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Development of a Customer-centric Structure Research Roadmap

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ABSTRACT

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The Hallmark of modern marketplace is globalised supply chain, increasing demands and expectations from customers and high rate of technology discovery. As a result, maintaining competitiveness is challenging for technology companies. Increased investments in Research and Development (R&D) activities have been widely adopted as the solution. Despite the huge investments, several R&D organizations have not succeeded in overcoming this new market forces. Some companies are starting to question the returns on R&D investments. If R&D organization is to remain relevant in the 21st century marketplace, it must re-invent itself. Traditional technology-push mindset must be abandoned, and a customer value creation mindset should be adopted.

This work was commissioned by the R&D organization of the case company to facilitate the shift to customer-centric research process. The objective was to develop a customer-centric research roadmap for the structure research area. Theoretical aspect involved study of literature works on customer centricity, value creation and technology roadmapping. Afterwards, a novel framework for research roadmap development was developed. The empirical part of the study aimed to acquire a clear picture of the readiness of the case-company to adopt a customer-centric mindset and to gather customer values that will be inputs to the theoretical framework. Primary data collected from internal stakeholders was triangulated with secondary data from other studies conducted by the company.

Despite strong support towards a customer centric way of working, results from the empirical studies suggest inadequate coordination and communication among different organization with regards how customer needs and feedbacks are managed. As a result, a unified and coherent list of customer values could not be established. Nevertheless, three customer values were selected from the empirical studies and utilized as input to the theoretical framework to develop a structure research roadmap for the next 5 years. The framework can be used to develop roadmaps for other research areas in the organization.

In conclusion, the R&D organization is encouraged to promote and facilitate the adoption of the developed research roadmap to other research areas and also ensure efficient cooperation and communication among the different organizations with regards customer data and value creation.

Key words: technology roadmap, customer value, research roadmap, customer-centricity, technology research process, value creation.

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1 INTRODUCTION

The Hallmark of 21st century marketplace is globalised supply chain, increasing demands and expectations from customers, high rate of technology discovery and changing geo-political alliances. These has put tremendous challenges to companies' competitiveness. In response, most companies are investing heavily in Research and Development (R&D) organizations with the objective of improving their profitability by bringing innovative products to the market much faster than their competitors. For example, funding allocated to R&D globally has been rising each year at an average rate of 7% . As of 2020, global investment in industrial R&D stood at €904.2bn (European Commission 2020).

Despite the huge investments, several R&D organizations have not succeeded in overcoming the formidable challenges created by the new emerging market forces. Some company leadership teams are beginning to question the returns on R&D investments, while others are adopting other strategic tool such as merger and acquisitions, cost cutting and restructuring to remain competitive. If industrial R&D organization is to remain relevant in the 21st century marketplace and beyond, it must re-invent itself. The traditional technology-push mindset should be abandoned, and a customer value-creation mindset must be adopted.

It is a well-known fact that R&D personnel of most industrial companies are neither trained nor experienced in customer value-creation way of thinking. Thus, it is not surprising that they naturally carry out their operations with technologies as the main driver. That is, they research a technology until maturity and then seek business case and market for it. This is often call Technology-push approach. An alternative is the so-called Market-pull approach. In the Market-pull approach, it is the customer needs that take the driver seat in driving the research and development activities. Once the customer needs are identified, then required technology is used to provide solutions to the needs. The limitations and inefficiencies of Technology-push approach has been studied and reported since the beginning of the 20th century (Woodruff 1997, Scott 2001). Furthermore, a shift to a Market-pull approach has been suggested as the solution to the new challenges of the 21st century marketplace (Scott 2001). Before R&D

organizations can make transition to a Market-pull approach, they need a customer-centric framework to systematically identify customer needs and transform those needs to research projects. The framework must be practical and simple enough such that no prior competence in marketing or business design is required for its implementation. The development of such a framework is the aim of this work. Furthermore, its effectiveness will be demonstrated by applying it to develop a roadmap for structure research area for the research organization of the case company.

This chapter discusses the background behind the study, starting from the general situation with R&D activities in technology companies since the 1990's and gradually dive into the current situation at the case company. Then, the research questions and objectives are introduced. The last section outlines the structure of this thesis work.

1.1 Background, Objectives and Deliverables

Since the early 1970s, corporations have appreciated the need to have a methodology to manage and control their R&D process from ideation to launch. The stage-gate system was widely adopted as a conceptual and operational tool to move from idea conceptualization to product launch (Cooper 1986). Figure 1 describe the stage-gate system. The key feature is that the R&D process includes quality control mechanism at each gate At each gate, there are set of criteria that must be meet and decision to Go/Kill/Hold/Recycle is given depending on how well those criteria are met.

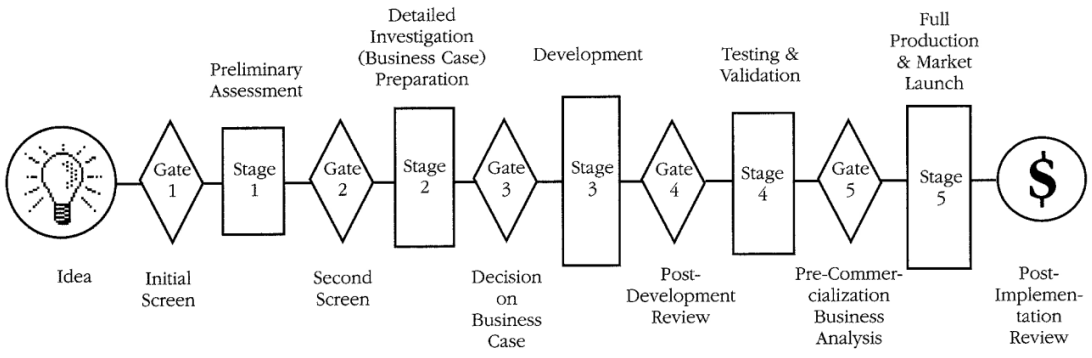


Figure 1. An overview of a stage-gate system (Cooper 1990).

The stage-gate model have been very successful in ensuring effectiveness and high quality in the development of idea that leads to successful market launch. Infact the model is still widely used in many R&D organizations globally (Cooper 1990). Although the model has in-built mechanism to ensure that ideas without a good business case will not proceed far in the development process, it does not provide a process to identifying the idea to start with. Clearly, the output of the stage-gate system is as good as it's input. Technical minded R&D personnel predominantly find the ideas from technology scouting or ideas generated during cost-cutting exercises. In the 80's and early 90's, this way of idea generation maybe sufficient then but not anymore. In the modern marketplace, a new way of idea generation that is compatible with the new emerging market forces is highly needed.

In a DELPHI questionnaire study consisting of 84 respondents from 18 countries, 39 from university affiliated technology research institutes and 45 from technology industry, participants were asked to list and rank 24 problems relating to management of technology and research, in order of importance (Scott 2001). The problem of "Strategic Planning for Technology Product" was ranked well above all others as the most pressing problem that they were facing. A follow-up study to elucidate the sub-problems under "Strategic planning for Technology Products" revealed that the two most important sub-problems that need urgent solution were:

- Linking Technology Strategic Planning to Corporate Strategic Planning.
- Linking R&D Strategic Planning to Business Unit Product Development Planning.

The two sub-problems due to their apparent relation were refer to as "The Linkage problem". Despite call to researchers to provide solutions for the linkage problem (Scott, 2001), studies in literature that address this problem directly are very rare. As a result, technology industries are still facing the linkage problem till today. A concrete example is the current situation with the case company where pre-study conducted before this work was initiated revealed an obvious linkage problem in their operations and processes. Technology industry urgently demands solution to the linkage problem.

At first glance, the problem of where to find ideas to the stage-gate system and the linkage problem appears to be distinct and unrelated. However, upon careful examination it will be clear that they are in fact related. In fact, the former is the consequence of the latter. This implies that the linkage problem is not only the root cause of the challenges faced by industrial R&D organization in identifying ideas to work on as research projects, but it also provides the clue to the solution.

The case company is a multinational corporation that specialises in manufacturing and servicing of industrial and ports equipments. A truly global leader in its industry with over 3 billion euros in revenue for year 2020. Its organization structure is arranged along different business areas. Each business area is further divided into many business units. Each business units then have related products lines under its portfolio. A global unit exist to support all business units in their functions. The case company global Research and Innovation (R&I) organization belongs to the global unit. A separate organization within the global unit is responsible for development functions.

The case company is using the stage-gate system for its product development process. The “idea” to “Gate 3” of the system, as shown in Figure 1., is undertaking within the R&I organization. “Stage 3” till “Stage 5” is under the responsibility of the development organization. The decision to proceed on a research project to the development stage is usually taken with the relevant business unit. A commitment from the relevant business unit is a crucial condition to get a “Go” decision to proceed to development phase.

This thesis work is commissioned by the global R&I organization with the objective of increasing the number of research projects that make it to the development phase and subsequently become a successful innovative line of products for the business units. In order to demonstrate the effectiveness and practical application of the end result of this work, it will be used to develop a 5 years research roadmap for structure research area. Therefore, the deliverables at the end of this work are:

- **Generic deliverable**: A framework to discover customer-centric research projects for R&D organization in technology industry.

- **Specific deliverable**: Structure research roadmap for the case company R&I organization, 2021-2026.

1.2 Research Questions

In the previous sections, it was argued that the problem of source of ideas to the widely used stage-gate system is a symptom of an even larger problem, the linkage problem. Hence, the solution to both problems must be sought simultaneously. The solution should be capable of helping R&D department of technology industry to discover many customer-centric research projects and offer guidance in organizing them into a coherence and realistic research roadmap. Keeping these specifications in mind, the research question for this thesis work is framed as:

- How to create a framework for developing customer-centric research project roadmap in technology industry ?

Furthermore, the main research question can be divided into the following sub-questions:

1. How to systematically identify customer needs ?
2. How to discover technologies to enable those needs ?
3. How to develop a realistic research roadmap based on the needs and the enabling technologies ?

1.3 Structure of the Thesis

Chapter 1 introduces the motivations, background, key deliverables, and objectives of this thesis work. It begins with the general problems facing the R&D organization of technology industry and then progress to the situation in the case company. Research questions are introduced as well as the thesis structure.

Chapter 2 considers the literature review on related theoretical framework. Relevant theories on customer centricity, customer satisfaction, value creation will be discussed from the vantage point of how they can be used to capture the voice of the customer and market. Theories on technology roadmapping will be discussed.

In chapter 3, a novel framework for research roadmap development in technology industry will be introduced. This framework is one of the two deliverables of this work.

Chapter 4 will highlight the adopted research methodology. Research onion concept (Saunders 2007) will be briefly discussed , then it's application in this work will then be discussed in detail.

In chapter 5, the empirical aspect of this thesis will be discussed. How the data collection was carried out in the case company will be elaborated and data that are not classified as secret by the case company will be reported. Analysis of collected data will also be included in this chapter.

Chapter 6 will provide practical application of the framework that was introduced in chapter 3 to develop a structure research roadmap for the case company. Related data collected from chapter 5 will serve as input to the framework. The structure research roadmap is the second deliverable of this work.

In chapter 7, the thesis work will be concluded with answers to the research questions and recommendations for the case companies on the deployment of the framework to its internal process. Other findings that were not part of the initial objectives of this work will be discussed. Reflections on the whole thesis process will be provided. Potential future research work will be highlighted.

2 LITERATURE REVIEW

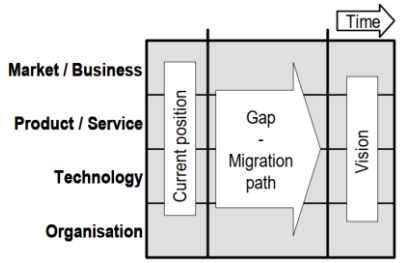
2.1 Technology Roadmapping

The first appearance of Technology Roadmapping as a strategic planning tool in R&D management of industrial corporations was in the 1970s by Motorola corporations (Willyard & McClees 1987). Motorola is a heavily technology-based company, their end-products are in fact technologies. The technology roadmap development was Motorola's upper management´s response to the increasing level of complexity of their products and the emerging threat of losing their competitiveness in the marketplace. It is therefore a strong technology-push approach to roadmapping. This is understandable keeping in mind the nature of Motorola's business. This is also evident in the naming of the process itself i.e., "Technology Roadmapping".

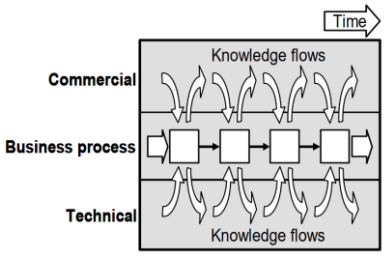
As a result of its early success at Motorola, the technology roadmapping approach gained widespread adoption in other industry and government research institutes (Phaal, Farrukh, Probert 2003). In addition, it has been applied to many other functional areas such as strategic appraisal, process development and research network development. This has led to the emergence of different customized templates developed by both industrial practitioners and university researchers. Farrukh (2003) made a compilation of the various available customised templates as shown in figure 2.

The European Industrial Research Management Association (EIRMA) attempted to harmonize the existing different technology roadmapping framework (EIRMA 1997). The result was a generic framework for technology roadmapping shown in Figure 3. EIRMA aimed to provide a general framework that provides guidance to technology industry on how technology can be aligned to corporate business strategy, available resources, product and service developments, and market opportunities. The generic roadmap is a 2-dimensional time-based chart, consisting of 5 layers. The layers comprises of both internal and external perspectives and the complex links that exists among them over time. This effort by EIRMA played a significant role in the emergence of Technology Roadmapping as a research field and the development of a unified theory.

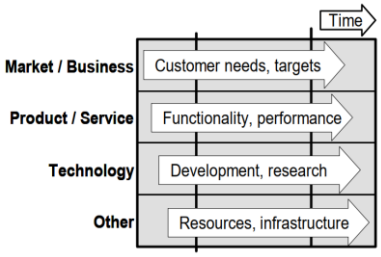
(a) Business reconfiguration



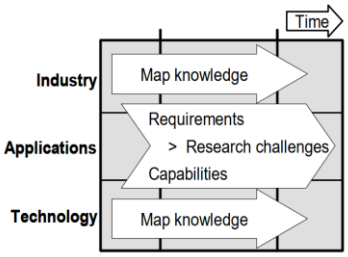
(b) Process development



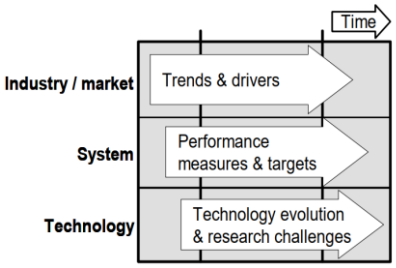
(c) Product-technology Development



(d) Research network development



(e) Sector foresight



(f) Strategic appraisal

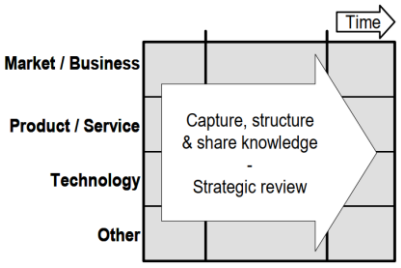


Figure 2 (a)-(f). Areas of application of Technology roadmap (Farrukh 2003).

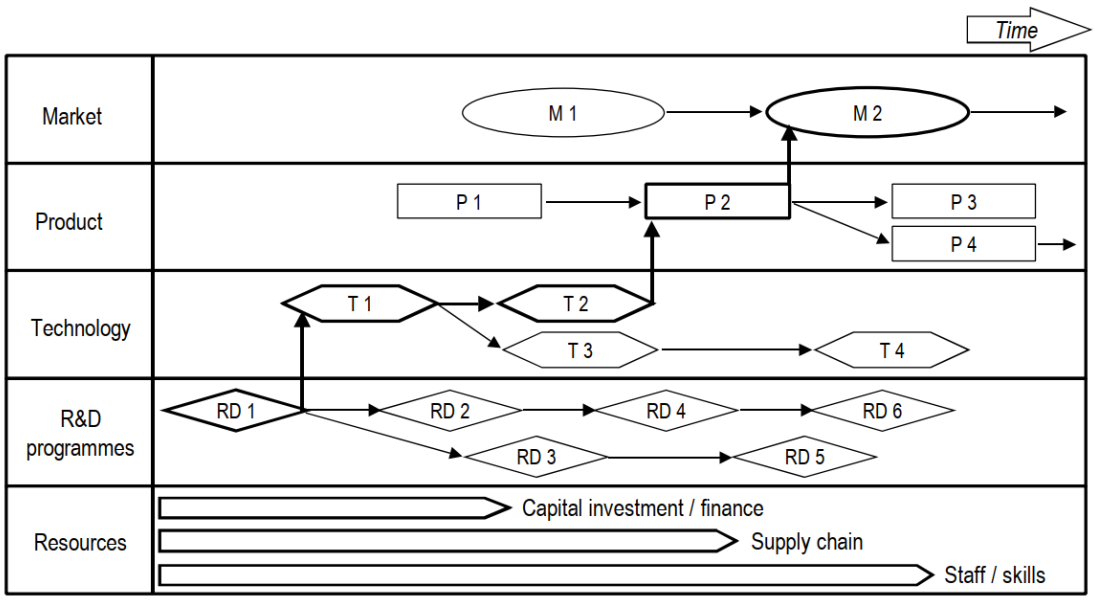


Figure 3. EIRMA generic template of technology roadmap (EIRMA 2017)

Garcia and Bray (1997) suggested that rapid development and obsolescence of technologies coupled with fast changing market needs means that a technology-push approach to technology roadmapping is no longer sufficient to maintain the competitiveness and profitability of industrial company. They advocated for a more market-pull approach in which a lot of emphasis is placed on why the technology roadmapping is been made in the first place and also how it will be utilized. In their words and I quote " The information about and analysis of needs and technology alternatives is far more important than following a precise process and format" (Garcia & Bray 1997.)

They proposed a 3 phase approach to the technology roadmapping process. Garcia and Bray´s contribution to technology roadmapping should not be underestimated. In their view, the studies on format, different layers, structure, and templates of the technology roadmap are well and good, but far more important are the activities that must be undertaken in the technology roadmapping process itself. They proposed that the process should consist of three phases - preliminary activity, development of the technology roadmap, and follow-up activity. The phases and their underlying activities are shown in Table 1.

Table 1. Phases in the technology roadmapping process (Garcia & Bray 1997).

Phase I	Preliminary activity 1. Satisfy essential conditions. 2. Provide leadership/sponsorship 3. Define the scope and boundaries for the technology roadmap.
Phase II	Development of the technology roadmap 1. Identify the "product" that will be the focus of the roadmap. 2. Identify the critical system requirements and their targets. 3. Specify the major technology areas. 4. Specify the technology drivers and their targets. 5. Identify technology alternatives and their timelines. 6. Recommend the technology alternatives that should be pursued. 7. Create the technology roadmap report.
Phase III	Follow-up activity 1. Critique and validate the roadmap. 2. Develop an implementation plan. 3. Review and update.

To Garcia and Bray (1997) , the mission and purpose of technology roadmapping is very simple and straightforward. It is a strategic technology planning technique. It must be driven by identified product industry needs. Those needs should drive technology selection and development projects and also generate the plan to deploy the enabling technologies to fulfil those product needs. In other words, it is clearly a market-pull approach to technology roadmapping. In phase I, they propose the formation of a committed group of people from relevant areas such as marketing, manufacturing, R&D e.t.c, for a collaborative development. A clear common vision and perceived need to create a technology roadmap to attain the vision must be established. The group must have the support of the organization leadership team. Furthermore, during this phase it must be made vividly clear to the group that the technology roadmap will be needs-driven, not solution-driven. (Garcia & Bray 1997.)

Phase II is where the development of the technology roadmap happens. Garcia and Bray suggest that “Product” should act as the central focus of the roadmap development. Hence, the first step is for the group to agree on the products that have missing features that addresses customer´s needs. According to them, the most critical step in the roadmap development is identifying and defining those missing product features upon which all other following technology-related activities in Phase II are based. A key gap in their proposition is that they do not provide guidance on how to systematically identify those product needs. This is a very important gap because the success of the technology roadmap depends on how well the group can identify relevant product needs. Nevertheless, the contribution of Garcia and Bray is very significant and a step in the right direction. (Garcia & Bray 1997.)

In this work, Garcia and Bray (1997) market-pull approach to technology roadmap is adopted. Attempt will be made in chapter 3 to fill the gap in phase II of the procedure. That is, this work will propose a solution to the problem of how to systematically identify product needs upon which the technology roadmap should be focused. The solution will be built on unified theme of customer centricity, customer satisfaction and value creation. These themes will be briefly discussed in the next section.

2.2 Customer Centricity and Value Creation

2.2.1 Customer Centricity

Customer centricity is a complex construct to comprehend. Perhaps this is the reason why it is challenging to develop a unified theory around it. The literature is filled with different attempts by researcher to define customer centricity, with nearly all of them approaching it from different perspectives (Sheth, Sisodia & Sharma 2000; Wagner & Majchrzak 2007; Kumar & Peterson 2005; Shah, Rust, Parasuraman, Staelin & Day 2006; Galbraith 2005)). Shah (2006) and Galbraith (2011) focused on the study of customer-centricity from the viewpoint of organization management. In their view, every organization can be categorized as either product-centric or customer-centric based on its strategies, processes, and structure. They did extensive studies on the main differences between a product-centric and a customer-centric organization, their main findings are summarized in table 2.

Gummesson (2008b) challenged the notion that customer-centricity can be the basic for organization management, marketing, and profitability. In his view, customer is only one of many stakeholders in a business setting, therefore it is not realistic that a single stakeholders should be nucleus upon which every other business decisions and strategies be based. He advocate for a “balanced-centricity” instead. Balanced centricity is essentially a form of relationship marketing. Balanced centricity suggest that a single stakeholder should not be the driver of business management rather trade-offs between the interests of all stakeholders should be central theme. Gummesson´s criticism of customer-centricity came not from the idea of focusing on customer needs itself but from the idea that all business decision should be “centered” around the customer. Infact he argued the principle of lean consumption developed by Womack and Daniel (2005) are truly the essence of customer-centricity. (Gummesson 2008a, 2008b, 2008c.)

Table 2. Product-Centric versus Customer-Centric (Galbraith 2005)

		Product-Centric Company	Customer-Centric Company
Strategy	Goal	Best product for customer.	Best solution for customer.
	Main Offering	New products.	Personalised packages of products, service, support, education, consulting.
	Value creation route	Cutting-edge products, useful features, new applications.	Customizing for best total solution.
	Most important customer	Most advanced customer.	Most profitable, loyal customer.
	Pricing	Price to market.	Price for value, risk.
Structure	Organizational concept	Product profit centers, product reviews, product teams.	Customer segments, customer teams, customer P&Ls.
Processes	Most important process	New product development	Customer relationship management and solutions development.
Rewards	Measures	• Number of new products • Percentage of revenue from products less than two years old. • Market share.	• Customer share of most valuable customer. • Customer satisfaction. • Lifetime value of customer. • Customer retention.
People	Approach to personnel	Power to people who develop products.	Power to people with in-depth knowledge of customer's business.
	Mental process	Divergent thinking: How many possible uses of this product?	Convergent thinking: What combination of products is best for this customer?
	Sales bias	On the side of the seller in a transaction.	On the side of the buyer in a transaction.
	Culture	New product culture: open to new ideas, experimentation	Relationship management culture: searching for more customer needs to satisfy.

The principles of lean consumption developed by Womack and Daniel (2005) are:

- Solve the customer's problem completely by ensuring that all the goods and services work and work together.
- Don't waste the customer's time.
- Provide exactly what the customer wants.
- Provide what's wanted exactly where it's wanted.
- Provide what's wanted where it's wanted exactly when it's wanted.
- Continually aggregate solutions to reduce the customer's time and hassle. (Womack and Daniel 2005.)

To Gummesson, any organization that follows those principles can be said to be customer-centric and to achieve those in practice, organization must focus on relationship management between all stakeholders not solely focusing on customer needs and satisfaction. Gummesson argument and criticism seem

relevant and valid because if the initial problem is due to been product centric then the solution cannot be shifting to being customer centric. By so doing, the actual issue has not been addressed, which is - solely focusing on one stakeholder, be it product or customer. In other words, it can be argued that Gummesson is hinting at “The Linkage problem” that was discussed in the introduction chapter of this work.

The third dominant perspective on customer centricity is by far the most popular in literature. In this perspective, an organization is considered to be customer centric if it:

1. Generate customer intelligence by collecting and analysing data at relevant touchpoints along customer journey.
2. Actively involve customers in marketing and innovation processes, co-creating value with them
3. Predominantly focus on whole customer experience with the aim of creating values in a new way rather than focusing on product/service offerings. (Gummesson 2008b.)

In this work, the dominant perspective that emphasize the triad consisting of Customer intelligence, customer co-creation and Value creation is adopted. Ideas from Gummesson viewpoint will be utilized, especially his emphasis on taking care of relationship and interaction among internal stakeholders in the organization.

2.2.2 Value Creation

About half a century ago, several organization around the world ,especially in Japan and the USA, adopted lean principles for quality control of their manufacturing and operations (Woodruff 2017). Then, companies competitive advantage comes from offering superior quality. Lean principles and other quality management techniques such as six-sigma brought remarkable improvement in quality of products and services. Quality management techniques are especially very effective in improving internal processes in an organization. There is no doubt that quality will always remain an important value in business management. 21st century marketplace is distinctly different from that of the 1990’s, a point that

has been discussed in detail in the introduction chapter. As a result, quality is no longer sufficient as a source of competitive advantage and sustainable growth in profitability. Delivering superior customer value is the new source of competitive advantage (Woodruff 1997; Grönroos 1997; Almquist & Bloch 2016).

Woodruff (1997) reported as early as 1990s that issue is not whether companies want to deliver superior values to their customer but how to deliver it. Furthermore, Woodruff suggested basic practical question that company managements often face that should be research questions for academics. Those questions includes:

1. What exactly do customers value?
2. Of all the things customers value, on which one should we focus to achieve advantage?
3. How well do customers think we deliver that value?
4. How will what customers value change in the future? (Woodruff 1997.)

The development of “tools of customer value” that practitioners can use to navigate the questions listed is the missing piece that is preventing the adoption of customer value delivery as a source of competitive advantage. Before further discussion on customer value, it is important to ask the question- What is customer value? Several definitions of customer value has been provided by many researchers and can be found in literature. For example:

> Customer value is a customer’s perceived preference for and evaluation of those product attributes, attribute performances, and consequences arising from use that facilitate (or block) achieving the customer’s goals and purposes in use situations. (Woodruff 1997.)

> By customer value, we mean the emotional bond established between a customer and a producer after the customer has used a salient product or service produced by that supplier and found the product to provide an added value. (Butz & Goodstain 1996.)

> Customer value is market perceived quality adjusted for the relative price of your product. (Gale 1994.)

> Value is customer's overall assessment of the utility of a product based on perceptions of what is received and what is given. (Zeithaml 1988.)

> Value in business markets [is] the perceived worth in monetary units of the set of economic, technical, service, and social benefits received by a customer firm in exchange for the price paid for the product, taking into consideration the available supplier's offerings and prices. (Anderson, Jain and Chintagunta 1993.)

> Buyer's perceptions of value represent a trade-off between the quality or benefits they perceive in the product relative to the sacrifice they perceive by paying the price. (Monroe 1990.)

Despite the apparent differences in the definitions above, there is a mutual consensus on the fact that value is a function of what customer gets, the solution provided by the product/service and the sacrifice of the customer to obtain the product/service. In this work, the definition provided by Woodruff (1997) is most relevant.

Grönroos (1997) approached the concept of value from a completely different perspective but with some element of resemblance to Woodruff viewpoint. According to Grönroos, concept of value to customer should be approached from a relational viewpoint rather than a transactional viewpoint. In the transactional viewpoint, the value(s) for customer is embedded in the product/service by the seller and delivered to the customer for a price during the transaction. In the relational viewpoint, value(s) for customer is created and perceived over time as the relationship between the seller and customer develops. Therefore, another way to define customer perceived value is expressed in equation (1).

$$Customer\ Perceived\ Value = Core\ Value \pm Added\ Value \qquad [1]$$

The double sign in equation (1) deserve attention because it implies that the supporting relational activities does not necessarily always "add" to the core value but can also "block/destroy" value from it. Similar point was made by Woodruff in his definition. In fact, if those supporting relational activities are so

poorly delivered, the total customer perceived value can be zero or even negative. Furthermore, in term of what the customer get as a function of the sacrifices the customer has to make, Grönroos value concept can be formulated as in equation (2).

$$Customer\ Perceived\ Value = \frac{Core\ Solution + Additional\ Services}{Price + Relationship\ Costs} \quad [2]$$

The relationship cost was divided into three categories: direct, indirect, and psychological. Direct cost are the additional necessary cost as a result of going into relationship with the seller but does not go into the asking price for the product/service for example the cost of needed space and personnel to operate the equipment as well as upkeeping and maintenance cost. Indirect cost are cost accrued due to unfulfilled promises by the seller such as cost of delayed deliveries, sudden breakdown of machines and general quality costs. Psychological cost are the negative emotions that the customer experience as a result of going into business with the seller, this is often perceived and not easy to quantify in monetary terms. (Grönroos 1997.)

Although, the contribution of Grönroos to the understanding of concept of value is very important and significant, it still appears to be on such an abstract level that management of companies struggles to make concrete action plan upon it. This is primarily because Grönroos and his contemporaries treats “value” as a singular conceptual construct with emphasis on the nature of what and when the customer get and give. They did not dwell into research on how to systematically identify what exactly do customers value. A further advance in the theory of customer value that appears to offer a new way of understanding, identifying, and applying customer value can be found in the work of Almquist and his colleagues at Bain Consulting (2016, 2018). This will be introduced in the next paragraph.

Earlier research on the value-construct has treated value as a single “thing”, as highlighted in previous paragraphs. The breakthrough comes when Almquist and his colleagues at Bain consulting applied the model of “hierarchy of needs”, originally developed by psychologist Abraham Maslow (Maslow,1943). According to Maslow, human decision-making is undergirded by the hierarchy of needs. He theorized that there are 5 core needs that forms the basis for human behavioural

motivation. The hierarchical needs, as proposed by Maslow, are shown in figure 4. Psychological and safety needs are at the bottom of the pyramid while Self-actualization and esteem needs are at the top. Maslow emphasized that numerous patterns of fulfilment of the needs are possible depending on individual, society, and other boundary conditions. That is, the pyramid arrangement does not necessarily imply that a need cannot be attained until those beneath it has been fulfilled.

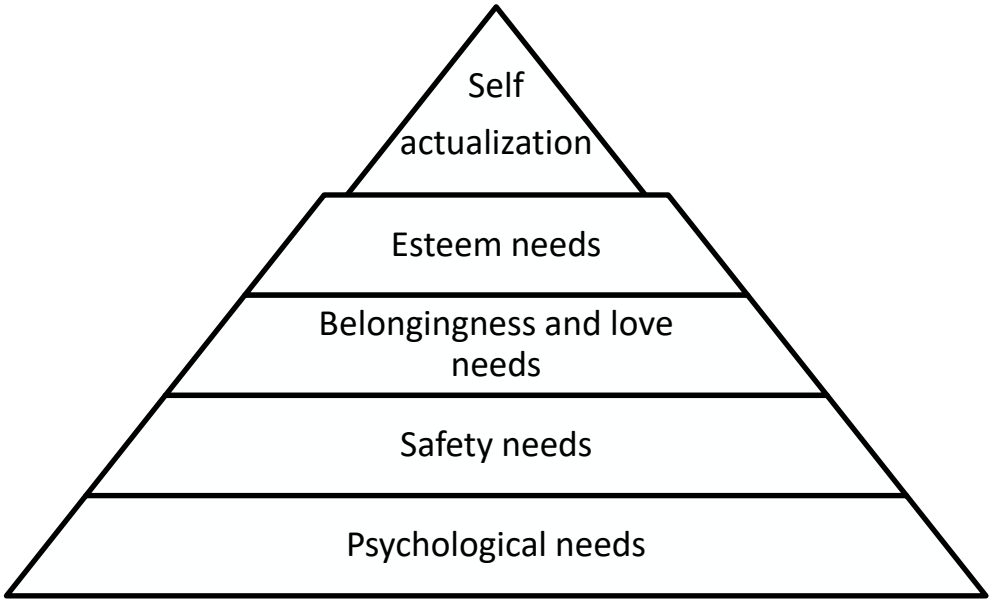


Figure 4. Maslow hierarchy of needs (Maslow 1943)

Through careful and meticulous analysis of numerous customer studies that were previously conducted from different industry segments over a period of 30 years and using Maslow's hierarchy of needs as the guiding theoretical background, Almquist and his colleagues derived and organized 40 fundamental elements of value that Business-to-Business (B2B) offerings provide to customers into a pyramid with five layers as shown in Figure 5. These elements of value represents the wide range of different motives behinds corporate personnel decision making for buying and using a product/service. Similarly, they derived and organized 30 fundamental elements of value that Business-to-Customer (B2C) offerings provide to customer into a pyramid with four layers as shown in figure 6. The definitions given to the elements of values for both B2B and B2C are provided in appendix 1 and 2, respectively. (Almquist & Bloch 2016; Almquist, Cleghorn & Sheher 2018.)

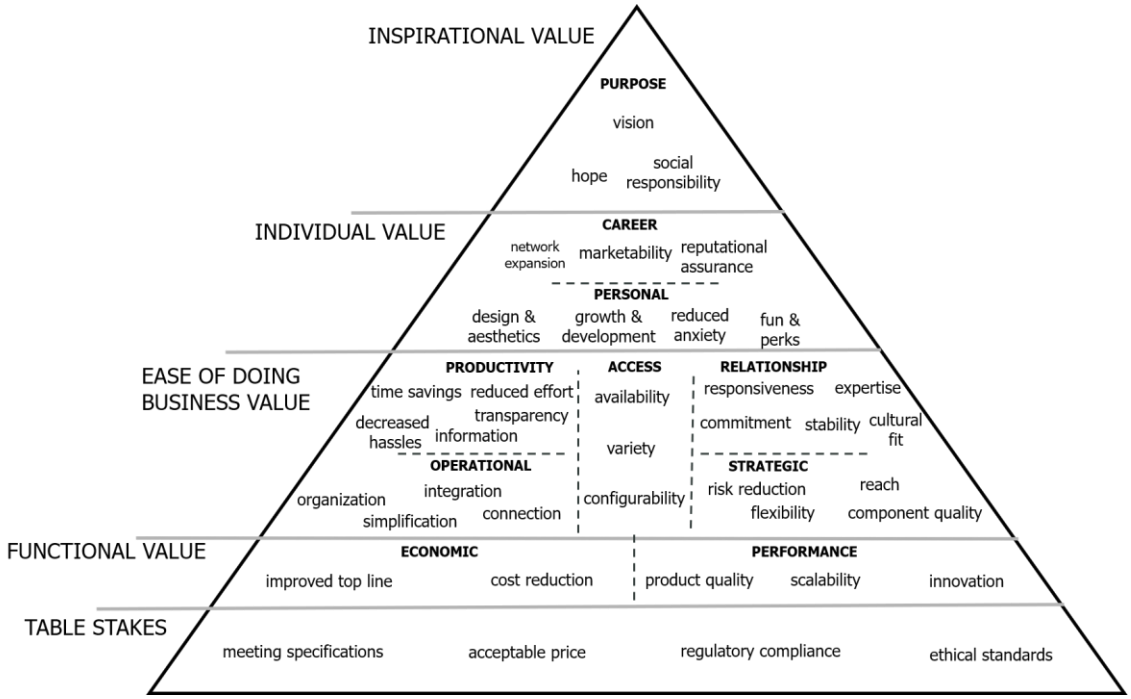


Figure 5. Elements of Value in B2B (Almquist, Cleghorn & Sheher 2018)

According to this author, the significance of the idea of “elements of values” for both B2B and B2C cannot be over-stated. It can be argued that earlier research on value creation has treated the “value” construct as a mysterious concept that is hard to comprehend and adopt in practice. Almquist et. al. idea, of developing and categorising the fundamental elements of value, demystified it and make it possible for companies to center their offerings around set of carefully selected values from the pyramid, upon which they can tailor their value proposition. It can also serve as a strategic tool to discover what matters most to their customers, this insight can serve as a powerful guide in the development of the next generation offerings that clearly difference them from competitors.

In this thesis, the element of value for B2B are most relevant because it is the line of operation of the case company in question. Hence, the B2B pyramid will be discussed a bit further in the following paragraph.

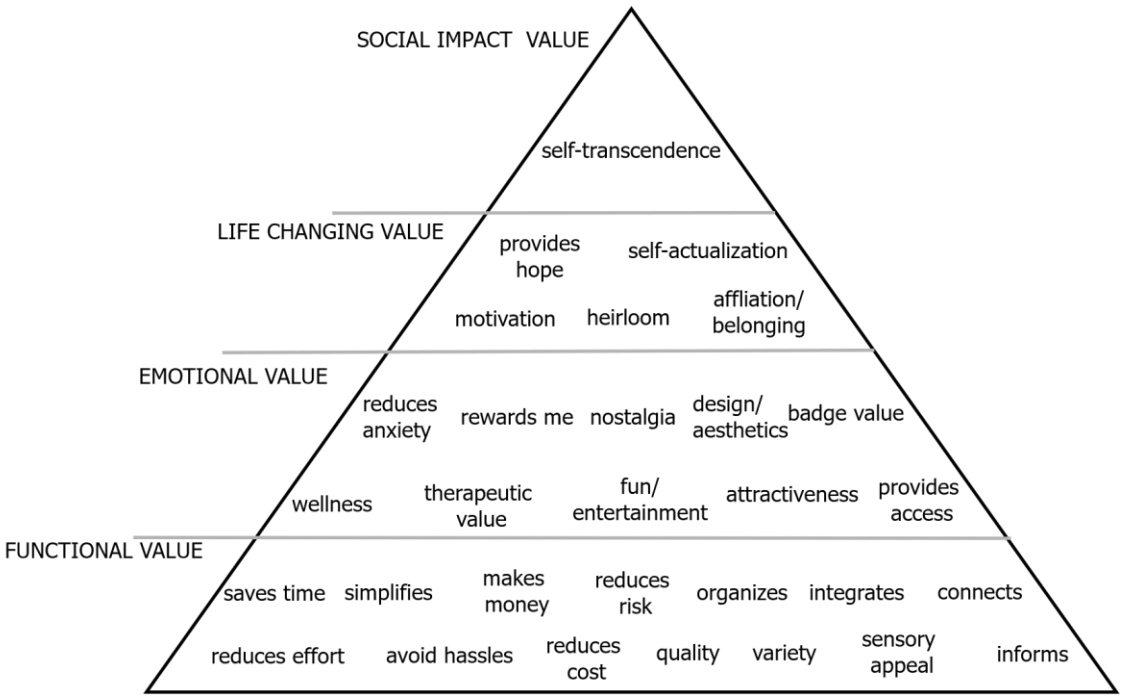


Figure 6. Elements of Value B2C (Almquist & Bloch 2016)

At the bottom of the B2B pyramid are the table stakes and functional value elements. These values has been what many companies have traditionally focus their attention and resources. They formed the basic of the value proposition that companies make to their customers. It has also been the traditional battle ground for competitiveness. The table stakes value are the minimum necessary proposition to even have a chance to be in the industry, hence not a source of competitiveness and differentiation. However, the functional values provides opportunity for a company to differentiate itself from competitors by offering more values in this layer. Doing business by focusing solely on the table stake and functional values constitute what Grönroos refer to as “transactional”. That is, they represent the core value in equation 1 that was discussed in previously.

However, 21st century marketplace has changed and is continuously changing at rapid rate. The dynamics of market forces are also shifting and changing. On one hand, competitors have basically catch up with each other on table stake and functional values, which leads to a situation of homogenous offering in the marketplace i.e., is no more clear differentiation among suppliers. On the other hand, customers are becoming much more demanding. Merely satisfying the table stake and functional values are no longer sufficient. In other words, customers are demanding values higher up the pyramid. Equation 1 provided by Grönroos worth revising at this point. Since customer are now more sensitive to

the so-called added value, this means companies that are not providing such values, or are doing poorly there because they are not paying needed attention, will score low in the total customer perceived value of their offering, even if they score in their core value delivery.

Therefore, companies must redefine their value proposition by adding more values higher up the pyramid. They must understand that table stake and functional values are no longer enough in the marketplace. They need to add values in the “ease of doing business”, “individual” and “inspirational” values. Clearly, no company can include all 40 elements in their value proposition, however they must ensure to add as much as possible among those that are relevant to their industry.

3 A FRAMEWORK FOR RESEARCH ROADMAP DEVELOPMENT

In the introduction chapter, two main challenges facing technology companies was discussed. The first challenge, named the " The linkage problem", relates to the problem of aligning corporate strategic planning, R&D strategic planning and business unit product developing planning. The second problem is specific to the R&D organization of technology companies. It has to do with the difficulty in systematically identifying customer needs that will drive the research projects in the organization. It was also argued that the latter challenge is due to the former.

In this chapter, a novel approach to address both challenges together will be provided. By combining relevant theories from earlier work in value creation, technology roadmapping and customer centricity, a novel framework for research roadmap development is proposed. This framework, shown in figure 7, has addressed the linkage problem by including a unified vision and target for all stakeholders and also invoke their active participation in co-creating the roadmap. Furthermore, the output of the process as proposed in the framework serves as the ideas that goes to cooper's stage-gate system or any other similar idea development method in use. The framework is divided into three phases, preliminary activities, development of the research roadmap and follow-up activities. The phases will be discussed in detail in the following paragraphs.

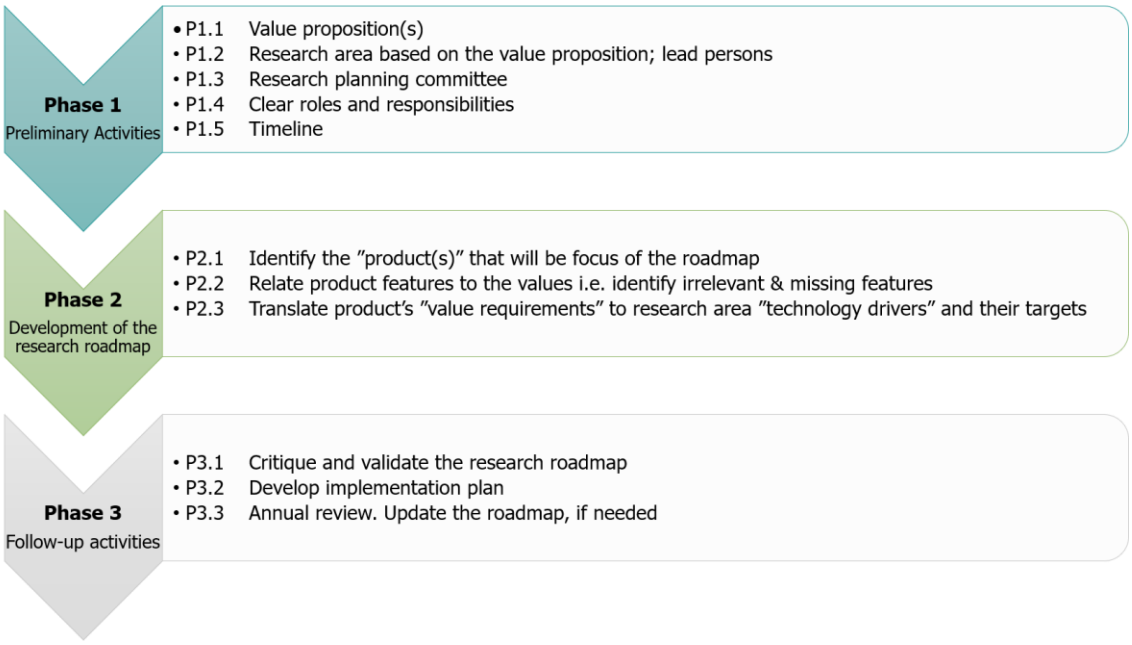


Figure 7. A novel framework for research roadmap development.

3.1 Phase 1- Preliminary Activities

The starting point is the creation of a value proposition or value propositions, if the market segments of the company demands different propositions, applicable to all organizations of the company. The value proposition serves as both a mission statement for the people involved and also a communication tool through which demands from the market and upper management vision is disseminated internally to all relevant stakeholders. The development of the value proposition should be facilitated and managed by the company upper management team. It should be based on the “elements of value” as shown in figure 5 for B2B business.

As first step, the company’s current value proposition should be benchmarked against that of competitors by carrying out surveys to customers on how the products and services performs on the 36 non-table stakes elements. Furthermore, it is very vital to talk to customers to understand their experiences. Before the interview with customers, it is beneficial to map who is on their buying team, who has influence on the procurements, and the different priorities and sources of value for each of them. These are the people who should be interviewed not just the people who use the product. After the survey and interviews, the set of elements warranting attention should have been identified.

An ideation session to determine which value elements to focus on first should be held. In addition to upper management and head of business units, the participants should include product admins, pricing experts, salespeople, service representatives and other frontline personnel, and even customers themselves. Once the elements of value to be focused on are agreed upon, then the new value proposition can be developed agreed and shared with all business areas including the Research and development organization. It is important to ensure that value elements from the top three layers of the B2B pyramids are included, this point has been discussed in detail in the previous chapter.

Once the value proposition is in place, it should be presented to the R&D department. The R&D management should create research areas based on the

value proposition. Each research area is responsible for developing research roadmap to identify and conceptualize enabling technologies for the related value elements. Furthermore, a lead person for each of the research areas should be selected to hold responsibility for the roadmap development and research project execution.

A research planning committee should be formed. This committee will be tasked with coordinating, monitoring, and steering the development of the research roadmaps of the different research areas. The role of the research planning committee is very important in the sense that, the committee is responsible for ensuring that the all the roadmaps under developments are synchronized effectively and timely. The committee should consist, at least, management team of the R&D organization and heads of the business units.

Furthermore, a document stating the role and responsibilities of all parties involved should be developed. Such document must clearly state the value proposition, established research areas, research areas lead person, roles and responsibilities of all parties, key deliverables, and timeline for which the roadmaps are been developed for. Such document should be developed by the research planning committee and shared with all involved stakeholders.

3.2 Phase 2- Development of the research roadmap

In phase 2, the development of the research roadmap should begin for each of the research areas. The research areas lead person should identify the product(s) that will be the focus of the research roadmap. This must be done in collaboration with products owners/admin in the company. The involvements of the products owners is paramount to the success of this phase. Infact, their participation in this exercise should be made mandatory and incentivized by the company upper management and respective business area management team. In an ideal scenario, all the company’s products will be included for the roadmap work. However, in reality this may not be possible in large companies. Nevertheless, it is recommended that as many products as possible should be included, especially products that share similar underlying technologies.

The features in the selected products should be related to elements of value in the value proposition with the objective of identifying existing features in the products that are not, or perhaps hindering the desired values in the proposition, as well as values in the proposition that are not currently having enabling features in the products. In other words, the objective is to generate list of irrelevant and missing product features. This exercise should be performed by each research area lead person in close collaboration with the product owner/admin. The list of values that are currently not having enabling features will form the “product value requirement” that will be the input to the next exercise in this phase.

The last exercise in the phase is to translate the product value requirement to “technology drivers” and their desired target level for each of the research areas. This exercise should be performed by each research area lead person in close collaboration with the product owner/admin. The participation of other frontline personnel and product designers will be beneficial but not a must.

Quality Function Deployment (QFD) is a very useful tool that help to facilitate the activity of transforming qualitative customer desire to quantitative engineering features and parameters. The work of Hauser and Clausing (1988) is an excellent guide(Hauser & Clausing 1988). However other useful tools are available in lean six sigma toolbox. Ideally, this exercise will be executed in form of a workshop with the research area lead acting as facilitators. The outcome is the translation of the abstract product value requirement to list of specific technology drivers of the particular research area. These technology drivers are infact potential research projects upon which the roadmap will be developed. It is possible that a single identified technology driver is sufficient to be a research projects however it is more likely that multiple technology drivers will be packaged together as a research project.

Furthermore, it is also likely that a set of packaged technology driver to form a research project is meant to be deployed into more than a single product group. Figure 8 is an illustrative example of a novel template for customer-value based research roadmap developed in this work. It shows 5 research projects (RP 1-5)) that hopes to deliver 2 identified customer values (CV 1-2), that has been successfully transformed to 4 technology drivers (TD 1-4), for two selected

product groups (PG 1-2) by the next 6 years. The roadmap shows for each research project the planned duration, time, related product group(s), target customer value(s) and their related technology driver(s). The visual representation can also serve as a useful tool for project portfolio management and resource planning. It will be repeated here again that each research area will have its own roadmap. All the roadmaps must be aligned and synchronised. This responsibility lies primarily with the research planning committee.

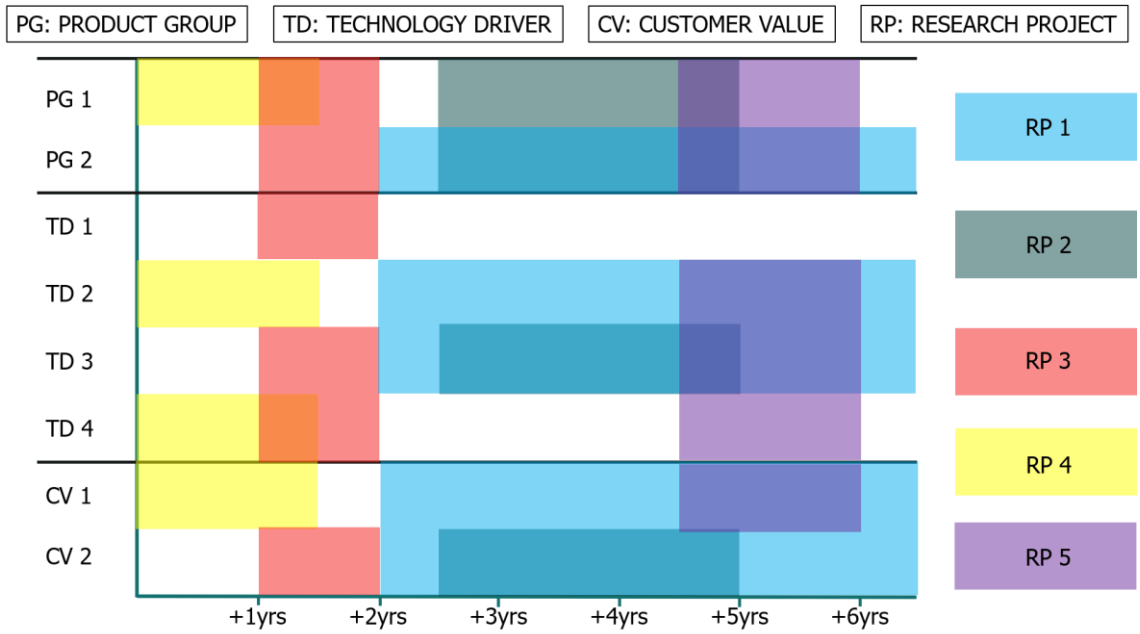


Figure 8. Illustrative example of a customer-value based research roadmap.

Based on the discussion in the previous paragraph, any R&D organization that aim to become customer-centric and customer-value driven will need to change the mindset of all its personnel with regards to what a research projects means and stands for. Such an organization should define a research project as follow:

> A research project is a timed mission to identify and deploy technologies that can enable certain pre-selected customer values, through their related technology drivers, for certain pre-selected product groups or to create a new product(s).

This definition should be widely shared and understood by all personnel related to research projects because it contains not only prerequisite for initiating a research project in the organization but also targeted deliverables upon which the

outcome of the project will be assessed when completed. Traditionally, a research project is typically assessed based on how well it keeps to the three project triads i.e., time, budget, and scope.

3.3 Phase 3- Follow-up Activities

The last phase is basically about critical review of the roadmaps by much larger group, consisting at least of the research planning committee, research area lead persons and product managers. It is important that all the roadmaps for the individual research areas are synergized and synchronized. Product managers should also ensure that the proposed research roadmap is in line with their product development roadmap if such documents exist.

In addition, an implementation plan should be developed. This includes the means of executing the projects and allocation of resources. There are usually various means available for R&D organization to run a projects for example as student work, other university collaboration, external consultancy e.t.c. It is important for the R&D management to select those projects that are better handled inside the organization and those that could be handled externally. These selection will be mostly driven by available resources and inhouse competence.

The research roadmaps should be annually reviewed for status check and updated when necessary. The roadmap should be seen as a living document that evolve with time depending on current situation with the products, market, and resources in the company.

4 RESEARCH METHODOLOGY, DATA

This chapter discusses the research methodology adopted in the empirical part of this work. The concept of research onion developed by Saunders, Lewis & Thornhill (2007) will be utilized as the guiding principle. After brief introduction, the research onion concept and selected procedure, data collected from the case company will be presented.

Saunders et. al (2007) suggest that research process planning should be approached as a series of stages. The relation between the stages can be viewed as that of layers of an onion. The concept suggest that researchers can develop a coherent research planning by developing the plan from the outermost player to the inner core. The research onion has 6 layers and at each layer, there are different methods and choice that a researcher can chose as part of the research methodology as shown in Figure 9.

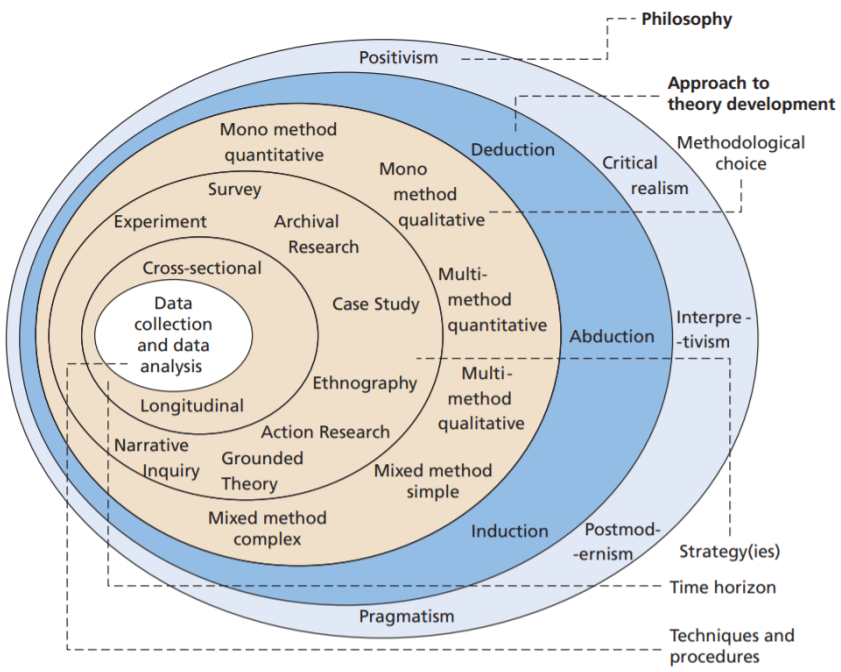


Figure 9. Research onion (Saunders et al. 2007).

At the core of the research onion concept is the determination of the most effective progression through which a research methodology can be designed so that most relevant data will be collected and analysed to answer the research questions. A detail discussion on the contents of each of the layers is out of the

scope of this work, the work of Saunders et al.(2007) is an excellent reference. In the following paragraphs, the selected procedures from the research onion concept, shown in Figure 10, that will be utilize as the research methodology in this work will be presented. Justification and reasoning for the choices will be provided.

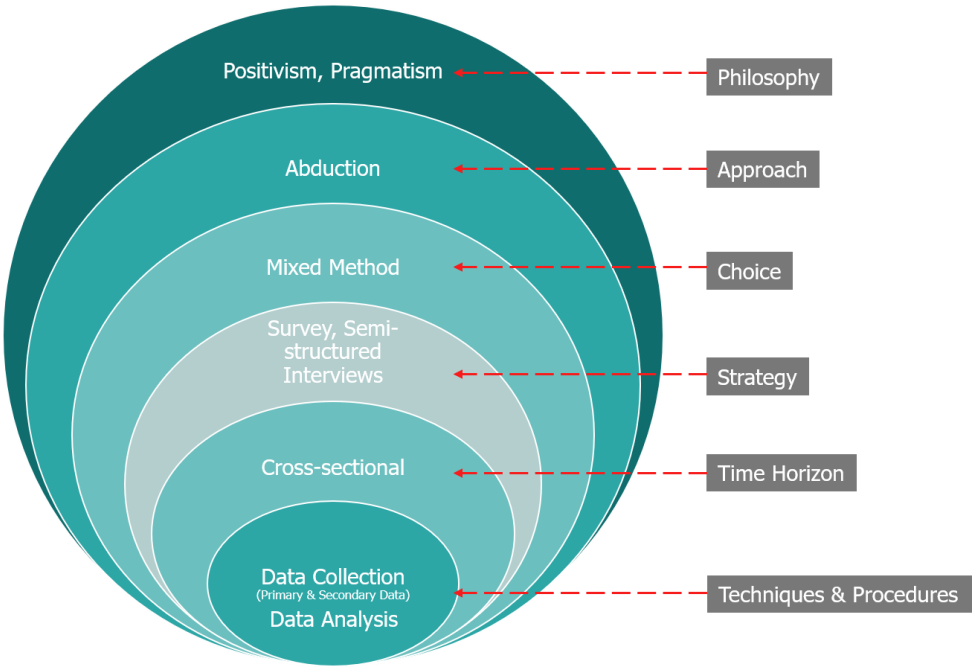


Figure 10. Research method based on research onion concept.

The philosophical background behind this work is positivism and pragmatism. A positivism stance in business management research implies a strict adherence to a highly structured methodology, that is similar in principle to that used by natural scientist, in observing an organization and collecting data that is not influenced by the opinion and stances of the observer. Observation and deduction of causal relationships from the data can then be used to create a law-like generalization that can facilitate replication. The replicable generalization can then be used to explain, manage, and predict behaviours and processes in the organisations. The generalization could lead to the development of a new theory or extension of an existing theory. Pragmatism lay high emphasis on the practical application of knowledge and concepts. In this philosophical stances, the design of the research questions and methodology is centered around a problem facing the organisation and incorporate the practicality of the outcome. To a pragmatist, a concept, theory, or framework is only meaningful if it can contribute practical

solution that will support organization actions to improve an existing practise or create a new practice that address an existing problem. (Saunders et al. 2007.)

By adopting both philosophical stances, positivism and pragmatism, this study aim to develop a practical framework to address a problem facing the pre-selected business organization through the synergy of relevant existing theories and new insights from gathered data. In practice, this means special attention will be given to the possibilities to apply selected theories during literature study in practice and attempt will be made to demonstrate the practical application of the theory, or an improved version of it, to a specific problem facing the organization selected as case-study.

In the approach to theory development, abduction method is selected as most suitable procedure for this study. Abduction is a synthesis of inductive and deductive approach. Induction involves moving from data to theory while deduction implies moving from theory to data, however abduction is much more flexible in the data-theory relationship. For example, in abductive approach, a research problem can be studied by collecting relevant data, identify patterns and relations, then attempt to explain the observation using existing theory. This could then lead to further improvement of the theory and the need to collect more data to validate the new theory. Abduction is judged the most relevant approach for this work because of the flexibility it provides in the data-theory relationship and also because it offers the possibility to generalize from the relationship between the specific (the case company) and the general (the technology industry). Furthermore, the uniqueness of the research problem suggests a need to combine existing theories with the help of gathered data and insights so as to generate a new theory that can effectively address the research questions. (Suddaby 2006.)

In the methodological choice, a mixed-method research is adopted. This implies that both quantitative and qualitative data will be collected and analysed. Quantitative data will be gathered from exploratory investigation where the subjects are in large quantities, and numerical output is possible, for example in surveys and questionnaires where data on customer needs, market insights and product performances in the marketplace are collected . Qualitative data will be

gathered for descriptive studies for example during interview with internal stakeholder of the case-company organization to get an accurate assessment of the current state of the issue and possible challenges or opportunities.

Survey will be used to collect quantitative data about customer needs, market insights and product performances in the marketplace. Semi-structured interviews will be used to gather qualitative data from different internal stakeholders in the case companies and also from some specially selected end-users. This will be discussed comprehensively in the following section under data collection.

The study is directed to the current situation in the organization and empirical data will be collected to gain understanding of the current situation with regards to readiness for moving towards customer centricity and having value-creation at the center of its research and development activities. Therefore, from the viewpoint of time horizon, this study is cross-sectional. Ideally, a more distributed timeline will be selected, however, due to limitation in the time and resources allocated to this project, a snapshot assessment of current situation will be adapted.

In the innermost layer, data collection, both primary and secondary data will be utilized. Primary data will constitute the descriptive study that aims to gain accurate understanding of the current situation in the case study organization especially from the viewpoint of customer-centricity readiness of key personnel in the company. Secondary data will be utilized for gathering and analysis of customer needs, market insights and product performances in the marketplace which will serve as input to the framework for research roadmap development.

The choice of using secondary data is because the data is readily available and applicable for this work. Additional reason is that the budget and time that will be needed to obtain primary data is not available for this work. Furthermore, the secondary data were collected either recently or during the course of this work through a parallel project, therefore its appropriateness to be utilized in this work is justified. The secondary data was collected by researchers that are not aware

of the scope and objectives of this work, hence special care will be taken during data analysis to ensure correct interpretation of this result.

5 DATA COLLECTION AND ANALYSIS

The empirical part of this work can be categorised into two broad themes. They are:

- **Readiness for customer-centricity**: The primary aim of this theme is to determine how ready the case company is for a shift to a customer-centric way of research and development of products. This is very important because it will be very challenging, if not outright impossible, for the research and development organization to be customer-centric if other organizations in the company are not following similar approach. In addition, findings from this study will be a vital focal-point in the development of a suitable framework for the development of a customer-centric research roadmap and also necessary recommendations and actions.
- **Customer value search**: This theme aim to identify and collect customer values that are relevant to the case-company's customers. This data will be the input into the theoretical framework developed for the development of the research roadmap. Furthermore, this study will attempt to uncover current values that the case company are providing, values that customers are demanding but the case companies are not currently providing. The theoretical concept of B2B elements of value will also be introduced to the key stakeholders inside the case company to collect their opinion on the feasibility of using it as a tool for customer value management and creation.

The targeted respondents are divided into three groups as shown in table 3. Group 1 are internal personnel in the case company. Group 2 are external companies that sells the case company product. Group 3 are the production management, maintenance management at customer sites of the case company where the products are key part of their production/manufacturing process. With such a wide spectrum of respondents, it is expected that the collected data from the study will have wide and rich contents that includes the opinion and wishes of different stakeholders that are involved in the whole value creation journey.

Table 3. Categories of respondents in the empirical study.

	Organization	Role/Position	Number
Group 1	Product administration Sales organization Business support Quality management Customer feedback	Product owner/manager Director, regional sale Director, business support Product quality manager Customer quality manager	6 1 1 1 1
Group 2	Product distributors	Global, 36 countries	77
Group 3	Customers, End-users	Production management, Maintenance.	8

Table 4 shows the theme(s) that is directed to the groups as well as the nature of the data collected, primary or secondary, and also the data collection strategy. In the remaining part of this chapter, data collected from the studies will be presented along the line of the two themes. These approaches helps to triangulate the responses from the different sources, as suggested by Ghauri and Gronhaug (2005). Eriksson and Kovalainen (2008) argued that triangulation could cause controversial and conflicting research results, in this work the possibility of such occurrence will be carefully assessed and reported if it is observed.

Table 4. Themes and their target group, data type and data collection strategy.

Theme	Target	Data type	Strategy
Readiness for customer-centricity	Group 1	Primary	Semi-structured interview
Customer value search	Group 1	Primary	Semi-structured interview
	Group 2	Secondary	Survey
	Group 3	Secondary	Semi-structured interview

5.1 Readiness for customer-centricity

Product owner/manager. According to the case company product handbook, one of the responsibilities of the product manager is to have market intelligence of the current performances, requirements, and level of customer satisfaction of their products. In other words, product managers should play a very important role in a customer-centric organization. Therefore, they were the first set of

people that was interviewed in this work. Invitation to participate in this study was sent to over 30 product managers, out of which 6 responded and offered to be interviewed. Some of the product managers that participated have more than one product family under their management and they spread across different business areas that the case company operates.

Prior to the interview session, an email explaining the big picture behind this work was send to the interviewee. The email clearly stated that R&I organization desire to become more customer-centric in its operations and research activities and ultimately develop a customer-centric research roadmap. It was also stated that as a starting point, structure research area is selected as a pilot program and if the result is promising, it will be extended to other research areas. The reason for this is to let the interviewee have a general idea of what the interview questions will be about.

All the product managers shows strong support for the case company becoming customer-centric and being much more market needs driven rather taking a technology-push approach. One of the respondent felt this is a long due strategic move and points to some previous product feature releases that in term of technology is very brilliant, however customer don't see the need for it in their operations. When asked about those needs that customers are demanding from the products under their management, needs that could be suitable for research topic, all the 6 respondents could not give such list of needs. In fact, they do not appear to see the discovery and compilation of such list of customer needs as part of their responsibilities. When pushed a bit further, some of the respondents were able to give some possible research projects idea, however, they are related to internal operation or cost reduction in manufacturing. To all the product managers interviewed, their duty is mainly to maintain and deliver the current product offers and ensuring smooth and timely delivery in a profitable manner.

Director, regional sale. The director of the sales activities in Northern Europe was interviewed so as to include the insights and opinion of the salesforce. The sales team are one of the frontline personnel that interact directly with the case company customer. The interviewee strongly believe that this is a step in the right direction. Experience from previous work history where their R&D

organization was heavily technology-driven resulting in many great innovation product with poor market performance was shared by the respondent.

The need for the whole company to be much more customer-centric and be driven by what is important to customer was supported by some concrete sales case examples, One of them was the case of sales opportunities that was lost because a competitor can make the delivery faster than the case-company, despite that the case company's product is technologically superior. When the interviewee was asked if customer insights and needs are systematically collected and shared internally with product manager and other organization that might find such data useful, the response was that such system does not exist, currently, those insights are not being systematically collected nor utilized in research and product development, although, the responder firmly believes such system should exist and be utilized in planning future products.

The interviewee was also asked if R&D should interview salesforce directly so as to gather the list of customer needs, arising from their interaction with customers, the response as a categorical no. The reason for not supporting such approach was that salesforce personnel usually have their own wish list as well, hence such data will likely be biased and inconclusive. In the responders opinion, gathering and managing such list of customer needs should collected from multiple sources including internal sources and from external sources. Furthermore, when trying to collect the needs from customers, the responder strongly suggest not limiting the sources to only end-user. Comments from procurement, project management and other management position that partake in purchase decision should be solicited. In the interviewee opinion, product users often wish for product features that procurement team are not willing to pay for due to budget limitation, so if the case company is only talking to product end-user, they will end up developing features that, the product users said they needed, but the procurement manager is not willing to pay for and will be removed from the offer list.

Product quality manager. The manager of the team responsible for quality and non-conformity of product delivery to customers of one of the business units also agreed to participate in this study. The interviewee is responsible for receiving the complains and plan corrective measures to address the issues with support

from product managers when needed. The respondent claimed that on average the number of customer complains could be as high as 600 in a month. A goldmine of data containing valuable information of unfulfilled promises to customer. When asked if those data are being systematically analysed to gather insight for future product improvement and new product, interviewee responded that such kind of data analytics is currently not in place. The responder further added that such data analytics will be very useful for understanding current pain-points of customers and generate area that research and development can focus on. A very positive response was received when asked if the case company R and D organization should be more customer centric in its activities.

Customer quality manager. The customer quality team is responsible for managing general feedback from customers. It manages the company-wide system where all feedbacks from customer, voice of customer, for all business area and products are collected. The system is intended to be a tool to support the case company internal people to better understand customer needs and experiences so that those information could be utilized to improve their processes and future product and service development. According to the interviewee, the customer feedbacks should be accessible to all other organization especially those in product development and also research organization. This centralized system is also a tool for product manager to gather insight about the performance of the products under their managements.

As with other interviews, the starting point was to ask the opinion of the interviewee about the current state of customer-centricity in the whole company and also on the idea of R&D moving towards a customer-centric way of working. The responders welcomed the idea to have at the core of research activities, a strong mindset to deliver what customer finds valuable to them. However, the respondent believes there is a lot of work to be done to implement such idea. According to the interviewee, the voice of customer that is coming to the system are not currently used for that purpose and this has led to struggles and difficulties in meeting the primary purpose and target for which the system was developed. As a concrete example, the interviewee felt most product managers prefer not to have negative feedback about products under their management in the system because it leads to poor result in certain Key Performance Indicator (KPI) by

which their product market performance is been measured. Those negative product feedbacks are infact golden data for future product improvement and research activities. In the opinion of the interviewee, true customer centricity can only be achieved if customer feedbacks, both positive and negative, are carefully and equally analysed in order to gain true understanding of market performance. The interviewee also suggested some actions to improve the current situation, such as, more customer feedbacks needs to be collected to the system, more resources is needed for analysing the data that comes to the system and overall change of mindset on the original purpose of collecting those customer feedback.

Key insights. All the interviewees clearly expressed their strong support for the idea of the R&D organization of the case company to have customer centricity at the core of their operations. However, they all felt the necessary process and system to gather customer needs is not in place. Furthermore, there does not appears to be a smooth flow of information regarding customer needs among different organizations. Valuable insights about customer needs and desires appears to be scattered about and there is no team or organization that seems to see this as their responsibilities. Before the R&D department can be customer centric, this lack of coordination and systematic way of gathering and analysing customer needs must be addressed.

5.2 Customer value search

The second objective of the empirical part of this work is to gather values that are important to the customers of the case company. Those identified values will be the key input for the development of the customer-centric research roadmap as discussed in previous chapters. Primary data was obtained from the interview targeted to group 1. Prior to the interviews, an email was sent to the interviewees to introduce them to the theoretical concept of “elements of values” for B2B. The 40 elements of the pyramid was also shared, and they were encouraged to study the material before the interview session. Among the group 1, only the director of sales and the director of business support appears to have a proper understanding of value creation thinking. The remaining interviewees does not demonstrate a clear understanding of what value creation and very likely have not studied the material shared prior to the meetings. However, when shown the

elements of value pyramid during the interview session, all the respondents felt that it is a useful tool to systematically manage value creation process.

Secondary data from group 2 and 3 was also utilized to gather the customer values. As this studies were not conducted as part of this study, their raw data are treated as confidential and will not be discussed here. However, the author of this work was granted access to the raw data from which the fundamental customer values was extracted using the 40 B2B elements of value as guide. Table 5 shows the customer values gathers from the three groups. Response from Director, business support is exactly same as that of group 2 because the personnel was responsible for the study targeted to group 2, hence same results was presented during the interview. All the collected customer value for the groups are shown on the B2B value pyramid in figure 11.

An interesting observation is that not so many of the identified values was mentioned by more than one group. There is no value that is common to the three groups. Out of the total 18 values gathered, only 3 is common to more than two groups. Group 1 and 2 both mentioned availability and configurability. Group 1 and 3 have acceptable price in common. This is likely due to the nature of the business of the case customer that the three group targeted in their study or thinking. Group 1, director of sales, mostly sells standard products to customer. This customer segment does not have the case company products as main part of their operation. They use the case company products once a while, therefore value such as improved top line is very likely not important to them. They are also expected to be price sensitive and demand fast delivery of their order.

Group 2 expresses what product distributors that mostly sell to similar customers as group 1. This may explain why the two groups have the highest number of common customer value. In addition, they are not likely to be interested in complex and troublesome product that results to additional cost for them. Group 3 reflects the value interest of people on the customer sites that are responsible for managing the smooth operation of their production system. Obviously, values such as time saving, reduced effort and improved top line is expected to be important for them.

Table 5. Identified customer values from the groups and their definitions.

Group	Interviewee	Customer value	Definition
Group 1	Director, regional sale	Acceptable price	Provides product and services at an acceptable price.
		Configurability	Offers goods/services that can be easily configured to the customer's needs.
		Availability	Ensures the good/service is available when and where needed.
		Meeting specification	Conforms to the customer's internal specifications.
	Director, business support	Same as group 2	
Group 2	Product distributors	Design and aesthetics	Provides aesthetically pleasing goods or services
		Decreased hassles	Helps the customer avoid unnecessary hassles
		simplification	Reduced complexity and keep things simple.
		configurability	Offers goods/services that can be easily configured to the customer's needs.
		flexibility	Move beyond standard goods or services to allow customization
		scalability	Expands easily to additional demand, processes, or tasks.
		cost reduction	Reduces cost for the customer's organization.
		Availability	Ensures the good/service is available when and where needed.
Group 3	Production management, Maintainance	Social responsibility	Helps the customer to be more socially responsible.
		Improved top line	Helps the customer increase productivity/revenue.
		Acceptable price	Provides product and services at an acceptable price.

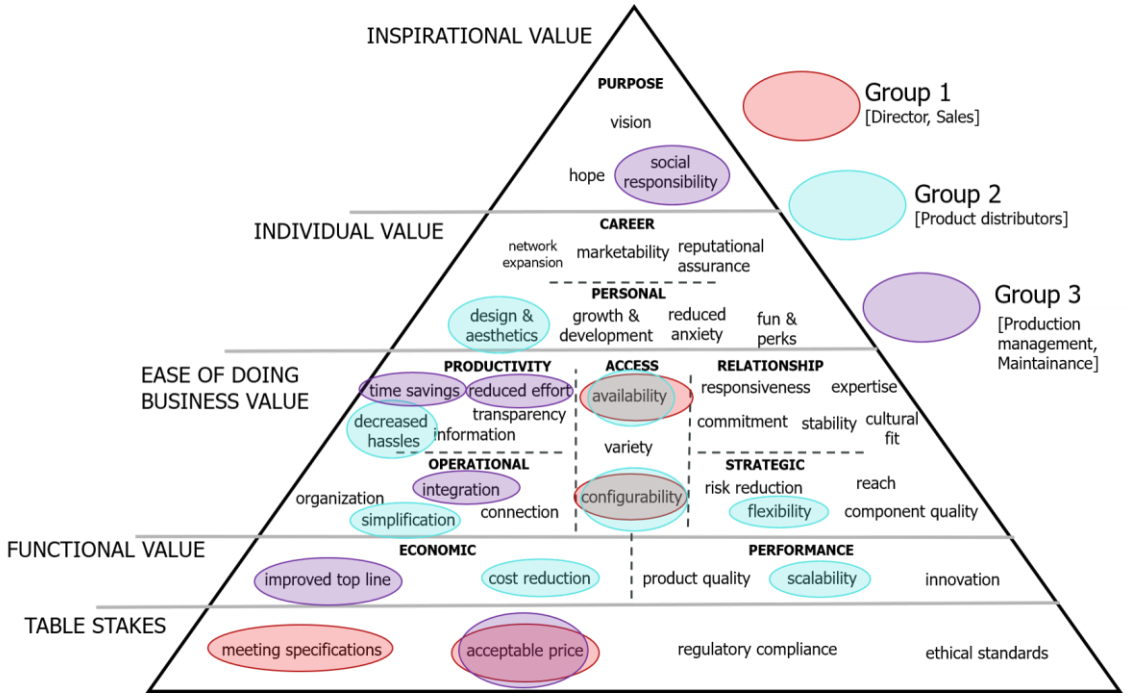


Figure 11. Identified customer values for case company from empirical studies.

Furthermore, the data collection method and sample size may also be a plausible explanation for the differences in the value the groups desires. Values from group 1 came from a single qualitative data source using semi-structured interview method as data collection strategy while group 2 value is a result of a comprehensive global survey style method, generating quantitative data that was then subjected to further data analysis. Group 3 also utilizes semi-structured style interview for rather limited number of end-users.

It is highly likely that a synergy of differences in targeted customer segment, data collection method and sample sizes provides rational explanation for the reported differences in desired customer values. This findings suggest that more comprehensive company-wide study is needed to identify, harmonize ,prioritize and select the customer values that the R&D department of the case company can use as the starting point for their research roadmap development. This is in line with phase 1 of the novel framework for research roadmap development that was introduced in chapter 3 of this work.

6 APPLICATION OF THEORETICAL FRAMEWORK TO DATA

In this chapter, the data collected from the empirical study will be utilized to demonstrate the practical application of the theoretical framework developed in chapter 3 of this work. The output will be a 5 years research roadmap for the Structure research area of the case company. The implementation of the theoretical framework is in 3 phases, as described in chapter 3. In the following sections, each of the phases will be implemented using the empirical data from chapter 4 as input.

6.1 Phase 1- Preliminary Activities

In accordance with figure 7, the starting point is the creation of the company-wide value proposition(s). Ideally, this should be a well-coordinated customer study that is initiated and managed by the company leadership team. However, in the absence of such study, the value proposition will be substituted with 3 values from data gathered from the three studies that was introduced in chapter 4 of this work. The three selected values are Availability, Sustainability (Social Responsibility) and Configurability. Availability and Configurability were selected because they are the only values from the B2B element of values that is common to two different studies (group 1 and 2) and above the table-stake level as shown in figure 11. Sustainability, as a form of social responsibility, is selected as the third value because it is the highest on the pyramid of all the values mentioned from the three studies.

The next activity will be to determine the research areas that is needed to enable the selected values. In this case example, the research areas at the case company is already sufficient to research technologies that is needed to develop enabling-features in the products been offered to the case-companies customers. Structure is one of the research area and it is assumed that the author of this thesis is the selected lead person for the Structure research area. Therefore, in this work, a research roadmap for the structure research area will be developed. The hypothetical goal is to research and identify the enabling technologies to deploy the three selected values for the selected product “Structure” within the next 5 years.

A research committee whose responsibility is to coordinate, steer and most importantly ensure alignment of the roadmap creation for all the research areas. In this case, such a research committee is not in place, therefore this step will be skipped. In the following section, the research roadmap for the next five years will be developed for the Structure research area only. Ideally, the roadmap should be concurrently developed for other research areas, however the development of the roadmap for other research area is beyond the scope of this work.

6.2 Phase 2- Development of Structure research roadmap

Not available for public.

6.3 Phase 3- Follow-up activities

Not available for public.

7 CONCLUSIONS AND RECOMMENDATIONS

This work was commissioned by the research and development organization of the case company as one of many pre-studies that aims to steer the organization towards becoming customer-centric in its research activities. Generic deliverable for this work is a theoretical framework for developing a customer-centric research roadmap. Specifically, it is desired to apply the framework to develop research roadmap for the structure research area as a concrete example and demostration of its practicality. In order to achieve these fore-mentioned targets, the following research questions was constructed to act as guide:

1. How to systematically identify customer needs?
2. How to discover technologies to enables those needs?
3. How to develop a realistic research roadmap based on the needs and the enabling technologies?

After extensive theoretical study, it was concluded that, from the viewpoint of research and development activities, to be customer centric simply means to put customer value creation at the core of all research activities, including research roadmap development. Therefore, proper understanding of the concept of customer value creation is an essential requirement for the transition to a customer centric R&D organization. The work of Woodruff (1997) and Grönroos (1997) provides excellent theoretical understanding of the value creation concept however they are still abstract in nature. On the other hand, the B2B elements of value concept developed by Almquist et al. (2018) is very simple and can be easily implemented in any organization because it provides 40 fundamentals customer values in hierarchical form. For that reason, it was adopted as the main guide in the construction of the theoretical framework for developing a customer-centric research roadmap.

Clearly, no company can or should target to provide all the 40 elements to its customers. Rather, through carefully conducted customer study, individual company can analyse the gathered data and use it to identify the fundamentals values that is related to their own industry and customer segment(s). Therefore, it is believed that this approach provided answer to the first research question dealing with how to systematically identify customer needs. Although, the

empirical study of this work clearly shows strong interest towards customer centricity, no agreement could be made as to whose responsibility it is to conduct customer study so as to identify the relevant customer values for the R&D organization to focus on. In fact, the current situation seems to be that those organizations that seems to already appreciate this customer-centric way of thinking are conducting their own customer study focusing on a niche market segment. As a result, the findings from the studies are inconclusive or even misleading when wrongly generalized.

The R&D organization of the case company is also considering its own customer study targeting a very small set of customer of one of the case company business area. Again, this lack of company-wide coordination is very dangerous expecially when claiming to be customer-centric because it gives an illusion that one is customer-centric but in reality, one is only answering to the wishes of a small segment of the market that may not necessarily be the most profitable segment. The solution is that the upper management of the case company needs to initiate and coordinate a company-wide that will not only successfully capture the customer values that are most relevant to the case-company customers but also help to address the linkage problem that is clearly happening among different organizations in the case company. This recommendation is embedded in phase 1 of the novel framework for research roadmap development that was developed in this work.

Once the relevant customer values are discovered from carefully conducted customer study, there remain the challenge of discovering the technologies to enables those customer values. Findings from the theoretical and empirical studies of this work suggests that can be done systematically by first realizing what research areas are needed to be able to achieve the competence that is needed to enable those values. Then, a lead person with clear responsibility lead activities within each of the research area should be nominated. Furthermore, a research planning committee should be set up to coordinate and harmonize the activities of the lead persons for each of the research areas. Each lead person will be responsible for developing a research roadmap for each of the research area. The research committee has the responsibility to manage and coordinate the roadmap development from each of the research area and ensure timely

delivery and execution as described in phase 2 of the theoretical framework developed in this work. The author is convinced that this provides satisfactory answer to the second research question.

Several techniques exist in literature to develop a technology roadmap. A number of those were introduced in chapter 2 of this report. However, they were all technology driven and it should not come as surprise that they were not applicable with a customer-centric way of working. This is because the central idea behind those technology roadmapping technique is to develop technology that will then find a market need, the so-called Technology-push approach, but a customer centric way of working demands a market-pull approach. This means that it is the market needs that should be first identified and then technologies to provide those needs are sought after. This is the central point behind the third research question, “How to develop a realistic research roadmap based on the needs and the enabling technologies?”.

In this work, all the technology-driven templates for roadmapping in literatures were abandoned and a new roadmapping template that has its starting point as set of customer values, followed by technology drivers and related product groups is developed. This novel template is specifically developed for R&D organization that is aiming to be customer centric in its activities. It is therefore a major contribution to the technology roadmapping research area. It is believed that the new roadmapping template with customer value at its core as well as follow-up activities of phase 3 of the novel research roadmap development framework provide very useful tool to address the third research question.

As future work, It will be interesting to study if the theoretical framework developed in this work can be applicable to non-technical organization, for example in financial sectors and hospitality.

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APPENDICES

Appendix 1. 40 Elements of Value in B2B

	Element	**Definition**
1.	Vision	Helps the customer anticipate the direction of its markets.
2.	Hope	Gives buyers and users hope for the future of their organization.
3.	Social responsibility	Helps the customer be more socially responsible.
4.	Network expansion	Helps users and colleagues expand their professional network.
5.	Marketability	Makes users and colleagues more marketable in their field.
6.	Reputational assurance	Does not jeopardize. Enhance the buyer's reputation at work.
7.	Design and aesthetics	Provides aesthetically pleasing goods or services.
8.	Growth and development	Helps users and colleagues develop personally.
9.	Reduce anxiety	Helps buyers and others in the organization feel more secure.
10.	Fun and perks	Is enjoyable to interact with or otherwise rewarding.
11.	Time savings	Saves time for users or the overall organization.
12.	Reduced effort	Helps an organization get things done with less effort.
13.	Availability	Ensures the good/service is available when and where needed.
14.	Responsiveness	Responds promptly to my organization's needs.
15.	Expertise	Provides know-how for the relevant industry or market.
16.	Decreased hassles	Helps the customer avoid unnecessary hassles.
17.	Information	Helps users become informed.
18.	Transparency	Provides a clear view into the customer's organization.
19.	Commitment	Shows it is committed to the customer's own success.
20.	Variety	Provides a variety of goods or services to choose from.
21.	Configurability	Offers goods/services that can be easily configured to the customer's needs.
22.	Stability	Is a stable company for the foreseeable future.
23.	Cultural fit	Fits well with the customer's culture and people.
24.	Organization	Helps users become more organized.
25.	Simplification	Reduces complexity and keeps things simple.
26.	Connection	Connects organizations and users with others internally and externally.
27.	Integration	Helps a customer integrate different facets of the business.
28.	Risk reduction	Protects the customer against loss or unnecessary risk.

29.	Reach	Allows the customer to operate in more locations or market segments.
30.	Flexibility	Moves beyond standard goods or services to allow customization.
31.	Component quality	Improves the perceived quality of the customer's own products or services.
32.	Improved top line	Helps the customer increase revenue.
33.	Cost reduction	Reduces cost for the customer's organization.
34.	Product quality	Provides high-quality goods or services.
35.	Scalability	Expands easily to additional demand, processes, or tasks.
36.	Innovation	Provides innovative capabilities.
37.	Meeting specifications	Conforms to the customer's internal specifications.
38.	Acceptable price	Provides products or services at an acceptable price.
39.	Regulatory compliance	Complies with regulations.
40.	Ethical standards	Performs its activities in an ethical manner.

Appendix 2. 30 Elements of Value in B2C

	Element	**Definition**
1.	Self-transcendence	Helping other people or society more broadly.
2.	Provides hope	Providing something to be optimistic about.
3.	Self-actualization	Providing a sense of personal accomplishment or improvement.
4.	Motivation	Spurring people to achieve their goals.
5.	Heirloom	A good investment for future generations.
6.	Affiliation and belonging	Helping people become part of a group or identify with people they admire.
7.	Reduces anxiety	Helping people worry less and feel more secure.
8.	Rewards me	Providing benefits for being a loyal customer.
9.	Nostalgia	Reminding people of something positive in the past.
10.	Design/aesthetics	Providing an appealing form or design.
11.	Badge value	Representing achieved status or aspirations.
12.	Wellness	Improving people's physical or mental state.
13.	Therapeutic value	Providing therapeutic value or well-being.
14.	Fun/entertainment	Offering fun or entertainment.
15.	Attractiveness	Helping people feel more attractive.
16.	Provides access	Providing access to information, goods, services, or other valuable items.
17.	Saves time	Saving time in tasks or transactions.
18.	Simplifies	Reducing complexity and simplifying.
19.	Makes money	Helping to make money.
20.	Reduces risk	Protecting from losses.
21.	Organizes	Becoming more organized.
22.	Integrates	Integrating different aspects of life.
23.	Connects	Connecting with other people.
24.	Reduces effort	Getting things done with less effort.
25.	Avoid hassles	Avoiding or reducing hassles.
26.	Reduces cost	Saving money in purchases, fees, or subscriptions.
27.	Quality	Providing high-quality goods or services.
28.	Variety	Providing a variety of things to choose from.
29.	Sensory appeal	Appealing in taste, smell, hearing, and other senses.
30.	Informs	Providing reliable and trusted information about a topic.