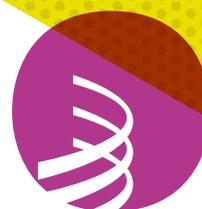




Toolkit
Using
Inventions
in the
Public
Domain

Tool 11

Life Cycle Risk Reduction



Tool 11/ Life Cycle Risk Reduction

In this document we explain how to use the Life Cycle Risk Reduction tool. New product development (NPD) is inherently risky, as the goal is to develop and market something new, meaning it has never been done before. The key to managing risk is to identify the risks at each stage of the NPD process, and then make decisions as to which risks can and should be avoided, which eliminated, which mitigated, and which you will accept.

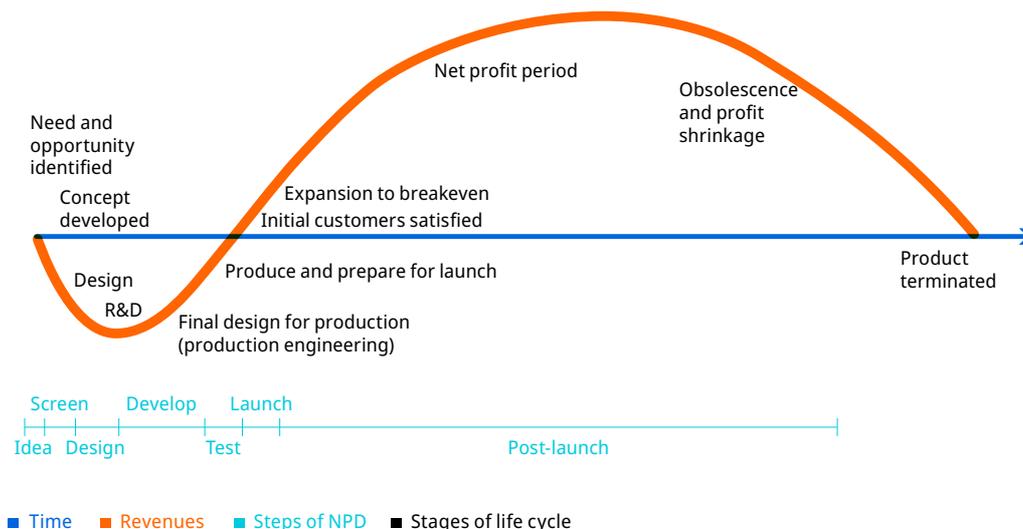
The Life Cycle Risk Reduction tool provides a two-step process to identify risks and assess their significance. The first step involves examining the entire life cycle for a product or service under development to identify risks which could affect your ability to complete NPD or to create value either for customers and end-users, or for your company or organization. The second step involves determining the significance of the risks and whether – and how – to avoid, eliminate, mitigate or accept these risks.

Following Ron Adner's approach in *The Wide Lens*,¹ there are three main types of risks that can be addressed during NPD. Adoption risk refers to whether the intended customer segments will actually buy the product or service, and the intended end-users actually deploy it. Execution risk refers to the ability of your organization or company to conduct NPD. Co-innovation risk refers to the ability of vendors, suppliers and partners to provide what you need as part of your NPD and to conduct their own NPD, if necessary, to develop consumables or other essential goods to effectively deploy your product or service. The Life Cycle Risk Reduction tool can address all three risks, but the emphasis is on execution and co-innovation risks. That is because it does not make sense to spend the time and money to conduct a life cycle risk analysis on a product or service until you have determined that it is likely to succeed in the market.

What is the Life Cycle Risk Reduction tool?

The Life Cycle Risk Reduction tool is a heuristic tool that helps you examine the risks that might occur during the life cycle of a product or service, from the initial conception of the idea, through NPD, into sales and use, and until its final disposal. Figure 1 illustrates the relationship between the stages in NPD and the product life cycle.

Figure 1: Relationship between NPD, product life cycle and revenues from product.



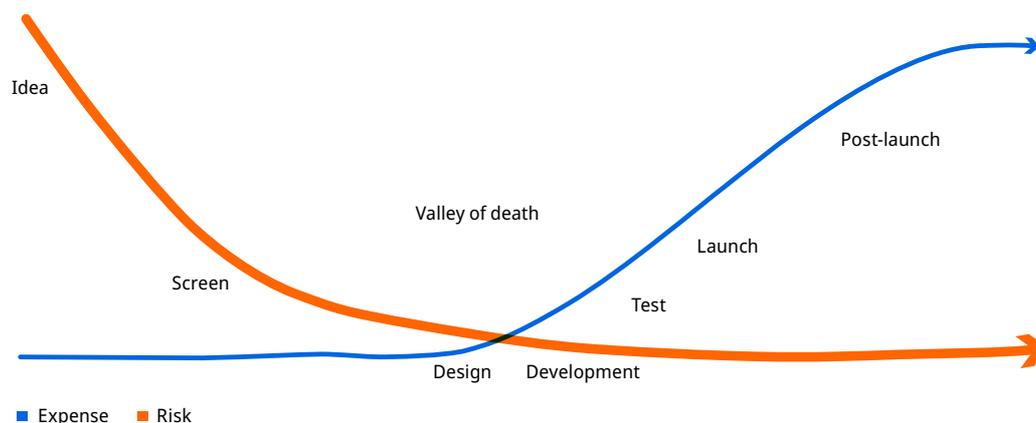
Source: Courtesy of Foresight Science & Technology.

Risks can occur anywhere in the product life cycle. An objective for NPD is to anticipate and identify downstream life cycle risks as early as possible so they can also be addressed when it is less expensive to do so.

For example, if there is an adoption risk, that means the desired sales may never occur due to a misalignment between the product’s concept and needs and trends in the market likely to exist at the time projected for market entry. This risk can be avoided by reconceptualizing the product during the Idea or Screen stages. If reconceptualization will not work to eliminate the risk that the product will not sell, it may be prudent to abandon NPD.

As the phrase “Valley of Death” emphasizes, the early stages of NPD are associated with the highest risk because the chance of failure is greatest (see Figure 2). Every potential risk for the entire NPD process and life cycle of the product exists when you first start an initiative.

Figure 2: Risks and expenses in NPD. The Design and Development stages are the “Valley of Death,” where risk is still significant and expenses are rising rapidly.



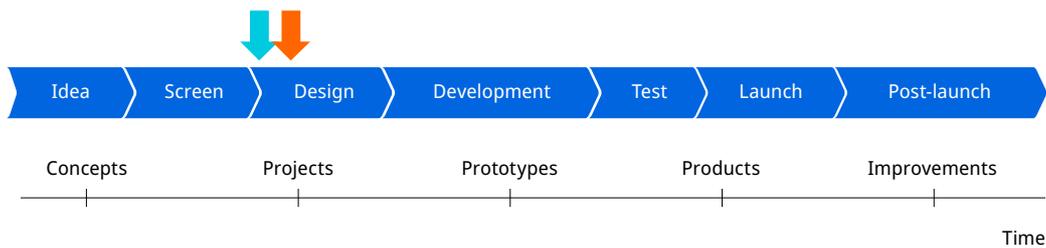
Source: Courtesy of Foresight Science & Technology.

The greater the risk, the less likely it is that NPD will be successful. So the early stages (Idea, Screen) heavily emphasize reducing adoption risk. While adoption risk reduction remains important for Design, at this stage execution and co-innovation risk reduction are emphasized. The objective is to bring down risk rapidly in the early stages, ideally by avoiding or eliminating it through focusing on a product or service with a strong competitive advantage and then designing that product or service in such a way that it maintains (or improves) the competitive

advantage while making it easy and cost-efficient for the primary value chain activities to make, sell and support the product or service effectively.

The Life Cycle Risk Reduction tool should be used early in the Design stage and the analysis completed early enough that the findings can inform the preliminary design.

Figure 3: Stages and gates. The blue arrow shows the Life Cycle Risk Reduction tool being used early in the Design stage but after the Business Model Canvas if it was deferred until this stage. The orange arrow indicates that the workbook and the analysis of results should be completed early enough in the stage for them to be useful in creating the preliminary design. In larger or multi-product or service companies, the tool may be used even earlier during the Screen stage, when screening concepts to consider their viability as the basis of a product family. Be aware that risk management is an ongoing activity throughout NPD.

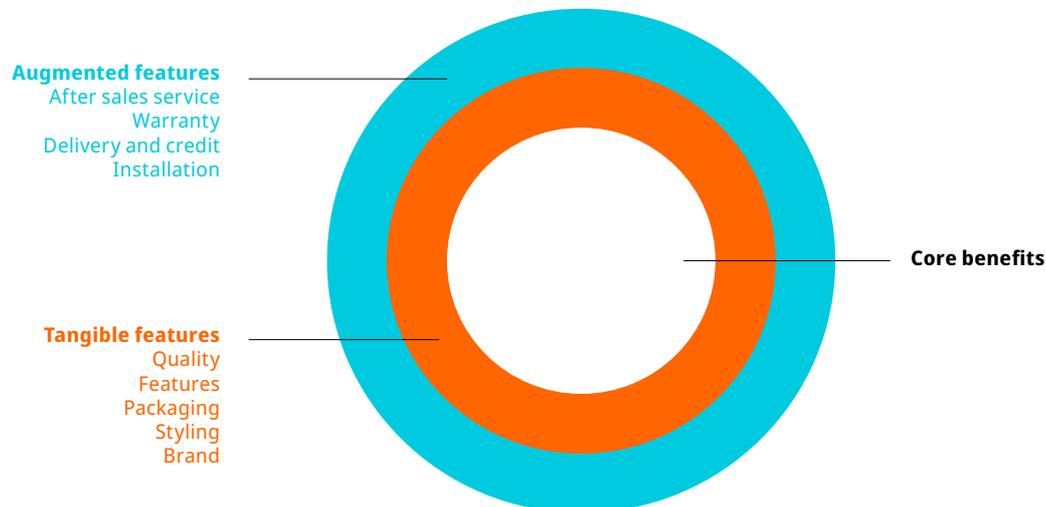


Life cycle risk reduction is not discussed directly in the WIPO Publication *Using Inventions in the Public Domain: A Guide for Inventors and Entrepreneurs* (2020). The need to reduce risk, however, is a theme throughout that guide. Technology risk management is the focus of section 9.4 “Design for manufacturing and technology risk management” in Module III “Integrating public domain knowledge into product development process” in the guide.

How do you enter data in the Life Cycle Risk Reduction tool?

As with other tools used in the early part of the Design stage, most of the data needed to use the Life Cycle Risk Reduction tool comes from re-examining data collected during earlier stages of NPD. This time, however, that data is examined from the perspective of what the data suggests about risks that can affect core benefits and tangible and augmented features desired by customers and end-users (see Figure 4). It is also helpful to review the business plan for the product (the completed Business Model Canvas workbook, for example) for potential risks to your own company’s or organization’s objectives associated with the NPD initiative.

Figure 4: Core benefits or services, with examples of tangible and augmented features.



Source: Courtesy of Foresight Science & Technology.

For example, suppose you are developing a bottled beverage product. Voice of the customer and competitive advantage market research suggests long shelf life – on the order of one year in a sealed container despite exposure to widely fluctuating temperatures from minus 10 to 80 degrees Celsius – would be a critical tangible feature. That suggests a source of potential execution or co-innovation risk. If the ingredients which would be included in the “Inbound logistics” section in the Value Chain tool cannot handle that temperature range over that time period, then a serious risk to product success has been discovered. This risk could be mitigated by mandating that the drink be stored at room temperature to avoid the problem of widely fluctuating temperatures, or it could be avoided altogether by substituting ingredients that can handle that temperature range for over a year without degrading, changing the flavor or raising health concerns. Each of these risk management strategies would involve trade-offs because mandating room temperature storage might narrow the potential market, and substituting temperature-tolerant ingredients might affect flavor and other properties.

Note that where a new product or service will rely upon technology in the public domain, regular reassessment of competitive advantage is essential. The reason is that anyone is free to use that public domain technology, so copycat products or services are always a threat.

The amount of data collection and analysis depends on the novelty of the product or service being developed, the size of the NPD budget, the importance of successful NPD for the future of the company or organization developing it, and other factors.

Collecting data for the Life Cycle Risk Reduction tool and then analyzing it requires going back over the results from all the previously deployed tools and looking for potential sources of execution risk, co-innovation risk or adoption risk which may affect: 1) the customers’ and end-users’ ability to realize the core benefits and services they are seeking from your product or service and obtain the tangible and augmented features they desire, and 2) your company’s or organization’s ability to implement your business model canvas (BMC).

The Life Cycle Risk Reduction workbook has four main sheets, each on its own tab, and an additional “Notes and references” tab.

The first tab, entitled “Risks” (see Figure 5, showing the tab filled out using the biofuels example), helps you think about where risks might exist. This tab is for brainstorming. Specific risks are identified by reflecting on the intersections in the matrix and whether a lack of capacity or capabilities indicate a potential problem for NPD or the activities of the value chain with respect to the product or service being developed.

On tab 2, entitled “Significance of risks,” risks entered in tab 1 are automatically carried over. Next you make an estimate as to the probability of the risk occurring (column D, entitled “Probably of occurrence”) and how much impact it could have on product success (column E, entitled “Impact on product success”).

A simple scale from low (1) to high (3) is used. Column F, entitled “Significance of the risk,” gives you a significance estimate created by multiplying the likelihood of occurrence with its likely impact if it does occur. The next three columns (G, H and I) help you think about how to address the risk. The last three columns (J, K and L) are a “reality check” that encourages you to evaluate if your proposed solution is worth the time and money it will involve.

Figure 5: Risks associated with the product or service on tab 1 of the biofuels example in the Life Cycle Risk Reduction workbook.

Risks associated with the product or service							
Factors contributing to the risk/Areas where risks are likely to occur	Areas where risks are likely to occur						
	New product development	Purchase	Delivery	Use	Consumables	Maintenance	Disposal or recycling
Communication	On-site biofuels production may not be a high priority, even with government incentives, making it challenging to identify and reach beta testers.			Limited or no internet access may restrict availability of online materials and hinder communication with customers and end-users.			
Labor				Unskilled labor may not understand how to use it.	Inserting new organisms may be difficult if it requires new skills.	Users may have low or no literacy.	
Knowhow				1. No existing know-how in biofuel production, although users may leverage their familiarity with other equipment. 2. Operating range tolerances are more stringent than what end-users are accustomed to, due to the requirements of the organisms.		There is likely a significant lack of know-how regarding the safe handling of organisms.	
Supplies and materials				There may be insufficient biomass to make the process worthwhile.	New organisms need to be sent periodically.		Filters and shipping materials for organisms must meet all standard waste collection criteria. Additionally, if tanks, piping, valves, etc., become outdated, they must also comply with these requirements.
Equipment and facilities				May lack access to computers, printers, CD readers, Wi-Fi, internet, or reliable cell service.		1. May lack access to computers, Wi-Fi, internet, or reliable cell service to remotely flush filters, tanks, pipes, and valves. 2. Need to determine how to remotely maintain chippers or other equipment requiring lubrication or oil, including disassembly for cleaning.	
Technology and intellectual property	License agreement for the use of organisms and related technology has not yet been signed.				Organisms must not cause harm when released into the environment.		
Working capital		Leasing must have either no impact or a positive impact on normal operational costs and cash flow.					The cost of organisms should not cause sticker shock.
Other factors			1. Delivery services and postal options may be nonexistent or require long transit times for remote locations. 2. Roads for delivery may be in very poor condition.				Delivery services and postal options may be unavailable or may involve long transit times for remote locations.

Tab 1: Risks

You develop the data to enter in this tab as follows. First, look at the BMC developed using the Business Model Canvas tool, as shown in Figure 6 using the biofuels example.

Figure 6: The Business Model Canvas workbook using the biofuels example.

Business Model Canvas				
Key partners <ul style="list-style-type: none"> Remarkable Biofuels LLC for organisms and know-how Vendor for sensors Vendor for software Regulatory and certification consultants Delivery service for overnight or up-to-three-day shipping of organisms and parts Government agencies funding sustainable energy, agricultural vitality, and waste reduction for customer financial support Investors and banks for working capital University or research institute for next-generation proprietary organisms, sensor/software systems, and other improvements or related products 	Key activities <ul style="list-style-type: none"> Obtain certifications and approvals Assemble mini-refinery Cultivate organisms Deliver, install, and provide training Perform servicing, remote operations, monitoring, and maintenance Manufacture, market, and sell/license products and services 	Value proposition <ul style="list-style-type: none"> Reduced energy expenses Rapid payback of initial investment Enhanced energy independence Flexibility in feedstock with abundant biomass options User-friendly, with options for remote operation, monitoring, and maintenance Domestically produced and supported 	Customer relationships <ul style="list-style-type: none"> Ongoing partnerships leveraging consumables and support options, modeled on infinitely repeating games in game theory Collegial relationships established by sales engineers and installers/trainers Extensive use of social media and electronic communications to maintain contact 	Customer segments <ul style="list-style-type: none"> Mid-sized and large farms Agricultural cooperatives and storage facilities (e.g., grain elevators) Towns, cities, and companies collecting biomass waste Military bases Licenses for any new technology we develop and patent
Key resources <ul style="list-style-type: none"> License for organisms Core staff with expertise in biology, sensors, software, and automation Marketing, sales, support, installation, training, and other staff for direct customer interactions Quality assurance lab Organism lab Assembly facility Test sites Web and telecommunications infrastructure Distributors and retail outlets Local and on-site repair personnel Working capital 		Channels <ul style="list-style-type: none"> Trade associations and trade publications Social media, with an emphasis on YouTube and other multimedia; content also available on the company website Phone, email, and other owned one-to-one channels Sales representatives Demonstrations (demos) conducted in cooperation with government agencies, agricultural extension agents, and beta testers 		
Cost structure <ul style="list-style-type: none"> Variable costs: Parts and components for integration; organism mats; assembly labor; delivery and associated labor; video production; energy and other utilities. Fixed costs: Factory; organism farm/clean room; core technical, customer support, marketing, installation/training, and managerial staff; telecom infrastructure; analytical lab; regulatory compliance; legal fees; amortization; taxes; interest; insurance; repair and maintenance; research and development (R&D) and new product development (NPD); advertising and promotion. Semi-variable costs: Click-through advertising; webstore; supplemental staff as needed; network economies in social media marketing. Initial estimate of cost ratios: Variable costs to fixed costs to semi-variable costs is approximately 3:1:0.5. 		Revenue streams <ul style="list-style-type: none"> Leases of mini-refineries Sales of mini-refineries Sales of organisms on mats, filters, and other consumables Service contracts Sales of operations and monitoring contracts Licensing of improvements to other markets Government grants, contracts, and tax incentives 		

Recall that you are always considering three types of risk: execution risk (can you build it?); co-innovation risk (can your suppliers, vendors and partners do what you need them to do?); and adoption risk (will your customers buy it and end-users use it?). You are also always considering project-specific sources of risk, where different types of risk can emerge from how you conduct your activities during the project life cycle.

To identify other risks, continue your review by looking at your BMC in light of the findings from using the other tools in the Toolkit. Always ask yourself: where can things go wrong?

For example, the BMC for the biofuels example calls for a mid-sized and large farm customer segment. It also calls for a customer relationship in which there is heavy use of social media and electronic communications to stay in touch with customers and end-users. But what happens if the internet goes down? What if it is not even available in some places? Looking at the “Key resources” component of the Business Model Canvas workbook highlights the importance of web and telecommunications infrastructure for this project. The possibility that this is a potential source of risk is strengthened by a statement in one of the expert interviews from the Voice of the Customer workbook (see Figure 7), where the expert noted that internet access is a problem for some mid-sized farms and many small ones. Accordingly, it makes sense to do some market research to determine just how widespread and significant this risk might be.

Figure 7: Extract from the “Expert interview 2” tab in the Voice of the Customer workbook using the biofuels example, suggesting internet accessibility as a potential risk. The relevant text is colored red here.

Expert on competitive opening	
Name	ATI
Title	Executive Director
Organization	Crop Farm Bureau
Phone	777-666-555
Email	Ati1@farmbureau.country.org
Importance of need(s) being addressed	We are all discussing biofuels in the agriculture sector, but there hasn't been much progress in countries like ours yet. Stronger government incentives may be necessary to achieve widespread adoption of this technology. The core issue is the start-up costs: who will cover them? While everyone likes the idea of free fuel, energy independence, and an additional cash product, many of our members view it as unrealistic at the moment, especially given concerns about drought in some areas and excessive flooding in others.
Key specifications and features to emphasize for this niche	While the system may work well in the lab, it needs to be demonstrated in field conditions, where maintaining low maintenance and minimal operation can be more challenging due to differing environmental factors. Sophisticated equipment is often limited, particularly outside of very large corporate farms. For perspective, some of our mid-sized and many small farm members don't even have internet access. The system should be cost-effective and demonstrate efficacy with various types of waste. Additionally, it needs to be operable and repairable by a reasonably skilled farm mechanic. I should have emphasized that it must be affordable both in absolute terms and in terms of quick return on investment.

Having identified a potential risk or potential source of risk, the risk is listed in a cell on the “Risks” tab. In the biofuels example, it shows up as a communication-related risk (fourth row) for the area “Use” (column E); see Figure 8.

Figure 8: Risks entered in the Life Cycle Risk Reduction workbook using the biofuels example.

Risks associated with the product or service							
Factors contributing to the risk\Areas where risks are likely to occur	Areas where risks are likely to occur						
	New product development	Purchase	Delivery	Use	Consumables	Maintenance	Disposal or recycling
Communication	On-site biofuels production may not be a high priority, even with government incentives, making it challenging to identify and reach beta testers.			Limited or no internet access may restrict availability of online materials and hinder communication with customers and end-users.			

In the biofuels example, the BMC also includes licensing the organism and related technology that is at the heart of the mini-refinery. If this deal has not yet been signed, that is clearly a source of risk. This is confirmed by the risks associated with organisms that were identified in the biofuels example in the Value Chain workbook on the “Inbound logistics” tab (see Figure 9), as well as on the “Solutions” tab in the discussion of organisms (see Figure 10, with relevant text in red).

Figure 9: Availability of organisms is a risk in the Value Chain workbook using the biofuels example, as entered here in the “Inbound logistics” tab.

Inbound logistics									
Requirements		Design requirements/specifications concerns							
Parts, components, etc.	Average of risks	Risk							
		Availability at affordable price	Efficiency/efficacy	Storage of inventory	Payment terms	Environmentally friendly	On-time delivery	Quality	
Vats	1	1	1	1	1	1	1	1	1
Piping and valves	1	1	1	1	1	1	1	1	1
Sensors	2.1429	3	2	1	2	1	3	3	
Organism	3	3	3	3	3	3	3	3	
Mats for organism	2	2	2	2	2	2	2	2	
Conveyers	1	1	1	1	1	1	1	1	
Chippers/mulchers	1	1	1	1	1	1	1	1	
Filters	1	1	1	1	1	1	1	1	
Software for monitoring and maintenance	2	2	2	1	2	1	3	3	
Telecommunications for data transmission and remote control	1.2857	1	1	1	2	1	2	1	
Average risk for inbound logistics	1.5918								

Figure 10: Possible mitigation measure found on the “Solutions” tab of the Value Chain workbook using the biofuels example. The relevant text is colored red here.

Solutions to risks				
Risk to be addressed	Who is responsible	What will be done	Feasibility (0-100%)	Anticipated effectiveness (0-100%)
Organism selection, their health and replacement throughout the product's life, and support for consumable sales	Technical expert, supported by a logistics expert, for licensing or contract research where applicable	Hire competent consultants or obtain know-how from the licensor on how to grow and maintain cultures, ship them, etc. Additionally, hire and train up to three master's-level microbiologists to handle operations, support sales of consumables, and address customer issues. Ship organism kits directly from us to the user. Develop a backup plan in case suitable organisms cannot be licensed, to ensure the project does not have to be canceled.	100%	90%

Going back to the Life Cycle Risk Reduction tool, the risk should be entered in the matrix on the “Risks” tab where it seems appropriate. This means that, when you see a potential source of risk, you need to describe the nature of the problem and identify the appropriate category or nature of the problem in column A, entitled “Factors contributing the risk,” and then decide in which areas and how during the product life cycle this problem could be a source of risk (columns B to H under the heading “Areas where risks are likely to occur”).

Depending on how you analyze and apply your data, you might decide that a problem can be a risk at multiple stages or for multiple activities listed in columns B to H, and you would enter specific comments about the potential risk associated with each stage or activity.

For example, in the biofuels example shown in Figure 11, the fact that a license for the organism has not yet been obtained was identified as a “Technology and IP” risk factor (row 9), and specific comments were entered in cells in row 9 to show that the licensing issue could be a “New product development” risk (cell B9), as well as a “Consumables” risk (cell F9). Although it is not shown in this example, this licensing issue could also be considered a “Purchase” (licensing) risk (column C) depending on how the issue is perceived. The issue of internet accessibility and telecommunications infrastructure for users was also identified as a “Communication” risk (row 4) and comments were entered in row 4 to show that this could be a source of risk for both “New product development” (cell B4) and “Use” (cell E4). As long as you place the risk where it seems reasonable, don’t worry about which cell is best. This is simply a brainstorming tool to identify risks and collect your comments.

Figure 11: Potential risks associated with obtaining the organisms classified as a “Technology and IP” risk entered on the “Risks” tab of the Life Cycle Risk Reduction workbook using the biofuels example, as both a “New product development” risk and a “Consumables” risk. Potential risks also associated with the issue of internet accessibility and telecom infrastructure were classified as a “Communication” risk in the areas of both “New product development” and “Use.” Some columns and rows have been hidden in this figure to improve readability.

Risks associated with the product or service					
Factors contributing to the risk\Areas where risks are likely to occur	Areas where risks are likely to occur				
	New product development	Purchase	Delivery	Use	Consumables
Communication	On-site biofuels production may not be a high priority, even with government incentives, making it challenging to identify and reach beta testers.			Limited or no internet access may restrict availability of online materials and hinder communication with customers and end-users.	
Technology and intellectual property	License agreement for the use of organisms and related technology has not yet been signed.				Organisms must not cause harm when released into the environment.

Be aware that not all risks are going to show up through this technique. Also use what you know about the market and environment your product or service will be entering, and what you know about your capacities and capabilities to conduct NPD and other activities related to the life cycle of the product.

Tab 2: Significance of risks

On the second tab, entitled “Significance of risks,” embedded functions automatically carry over and categorize the risks identified on tab 1 at the appropriate location on tab 2. Descriptions of risks from tab 1 (Risks) are automatically carried to tab 2 (Significance of risks) in the first column, entitled “Risk from user experience table.” Areas where risks are likely to occur from tab 1 (Risks) are automatically carried to tab 2 (Significance of risks) in the second column, entitled “User interaction.” Factors contributing to the risk from tab 1 (Risks) are also automatically carried to tab 2 (Significance of risks) in the third column, entitled “Nature of the problem.”

The first task on this tab is to think about how probable the risk is and then enter a rank in the fourth column (column D, entitled “Probability of occurrence”) and what its impact is likely to be and enter a rank in the fifth column (column E, entitled “Impact on product success”). Embedded formulas will calculate the product of these two rankings and display it in column F, entitled “Significance of the risk.”

Next on that tab, use the two legends presented below the main table to indicate what phase of the product or service life cycle (using the abbreviations in the legend) is impacted and enter it into column G, entitled “Phase of life cycle impacted,” and in which stage you believe you can best address this risk during NPD by entering this into column H, entitled “Stage of new product

development where the risk is addressed.” In the next column (column I), entitled “Preventive or mitigation measure,” identify what you will do to address, and preferably avoid or mitigate, the risk. You can include concrete suggestions for action as well as mere ideas about possible solutions.

As shown in Figure 12 using the biofuels example, one source of risk was that the license for organisms had not been signed yet (cell A9), and the proposed preventative or mitigation measure was listed as “Accelerate in-licensing efforts and identify the next best option for exploration and licensing. Start by approaching national universities, research institutes, and companies in the region that may have relevant organisms, and then expand your search to others farther afield.” (cell I9). Another source of risk was associated with whether end-users have reliable access to the internet and other telecommunications options (“Communications problem” – cell A28) and the proposed “Preventative or mitigation measure” was listed as “Offer CD, videotape, and print options at no additional cost. Additionally, ensure that as much as possible can be operated via a cell phone or satellite communication if desired. Provide a bundle with various telecom equipment available for purchase or lease.” (cell I28). This tab shows how other problems/sources of risk are broken down as separate risks with separate risk analyses and proposed mitigation strategies; for example, the organism-related risk for “Consumables” is entered in a separate row (row 41) for analysis and proposed mitigation.

Figure 12: The “Significance of risks” tab of the Life Cycle Risk Reduction workbook using the biofuels example with some risks entered into the spreadsheet, and possible preventive or mitigation measures identified highlighted in yellow. Some columns and rows have been hidden in this figure to improve readability.

Risk from user experience table	User interaction	Nature of problem	Preventive or mitigation measure
License agreement for the use of organisms and related technology has not yet been signed.	New product development	Technology and intellectual property	Accelerate in-licensing efforts and identify the next best option for exploration and licensing. Start by approaching national universities, research institutes, and companies in the region that may have relevant organisms, and then expand your search to others farther afield.
Limited or no internet access may restrict availability of online materials and hinder communication with customers and end-users.	Use	Communication	Offer CD, videotape, and print options at no additional cost. Additionally, ensure that as much as possible can be operated via a cell phone or satellite communication if desired. Provide a bundle with various telecom equipment available for purchase or lease.
Organisms must not cause harm when released into the environment.	Consumables	Technology and intellectual property	The organisms must either be harmless, or their removal from the unit must simultaneously kill them without requiring any special tasks from the user. Prototypes must meet regulatory approval and be certified safe by a third party.

Finally, reassess the likelihood of occurrence and impact after the risk management measure is implemented. Enter a value in column J, entitled “Probability of occurrence after measure,” and a value in column K, entitled “Impact after measure.” Embedded formulas in the spreadsheet will then calculate the product of these two new rankings and display it in the last column in the table, entitled “Revised significance of the risk,” which indicates how well you think the risk is managed.

If a risk does not seem to be well managed, go back and reassess the risk and your solutions for it. Be aware that you can never completely eliminate a risk identified by this tool and entered in the workbook. That is because you can never have 100 percent certainty about the future. The only way you know a risk is totally eliminated is after a time when that source of risk can no longer have a negative impact, and no negative impact was seen prior to that time.

Figure 13 from the Life Cycle Risk Reduction workbook using the biofuels example illustrates what the “Significance of risks” tab should look like after you have done this work.

Figure 13: The full “Significance of risks” tab of the Life Cycle Risk Reduction workbook using the biofuels example.

Risk significance for new product development and life cycle											
Risk from user experience table	User interaction	Nature of problem	Probability of occurrence: enter 1 (low) to 3 (high)	Impact on product success: enter 1 (low) to 3 (high)	Significance of the risk (column D + column E)	Phase of life cycle impacted	Stage of new product development where the risk is addressed	Preventive or mitigation measure	Probability of occurrence after measure	Impact after measure	Revised significance of the risk (column J + column K)
On-site biofuels production may not be a high priority, even with government incentives, making it challenging to identify and reach beta testers.	New product development	Communication	2	2	4	PPL	L	Leverage associations supporting biofuels for assistance. Additionally, approach military bases for demonstrations, as government policy encourages the use of biofuels.	2	1	2
0	New product development	Labor			0						0
0	New product development	Knowhow			0						0
0	New product development	Supplies and materials			0						0
0	New product development	Equipment and facilities			0						0
License agreement for the use of organisms and related technology has not yet been signed.	New product development	Technology and intellectual property	1	3	3	RPD	R&D	Accelerate in-licensing efforts and identify the next best option for exploration and licensing. Start by approaching national universities, research institutes, and companies in the region that may have relevant organisms, and then expand your search to others farther afield.	1	1	1
0	New product development	Working capital			0						0
0	New product development	Other factors			0						0
0	Purchase	Communication			0						0
0	Purchase	Labor			0						0
0	Purchase	Knowhow			0						0
0	Purchase	Supplies and materials			0						0
0	Purchase	Equipment and facilities			0						0
0	Purchase	Technology and intellectual property			0						0
Leasing must have either no impact or a positive impact on normal operational costs and cash flow.	Purchase	Working capital	2	3	6	ICS	PSD	To the extent feasible, everything incorporated should be commercially off-the-shelf and of moderate cost.	2	2	4
0	Purchase	Other factors			0						0
0	Delivery	Communication			0						0
0	Delivery	Labor			0						0
0	Delivery	Knowhow			0						0
0	Delivery	Supplies and materials			0						0
0	Delivery	Equipment and facilities			0						0
0	Delivery	Technology and intellectual property			0						0
0	Delivery	Working capital			0						0
1. Delivery services and postal options may be nonexistent or require long transit times for remote locations. 2. Roads for delivery may be in very poor condition.	Delivery	Other factors	3	3	9	ICS	PSD	1. Not really an issue if we plan for it. 2. Must be deliverable on a small pickup or trailer in very robust packaging.	3	1	3

Risk significance for new product development and life cycle

Risk from user experience table	User interaction	Nature of problem	Probability of occurrence: enter 1 (low) to 3 (high)	Impact on product success: enter 1 (low) to 3 (high)	Significance of the risk (column D * column E)	Phase of life cycle impacted	Stage of new product development where the risk is addressed	Preventive or mitigation measure	Probability of occurrence after measure	Impact after measure	Revised significance of the risk (column J * column K)
Limited or no internet access may restrict availability of online materials and hinder communication with customers and end-users.	Use	Communication	3	3	9	FPD	PPL	Offer CD, videotape, and print options at no additional cost. Additionally, ensure that as much as possible can be operated via a cell phone or satellite communication if desired. Provide a bundle with various telecom equipment available for purchase or lease.	3	1	3
Unskilled labor may not understand how to use it.	Use	Labor	2	3	6	ESB	D	Incorporate smart software and ensure an intuitive user interface.	2	1	2
1. No existing know-how in biofuel production, although users may leverage their familiarity with other equipment. 2. Operating range tolerances are more stringent than what end-users are accustomed to, due to the requirements of the organisms.	Use	Knowhow	3	3	9	ESB	D	The user interface must be no more difficult to learn than the tasks required to use and maintain a tractor or truck.	3	1	3
There may be insufficient biomass to make the process worthwhile.	Use	Supplies and materials	3	3	9	RPD	R&D	Allow biomass to be stored until a sufficient amount is accumulated. Additionally, enable biomass to be added once a production round has started. The unit should automatically shut off when no further fuel is being produced and only restart when manually activated or when it senses that a sufficient amount of biomass has been added.	3	2	6
May lack access to computers, printers, CD readers, Wi-Fi, internet, or reliable cell service.	Use	Equipment and facilities	3	3	9	PPL	R&D	Remote operations must be capable of running off a landline, cell, or satellite phone, and possibly a ham radio if those are in widespread use. Bundle telecom and IT equipment as an add-on option.	1	1	1
0	Use	Technology and intellectual property			0						0
0	Use	Working capital			0						0
0	Use	Other factors			0						0
0	Consumables	Communication			0						0
Inserting new organisms may be difficult if it requires new skills.	Consumables	Labor	3	3	9	PSD	D	Use a simple, intuitive measuring unit to draw in and deliver the organisms, or have them prepackaged in the correct volume.	1	1	1
0	Consumables	Knowhow			0						0
New organisms need to be sent periodically.	Consumables	Supplies and materials	2	3	6	PSD	D	Design the packaging to meet both the unit's requirements and the available delivery options.	1	1	1
0	Consumables	Equipment and facilities			0						0
Organisms must not cause harm when released into the environment.	Consumables	Technology and intellectual property	3	3	9	PSD	R&D	The organisms must either be harmless, or their removal from the unit must simultaneously kill them without requiring any special tasks from the user. Prototypes must meet regulatory approval and be certified safe by a third party.	1	1	1
The cost of organisms should not cause sticker shock.	Consumables	Working capital			0						0

Risk significance for new product development and life cycle

Risk from user experience table	User interaction	Nature of problem	Probability of occurrence: enter 1 (low) to 3 (high)	Impact on product success: enter 1 (low) to 3 (high)	Significance of the risk (column D + column E)	Phase of life cycle impacted	Stage of new product development where the risk is addressed	Preventive or mitigation measure	Probability of occurrence after measure	Impact after measure	Revised significance of the risk (column J + column K)
Delivery services and postal options may be unavailable or may involve long transit times for remote locations.	Consumables	Other factors	3	3	9	ICS	PSD	Once we determine the maximum possible delay, we need a low-cost, battery-powered unit that can last for that duration. If necessary, the unit can be shipped back and reused to reduce costs.	2	1	2
0	Maintenance	Communication			0						0
Users may have low or no literacy.	Maintenance	Labor	3	2	6	PPL	T	Develop video and pictorial training materials.	1	1	1
There is likely a significant lack of know-how regarding the safe handling of organisms.	Maintenance	Knowhow	3	3	9	PSD	D	Handling should be no more complicated than putting on a set of gloves to protect against heat or chemicals, which we provide at no cost.	1	1	1
0	Maintenance	Supplies and materials			0						0
1. May lack access to computers, Wi-Fi, internet, or reliable cell service to remotely flush filters, tanks, pipes, and valves. 2. Need to determine how to remotely maintain chippers or other equipment requiring lubrication or oil, including disassembly for cleaning.	Maintenance	Equipment and facilities	2	2	4	PSD	D	Some tasks will need to be done manually, but they should not require skills beyond those that users are likely to already possess. Additionally, consider offering bundled telecom and IT equipment	1	1	1
0	Maintenance	Technology and intellectual property			0						0
0	Maintenance	Working capital			0						0
0	Maintenance	Other factors			0						0
0	Disposal or recycling	Communication			0						0
0	Disposal or recycling	Labor			0						0
0	Disposal or recycling	Knowhow			0						0
Filters and shipping materials for organisms must meet all standard waste collection criteria. Additionally, if tanks, piping, valves, etc., become outdated, they must also comply with these requirements.	Disposal or recycling	Supplies and materials	3	3	9	ESB	R&D	To the extent possible, everything should be biodegradable. If something cannot biodegrade, it must be suitable for disposal in the trash, recycling, or through a junk dealer. In the worst case, we would need to pick it up and dispose of it ourselves, requiring a safe storage unit.	1	1	1
0	Disposal or recycling	Equipment and facilities			0						0
0	Disposal or recycling	Technology and intellectual property			0						0
0	Disposal or recycling	Working capital			0						0
0	Disposal or recycling	Other factors			0						0

Phases of product or service life cycle	Abbreviation
Need and opportunity identified	NOI
Concept development for good	CDG
Product or service design	PSD
Research and prototype development	RPD
Final design for production	FDP
Produce and prepare for launch	PPL
Initial customers satisfied	ICS
Expansion of sales to break even	ESB
Net profit period	NPP
Obsolescence and profit shrinkage	OPS
Product or service terminated	PST

Stages of NPD from guide	Abbreviation
Idea	ICS
Screen	S
Design	D
Development	R&D
Test	T
Launch	L
Post-launch	PL

A closer look at the biofuels example in Figure 14 shows for example that addressing the risk associated with licensing the organism was ranked as a low probability of occurrence (rank 1, cell D9) but high potential impact (rank 3, cell E9) for an overall significance of 3 (cell F9), and after the proposed mitigation measure the potential impact decreased (cell K9) and the overall significance decreased to 1 (cell L9). Likewise, Figure 14 also shows that for the risk associated with the internet/telecommunications access problem (cell A28), the probability of occurrence was considered high without the proposed mitigation measure (rank 3, cell D28) for an overall significance of 9 (cell F28) and remained high after the proposed mitigation measure (rank 3, cell J28), but the proposed mitigation decreased the potential impact from 3 (cell E28) to 1 (cell K28), with dramatic decrease in overall significance to 3 (cell L28). Because the likelihood of poor internet accessibility is outside the developers' control, the ranking for the risk of occurrence remains high even after mitigation. However, the ability to reduce the impact through the mitigation measures is very good, reflected in the dramatic decrease in perceived significance from 9 before mitigation (cell F28) to 3 after proposed mitigation (cell L28). This means the developers of the mini-refineries in the biofuels example were able to recognize an ongoing source of risk and decide that they could bear it.

Figure 14: The “Significance of risks” tab of the Life Cycle Risk Reduction workbook using the biofuels example with risks, their probability of occurrence and impact on product success entered into the spreadsheet, and possible preventive or mitigation measures affecting the final rank and overall significance of the risk. Some columns and rows have been hidden in this figure to improve readability.

Risk significance for new product development and life cycle

Risk from user experience table	Probability of occurrence: enter 1 (low) to 3 (high)	Impact on product success: enter 1 (low) to 3 (high)	Significance of the risk (column D * column E)	Preventive or mitigation measure	Probability of occurrence after measure	Impact after measure	Revised significance of the risk (column J * column K)
License agreement for the use of organisms and related technology has not yet been signed.	1	3	3	Accelerate in-licensing efforts and identify the next best option for exploration and licensing. Start by approaching national universities, research institutes, and companies in the region that may have relevant organisms, and then expand your search to others farther afield.	1	1	1
Limited or no internet access may restrict availability of online materials and hinder communication with customers and end-users.	3	3	9	Offer CD, videotape, and print options at no additional cost. Additionally, ensure that as much as possible can be operated via a cell phone or satellite communication if desired. Provide a bundle with various telecom equipment available for purchase or lease.	3	1	3

Tab 3: Significance for life cycle, and Tab 4: Where risks are addressed

The tables and graphs on the last two main tabs are automatically generated from the data in the “Significance of risks” tab.

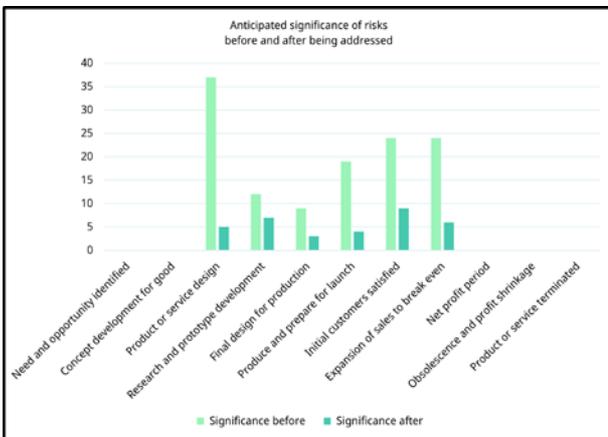
On the “Significance for life cycle” tab, a table entitled “Significance of risks by life cycle phase before and after being addressed” and a bar graph are automatically generated. On the “Where risks are addressed” tab, a table entitled “Where in new product development risks are addressed” and a bar graph are also automatically generated. Figure 15 shows these two tabs as generated for the biofuels example.

These tabs provide summaries and graphs that help you see your progress in addressing risks and help you focus attention on where more work needs to be done. Because future risks can never be completely eliminated with certainty, you can make suggestions about risk management based on results from using the Life Cycle Risk Reduction tool, but deciding what risk management strategies to implement is ultimately a question for management.

Figure 15: The “Significance for life cycle” and “Where risks are addressed” tabs of the Life Cycle Risk Reduction workbook using the biofuels example, showing the tables and graphs that are automatically generated from the previous tabs.

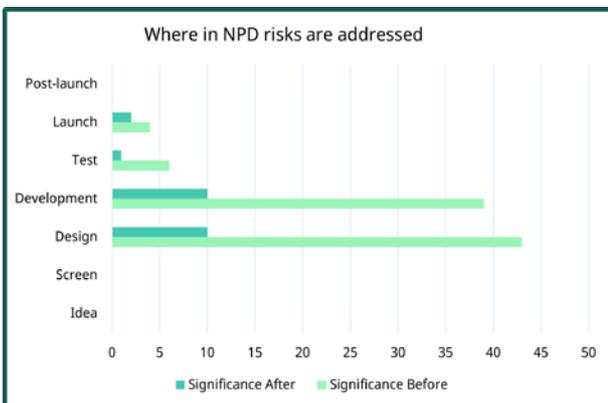
Significance of risks by life cycle phase before and after being addressed

Phase of product or service life cycle	Abbreviation	Significance before	Significance after
Need and opportunity identified	NOI	0	0
Concept development for good	CDG	0	0
Product or service design	PSD	37	5
Research and prototype development	RPD	12	7
Final design for production	FDP	9	3
Produce and prepare for launch	PPL	19	4
Initial customers satisfied	ICS	24	9
Expansion of sales to break even	ESB	24	6
Net profit period	NPP	0	0
Obsolescence and profit shrinkage	OPS	0	0
Product or service terminated	PST	0	0



Where in new product development risks are addressed

New product development stage or step	Abbreviation	Significance before	Significance after
Idea	ICS	0	0
Screen	S	0	0
Design	D	43	10
Development	R&D	39	10
Test	T	6	1
Launch	L	4	2
Post-launch	PL	0	0



How do you interpret the data from the Life Cycle Risk Reduction tool and use it in your NPD process?

Once you have entered the Design stage, costs begin to escalate more rapidly, and they will escalate even more rapidly during the Development stage. To justify these expenditures, risks must be identified and analyzed, and avoidance, elimination or mitigation measures must be proposed and evaluated as early as possible during this stage. The Design stage presents opportunities to strategically manage risks because of this ability to incorporate risk avoidance, elimination and mitigation strategies as guardrails for the design being created.

Putting the solution for these problems and risks in place becomes a task to be added to the action plan during the Design or Development stage, if it is not already there. Using the Life Cycle Risk Reduction tool will trigger a re-examination of the original action plan, which usually confirms that you must revise your action plan to address the risks and avoidance, elimination or mitigation measures you adopted. When you check where in the action plan these measures are implemented, this may reveal other potential sources of risk, such as the lack of any task related to sales and marketing. This indicates the original action plan was weaker than previously thought, and the newly identified risks associated with product launch that must be addressed before proceeding.

Taking steps to confirm that all risks are being considered and to check when and how risk avoidance, elimination or mitigation measures are implemented, is essential for navigating the "Valley of Death." When you re-examine the Life Cycle Risk Reduction tool findings concerning what the identifiable risks are, and what compensating measures you have proposed for them, you will gain greater confidence that you are managing risks at an acceptable level and in line with the level of risk tolerance defined by management. By identifying potential sources of risk and making concrete plans for dealing with those risks, support is increased for a decision to move through the gate at the end of the Design stage into the more expensive stage of Development.

