEMs (text from call). This initial awareness creation will be done by gamification of the survey.

There is a strong dependency on the progress in WP5. Clear definition of the survey, it's target audience and USPs are first needed.

In the current stage of survey design (October 2024) a couple of decisions have been made over the last period in WP5. A "game" has been developed to check the definitions made in WP5. So, this Survey game is not part of the gamification to motivate participants but is an extra game to support WP5 in defining a clear survey. In addition to the definition of expected future demand the definitions of Technology nodes and market segments were also incorporated in the game.

Once definitions have been clarified and decided upon regarding other survey elements (e.g. current demand, inventory, order cancellation) we can design/develop new "games". We would like to use the same "test audience" for these games.

A next step will be expanding the discussions to other echelons/tiers of the semiconductor supply chain. This will ultimately contribute and result in a "game" which can be used to incentivize and attract new participants to the survey (overall objective of WP7).

Due to the delay of the survey development task 7.1 hasn't been finished yet. In task 7.2 we will continue with quality improvement of the surveys. Once participants have decided to participate it is important to continuously improve (PDCA) the quality of the surveys filled in by them. This continuous improvement should result in an acceptable quality level of the surveys in order to achieve the overall "true demand" objectives.

The intention is to create feedback loops for the participants so they can learn from their surveys and the results. A continuously reinforcement of the original objective and the achieved results hopefully will lead to an increasing overall (and individual) quality level of the surveys. Special attention will be given to biases of the participants when filling in the surveys.

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1. Introduction

1.1   Objective and scope of the document

Objective: Give an overview of the current status of the deliverables of WP7 (Gamification and User Experience Aspects of the Survey)

- Description of the problem to be solved by the development of the true demand platform as well as the expected outcome
- The role of incentivisation for participation in anonymous survey in order to obtain data
- An overview of the theoretical models to be used in gamification of the survey
- An explanation of the link and dependency to the survey design in WP5
- A status update of a survey game for WP5 (objective, design and next steps)

Scope: Achieved progress between kick-off of the project and end of October 2024

1.2   Structure of the deliverable report

- Scope
- Desk research Gamification
- Link to survey design (WP5)
- Conclusion

2. Scope

The following chapter aims to provide an overview of this project's motivation, objective, the methodology used to tackle this problem, as well as the expected outcome.

2.1 Motivation

The semiconductor industry is highly dynamic and sensitive to fluctuations in demand. The bullwhip effect, where small changes in consumer demand cause larger variations in orders up the supply chain, can lead to inefficiencies, overproduction, and panic buying. By using an anonymized demand survey, businesses within the supply chain can gain a clearer picture of the "true demand," leading to more stable and efficient operations.

2.1.1 Problem Statement

The semiconductor supply chain faces significant challenges due to the bullwhip effect and panic buying. These issues are exacerbated using different units of measurement across various echelons (e.g., number of chips, number of cars) and the strategic nature of the information. Traditional methods of demand forecasting often fail to capture the nuanced and real-time demand signals needed to mitigate these effects. A second challenge is that the semiconductor industry goes through periods of oversupply and shortages, because capacity is not always exactly in line with demand. For a good capacity planning it is needed to have a better insight in the development of demand.

2.1.2 Objective and Methodology

The primary objective is to design and implement an anonymized demand survey that captures key leading indicators such as inventory levels and demand. The survey will be tailored to address the specific needs of different echelons within the supply chain, ensuring that the data collected is both relevant and actionable.

Survey Design: Develop the survey questions, focusing on inventory levels, demand and demand forecast, and technology node categories. Ensure that the questions are designed to be easily understood and answered by all participants.

The overall objective of WP7 is the incentivisation of participants to participate in the survey and in this way to obtain enough and qualitative good data. The set of participants should in any case consist of companies covering the whole semiconductor supply chain while being sufficiently representative and in sufficient numbers (text from call). As a first step (task 7.1) the idea is to create awareness and attract participants to build a community of first-time users who provide first data both on demand and supply. Those first-time users should be representative of the semiconductor supply chain including semiconductor manufacturers, Tier 1, Tier 2 and OEMs (text from call). This initial awareness creation will be done by gamification of the survey.

2.1.3 Expected Outcome

The project aims to develop a comprehensive demand survey that can be used across the semiconductor supply chain to accurately gauge true demand. This will help in reducing the bullwhip effect, preventing panic buying, and ensuring a more stable allocation of resources across different market segments and technology node categories.

3. Desk research Gamification

3.1   Practical experiences with Gamification

As a first step the idea is to create awareness and attract participants to build a community of first-time users who provide first data both on demand and supply. This initial awareness creation will be done by gamification of the survey. We apply the AIDA principle (Awareness/Interest/Desire/Action) to convince potential participants to participate in the survey (Action= survey participation).

The first step is to create awareness of the why, how and what of the project and the surveys. We believe that experiential learning (gamification of the survey) will be an excellent way to create that first awareness step.

In our own learning practice over the last 15 years, we've applied the "Magic Circle", a learning cycle covering all elements of learning and various learning styles: experiencing, reflecting, conceptualizing and applying. This experience creates faster and more frequent feedback cycles and therefore links awareness already with interest and desire. An accelerated way to pave the path to convince participants to take action.

For this project, we've decided to expand the scope of theoretical models and dive into literature and theory to find further applicable models to be used (see 3.2).

In parallel we've spent a lot of time in the first half year of the project to reflect on our own experience regarding gamification. What are the lessons learnt, do's and don'ts and what can we take into account with regard to the development of the gamified survey for SC4EU. In addition to internal reflection and interviewing training designers, facilitators and participants we also investigated and discussed additional gaming experiences. Gathering practical experiences will continue during the project.

An important conclusion is that clear definition of target audiences and their needs and a clear USP definition of the survey are needed. This relates to the link to WP5 development (see 4).

3.2   Theoretical models to be used

Over the years we've used the Magic Circle concept from Jan Klabbers (see reference 1 Extensive desk research resulted in adopting two more theoretical models to be used when developing a game for the survey. All three models will be used as theoretical frameworks in the next steps.

3.2.1 Magic Circle

The basic concept of the Magic Circle is quite simple. The concept of the Magic Circle revolves around the idea of creating a special space for play and learning. In this context, the Magic Circle is a metaphorical boundary that separates the real world from a space where different rules apply. Within this space, participants can experiment, take risks, and explore new ideas in a safe environment. This concept is widely used in game design, education, and organizational development to foster creativity and collaboration. It integrates two-cycles; the micro-cycle and the macro-cycle (see Figure 1).
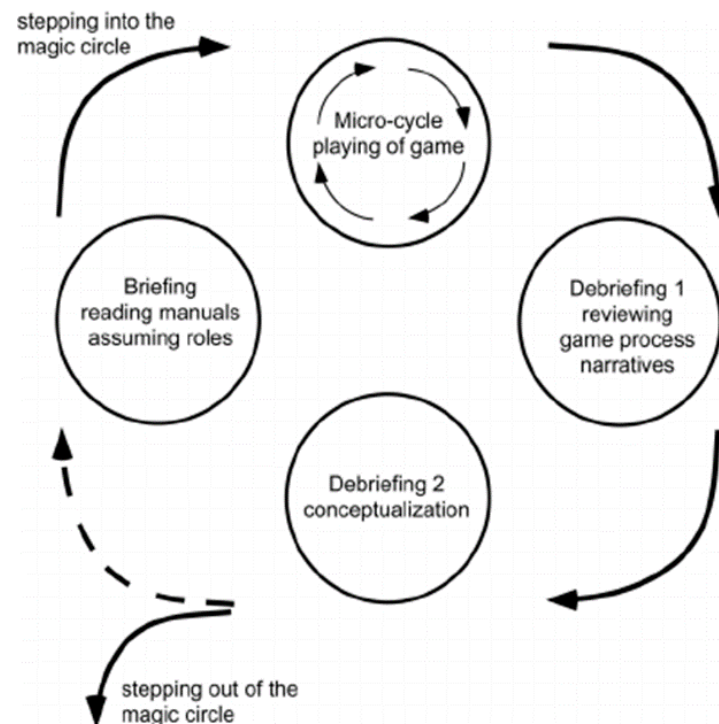
Figure 1: The Magic Circle

The Magic Circle concept is very similar to Kolb's learning cycle (reference 1). The Magic Circle and Kolb's Learning Cycle are both valuable concepts but serve different purposes. The Magic Circle creates a space for play and experimentation, often used in game design and learning environments. It emphasizes a boundary where normal rules are suspended, fostering creativity and exploration.

Kolb's Learning Cycle, on the other hand, is a model for understanding the process of experiential learning. It consists of four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation. Learners cycle through these stages to gain knowledge and skills from their experiences. While both concepts emphasize learning through experience, the Magic Circle focuses more on the environment and context, while Kolb's Learning Cycle provides a structured approach to how individuals process experiences to learn.

The Magic Circle offers several advantages. First, it provides a safe space for experimentation, allowing people to try new things without fear of real-world consequences. Second, it encourages creativity and innovation, as the usual rules and norms are suspended. Third, it fosters collaboration and teamwork, as participants work together within this unique environment. Finally, it can be a powerful tool for learning and personal development, as it encourages reflection and growth through play.

By integrating the Magic Circle into a survey, you can transform the survey into an interactive experience. This could involve elements like narratives, challenges, or rewards that make the process more engaging. For example, you could present questions as quests or challenges, with participants earning points or badges for completing sections. This approach can make the survey more fun and increase participation and completion rates.

3.2.2 Game-based learning design

The second theoretical concept we will use is the Game-based learning design. This model is from the book "Spelen werkt" (which could be translated as "Playing works") by Karen Sikkema and Michiel van Eunen (reference 2). The book starts with an explanation of learning versus gaming. Every game in essence contains 4 elements: objective, rules, feedback systems and voluntary participation. These elements are explained and have been more structured in the Game-Based Learning Design Wheel. It is a practical tool that helps you through the design steps of a game. It is a very simple and easy-to-use model.

In total it contains 9 steps (see Figure 2); based on the 3 elements Content, Incentive and Interaction. The model provides a bit more in-depth practical help when designing games. The same principles can be applied when "gamifying" a survey. We will use this model as a framework when we "translate" the survey into a game.
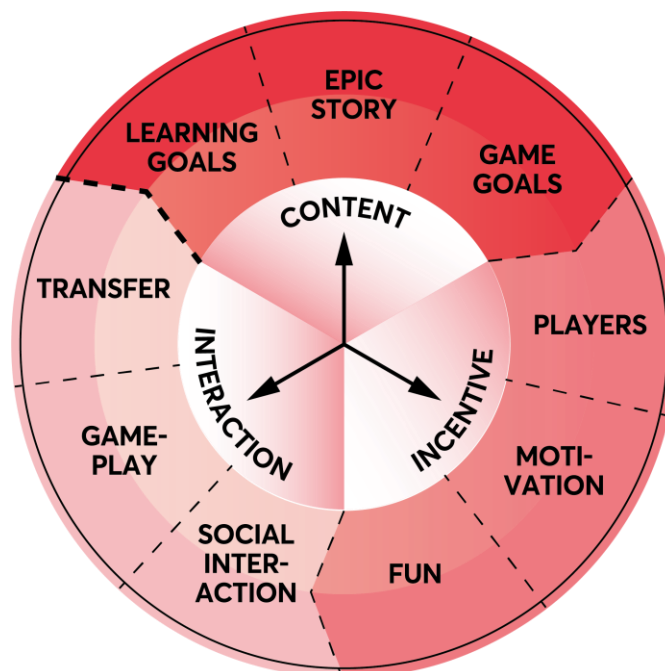

Figure 2: Game-Based Learning Design Wheel
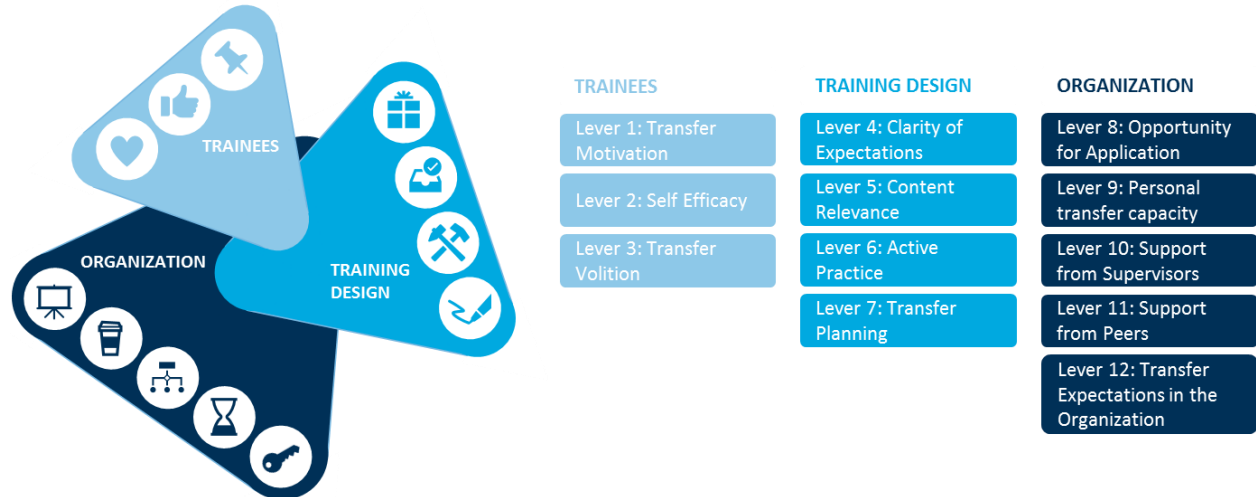
3.2.3 Transfer effectiveness

The third theoretical concept we will use is related to transfer effectiveness. Although a bit different compared to the other two models we believe it will help in the steps of "gamifying" the survey. The other two concepts are specifically tailored to "gaming" whereas this third model is more about creating impact.

The model we will use (12 levers of transfer effectiveness) is from the book "What Makes Training Really Work: 12 Levers Of Transfer Effectiveness" (reference 3).

Most seminars are useless - it's an open secret in HR circles. Less than 20 percent of what trainees supposedly learn is actually put into practice. Small wonder that training programs regularly fall victim to budget cuts. Summing up 100 years of transfer research, this book demonstrates that transfer success is manageable. The 12 levers of transfer effectiveness® represent the gist of scientific research for HR practitioners. Once familiar with them, you will know what determines transfer success and how to manage it. The book presents a conclusive

framework based on a solid scientific foundation. The 12 levers are split into 3 categories: trainees, training design and organization (see Figure 3).

We will use this framework for different purposes. First of all, as help for task 7.1 (Gamification of the survey) but also for task 7.2 (Survey tricks). Especially the link to trainees and organization can help to achieve the objectives of this task.

TRAINEES	TRAINING DESIGN	ORGANIZATION
Lever 1: Transfer Motivation	Lever 4: Clarity of Expectations	Lever 8: Opportunity for Application
Lever 2: Self Efficacy	Lever 5: Content Relevance	Lever 9: Personal transfer capacity
Lever 3: Transfer Volition	Lever 6: Active Practice	Lever 10: Support from Supervisors
	Lever 7: Transfer Planning	Lever 11: Support from Peers
		Lever 12: Transfer Expectations in the Organization

1. Transfer motivation: *I want*
2. Self-efficacy: *I can*
3. Transfer volition: *I will*
4. Clarity of expectations: *I know what I am supposed to learn*
5. Content relevance: *The content is practical and relevant to me*
6. Active practice: *I already practiced and tried it in training*
7. Transfer planning: *I know what I have to do after training*
8. Application opportunity: *I can apply what I learned in my daily work*
9. Personal transfer capacity: *My working day allows me time to apply what I learned*
10. Support from supervisor: *My supervisor encourages implementation*
11. Support from peers: *My colleagues are backing me up*
12. Transfer expectation in the organization: *My colleagues notice when I apply what I learned*

Figure 3: The 12 levers of transfer effectiveness

4. Link to survey design (WP5)

The overall objective of WP7 is the incentivisation of participants to participate in the survey and in this way to obtain enough and qualitative good data. The set of participants should in any case consist of companies covering the whole semiconductor supply chain while being sufficiently representative and in sufficient numbers (text from call).

There is a strong dependency on the progress in WP5. Clear definition of the survey, it's target audience and USPs are first needed. Figure 4 outlines the overall methodology of the work package (WP5) with the main building blocks. It consists of the specification and requirements of the survey, which is developed to gather information from semiconductor supply chains. This includes specifying the topics which are relevant to be surveyed across the whole supply chain as well as the survey process when a survey is started and at which interval we survey. This is the part that is actually needed for WP7 in order to take the next steps.
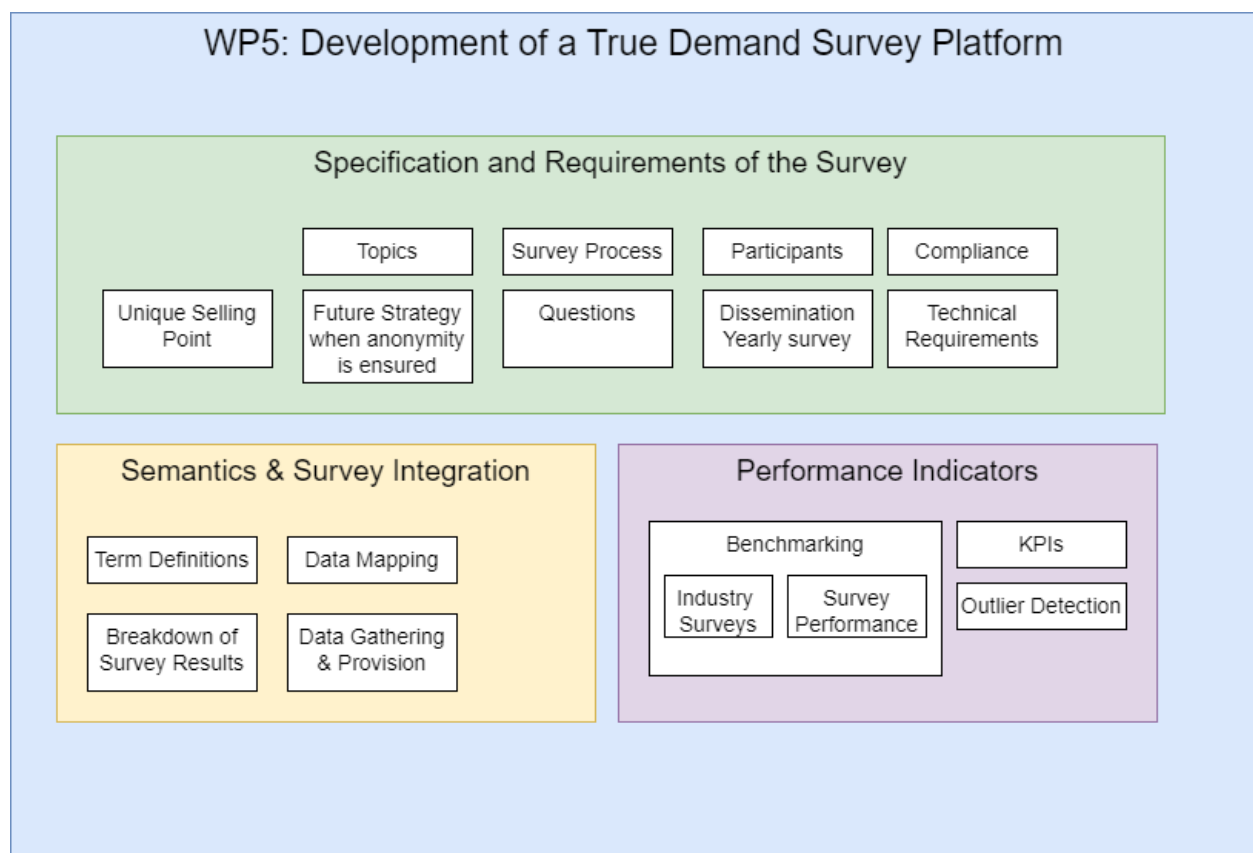

Figure 4: Use Case Methodology of WP5

4.1 Survey specification WP5

In the current stage of survey design (October 2024) a couple of decisions have been made over the last period in WP5. More specifically, a definition on expected future demand (part of the Demand Questions) had been decided upon in the several workshops. For example, horizon and product granularity detail (technology nodes). On another topic (baseline) there is still discussion on which option to choose.

Definition of Expected Future Demand (Sales & Marketing FC): The period which will be surveyed are the current quarter and the next six quarters from the date the survey takes

place. The expected future demand is defined as demand data from the Sales & Marketing forecast of the companies in units. It has no capacity restrictions and is therefore unconstraint demand. Currently it is discussed how the question will be designed in regard to growth rate measurement and baseline relation with the help of a demand game created by INVOLVATION (see 4.2).

4.2   Survey game WP5

A "game" has been developed to check the definitions (quote from Survey Design WP5 2.1.2.: "Ensure that the questions are designed to be easily understood and answered by all participants.") and get input for the final decision on baseline. So, this Survey game is not part of the gamification to motivate participants but is an extra game to support WP5 in defining a clear survey. In addition to the definition of expected future demand the definitions of Technology nodes and market segments were also incorporated in the game.

- Technology nodes:

   The survey should have the following product granularity for the technology nodes:
   - <=7nm   (Advanced EUV nodes)
   - 10nm to <28nm,   (Advanced Immersion nodes)
   - 28nm to <65nm,   (Mainstream Immersion nodes)
   - 65nm to <180nm,   (Mainstream Dry nodes)
   - 180nm or greater   (Nodes on 8" and smaller wafers)

   That groups technology nodes and links them to the fab capabilities. The capabilities are determined by the wafer size and lithography type.

- Market Segments

   The technology nodes should be linked to the following (End-)Market segments:
   - Consumer
   - Mobile Phone
   - Automotive
   - PC / Tablet
   - Server / HPC
   - Wireless & Wired Infrastructure
   - Industrial & Others

This can be achieved by an annual survey (see WP5 activities) to update the corresponding "translation tables". The technology nodes should also be linked to the WSTS categories with a corresponding second "translation table".

4.2.1 Objectives and scope

The objectives of the "survey game" are:
- Are definitions clear?
- Is it doable to fill in the requested data?
- Does the output contribute to determine "true demand" (especially after a disruption)?
- Support the choice for one of the baseline options

The "game" is excel based and can be played without much training and instruction. The process consists of briefing of participants, gameplaying and de-briefing. It is important to get the insights from the participants to reflect on the objectives as stipulated.

The participants were nominated in October 2024 and the process will be finished in November 2024. Discussion on profile of participants (from semiconductor suppliers and ASML) was important. Deliberately, participants were selected who were not part of the SC4EU project team to get an unbiased result.

An additional objective that was added to this "game" was the creation of a "test audience". If the results of this "game" are positive we want to continue with this "test audience" for future discussions. Once definitions have been clarified and decided upon with regard to other survey elements (e.g. current demand, inventory, order cancellation) we can design/develop new "games". Hopefully we can use the same "test audience" for these games.

A next step will be expanding the discussions to other echelons/tiers of the semiconductor supply chain. This will ultimately contribute and result in a "game" which can be used to incentivize and attract new participants to the survey (overall objective of WP7).

4.2.2 Game design

The game that was developed included 3 different options (the baseline options that still need to be decided upon):
- Baseline scenario 1: Fixed number during the whole game
- Baseline scenario 2: Baseline is recalculated per calendar year, as the average of the 4 quarters of the last calendar year
- Baseline scenario 3: Baseline is recalculated per quarter, as the average of the last 4 quarters

The gameplay was the same for all participants. They all needed to play 6 identical rounds per option.
The game starts with a fictitious company with a fictitious forecast.
Information about the fictitious company; market segments and % turnover:
- Automotive   25%
- Power   25%
- IoT   25%
- Security   25%

The rounds of all the three options need to be played in a consecutive order. For each round the excel sheet showed a forecast table and a table to be filled in (see Figure 5). In round 4 and 6 big "events/disruptions" were included in the gameplay in order to see the effects on the forecast.

The two fictitious events that were included in the gameplay were:
- Worldwide all subsidies on EVs will be stopped per July 1st,2025. Take this into account in your forecast.
- Due to revival of a pandemic, sales dropped dramatically last month (January)

Assume today is September 1st

Last month (August 1st) the expected demand has been filled out with these numbers:

Demand	Baseline (internal Number in units sold)	Current Quarter Q3 2024	Q4 2024	Q1 2025	Q2 2025	Q3 2025	Q4 2025	Q1 2026	Q2 2026
Under 7nm	150	5,0%	3,0%	-2,0%	6,0%	-1,0%	4,0%	2,0%	-3,0%
7nm to <28nm	310	4,0%	-4,0%	2,0%	-8,0%	3,0%	-9,0%	3,0%	1,0%
28nm to <90nm	270	-2,0%	-2,0%	4,0%	3,0%	-5,0%	7,0%	-2,0%	5,0%
90nm to <350nm	250	-9,0%	5,0%	6,0%	-2,0%	3,0%	-3,0%	7,0%	-2,0%
350nm or greater	190	2,0%	4,0%	6,0%	-5,0%	3,0%	-1,0%	7,0%	2,0%

Every percentage refers to the baseline.

Now there is an update of the expectation for the current quarter (which is Q3 2024) based on the actuals of July and August as shown in the numbers below

Please enter the new forecast numbers based on the new information of the current quarter

Demand	Baseline (internal Number in units sold)	Current Quarter Q3 2024	Q4 2024	Q1 2025	Q2 2025	Q3 2025	Q4 2025	Q1 2026	Q2 2026
Under 7nm	150	7,0%							
7nm to <28nm	310	3,0%							
28nm to <90nm	270	-3,0%							
90nm to <350nm	250	-7,0%							
350nm or greater	190	4,0%							

Figure 5: example of a round of the survey game

4.2.3 Next steps

As was mentioned in 4.2.1 the participants were nominated in October 2024 and the intention was to finish the process in November 2024. It took much longer than expected to get nominations for participants. We finally got 5 nominations (2 NXP, 2 Infineon, 1 ASML) and could start with the briefing of the participants November 7th. The participants played the game in the following week.

De-briefings were planned end November. Only 3 of the 5 participants were interviewed end November (unfortunately no or late reactions from 2 participants). Planning is to conclude de-briefings in December. Analysis of results and final report-out therefore also planned in December. If needed additional interviews and iterations will be done.

Hopefully the participants want to continue as a "test audience" for future discussions. Once definitions have been clarified and decided upon regarding other survey elements (e.g. current demand, inventory, order cancellation) we can design/develop new "games". We would like to use the same "test audience" for these games.

A next step will be expanding the discussions to other echelons/tiers of the semiconductor supply chain. This will ultimately contribute and result in a "game" which can be used to incentivize and attract new participants to the survey (overall objective of WP7).

5. Conclusions

The overall objective of WP7 is the incentivisation of participants to participate in the survey and in this way to obtain enough and qualitative good data. This initial awareness creation will be done by gamification of the survey. There is a strong dependency on the progress in WP5. Clear definition of the survey, it's target audience and USPs are first needed.

In the current stage of survey design (October 2024) a couple of decisions have been made over the last period in WP5. A "game" has been developed to check the definitions made in WP5.

A next step will be expanding the discussions to other echelons/tiers of the semiconductor supply chain. This will ultimately contribute and result in a "game" which can be used to incentivize and attract new participants to the survey (overall objective of WP7). In task 7.2 we will continue with quality improvement of the surveys.

6. References

[1] Klabbers, J. H. G. (2006). The Magic Circle: Principles of Gaming and Simulation. Rotterdam: Sense Publishers. 332 pages. ISBN 90-8790-006-6 (paperback); ISBN 90-8790-007-4 (hardback)

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