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**Master's Degree in Engineering and Management**

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# The PRISM Framework: A Managerial Decision-Support Approach for Translating Operational Risk into Customer-Relevant Priorities in Service Systems


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# Abstract

Service organizations operate in contexts where operational processes are closely linked to customer experience. Operational failures—whether process-based, technological, or human—can become perceptible to customers and influence evaluations of service quality. Although structured techniques such as Failure Mode, Effects and Criticality Analysis (FMECA) support systematic operational risk assessment, they rarely incorporate the perceptual channels through which customers experience service-related risks. To date, no integrated framework systematically translates operational risk criticality into service quality dimensions to support customer-relevant managerial prioritization. As a result, managers may allocate improvement efforts toward technically severe failures that are not necessarily the most salient from the customer's perspective.

This thesis proposes the **PRISM (Perceptual Risk Integration for Service Management) Framework**, a managerial decision-support methodology designed to translate operational risk assessment into customer-relevant prioritization criteria in service systems. The framework integrates three complementary components: (1) service blueprinting to structure service processes and identify potential failure modes; (2) FMECA to assess operational criticality through severity, occurrence, and detectability; and (3) a QFD-based relationship matrix that allocates operational risk impact across service quality dimensions.

The resulting indicator, **Perceived Risk Exposure (PRE)**, combines operational criticality with perceptual impact allocation to provide a dimension-level representation of how service-related operational risks manifest in customer perceptions. PRE does not measure objective risk magnitude or satisfaction levels; rather, it functions as a structured, relative prioritization metric that supports managerial decision-making under uncertainty and resource constraints.

By linking internal risk assessment to customer-perceived service quality dimensions, the PRISM Framework establishes a coherent prioritization logic that integrates operational and perceptual perspectives. The methodology supports both firm-level decision-making and comparative exploratory applications across service contexts. Its main contribution lies in enabling managers to direct improvement efforts toward those failure modes and underlying causes that most strongly shape customer-perceived manifestations of service-related operational risk, thereby increasing the strategic effectiveness of quality investments.

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# Introduction

Service industries play a dominant role in modern economies, contributing substantially to employment, value creation, and economic growth. According to data from the World Bank, services account for around two-thirds of global gross domestic product (GDP), far exceeding the contributions of industry and agriculture. This structural transformation reflects a long-term shift from manufacturing-based production systems toward service-oriented economic activity (World Bank, 2024).

The growing importance of services is also emphasized by the Organization for Economic Co-operation and Development (OECD), which highlights that the service sector generates the largest share of global employment, attracts a substantial proportion of foreign direct investment in advanced economies, and plays a critical role in facilitating access to information, technology, and specialized skills (OECD, 2023).

As services increasingly replace manufacturing as a primary source of competitive advantage, organizations face growing challenges related to uncertainty, variability, and risk. Although service systems vary in their degree of customer contact and technological mediation, many are characterized by process interdependence, real-time performance requirements, and exposure to variability in human and system interactions (Zeithaml et al., 1985; Grönroos, 2015). These characteristics make service systems particularly vulnerable to operational failures whose consequences often extend beyond efficiency losses to include reputational damage and negative customer perceptions.

In this context, risk management in services has emerged as a critical managerial concern. Service failures such as excessive waiting times, inaccurate information, system breakdowns, or inadequate employee behavior may generate significant negative impacts on customer satisfaction, trust, and loyalty, ultimately affecting organizational performance and competitiveness (Bitner et al., 2008; Haksever et al., 2015). Due to the simultaneity of production and consumption, operational breakdowns become perceptible to customers—whether through direct interaction or mediated channels—and their impact is amplified, limiting the organization's ability to fully control outcomes once the failure has materialized.

Service quality plays a central role in shaping how customers interpret and evaluate service experiences. Models such as SERVQUAL conceptualize service quality as a multidimensional construct through which customers assess service performance, including dimensions such as reliability, responsiveness, assurance, empathy, and tangibles (Parasuraman et al., 1988). While an extensive body of literature recognizes the importance of service quality for customer satisfaction and value creation, structured risk assessment approaches rarely incorporate these perceptual dimensions as formal prioritization criteria. To date, no integrated framework seems to systematically redistribute operational risk criticality across service quality dimensions in order to support customer-relevant managerial prioritization.

From a managerial perspective, decision-makers are not only interested in understanding whether service quality and risk are related, but primarily in identifying where and how to intervene within service systems to effectively reduce service-related operational risks under limited resources. This requires analytical tools capable of systematically linking service processes, potential failure modes, and customer-perceived quality dimensions, enabling the prioritization of improvement actions based on both operational criticality and perceptual impact.

Against this background, this thesis develops the **PRISM (Perceptual Risk Integration for Service Management) Framework**, a structured managerial decision-support methodology designed to translate operational risk assessment into customer-relevant prioritization criteria. The framework integrates Service Blueprinting (Shostack, 1984; Bitner et al., 2008) to structure the service process, Failure Mode, Effects and Criticality Analysis (IEC 60812, 2018) to assess operational criticality, and SERVQUAL (Parasuraman et al., 1988) as a multidimensional perceptual lens. Quality Function Deployment (Akao, 1990; Chan & Wu, 2002; Franceschini, 2001) is employed as a structured translation mechanism to allocate operational risk impact across service quality dimensions.

Rather than testing causal relationships between service quality and risk, the PRISM Framework supports managerial decision-making by identifying critical failure modes, revealing the service quality dimensions through which operational risks are predominantly perceived by customers, and guiding the selection of targeted improvement actions.

To achieve this objective, the thesis addresses the following research questions:

> **RQ1**: How can service processes and potential failure modes be systematically analyzed in order to identify service-related operational risks?
>
> **RQ2:** How can service quality dimensions be integrated into operational risk assessment as structured perceptual lenses to support managerial prioritization?

**RQ3:** How can a decision-support framework translate operational risk assessments into actionable managerial priorities by identifying service quality dimensions that act as perceptual leverage points for risk reduction?

The contribution of this work lies in the development of an integrated methodological approach that bridges service process analysis, operational risk assessment, and service quality management. The PRISM Framework offers both a practical tool for managerial decision-making in service contexts and a conceptual foundation for future empirical and comparative research exploring structural patterns in the relationship between service-related operational risks and customer-perceived quality dimensions across service sectors.

The remainder of the thesis is structured as follows. Chapter 1 examines the conceptual foundations of services, reviewing definitions, typologies, and systemic perspectives to clarify structural sources of variability and risk. Chapter 2 analyzes the multidimensional nature of service quality, discussing key models and measurement approaches, and synthesizing their implications for managerial prioritization. Chapter 3 explores service-related operational risks and existing risk assessment approaches in service systems. Chapter 4 establishes the conceptual link between operational failures and their perceptual allocation across service quality dimensions, highlighting the economic and managerial implications of misalignment. Chapter 5 presents the PRISM Framework in detail, describing its objective, methodological structure, analytical steps, computational logic, and limitations. Chapter 6 provides an illustrative application of the framework to a real service context (Rcalls), followed by Chapter 7, which discusses the results and their managerial implications. Finally, Chapter 8 summarizes the main conclusions and outlines directions for future research.

# 1. Understanding Services

## 1.1 Definition and characteristics of services

The concept of *service* has evolved significantly over time. Initially treated as a residual economic category defined by its contrast to tangible goods, it has gradually become a central perspective for understanding contemporary value creation. As service activities have expanded across industries, researchers have worked to clarify what constitutes a service, identify its defining characteristics, and explain how value is created and experienced.

This section reviews key conceptual contributions from Fitzsimmons, Lovelock and Wirtz, Grönroos, and Vargo and Lusch. Each brings their own focus, but taken together, they show the transition from traditional product-centric views toward a process-oriented and relational understanding of service value creation. This evolution sets the basis for analyzing service operations, the role of the customer in service delivery, and the inherent challenges of managing quality and risk in service environments.

### *1.1.1 Operational and non-ownership perspectives on service*

Early definitions of service focused on the operational aspects and the elements that differentiated them from manufacturing. From this perspective, James A. Fitzsimmons defines a service as *"a time-perishable, intangible experience performed for a customer acting in the role of co-producer"* (Fitzsimmons, 2011, p. 4). This definition is crucial because it frames service as **a process rather than a physical output**, explicitly recognizing the customer as an active participant in production.

From this view emerges the classical IHIP model, which outlines four features that characterize service systems and their managerial challenges (Fitzsimmons & Fitzsimmons, 2011, pp. 19–21):

- **Intangibility**: Services are performances or experiences rather than tangible objects. They cannot be seen, touched, or tested prior to purchase, which makes quality evaluation difficult and increases the importance of trust and reputation.
- **Heterogeneity**: Since services are intangible and the customer participates in the delivery process, each service experience may differ from customer to customer. Variability arises from human performance and situational factors, which means that employee and customer feedback are essential to maintain consistency.

- **Inseparability:** Production and consumption occur simultaneously. The customer must be present during service delivery, and quality must be managed "in real time", since there is no opportunity for inspection prior consumption.
- **Perishability**: A service cannot be stored for later use. As a result, any unused capacity (e.g., an empty seat on a flight) is lost forever, making capacity and demand management crucial in service operations.

Fitzsimmons and Fitzsimmons (2011) also highlight that, unlike goods, services do not involve transfer of ownership. Instead of purchasing an asset, service customers gain temporary access to benefits, experiences, or capabilities, that are enabled by human labor, technology, or physical resources (p. 21). To operationalize this idea, the notion of the **service package** is introduced, defined as *"a bundle of goods and services with information that is provided in some environment"* (Fitzsimmons & Fitzsimmons, 2011, p. 22). This package consists of five elements (supporting facilities, facilitating goods, information, and explicit and implicit services) that together shape the offering, showing that service value arises from the integration of multiple components during the customer experience (Fitzsimmons & Fitzsimmons, 2011, p. 22).

This operational understanding is complemented by the non-ownership perspective developed by Lovelock and Wirtz. While acknowledging that some traditional IHIP characteristics no longer apply in every context (for example, production and consumption can sometimes be separable and not all service performance are perishable), these authors argue that their **non-ownership nature** remains valid**.** They define services as *"economic activities performed by one party to another",* where in exchange for money, time and effort, customers expect value from access to labor, skills, facilities, networks, and systems without taking ownership of the physical elements involved (Lovelock & Wirtz, 2016, pp. 55–58).

By defining services as economic activities between two parties, the authors highlight the value exchange inherent in service transactions, and by emphasizing access rather than ownership, this perspective reinforces the view of services as performances aimed at delivering desired outcomes to customers, their possessions, or their assets. Value is thus derived from the effective deployment of provider resources within a service process, rather than from the exchange of tangible goods.

Together, the operational and non-ownership perspectives establish services as process-based, interactive systems whose performance is shaped by variability, customer participation, and real-time execution; conditions that make the identification and management of service-related risks particularly challenging.

### *1.1.2 The relational perspective*

Grönroos offers one of the most influential conceptualizations of service by explicitly linking operational processes with a relational and customer-oriented business logic. He argues that the concept of service carries two closely related but analytically distinct meanings: service as an activity or process, and service as a business and marketing logic.

From an **operational perspective**, Grönroos defines service as *"a process consisting of a series of more or less intangible activities that normally, but not necessarily always, take place in interactions between the customer and service employees and/or physical resources or goods and/or systems of the service provider, which are provided as solutions to customer problems"* (Grönroos, 2015, p. 60). This definition frames services as interactive problem-solving processes where value emerges through the co-performance of provider and customer, delivering solutions to the customer's needs.

In this view, the typical characteristics of services (intangibility, heterogeneity, inseparability, perishability) emerge naturally from customer participation. Because customers act as co-producers, they influence both the execution and the outcome of the service, making consistency difficult to achieve and increasing variability across service encounters. As a result, each service instance is potentially unique, and operational failures may manifest differently depending on the interaction context.

Beyond the operational level, Grönroos also conceptualizes service from a **strategic perspective**. In his service logic, service means *"the support for customers' individual processes in a way that facilitates their value creation, enabled by the use of knowledge and skills on resources" (Grönroos, 2015, p. 2).* Here, service is not viewed as an output delivered by the firm, but as an ongoing process of interaction through which value is co-created in use as the customer integrates the provider's resources with their own context, activities and goals.

This logic suggest that service offerings may include physical goods, information, or activities, but what truly makes it a "service" is its orientation toward facilitating the customer's life or business processes rather than merely transferring ownership of a product. Therefore, firms shift from being mere producers of outputs to facilitators of value creation for the customer, which in return enables the service provider to capture value from the relationship, with service as a mediator. Grönroos contrasts this **"outside-in" service logic**, focused on understanding customer processes and resources, with the traditional **"inside-out" product logic**, that prioritizes the firm's internal resources and processes, efficiency, and cost control (Grönroos, 2015, pp. 4-7). Under the service logic, the firm's primary task becomes managing customer relationships and supporting customer processes to enable value-in-use

This relational and customer-oriented perspective is particularly relevant for this thesis as it highlights how service quality and risk are inherently intertwined. Operational failures do not generate value loss solely through inefficiency, but through their impact on customers' value creation processes and perceptions. For this reason, Grönroos's framework constitutes a conceptual precursor to Service-Dominant Logic and provides a critical foundation for integrating operational risk analysis with customer-perceived service quality.

### *1.1.3 The Service-Dominant Logic*

Vargo and Lusch (2004) propose a paradigmatic shift from a Goods-Dominant Logic, focused on tangible outputs, production efficiency, and discrete transactions, to a Service-Dominant (S-D) Logic, which conceptualizes service as the **fundamental basis of economic exchange** and value creation (p. 8). To articulate this worldview, the authors introduce a set of Foundational Premises (FPs), later refined and consolidated into axioms.

In their foundational article, service is defined as *"the application of specialized competences (knowledge and skills) through deeds, processes, and performances for the benefit of another entity or the entity itself"* (Vargo & Lusch, 2004, p. 2). Accordingly, rather than representing a specific industry or an intangible output, service (singular) is seen as an activity or process derived from the application of operant resources (instead of operand resources), while goods and services (plural) are viewed merely as mechanisms for delivering service for and in conjunction with the consumer (FP3). Even when trading goods, what is really exchanged is service, as economic actors ultimately seek the benefits enabled by those goods (FP1) (Vargo & Lusch, 2004, p. 8).

Within this logic, **operant resources** (such as knowledge, skills, and organizational capabilities) are identified as the primary sources of value creation, competitive advantage, and economic growth (FP4). In contrast, monetary systems, organizations, technologies, and institutions tend to mask the underlying service-for-service nature of exchange (FP2) (Vargo & Lusch, 2004, pp. 8–9). From this perspective, all economies are essentially service economies, regardless of their apparent sectoral composition (FP5) (Vargo & Lusch, 2004, p. 10; 2006, p. 3).

A core principle of S-D Logic is that value is not embedded in outputs but emerges only through use, when beneficiaries integrate a firm's value proposition with their own resources, context, and goals—a concept referred to as **value-in-use** (Vargo & Lusch, 2004, pp. 6–11). This implies a customer-centric approach, in which firms collaborate with customers to address individual and dynamic needs. As a consequence, value is inherently idiosyncratic, experiential, contextual, and phenomenologically determined by the beneficiary (FP10) (Vargo & Lusch, 2008, p. 8; 2016, p. 4). Since value propositions are perceived and integrated differently by each actor, service outcomes cannot be fully controlled by the provider, as customers actively shape both the service process and its perceived results.

S-D Logic further emphasizes that value creation is always **co-created** through interactions among multiple actors, always including the beneficiary (FP6, Axiom 2) (Vargo & Lusch, 2016, p. 6). As a result, firms cannot deliver value directly but can only propose value through their offerings (FP7) (Vargo & Lusch, 2004, p. 11; 2016, p. 20), and all social and economic actors are considered resource integrators (FP9, Axiom 3). This shifts attention from dyadic provider–customer relationships to broader networks and, ultimately, to *service ecosystems* (Vargo & Lusch, 2008, p. 8; 2016, p. 4). Within these ecosystems, institutions—defined as shared rules, norms, meanings, and practices—and institutional arrangements coordinate value co-creation among the multiple actors (FP11, Axiom 5) (Vargo & Lusch, 2016, pp. 8–15).

Moreover, because service is defined in terms of customer-determined benefit and co-creation, it is inherently **beneficiary-oriented and relational** (FP8) (Vargo & Lusch, 2008, p. 8). Markets are therefore conceptualized as systems of ongoing reciprocal service provision, in which interactions before, during, and after the transaction play a critical role in value formation (Vargo & Lusch, 2006, p. 3).

While highly influential, Service-Dominant Logic has been criticized for its abstract and macro-level orientation, which may limit its direct applicability for operational analysis (Grönroos, 2015, p. 14). Nevertheless, its conceptual contribution is essential for understanding why service quality and risk must be analyzed from the customer's perspective.

### *1.1.4 Comparing perspectives and selecting a guiding definition*

Across the authors reviewed, several common topics emerge. All of them agree that services are fundamentally processes rather than objects and emphasize the active role of the customer in value creation. Despite their different analytical levels, these frameworks collectively shift attention from outputs and transactions toward interactions, access to resources, and experiential outcomes.

Fitzsimmons and Fitzsimmons provide an operational foundation that introduces the inherent characteristics of service encounters (IHIP model); Lovelock and Wirtz complement this view by emphasizing access and non-ownership; Grönroos frames service as facilitation of value creation in the customer’s processes, emphasizing interaction and co-production; and Vargo and Lusch extend this logic by positioning service as the basis of all exchange and value as phenomenologically determined, co-created in use, and embedded in service ecosystems.

Table 1.1 synthesizes these perspectives by comparing their definitions of service, core characteristics, underlying logics of value creation, and managerial implications. Together, they provide a coherent conceptual foundation for understanding why service systems are inherently exposed to variability, uncertainty, and risk, particularly due to their interactional and customer-dependent nature.

For the purposes of this thesis, a definition that combines operational tractability with a customer-centered and relational view of value is most suitable. A purely operational definition, such as that proposed by Fitzsimmons, may be useful for process analysis but remains limited in capturing how service outcomes are perceived and evaluated by customers. At the same time, the S-D Logic (Vargo & Lusch), although conceptually powerful, can be too abstract for direct applicability to managerial decision-making in specific service contexts.

As a result, this thesis adopts a *hybrid perspective,* grounded primarily in Grönroos's process-based and value-facilitation logic, and complemented by key principles from Service-Dominant Logic, particularly value co-creation and value-in-use, and beneficiary-determined value. Accordingly, service is defined as:

*“An interactive process through which the provider facilitates value creation for the beneficiary.”*

This definition is chosen because it explicitly locates **service-related risk within interactional processes**, where variability, human behavior, and contextual factors shape both operational outcomes and customer perceptions. Moreover, it establishes a clear conceptual link between service processes, failure occurrences, and customer-evaluated outcomes.

By framing service quality as an expression of how effectively a provider facilitates customer value creation, this perspective supports the treatment of service quality dimensions not as direct causal drivers of risk, but as **perceptual channels through which operational risks are manifested and interpreted by customers**. This conceptualization provides theoretical basis for the PRISM Framework developed in Chapter 5, in which service quality dimensions are leveraged as managerial prioritization lenses to support decision-making under conditions of limited resources and uncertainty.

**Table 1.1.** *Literature comparison – Definitions and characteristics of services*

| Author | Definition of Service | Core Characteristics | Underlying Logic | Managerial Implications |
|---|---|---|---|---|
| Fitzsimmons & Fitzsimmons (2011) | "A time-perishable, intangible experience performed for a customer acting in the role of co-producer." | • IHIP model<br>• Customer as co-producer<br>• Service package: supporting facility, facilitating goods, information, explicit & implicit services | Value created through delivery and customer participation in real-time experiences. | Focus on service design, prioritization of critical interactions, capacity management, demand matching, and frontline employee performance. |
| Lovelock & Wirtz (2016) | "Economic activities performed by one party to another... customers expect value from access to labor, skills, goods, facilities, networks, and systems, without taking ownership." | • Non-ownership logic<br>• Access-based value<br>• Services may be separable and non-perishable (modern critique of IHIP) | Value derived from access to provider competencies, not ownership. | Emphasis on service delivery design, managerial prioritization under uncertainty, access systems, customer convenience, and resource-based view of service. |
| Grönroos (2015) | Operational definition: "A process of intangible activities occurring in interactions that provide solutions to customer problems". Strategic definition: "Service is support for customers' processes that facilitates value creation". | • Interaction-based<br>• Co-production<br>• Tangible and intangible elements combined<br>• Focus on supporting customer processes | Value is co-created in use, and firms act as value facilitators, not producers. | Requires "outside-in" thinking, relationship management, customer-process understanding, and redesigning business logic toward value facilitation. |

| Author | Definition of Service | Core Characteristics | Underlying Logic | Managerial Implications |
|---|---|---|---|---|
| Vargo & Lusch (2004–2016) | "The application of specialized competences (knowledge and skills) for the benefit of another entity." | • Service-for-service exchange<br>• Goods as service distribution mechanisms<br>• Operant resources as key<br>• Value-in-use<br>• Networked resource integration | Value is always co-created by multiple actors, relational, contextual, and determined phenomenologically by the beneficiary; economies are inherently service systems. | Managers design value propositions, engage in ongoing relationships, focus on knowledge-based differentiation, and integrate into service ecosystems. |

***Note.*** Compiled by the author based on the literature review.

## 1.2 Service typologies and service systems

Classifying services is not just a taxonomic exercise; it helps anticipate where variability originates in the service delivery system and, consequently, where service-related risks are most likely to emerge.

Although services share several common features, the challenges managers face can differ depending on the nature of the service process, the degree of customer involvement, the level of customization, and the underlying technological or institutional structures. For this reason, researchers have developed multiple models to classify services along strategic and operational dimensions. By situating a specific service within these classifications, it becomes easier to identify inherent sources of variability and risk, clarify managerial constraints, and inform where limited resources should be allocated for improvement.

In this thesis, service typologies are used as an interpretative lens to (i) contextualize the sources of operational risk in services, and (ii) motivate the need for a structured, process-based decision-support framework that links operational failures to customer-perceived service quality dimensions.

To keep the discussion aligned with the objectives of this work, the following subsections focus on a limited set of classification frameworks that are directly relevant to risk identification and managerial prioritization: **operational typologies** capturing customer-induced variability and process structure (Chase; Schmenner), selected **strategic and relational dimensions** centered on the nature of the offer and customer relationships (Lovelock; Grönroos), and a final **systemic**

**perspective** highlighting access rights and ecosystem dynamics (Lovelock & Wirtz; Vargo & Lusch).

### *1.2.1 Operational Classifications*

A central operational feature of services is that customers often participate in production and consumption, introducing uncertainty into workflows. Chase and Tansik formalize this idea through the **Customer Contact Model**, defining customer contact as *"the proportion of time during which the customer is in direct contact with the service system relative to the total time required to create and deliver the service*" (Chase & Tansik, 1983, p. 4).

The model argues that the customer's physical presence during the service process constrains operational efficiency because customers bring heterogeneous needs, behaviors, and timing into the process. As a result, high-contact systems face greater variability and unpredictability, reducing the degree to which activities can be standardized. Conversely, low-contact operations are more protected from customer-induced disturbances and can achieve higher routinization, process control, and operational efficiency (Chase & Tansik, 1983, p. 4).

Based on these ideas, Chase (1983, 2010) proposes a contact-based classification distinguishing **pure services** (requiring the customer's physical presence for most of the service delivery process), **mixed services** (combining face-to-face customer contact with back-office activities), and **quasi-manufacturing services** (involving little or no direct customer contact and resembling manufacturing in their stable and controllable process environment). Chase's central proposition is that "the lower the degree of customer contact, the greater the service system's potential for operational efficiency" (Chase, 2010, p.2).

This framework gained relevance due to its managerial implications for designing and running service systems (Chase & Tansik, 1983, pp. 7–10). In general, high-contact areas must be organized for flexibility and adaptability to customer needs, aiming at prioritizing effectiveness (customer satisfaction and responsiveness) and relying more on judgment-based decisions, while low-contact areas can be optimized for efficiency (cost control and productivity) through programmed decisions guided by standardized rules. From a risk perspective, this model clarifies that failures in high-contact services are often not only technical, but also interaction-driven, making real-time coordination and frontline execution critical. At the same time, *decoupling* front-office (high-contact) and back-office (low-contact) activities can protect technical operations from demand fluctuations and behavioral variability, while concentrating customer-perceived consequences at the service interface points.

While Chase's model was groundbreaking in linking customer contact to efficiency, it was criticized for not fully distinguishing between services that require the customer's physical presence and those characterized by high degree of interaction and customization. Schmenner (1986) argues that "*contact time simply does not capture completely what is challenging about service managemen*t" (p.24). He therefore introduces the **Service Process Matrix** (Figure 1.1), which classifies services along two dimensions (Schmenner,1986, pp.21-22):

(i) *Degree of labor intensity,* defined as the proportion of human labor relative to capital or technology required (labor cost/capital cost).
(ii) *Degree of interaction and customization*, describing the extent to which customers can influence both the process and the service outcome.

By combining these dimensions, services can be positioned into four categories— **service factory** (standardized, capital-intensive), **service shop** (customized, capital-intensive), **mass service** (standardized, labor-intensive), and **professional service** (customized, labor-intensive) —each associated with different strategic approach, operational constraints and risk profiles (Schmenner, 1986, pp. 21–24). Fitzsimmons (2011, p.25) later adopts and extends this framework to show how management challenges are common across service industries.

In general, service shops and professional services emphasizes customization, expertise, and interpersonal interaction, with a clear focus on value co-creation with customers and reflecting stronger exposure to risks driven by human variability and coordination. On the other hand, service factories and mass services prioritize efficiency, standardization, and cost management, often relying on automation and economies of scale. For the purposes of this thesis, the Service Process Matrix is particularly useful because it anticipates whether failures are more likely to arise from **human variability and coordination** (high labor intensity and/or high customization), or from system **reliability and capacity constraints** (more standardized and/or capital-intensive settings). This typological framing supports the rationale for adopting structured, process-based risk identification and prioritization tools.

| Degree of Labor Intensity | Degree of Interaction and Customization: Low | Degree of Interaction and Customization: High |
|---|---|---|
| Low | *Service factory:*<br>• Airlines<br>• Trucking<br>• Hotels Resorts and recreation | *Service shop:*<br>• Hospitals<br>• Auto repair<br>• Other repair services |
| High | *Mass service:*<br>• Retailing<br>• Wholesaling<br>• Schools<br>• Retail aspects of commercial banking | *Professional service:*<br>• Physicians<br>• Lawyers<br>• Accountants<br>• Architects |

**Figure 1.1.** *The Service Process Matrix.* Adapted from Schmenner (1986).

### *1.2.2 Strategic and Relational Classifications*

Beyond the operational structure, strategic and relational classifications of service systems help explain how customer expectations are formed, how value is perceived over time, and how failures are tolerated or amplified.

Christopher Lovelock (1983) proposes a set of strategic dimensions that cut across service industries and help managers understand the structural variety of service systems. Fitzsimmons (2011) later builds on these ideas, showing how each dimension affects service design and managerial decisions.

Lovelock's first-dimension concerns who or what is the **direct recipient** of the service, and the **nature of the service act** itself. Services may "process" people, physical possessions, or information, and these actions can be either tangible or intangible (Wirtz & Lovelock, 2016, p. 61). Combining these elements leads to four main categories (Figure 1.2): *people-processing* (tangible actions directed at the people's body), *possession-processing* (tangible actions performed on the customer's assets), *mental stimulus processing* (intangible actions directed at the customer's mind), and *information processing* (intangible actions performed on the customer's intangible assets) (Wirtz & Lovelock, 2016, pp. 62-65).

Although many services involve elements from more than one category, their core service act usually fits predominantly into a single classification. For example, education and entertainment may require physical attendance, but the essential service is an intangible mental-stimulus process (Lovelock, 1983, p. 12). This scheme is important because it shows how different types of services may require different resources, technologies, and customer participation mechanisms. For example, when customers must be physically present, their quality perceptions depend not only on the technical outcome but also on interactions with employees, the physical environment, and other customers. By contrast, services centered on information or possessions tend to shift risk toward data accuracy, system reliability, and process consistency (Fitzsimmons, 2011, p. 27 & Lovelock, 1983, p.5).

***Direct Recipient of the Service***

| ***Nature of the Service Act*** | People | Possessions |
|---|---|---|
| Tangible | *People processing:*<br>• Hairstylist<br>• Healthcare<br>• Passenger transportation | *Possession processing:*<br>• Freight transportation<br>• Laundry and Dry Cleaning<br>• Repair and Maintenance |
| Intangible | *Mental stimulus processing:*<br>• Education<br>• Advertising/PR<br>• Psychotherapy | *Information processing:*<br>• Accounting<br>• Banking<br>• Legal Services |

**Figure 1.2.** *Nature of the Service Act.* Adapted from lovelock (1983).

A second strategic dimension (Figure 1.3) contrasts the **nature of service delivery** (continuous delivery vs. discrete transactions) with the type of **relationship between the firm and its customers** (membership relationships vs. no formal relationship). Since the original formulation of this framework, many industries (e.g., airlines and hotels) have shifted from isolated transactions toward relationship-based models through subscriptions, loyalty programs, and long-term contracts (Fitzsimmons, 2011, p. 27), illustrating the growing strategic importance of customer retention to reinforce trust and repeat business.

***Type of Relationship between Service Firm and Its customers***

| ***Nature of the Service Delivery*** | "Membership" relationship | No formal relationship |
|---|---|---|
| Continuous delivery | • Insurance<br>• Telephone subscription<br>• Electric utility<br>• Banking | • Radio station<br>• Police protection<br>• Lighthouse<br>• Public highway |
| Discrete transaction | • Long-distance phone calls<br>• Theater series tickets<br>• Transit pass<br>• Wholesale buying club<br>• Airline frequent flyer | • Toll highway<br>• Car rental<br>• Movie theater<br>• Public transportation<br>• Restaurant |

**Figure 1.3.** *Relationships with Customers*. Adapted from Lovelock (1983).

From a quality and risk perspective, ongoing relationships can buffer the impact of individual service failures by allowing recovery over time, while also increasing customer expectations and switching costs. Membership-based models can also provide firms with better customer information, supporting better segmentation and targeted marketing, and enable flexible pricing schemes (ranging from flat subscriptions to usage-based fees or hybrid structures) that help balance profitability, perceived fairness, and customer convenience. However, firms must design these systems carefully to avoid deter valuable occasional users, especially in sectors where both membership-based and casual users coexist *(Lovelock, 1983, p.14).*

Other Lovelock dimensions (such as **customization and judgment**, **demand relative to capacity**, and **method of service delivery**) are reported in detail in Appendix A. These classifications are conceptually important because they explain structural sources of variability in service systems. However, they are not discussed extensively here, as their role in this thesis is primarily contextual: they help frame where variability and risk originate, rather than serving as direct inputs for the process-level risk prioritization developed in the proposed decision-support framework.

Complementing Lovelock's strategic dimensions, Grönroos (2015) propose a classification based on the dominant resource used or interaction mode, and the temporal structure of the service relationship, offering a more process-oriented perspective on risk.

The first distinction differentiates **high-touch** and **high-tech services.** High-touch services are predominantly dependent on people and expertise, making the service process fluid and highly interactive and variability largely behavioral and relational. In contrast, high-tech services are mostly based on the use of automated systems, information technology and other types of physical resources, where the service process is programmed and deterministic and risk is more closely associated with technical reliability and system failures.

The second distinction contrasts **continuously rendered services** with **discrete transactions.** Continuous services involve a continuous flow of interactions between the customer and the service, allowing relationships to develop over time and enabling service recovery and trust-building following isolated failures. Discrete services, by contrast, involve distinct, separate episodes of services, concentrating risk within individual encounters, where each interaction represents a critical "moment of truth" with limited opportunities for recovery.

Taken together, these strategic and relational classifications highlight how the nature of the service act, the structure of customer relationships, the dominant interaction mode and temporal structure influence both customer expectations and the tolerance for failure. They therefore provide a conceptual bridge between service design choices and the need for managerial frameworks capable of prioritizing service-related risks based on their potential impact on perceived service quality.

### *1.2.3 Systemic Classifications*

Modern service management looks beyond a simple dyadic provider-customer interaction to view services as systems of access and resource integration. From this perspective, service performance and risk are not determined solely by the execution of individual processes, but also by the broader structural conditions under which access, use, and coordination take place.

Christopher Lovelock and Evert Gummesson argue that services can be understood as a form of rental through which customers obtain access to benefits (Lovelock & Gummesson, 2024, pp. 20–41). As previously discussed, purchasing a service does not imply a transfer of ownership; instead, customers gain temporary rights to use labor, expertise, physical goods, facilities, or systems.

Based on this non-ownership logic, Lovelock and Wirtz classify services into five categories depending on the nature of the rented benefit (Wirtz & Lovelock, 2016, p. 56): **labor, skills, and expertise rentals** (where customers hire people to perform work that they cannot, or prefer not to, do themselves); **rented-goods services** (customers obtain the temporary and exclusive right to use a physical object without owning it); **defined space and facility rentals** (customers rent access to a certain portion of a larger facility); **access to shared facilities** (customers pay for the right to share the use of a facility with others, without exclusive control); **access and use of networks and systems** (customers rent the right to participate in a defined network or system under specified conditions of access and use).

This classification underscores that service value lies less in possessing assets and more in having **reliable and timely access** to resources, capabilities, or environments that help customers achieve their goals. From a risk perspective, this implies that failures related to availability, access conditions, usage rights, congestion, or system operability are important and may affect multiple customers simultaneously, particularly in shared or network-based services. Consequently, service-related risks in these contexts tend to be systemic rather than isolated, increasing the managerial relevance of prioritization mechanisms.

A broader systemic view is offered by Service-Dominant Logic, which reframes the distinction between goods and services within a value-creation ecosystem. As discussed earlier, Vargo and Lusch (2004, 2006, 2008, 2016) treat all market offerings as mechanisms for service provision, with service representing the fundamental basis of exchange and goods acting as vehicles that enable service during use.

Within this perspective, offerings can be distinguished according to whether service is provided **directly**, through the application of operant resources in interaction with the beneficiary to co-create value, or **indirectly**, via goods that embed competences and function as service distribution mechanisms enabling value-in-use. In practice, most offerings combine both modalities.

Beyond this distinction, Service-Dominant Logic emphasizes an actor-to-actor (A2A) configuration, assuming that all economic and social actors are simultaneously service providers and beneficiaries. Since value creation occurs through interactions in service ecosystems— defined as "*self-adjusting systems of resource-integrating actors connected by shared institutional arrangements*" (Vargo & Lusch, 2016, pp. 10-11) —services can also be classified according to the level at which interactions occur: **micro** (individual service encounters), **meso** (organizations and networks), and **macro** (industry-wide or societal ecosystems).

As a result, service-related risks may emerge not only within individual service processes, but also from coordination failures, interdependencies, or institutional misalignments across actors and systems. While such systemic risks are not explicitly modeled in the proposed framework, they form part of the contextual conditions that influence the severity, visibility, and propagation of service failures, reinforcing the need for prioritization mechanisms grounded in customer-perceived impact.

### *1.2.4 Synthesis and implications for Quality and Risk in Service Management*

Although the typologies discussed in this section focus on different structural aspects of services, taken together they help clarify how, why, and where service-related risks emerge, as well as why their perceptual relevance may vary across service contexts. To support this comparison, Table 1.2 summarizes how each framework conceptualizes service systems, identifies key sources of variability, and outlines their main implications for risk analysis and quality-related decision-making.

Across these typologies, a common pattern emerges. Service-related risks are closely linked to structural sources of variability, whose nature and intensity depend on the specific service configuration. In particular, variability tends to originate from customer participation, degree of customization, demand fluctuations, reliance on technology, and institutional or network complexity. These factors influence not only the likelihood of operational failures, but also **how such failures are perceived and evaluated by customers**.

From a managerial decision-support perspective, this has an important implication. Because service systems differ systematically in how and where variability is generated, service failures cannot be evaluated or prioritized solely based on technical criteria such as severity or frequency. Their relevance also depends on the service quality dimensions through which disruptions are perceived by customers in a given context. This highlights the need for prioritization mechanisms that explicitly connect operational risk sources with customer-perceived outcomes.

The comparison further shows that no single approach fits all service contexts. High-contact and professional services rely heavily on interpersonal interactions and expectation management, while mass services and service factories depend more on standardization, process control, and technological reliability. Networked and ecosystem-based services, in turn, introduce additional challenges related to coordination, interoperability, and institutional alignment.

Taken together, these insights do not prescribe how services should be designed or managed. Instead, they motivate the need for an integrated methodological framework capable of translating heterogeneous sources of service variability into actionable managerial priorities. This provides the conceptual foundation for the PRISM Framework developed in Chapter 5, which explicitly links service processes, failure modes, and customer-perceived service quality dimensions to support risk prioritization.

**Table 1.2** Literature comparison – *Service typologies*

| Framework | Classification Logic | Risk considerations | Managerial and quality implications |
|---|---|---|---|
| Chase (1981, 1983) – Customer Contact Model | Degree of customer contact (high ↔ low) | Risk exposure increases with customer contact due to the real time interactions with unpredictable customer behavior, different needs and fluctuating demand. | High-contact systems require flexibility, real-time problem solving, and empowered employees. Low-contact systems enable standardization, preventive quality controls and efficiency. Decoupling front- and back-office activities helps manage variability. |

| Framework | Classification Logic | Risk considerations | Managerial and quality implications |
| --- | --- | --- | --- |
| Schmenner (1986) – Service Process Matrix | Labor intensity × customization | High labor intensity increases human-error risks, while high customization heightens the risk of misaligned expectations. Standardized, high-volume systems face risks from system breakdowns and capacity overload. | Professional/Service Shop: require managing expertise, expectations, and interaction quality. Mass/Factory: need strong process control, reliable technology, and robust capacity planning to emphasize consistency and productivity. |
| Lovelock (1983); Lovelock & Wirtz (2016) – Strategic Dimensions | Nature of service act; relationship type; customization; demand-capacity; delivery modes | Different service acts introduce distinct risks: co-presence risks in people-processing, asset damage in possession-processing, cognitive/security risks in information-processing. Seasonal or variable demand and multi-site or digital delivery add risks of inconsistency and congestion. | Quality must match the service's structural configuration: managing physical and interpersonal aspects, securing information flows, and ensuring consistency across sites and channels. Capacity management and standardization become key levers. |
| Grönroos (2015) – Process Logic | High-touch vs. high-tech; continuous vs. discrete relationships | High-touch services present interactional and relational risks; high-tech services face reliability and technology-failure risks. Continuous services risk long-term trust erosion; discrete services risk transactional failures. | High-touch services require relational management; high-tech services require reliability engineering. Continuous services need consistent experiences; discrete services require precise execution. |
| Lovelock & Wirtz (2016) – Non-ownership Typology | Nature of rented benefit (labor, goods, space, facilities, networks) | Risks arise from access failures, downtime, congestion, and uneven availability. Network-based services add cybersecurity and dependency risks. | Quality management focuses on availability, uptime, fair access, and resource operability. Preventive maintenance, access protocols, and capacity control are essential, especially in shared or networked services. |
| Vargo & Lusch (2004–2016) – S-D Logic / Service Ecosystems | Direct vs. indirect service provision; A2A networks; multi-level ecosystems | Variability stems from multi-actor coordination, resource-integration failures, and misaligned institutional arrangements. Failures can propagate through the ecosystem. | Quality must address not only internal processes but ecosystem coordination. This requires robust interfaces, partner alignment, interoperability, and institutional support to prevent systemic breakdowns. |

***Note.*** Compiled by the author based on the literature review.

# 2. Defining Service Quality

## 2.1 The challenge of evaluating service quality

Evaluating quality in service contexts is inherently more complex than assessing the quality of manufactured goods. As Parasuraman, Zeithaml, and Berry explain, "unlike goods quality, which can be measured objectively by such indicators as durability and number of defects, service quality is an abstract and elusive construct" due to core service characteristics: intangibility, heterogeneity, perishability, and inseparability of production and consumption (1985, p. 42; 1988, p. 13).

At the core of these challenges lies **intangibility**. Because services are performances rather than objects, it is difficult to define precise specifications or uniform standards beforehand. Most services "cannot be counted, measured, inventoried, tested, and verified in advance of sale to assure quality" (Parasuraman et al., 1985, p. 13). Additionally, this lack of physical evidence makes it difficult for customers to visualize the experience before purchasing it and to evaluate the quality of the service performance itself (Zeithaml, 1981; Lovelock & Wirtz, 2016, p. 73). As a result, customers often rely on indirect cues and subjective impressions to form expectations and evaluate outcomes, making service quality inherently perception-based and context-dependent, rather than purely technical.

A second challenge stems from **inseparability**. Since services are produced and consumed simultaneously, there is little room for traditional quality-control interventions before the offering reaches the customer (Fitzsimmons, 2011, p. 19). As Grönroos (2015) notes, when there is no "pre-produced" output to inspect, "quality control must take place at the time and place of simultaneous service production and consumption", otherwise the areas of the service process where customers are actively involved may remain unmanaged, potentially generating negative experiences (Grönroos, 2015, p. 50). In other words, inseparability implies that failures often emerge in real time and directly affect the customer experience, leaving limited room for ex post correction.

These difficulties are further intensified by **heterogeneity**. Services performance tends to vary "from producer to producer, from customer to customer, … and from day to day" (Booms & Bitner, 1981; Parasuraman et al., 1985, p. 13). Customers expect fairness and consistency, but human interaction and contextual factors makes it difficult for organizations to guarantee uniform quality, and for customers to develop stable expectations. Training and standardization become essential to reduce dispersion but monitoring every interaction is unrealistic, so customers ultimately play an active role in evaluating and signaling quality through their perceptions and feedback (Fitzsimmons, 2011, p. 21).

A final characteristic that affects service quality evaluation is **perishability.** Because services cannot be stored, repeated, or reworked, a poorly executed encounter cannot simply be replaced or corrected afterwards. As Lovelock and Wirtz (2016) point out, services are "temporary and perishable", meaning that unused or mismanaged capacity is permanently lost (p.72). Consequently, customers assess quality based on a single, non-repeatable experience, which increases the impact of each interaction and amplifies the consequences of service failures.

Taken together, these characteristics help explain why evaluating service quality is inherently difficult. While product quality can be verified through technical specifications, objective standards, or post-production inspection, service quality depends on intangible, interactive, and highly contextual processes that are experienced subjectively by each customer, who also plays an active role in it. As Grönroos (2015) emphasizes, service providers must understand how service is perceived and evaluated by the users in order to identify ways of managing these evaluations and influencing them in a desired direction (p. 94). For this reason, studying the customer's perspective becomes essential, not only for improving service design but also for interpreting the relevance and impact of operational failures.

## 2.2 What defines a good vs. poor service

When discussing quality in service contexts, what ultimately matters is the customer's perception. Grönroos (2015) explicitly states that "quality is what customers perceive" (p. 137) and warns that if quality is defined differently from how customers define it, organizations may invest resources in improvements that do not translate into better perceived performance (Grönroos, 2015, p. 95).

A broad consensus in the literature explains perceived service quality through the **expectancy–disconfirmation paradigm**. Originally introduced in studies of consumer satisfaction (Oliver, 1980), this framework suggest that customers evaluate a service by comparing their prior expectations with their actual experience. When perceived performance meets expectations, confirmation occurs and customers tend to be satisfied; when it exceeds expectations, positive disconfirmation may result in delight; and when it falls short, negative disconfirmation leads to dissatisfaction (Oliver, 1997; Parasuraman et al., 1993). This theory explain that satisfied or delighted customers are more likely to repurchase, remain loyal, and recommend the service to others.

Although **customer satisfaction** and **service quality** are related concepts and often used interchangeably, they have different meanings. Satisfaction is typically described as a transaction-specific and emotional response to a single service encounter, whereas perceived service quality represents a more stable set of beliefs and attitudes about a provider's overall excellence over time (Parasuraman et al., 1988, p. 16; Wirtz & Lovelock, 2016, p. 136). Oliver's early research further suggests that satisfaction mediates the relationship between prior expectations and revised perceptions of service quality: each service encounter updates the customer's overall attitude toward the firm, shaping an evolving perception of service quality (Cronin & Taylor, 1992, p. 57).

In other words, repeated incidents of satisfaction or dissatisfaction gradually contribute to customers' overall perceptions of service quality (Parasuraman et al., 1988, p. 16). Lovelock and Wirtz emphasize that it is this broader perception of service quality that most strongly influences future behavior, such as loyalty, repurchase intentions, and word-of-mouth. As a result, even if a single encounter is disappointing, customers may still return if their overall belief about the provider remains positive; only a series of negative experiences is likely to erode that belief (Wirtz & Lovelock, 2016, p. 136).

Because "the perceptions of a firm's overall service quality will change over time in the same direction as transaction-specific satisfaction ratings" (Wirtz & Lovelock, 2016, p. 136), **perceived service quality** is generally treated as the outcome of an evaluation process in which customers compare what they expected with what they actually experienced (Grönroos, 1984, p. 37). Expectations are shaped by factors such as word of mouth, past experiences, marketing communications, company image, and individual needs and values. Customers then assess service quality by contrasting these expectations with their perceptions of actual performance (Grönroos, 2015, p. 99). When expectations are exceeded, quality is perceived as exceptional; when expectations are confirmed, quality is satisfactory; and when expectations are not met, service quality is perceived as unacceptable (Fitzsimmons & Fitzsimmons, 2011, p. 116).

A key insight emphasized by Grönroos (2015) is that "service quality cannot be separated from the service production process" (p. 138). Because services are produced and consumed through interactions, perceived quality depends not only on *what* the customer receives (the outcome), but also on *how* the service is delivered (the process). Even a technically correct outcome may result in poor perceived quality if the delivery process is unsatisfactory. Moreover, a firm's image acts as a filter through which customers interpret service experiences, influencing both expectations and perceptions (Grönroos, 2015, pp. 95–99).

Once service quality is framed as a perception-driven evaluation, the next step is to clarify what customers actually consider when judging a service as good or poor. Early work by Parasuraman, Zeithaml, and Berry (1985) identified ten determinants of perceived service quality:

- **Reliability** (performing the service dependably and accurately)
- **Responsiveness** (willingness/readiness to help and provide prompt service)
- **Competence** (skills and knowledge required to perform the service)
- **Access** (approachability and ease of contact)
- **Courtesy** (politeness, respect, consideration and friendliness of personnel)
- **Communication** (keeping customers informed and listening to them)
- **Credibility** (trustworthiness and honesty; having customers' best interests at heart)
- **Security** (freedom from danger, risk, or doubt; including confidentiality, and physical/financial security)
- **Understanding/Knowing the customer** (effort to understand needs and provide individualized attention)
- **Tangibles** (physical evidence such as facilities, personnel appearance, tools, and other visible cues)

These determinants reflect a combination of outcome-related and process-related cues and differ in how easily customers can evaluate them. Attributes with **search properties** (assessable before purchase) are the easiest to evaluate; **experience properties** (assessable only during or after consumption) are more difficult; and **credence properties** (which may remain unverifiable even after consumption) are the most difficult. In services, search properties are limited, and most quality attributes are experience or credence based. As a result, customers rely heavily on process-related signals, such as responsiveness, courtesy, and reliability, when forming quality judgments (Parasuraman et al., 1985, p. 48).

In subsequent research, Parasuraman, Zeithaml, and Berry (1988) found a high degree of correlation among these determinants and consolidated them into broader dimensions (tangibles, reliability, responsiveness, assurance, and empathy), which are widely used in service quality research (Grönroos, 2015, p. 103; Fitzsimmons & Fitzsimmons, 2011, p. 116; Wirtz & Lovelock, 2016, p. 137).

However, the key insight for this thesis is that **customers evaluate service quality** by comparing expectations and experiences **across multiple dimensions that translate operational performance into perceptual judgments**. In this sense, excellent service quality can be defined as a "high standard of performance that consistently meets or exceeds customer expectations" (Lovelock & Wirtz, 2016, p. 135) across both outcome and process dimensions. Building on this logic, Grönroos (2015, p. 107) proposes **seven criteria of good perceived service quality**: professionalism and skills; attitudes and behavior; accessibility and flexibility; reliability and trustworthiness; service recovery; service scape; and reputation and credibility.

Most of these criteria are strongly process-oriented, reinforcing the idea that perceived quality is heavily influenced by how services are delivered and how problems are handled when failures occur. Managing service quality, therefore, is not only about preventing failures, but also about understanding which aspects of service performance matter most to customers when they evaluate and interpret those failures.

Ultimately, service quality is subjective, contextual, and dynamic. Because services are processes and inherently relational, customers' expectations and quality perceptions evolve over time as relationships develop. **Relationship quality** captures this cumulative process, in which repeated interactions shape trust, tolerance, and expectations. Managing service quality over time therefore requires avoiding unrealistic promises, recognizing that customers may value different quality aspects at different stages of the relationship, and understanding the mechanisms that drive expectation dynamics (Grönroos, 2015, p. 116).

## 2.3 Service quality measurement models

Building on the conceptual understanding of service quality and its determinants, this section examines how service quality can be measured and operationalized in practice. Over time, researchers have proposed a variety of models aimed at explaining how customers form quality judgments and how organizations can capture these judgments in a systematic and structured way.

These models reflect different theoretical perspectives and methodological choices, especially regarding the role assigned to expectations, perceptions, and service experiences. While they differ in scope and level of abstraction, together they provide complementary insights into how service quality can be defined, measured, and interpreted across diverse service settings. Rather than offering an exhaustive review of all available approaches, this section focuses on a selected set of influential models that progressively build the conceptual foundations for using service quality dimensions as analytical lenses in managerial decision-making.

The discussion begins with Grönroos's model of Total Perceived Service Quality, which establishes the distinction between outcome, process, and image-related components of quality. It then moves to the GAP model of service quality and the related expectation–perception frameworks developed by Parasuraman, Zeithaml, and Berry, which formalize the mechanisms through which service shortfalls translate into perceived quality gaps. This progression ends in the SERVQUAL scale, which operationalizes perceived service quality through a set of standardized dimensions widely used in both academic research and managerial applications. Finally, key critiques and alternative approaches, such as SERVPERF and E-S-QUAL, are briefly discussed to highlight the limitations of traditional expectation-based models and the extensions proposed for performance-only and digital service contexts.

### *2.3.1 The Grönroos Model of Total Perceived Service Quality*

The model of Total Perceived Service Quality (Figure 2.1) was first developed by Grönroos in 1984 and later refined in subsequent work (Grönroos, 2015, pp. 95–100). It conceptualizes service quality as a holistic perception formed during service encounters, which cannot be reduced to service outcomes alone. In Grönroos's view, customers evaluate quality not only based on *what* they receive, but also on *how* is delivered, especially in contexts where production and consumption occur simultaneously.

According to this model, perceived service quality is shaped by two main dimensions:

a) **Technical quality** refers to what the customer actually receives as the outcome of the service process, such as a completed bank transfer, a repaired device, or a delivered meal. Because it represents the concrete solution to the customer's problem, this aspect can often be assessed in relatively objective terms.

b) **Functional quality** captures how customers experience the service delivery process itself, including aspects such as employee behavior, communication style, responsiveness, and the way interactions are handled during the service encounter. This dimension is inherently subjective, as it depends on customers' perceptions of how they have been treated.

Managerially, this implies that technically correct outcomes can still lead to poor perceived quality if the delivery process is unsatisfactory. Conversely, strong functional quality can partially compensate for minor technical shortcomings, particularly in people-intensive services.

Grönroos also introduces **corporate image** as a key moderating factor. Image acts as a filter through which customers interpret both technical and functional quality. When a firm has a favorable image, customers are more inclined to forgive minor service failures; when the image is negative, even small issues can be perceived as serious. Over time, repeated failures can erode corporate image, while consistently positive experiences reinforce it (Grönroos, 2015, p. 96). This highlights the strategic role of long-term reputation management, as image shapes both current quality perceptions and expectations for future service encounters.

Central to the model is the **disconfirmation process**, according to which total perceived service quality results from comparing expected quality with experienced quality (Grönroos, 2015, pp. 98–99). Good perceived quality is achieved when experienced quality meets or exceeds customer expectations. Expected quality, in turn, is influenced by multiple factors, including marketing communication, word-of-mouth and social media, price, customer needs and values, previous experiences, and corporate image. As a consequence, improvements in service performance can be undermined by marketing campaigns that overpromise and raise expectations beyond what the organization can realistically deliver. Even when objective performance improves, such misalignment can damage perceived quality and corporate image. For this reason, Grönroos (2015) argues that "external marketing has to be integrated with quality management" (pp. 138–139).

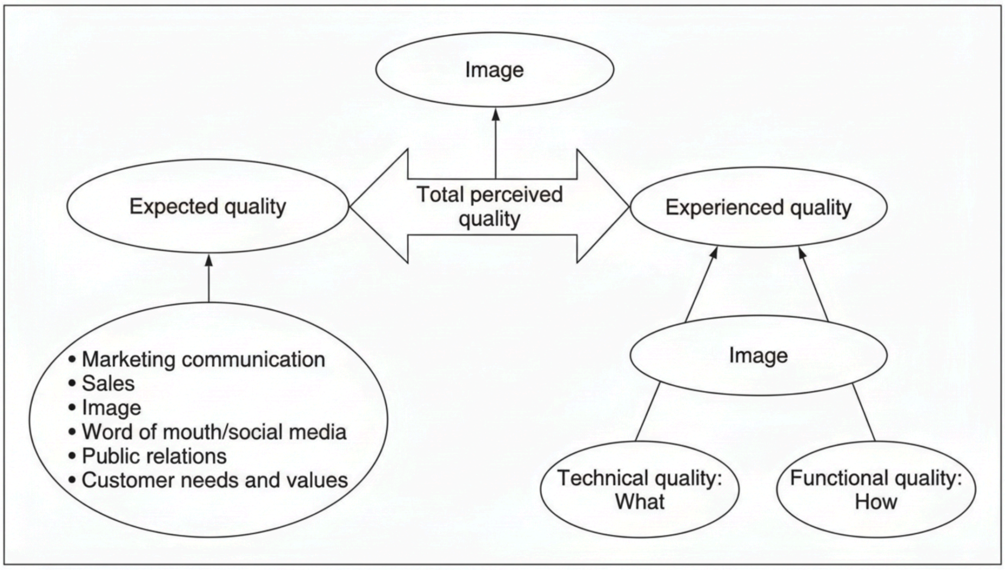



**Figure 2.1.** *Total Perceived Quality.* Adapted from Grönroos (2015, p. 96)

A key operational implication of the model is captured by the concept of "**moments of truth**", defined as the "time and place where customers interact with the service provider and quality is demonstrated" (Grönroos, 2015, p. 100). Customers experience a sequence of such moments throughout their relationship with a service organization, and quality judgments are formed locally in these encounters. This means that service processes must be designed and managed with strong attention to frontline interactions, rather than relying only on centralized quality plans.

From an organizational perspective, Grönroos emphasizes that perceived service quality is created by the entire organization, not by a single department (Grönroos, 2015, pp. 138–139). While frontline employees play a visible role, their performance depends on support from back-office functions, systems, and structures. Failures anywhere in the process can affect customer perceptions, implying that "quality has to be monitored throughout the organization by the whole organization" (Grönroos, 2015, p. 139).

Finally, customers themselves are seen as **co-producers of service quality**. Their participation can influence both the service process and its outcome, affecting not only their own perceptions but also those of other customers. Firms therefore need to manage customer participation actively, by providing clear information, guiding or instructions, so that customers can contribute positively to the service experience.

### *2.3.2 The GAP Model of Service Quality*

The GAP Model was proposed by Parasuraman, Zeithaml, and Berry (1985) with the aim of identifying the sources of service quality problems and helping managers improve service performance. It explains perceived service quality through the identification of five potential gaps that may prevent organizations from delivering services that customers perceive as high quality. Rather than focusing exclusively on outcomes, the model emphasizes that service quality failures often originate upstream, within managerial interpretations, organizational processes, and internal coordination and communications mechanisms.

**Gap 1: Consumer expectation – management perception**

This gap represents the discrepancy between customers' actual service quality expectations and management's perception of those expectations. Parasuraman et al. (1985) note that executives may not always fully understand what customers expect, which service attributes signal high quality, and what performance levels are necessary to meet those expectations (p. 4). As a result, quality problems can arise even before service design begins simply because expectations are misread. For example, managers of repair service firms may assume that customers associate quality with large, well-established providers, while customers may instead value personalized attention and flexibility offered by smaller firms.

**Gap 2: Management Perception – Service Quality Specification Gap**

Gap 2 appears when managers understand customer expectations in principle but fail to translate that understanding into clear, realistic, and actionable service standards. Resource constraints, market conditions, organizational priorities, or limited managerial commitment may prevent firms from setting appropriate specifications (Parasuraman et al. p. 5). In practice, this means employees lack clear guidelines to consistently deliver the expected level of service.

**Gap 3: Service Quality Specification – Service Delivery Gap**

Gap 3 captures the difference between defined service quality standards and real service delivery, which is especially relevant in services due to their reliance on human performance. Employees strongly influences customers' perceptions, but their behavior cannot be fully standardized or controlled, making it difficult to ensure consistent compliance with predefined specifications (Parasuraman et al., 1985, p. 5). The effect can be negative when standards are not met, but the gap can also be positive when employees exceed formal requirements through extra effort, flexibility or initiative. Managerially, this reinforces the importance of training, motivation, and support systems in shaping service quality outcomes.

**Gap 4: Service Delivery – External Communications Gap**

Gap 4 arises when external marketing communications (advertising, promotions, sales messages, etc.) are inconsistent with the actual service delivered. Because marketing communication strongly influences customer expectations, overpromising can raise expectations beyond what the organization can realistically deliver, and ultimately lower perceived service quality when those promises are not fulfilled (Parasuraman et al., 1985, p. 6). Accurate communication can improve expectations, but also perceptions of the delivered service as customers who are aware of the efforts undertaken to serve them well are more likely to perceive the delivered service in a favorable way.

**Gap 5: Expected Service – Perceived Service Gap**

The fifth gap represents the difference between customers' expected service and their perceived service, reflecting the customer's overall judgment of service quality. Perceived quality is high when actual performance meets or exceeds expectations and low when it falls short. As Parasuraman et al. (1985) summarize, "the key to delivering high service quality is meeting or exceeding customer expectations" (p. 6). Importantly, Gap 5 is a cumulative outcome of the previous gaps and can be expressed as:

$$\text{Gap}_5 = f\,(\text{Gap}_1, \text{Gap}_2, \text{Gap}_3, \text{Gap}_4) \quad (1)$$

This formulation emphasizes that perceived service quality is directly influenced by a chain of managerial and operational decisions that generate inconsistencies in service design, service delivery, and communication processes, rather than by isolated service encounters alone.

Figure 2.2 also males a clear distinction between **customer-related phenomena** (upper part of the model) and **service provider-related aspects** (lower part). Expected service is a function of the customers' personal needs, past experiences, and word-of-mouth communication, while perceived service is the result of a series of internal managerial decisions and activities. Management perceptions of customer expectations guide the formulation of service quality specifications, which are then implemented during delivery. Customers evaluate this delivery both functional and technical terms, and external communications influence not only what they expect but also how they interpret what they receive, reinforcing the link between marketing and operation (Grönroos, 2015, p. 130).

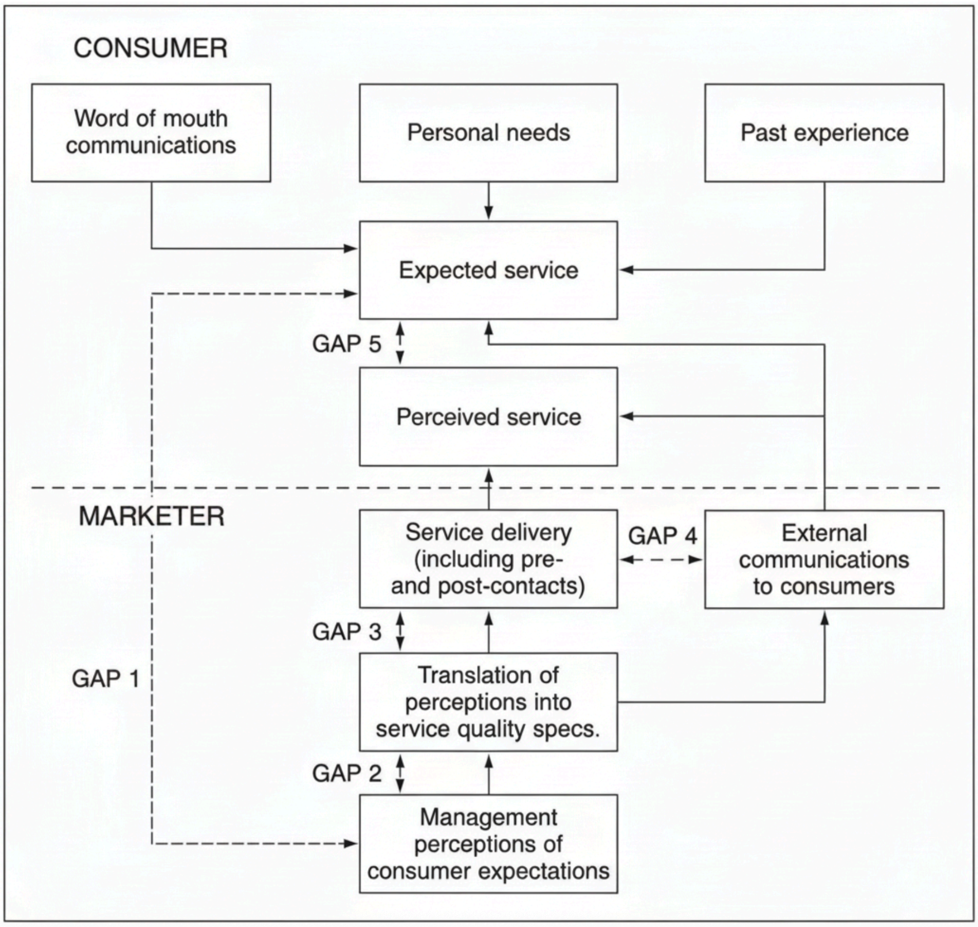



**Figure 2.2.** *The GAP Model of Service Quality (Parasuraman, Zeithaml, and Berry, 1985).* Adapted from Grönroos (2015, p.130).

Grönroos (2015) further develops the GAP Model by analyzing the main causes, consequences, and managerial implications of each gap, as summarized in Table 2.1 His analysis shows that service quality problems typically stem from misalignments across market research, service process design, service execution, and communication activities (Grönroos, 2015, pp. 131–135).

From a managerial decision-support perspective, the GAP Model acts as a diagnostic tool that provides a conceptual bridge between failures and perceived service quality. By identifying where misalignments occur, gap analysis helps organizations prioritize improvement efforts and target interventions at the stages of the service system where failures are most likely to translate into negative customer perceptions. As Grönroos (2015) concludes, addressing these gaps provides a logical basis for developing service processes in which expectations and experiences consistently meet, thereby increasing the likelihood of achieving good perceived service quality (p. 134).

**Table 2.1.** *Main causes and managerial implications of the GAP model.*

| Gap | Gap meaning | Main causes | Main consequences |
|---|---|---|---|
| Gap 1: Management Perception Gap | Management perceives the customers' actual service quality expectations inaccurately. | • Inaccurate or insufficient information from market research and demand analysis.<br>• Misinterpretation of customer expectations.<br>• Non-existent demand analysis<br>• Poor upward communication from customer-contact personnel to management.<br>• Excessive organizational layers that distort or block information flows. | • Strategic decisions based on incorrect assumptions about customer needs.<br>• Service designs that do not reflect real customer expectations.<br>• Need to improve market research, feedback systems, and managerial understanding of service competition. |
| Gap 2: Quality Specification Gap | Service quality specifications are not consistent with management's perceptions of customers' quality expectations. | • Planning mistakes or insufficient planning procedures.<br>• Lack of top management commitment to service quality.<br>• Unclear or poorly defined organizational goals.<br>• Insufficient involvement of service employees in defining quality standards.<br>• Overly rigid service quality specifications. | • Quality standards that are unrealistic or difficult to implement.<br>• Low employee commitment to service quality specifications.<br>• Reduced flexibility and customer orientation.<br>• Need to realign strategic priorities and foster organization-wide commitment to service quality. |
| Gap 3: Service Delivery Gap | Quality specifications are not met by performance in the service production and delivery process. | • Specifications that are too complex or inflexible.<br>• Employees that do not agree with specifications and/or have inadequate skills and attitudes.<br>• Misalignment between specifications, organizational culture, and control and reward systems.<br>• Inadequate supervision and poor management of service operations<br>• Insufficient internal marketing and employee training.<br>• Technology and operational systems that do not support performance in line with specifications. | • Systematic failure to meet service quality standards.<br>• Role ambiguity and decreased motivation among service employees.<br>• Conflicts between customer needs and employees' ability to respond within organizational constraints.<br>• Need to revise control and reward systems, recruitment practices, training programs, and technological support. |

| Gap | Gap meaning | Main causes | Main consequences |
|---|---|---|---|
| Gap 4: Market Communication Gap | Promises made by external marketing communication are not consistent with the actual service delivered. | • Lack of integration between marketing communication planning and service operations.<br>• Insufficient coordination between marketing and operational functions.<br>• Marketing campaigns based on specifications that are not fulfilled in practice.<br>• Organizational tendency to overpromise in advertising and sales communication. | • Creation of unrealistic customer expectations.<br>• Loss of credibility and trust.<br>• Increased likelihood of customer dissatisfaction.<br>• Need for a system that coordinates planning and execution of external marketing communication with service operations (e.g., planning marketing campaigns in collaboration with service provider employees).<br>• Need for more realistic planning and supervision of marketing and sales activities. |
| Gap 5: Perceived Service Quality Gap | The perceived or experienced service quality is not consistent with the expected service. | • Cumulative outcome of one or more of the preceding gaps.<br>• Failures in market research, service planning, service delivery, and/or external communication. | • Negatively confirmed service quality and customer dissatisfaction.<br>• Negative word of mouth and adverse social media communication.<br>• Damage to corporate or local image.<br>• Loss of customers and business. |

***Note.*** Adapted from Grönroos, 2015, pp. 131-135.

### 2.3.3 The Perceived Service Quality Model and Customer Expectations

Based on the idea that perceived service quality results from the consumer's comparison between expected and experienced service, Parasuraman, Zeithaml, and Berry (1985) proposed a conceptual model (Figure 2.3) in which service quality is positioned along a continuum, ranging from ideal quality to totally unacceptable quality, with satisfactory quality lying somewhere in between.

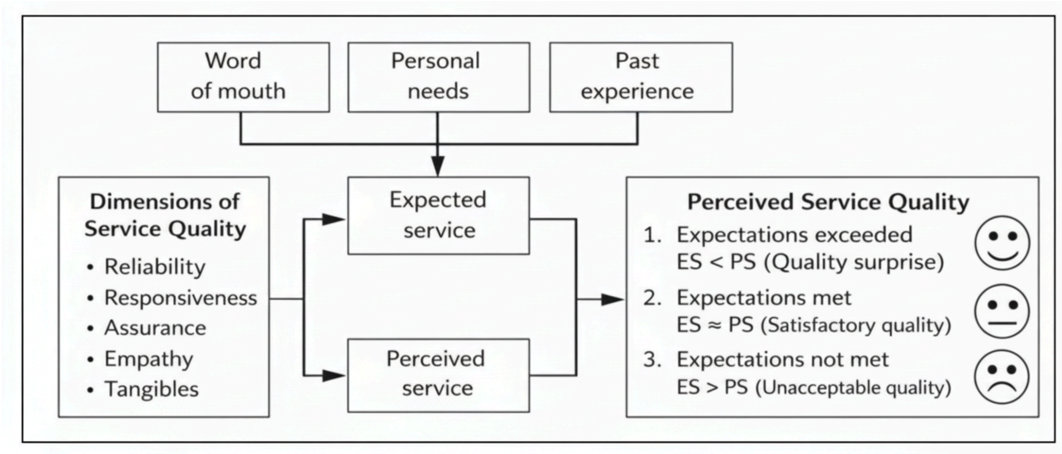



**Figure 2.3.** *The Perceived Service Quality Model (Parasuraman, Zeithaml, and Berry, 1985).* Adapted from Fitsimmons & Fitzsimmons (2015, p.116).

The position of a consumer's perception along this continuum depends on the discrepancy between expected service (ES) and perceived service (PS) (Parasuraman et al., 1985, p. 8):

- When **ES < PS**, perceived quality exceeds satisfactory levels and moves towards ideal quality.
- When **ES = PS**, perceived quality is judged satisfactory.
- When **ES > PS**, perceived quality is below satisfactory and tends toward totally unacceptable quality as the gap increases.

Grönroos (2015) argues that merely meeting expectations may be sufficient to achieve satisfaction, but it is rarely enough to create strong relationships or positive word of mouth. To foster retention and advocacy, firms often aim to exceed expectations and generate customer delight. Customers who are positively surprised are more likely to remember the experience and to talk about it with others. This "surprise effect" does not necessarily require large investments. Small, low-cost gestures, such as a helpful explanation, a proactive response, or a small token of appreciation, can be enough to create a positive emotional response. What matters is not the absolute level of quality, but whether the service experience exceeds what the customer expected (Grönroos, 2015, pp. 128–129).

This formulation reinforces the central role of expectations as the reference standard against which service performance is evaluated (Oliver, 1981b, p.33; Parasuraman et al., 1993, p. 1). In the original perceived service quality model (Parasuraman et al., 1985), expectations were treated as a single prediction point for each service attribute. Parasuraman, Zeithaml, and Berry (1993) later argued that this assumption was too simplistic because customers can tolerate some variation in service performance while still considering it acceptable.

To address this limitation, they introduced the concept of the **Zone of Tolerance**, defined as the range between two expectation levels; the *desired* service (i.e., the level of service that customers hope to receive), and the *adequate* service (i.e., the minimum level of service that customers are willing to accept without feeling dissatisfied) (Parasuraman et al., 1993, p. 6).

Customers therefore evaluate service quality against a range of acceptable performance rather than a single standard. As long as perceived service falls within this zone, quality is judged acceptable or sufficiently good. This framework also implies that customers make two different evaluations: **perceived service superiority,** by comparing perceived service with desired service, and **perceived service adequacy,** by comparing perceived service with adequate service (Parasuraman et al., 1993, p. 8). These two assessments effectively replace the single Gap 5 in the original GAP Model.

From a risk management perspective, the zone of tolerance is particularly relevant because it is **elastic**. It varies across customers, service attributes, and situations, and it can expand or contract over time for the same customer; customers with a narrow zone of tolerance require highly consistent service performance. Additionally, while desired service levels tend to be relatively stable, adequate service levels are more sensitive to contextual factors such as price, urgency, and situational constraints (Parasuraman et al., 1993, p. 6). Grönroos (2015) further observes that the zone of tolerance "is generally narrower for outcome-related features (technical quality) and broader for process-related features (functional quality)" (p. 134). Customers therefore tend to be less tolerant of failures that affect the core service outcome (e.g., an incorrect bank transfer), but more patience for variability in the service process (e.g., waiting times).

To explain how expectations are formed and modified, Parasuraman, Zeithaml, and Berry (1993) developed a comprehensive model of customer expectations of service (Figure 2.4), based on exploratory qualitative research. In this model, expectations are multidimensional and influenced by several groups of antecedents that shape both desired and adequate service levels (Parasuraman et al., 1993, pp. 5–9):

**Antecedents of desired service** include relatively stable factors such as:

- *Enduring service intensifiers:* individual factors that heighten sensitivity to service, such as derived expectations (expectations shaped by third parties) and personal service philosophies (customers' underlying beliefs about how service should be delivered).
- *Personal needs*: conditions essential to customers' physical, social, or psychological well-being. Higher personal needs lead to higher desired service levels.

**Antecedents of adequate service** include more dynamic and context-dependent factors, such as:

- *Transitory Service Intensifiers:* short-term situations, such as emergencies or service failures, which raise the level of adequate service and narrow the zone of tolerance.
- *Perceived Service Alternatives:* the customer's perception of available competitors. If customers believe they have better options, their threshold for adequate service rises.
- *Self-Perceived Service Role:* the extent to which customers believe they influence the service outcome. When they realize that they performed their role poorly (e.g., arriving late), their zone of tolerance expands, and they accept lower service levels.
- *Situational Factors:* contingencies seen as beyond the provider's control (e.g., bad weather), which temporarily lower the level of adequate service, widening the zone.
- *Predicted service:* the level of service customers believe they are likely to get. When customers expect good performance, their minimum acceptable level increases.

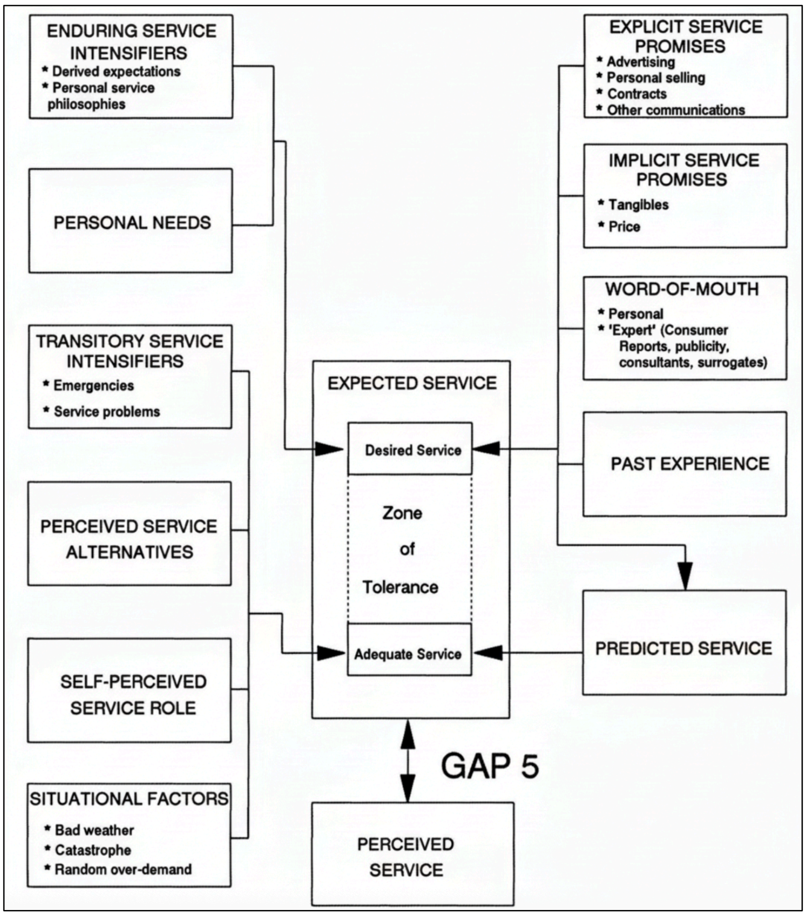



**Figure 2.4.** *Nature and Determinants of Customer Expectations of Service*. Adapted from Parasuraman, Zeithaml, and Berry (1985, p.5).

In addition, both desired and predicted service are also influenced by *explicit service promises* (e.g., advertising, guarantees), *implicit service promises* (e.g., physical cues), *word-of-mouth* communication, and *past experience*. As a result, **service-related risks are not only associated**

**with operational failures, but also with expectation dynamics**. Over-promising, unmanaged word of mouth, or inconsistent experiences can raise adequate service levels and narrow the zone of tolerance, increasing the likelihood that otherwise minor failures will be perceived as unacceptable.

By systematically mapping these determinants, organizations can better anticipate how customers' zones of tolerance will shift and proactively manage the risks associated with fluctuating expectations. Overall, the perceived service quality and expectations models provide a nuanced understanding of how customers form expectations and evaluate service performance. They show that quality judgments are inherently relative, context-dependent, and expectation-driven; an insight that is essential for linking operational failures to customer-perceived impact in a structured risk prioritization framework.

### *2.3.4 SERVQUAL*

In service contexts, quality cannot be evaluated through objective indicators such as durability or defect rates, which are typically used for manufactured goods. For this reason, Parasuraman, Zeithaml, and Berry argue that an appropriate way to assess service quality is by measuring customers' perceptions of service performance (Parasuraman et al., 1988, p. 13). Building on this premise, they developed **SERVQUAL**, a multiple-item scale designed to measure perceived service quality and introduced as a generic instrument applicable across a wide range of service industries.

The primary purpose of SERVQUAL is to help managers identify gaps between what customers expect and what they perceive they receive, revealing areas of service strength and weakness and pointing to opportunities for improvement (Parasuraman et al., 1988, p. 30; 1991, p. 445). In this sense, SERVQUAL operationalizes the logic of the GAP Model by transforming the expected–perceived service gap (Gap 5) into a measurable construct.

The scale is grounded in the original determinants of service quality proposed by Parasuraman et al. (1985), later consolidated into five broader dimensions that capture how customers typically evaluate service quality (Parasuraman et al., 1988, p. 23; Fitzsimmons & Fitzsimmons, 2011, p. 116):

- **Tangibles:** the physical facilities, equipment, communication materials, and the appearance of service employees.
- **Reliability:** the ability to deliver the promised service dependable and accurately, performing what was agreed, on time, and without errors.

- **Responsiveness:** the willingness to help customers and provide prompt service, especially in situations involving waiting time or service recovery.
- **Assurance:** employees' knowledge and courtesy, and their ability to inspire trust and confidence.
- **Empathy:** the organization's ability to provide caring, individualized attention and its effort to understand and act in the customer's best interest.

Although it formally includes five dimensions, together they encompass all ten original determinants. In particular, the assurance and empathy integrate several earlier criteria such as competence, courtesy, credibility, communication, security, access, and understanding the customer (Parasuraman et al., 1988, p. 23).

Methodologically, SERVQUAL is implemented through a structured questionnaire consisting of 22 paired statements, each corresponding to one of the five dimensions. The instrument includes two parallel sections: one measuring customers' expectations of excellent service providers in a given industry, and the other measuring their perceptions of a specific firm's service performance within that sector (Parasuraman et al., 1991, p. 422). Responses are typically collected using a seven-point scale ranging from "strongly disagree" to "strongly agree."

After a large number of customers complete the questionnaire, descriptive statistics such as means and standard deviations are computed for each item, along with difference scores calculated as perception minus expectation. Negative gap scores indicate perceived service quality shortfalls, while smaller or positive gaps indicate better perceived quality. This allows managers to analyze performance at the level of individual dimensions and attributes, as well as to produce an overall service quality score. Additionally, respondents can be asked to allocate a fixed number of points (e.g., 100) across the five dimensions to reflect their relative importance, enabling firms to prioritize improvement efforts based on what matters most to customers (Parasuraman et al., 1991).

The SERVQUAL instrument has been designed and validated with good reliability for use in a variety of service encounters. However, from a managerial standpoint, SERVQUAL should be viewed as a **diagnostic and monitoring tool** rather than a prescriptive solution. It is particularly valuable when used periodically to track changes in perceived service quality over time or to compare performance across different units, locations, or competitors (Fitzsimmons & Fitzsimmons, 2011, p. 119). However, several authors caution against its mechanical application. Grönroos (2015) emphasizes that both the dimensions and the specific items should be adapted to the service context, since customers may rely on different criteria depending on the nature of the service (p. 104).

The widespread adoption of SERVQUAL has also prompted numerous adaptations, modifications and critiques. Many empirical applications adjust the wording, number, or composition of items to better reflect industry-specific characteristics. Moreover, meaningful responses require prior experience with the focal firm, which limits SERVQUAL to current or past customers. For this reason, it is most effective when used in combination with other sources of information or forms of service quality measurements, such as employee assessments, customer complaints, or operational performance data.

Overall, SERVQUAL represents a key milestone in the operationalization of service quality. By translating abstract concepts such as expectations, perceptions, and disconfirmation into a structured survey instrument, it provides organizations with a practical way to assess how customers experience service performance and where perceptual quality gaps or quality-related risks might emerge (Parasuraman et al., 1988). At the same time, its limitations highlight the need for contextual adaptation and for combining SERVQUAL with complementary measurement approaches, particularly when service quality assessments are used to support managerial prioritization in complex service systems.

### *2.3.5 Alternative Models: SERVPERF and E-S-QUAL*

Despite its widespread adoption, SERVQUAL has been subject to extensive criticism, especially because it relies on the expectations–performance gap as the basis for measuring service quality. A central concern is whether it is conceptually and methodologically valid to measure expectations separately from perceptions. Grönroos (2015) points out that customer experiences are themselves perceptions of reality already filtered through prior expectations; if expectations are measured first and perceptions afterwards, expectations may effectively be counted twice, adding redundancy and noise to the measurement process. As a result, he suggests that measuring experienced performance alone may provide a more valid representation of perceived service quality (Grönroos, 2015, p. 105).

This critique is most prominently articulated by Cronin and Taylor (1992), who argue that SERVQUAL is inadequate because "little if any theoretical or empirical evidence supports the relevance of the expectations–performance gap as the basis for measuring service quality" (p. 56). Drawing on attitude theory, they conceptualize service quality as a long-term, overall attitude toward a service provider rather than the result of a cognitive comparison between expectations and performance. In their view, expectations and disconfirmation do not define service quality but, at most, mediate its formation (Cronin & Taylor, 1992, p. 57). Empirical evidence supports this position; studies such as Bolton and Drew (1991) show that customers' perceptions of current performance have a stronger and more stable influence on perceived quality than expectations or disconfirmation, whose effects tend to be relatively weak and transitory.

Based on these arguments, Cronin and Taylor (1992) propose **SERVPERF**, a performance-only measure of service quality. SERVPERF uses the same service attributes as SERVQUAL but removes the expectations section, focusing exclusively on customers' perceptions of performance. This approach is more parsimonious and, according to the authors, more theoretically consistent with the notion of service quality as an attitude. Their empirical comparisons demonstrate that SERVPERF explains more variance in overall service quality and behavioral intentions than SERVQUAL, while avoiding the methodological problems associated with difference scores (Cronin & Taylor, 1992, pp. 59–61).

Beyond introducing SERVPERF, Cronin and Taylor also challenge several assumptions underlying SERVQUAL. First, their confirmatory factor analyses fail to support the five-dimension structure of service quality proposed by Parasuraman, Zeithaml, and Berry (1988), as the model fit poorly across different service industries (Cronin & Taylor, 1992, p. 61). Second, they find that weighting service quality dimensions by importance adds little explanatory power, reinforcing the case for simpler measurement models. Finally, their structural analyses suggest that customer satisfaction has a stronger and more direct effect on purchase intentions than perceived service quality, positioning satisfaction as a more proximal driver of customer behavior (Cronin & Taylor, 1992, pp. 63–64).

While SERVPERF simplifies SERVQUAL methodologically, other critiques point to the limits of both instruments in technology-mediated service contexts. Parasuraman, Zeithaml, and Malhotra (2005) argue that traditional models were developed mainly for face-to-face service encounters and are not fully applicable to online environments. In response, they introduce **E-S-QUAL**, an alternative scale designed to measure electronic service quality (e-SQ), defined as "the extent to which a website facilitates efficient and effective shopping, purchasing, and delivery" (Parasuraman et al., 2005, p. 5).

E-S-QUAL is grounded on a means–end logic: concrete website features drive perceptual attributes, which then shape higher-order evaluations such as overall quality, perceived value, and loyalty intentions (Parasuraman et al., 2005, pp. 5–6). Using qualitative research and scale development procedures, the authors show that merely adapting SERVQUAL dimensions to online settings is insufficient, as customers evaluate e-services using distinct technology-related attributes (pp. 2–3).

The resulting E-S-QUAL instrument is a 22-item, performance-based scale comprising four dimensions: **efficiency** (ease and speed of accessing and using the website), **fulfillment** (the extent to which delivery and availability promises are met), **system availability** (the correct technical functioning of the site), and **privacy** (protection of customer information) (Parasuraman et al., 2005, p. 8).

In addition, the authors develop **E-RecS-QUAL**, an 11-item scale measuring electronic service recovery quality for customers who experience problems. It consists of three dimensions: **responsiveness** (effective handling of problems and returns), **compensation** (the extent to which customers are compensated for failures), and **contact** (availability of human assistance through telephone or online representatives) (Parasuraman et al., 2005, p. 8). Empirical tests across large samples of online customers show strong reliability and validity, as well as significant relationships with perceived value and loyalty intentions (Parasuraman et al., 2005, pp. 9–15).

Taken together, SERVPERF and E-S-QUAL illustrate two important directions in the evolution of service quality measurement. SERVPERF reflects a shift toward performance-only, attitude-based evaluations and challenges the centrality of expectation gaps, while E-S-QUAL extends the framework to digital environments characterized by self-service technologies and reduced human interaction. Rather than replacing SERVQUAL, these models reinforce the idea that service quality measurement must be context sensitive. Instruments should be selected and adapted based on the nature of the service system, the role of technology, and the type of customer experience under analysis.

### *2.3.6 Quality Function Deployment (QFD)*

Quality Function Deployment (QFD) is a structured, customer-driven planning and quality management approach that systematically translates the "voice of the customer" into appropriate internal requirements across product or service development stages, from early planning and design to process definition and delivery, with the goal of increasing customer satisfaction (Chan & Wu, 2002, p. 24). Consistently, Akao (1990) defines QFD as a "method for developing a design quality aimed at satisfying the consumer and then translating the consumers' demands into design targets and major quality assurance points to be used throughout the production stage" (p. 4). He argues that customer information must be interpreted and converted into usable "quality characteristics" through explicit relationship charts that connect demands to technical responses (Akao, 1990, pp. 6–7). In practice, QFD supports a proactive shift from *inspecting quality* to *designing quality into the offering* from the beginning (Chan & Wu, 2002, p. 24).

Beyond being a set of matrices, QFD also functions as an organizational coordination mechanism. Franceschini (2001) notes that Akao's original intention was to introduce a tool in which "responsibilities for producing a quality item must be assigned to all parts of a corporation" (p. 21). Similarly, Hauser and Clausing (1988) emphasize that QFD coordinates organizational capabilities to design, manufacture, and market offerings that customers want to purchase and continue purchasing, which requires close collaboration across functions (p. 3). For this reason, QFD is typically developed by an interdisciplinary team (often involving marketing, design, quality, technical staff, production, and suppliers) so that customer expectations remain visible in development decisions (Franceschini, 2001, p. 30), and effective implementation requires collaboration across organizational levels (Franceschini, 2001, p. 22).

A distinctive feature of QFD is its **deployment logic**: customer requirements are progressively "deployed" into technical, operational, and control specifications through linked matrices. Chan and Wu (2002) describe a widely used Four-Phase Model (Fig. 2.5) in which customer needs are first collected and translated into technical measures in the initial matrix (known as the House of Quality or Product Planning) and then converted into part characteristics, process planning parameters, and production requirements in subsequent phases (Chan & Wu, 2002, pp. 24–25). Franceschini (2001) presents an equivalent sequence: customer requirements are translated into global design specifications, then subsystem/part specifications, then manufacturing process planning specifications, and finally quality control specifications such as inspection plans and process control parameters (Franceschini, 2001, pp. 24–25). Across these perspectives, the managerial promise of QFD is ensuring that what customers value is explicitly connected to what the organization designs, executes, and controls. This reflects Akao's broader view that quality is formed through a connected "network of relationships" that links customer demands to design, parts, and processes (Akao, 1990, p. 5).

Procedurally, this translation is supported by a family of structured "quality tables" (matrices) designed to represent key project variables and make their interactions explicit, generating documentation that can guide subsequent planning and coordination (Franceschini, 2001, pp. 26–27). As shown in Figure 1, each phase's outputs (HOWs), generated from the phase's inputs (WHATs), become the inputs (new WHATs) of the next phase, enabling traceability across the full development chain (Chan & Wu, 2002, pp. 24–25).

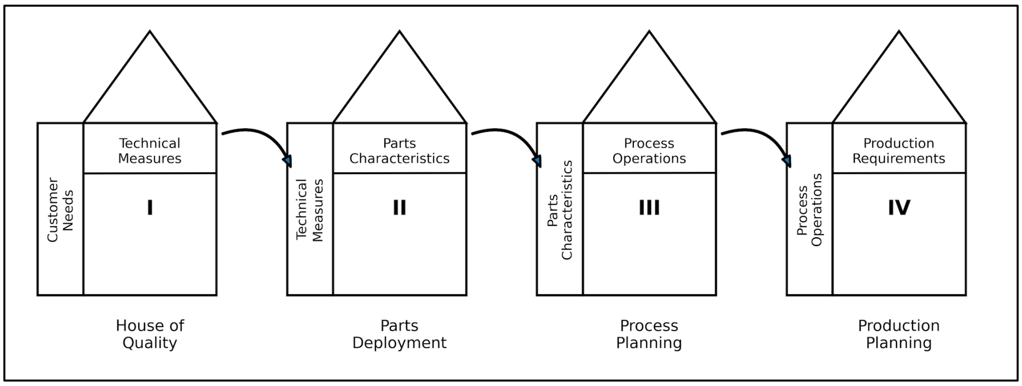



**Figure 2.5.** *The Four-Phase Model of QFD*. Adapted from Chan & Wu (2002, p. 25).

The **House of Quality (HoQ)** is commonly described as the first and most strategic matrix in QFD because it operationalizes the transition from what customers need to how the organization will respond through product or service characteristics, in technical terms (Franceschini, 2001, p. 27). Chan and Wu (2002) similarly highlight the HoQ as fundamental because it is the stage where customer needs are identified and—considering competitive priorities—transformed into prioritized technical measures that guide downstream deployment (Chan & Wu, 2002, p. 25). This matrix defines both the relationships between customer needs and technical responses and their reciprocal priorities, while also enabling competitive benchmarking (Franceschini, 2001, p. 24).

Although terminology and procedures are not fully unified in the literature (Chan & Wu, 2002, p. 24), most authors converge on six core phases for constructing a typical HoQ (Chan & Wu, 2002, pp. 28–31; Franceschini, 2001, p. 35):

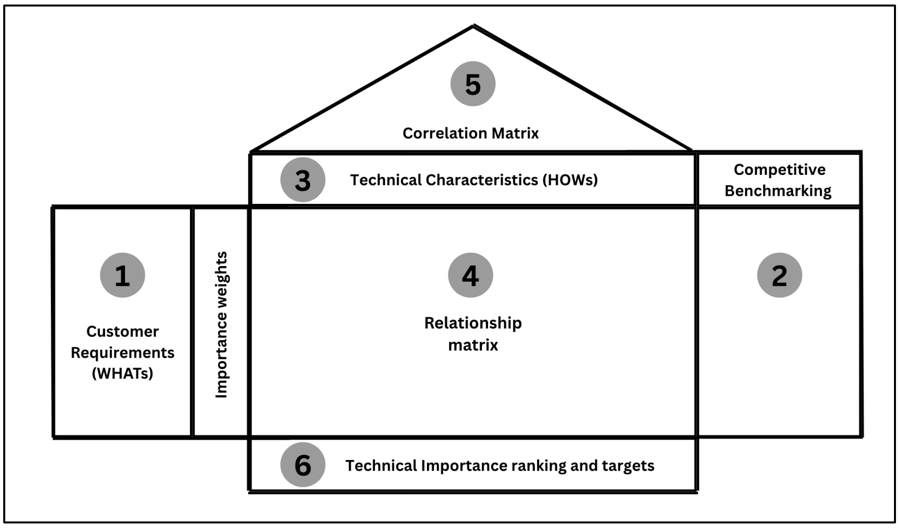



**Figure 2.6.** *Main components of the house of quality (HoQ)*. Adapted from Franceschini (2001, p.36).

1. **Customer requirements (WHATs):** The process begins by identifying the target customer and collecting needs expressed in customer language (Voice of the Customer) using methods such as surveys, interviews, focus groups, market research, and complaint analysis. Because raw statements may be vague or overly detailed, they are typically clarified and grouped into manageable categories (often via hierarchical structures) while preserving the original meaning as much as possible (Chan & Wu, 2002, p. 28; Franceschini, 2001, pp. 35–38). Then, customers assign importance weights to each WHAT (often through surveys and rating scales) so the team can prioritize what matters most to them (Hauser & Clausing, 1988, pp. 5–6; Chan & Wu, 2002, p. 28).

2. **Competitive benchmarking assessment (WHY)**: The HoQ often includes customer evaluations comparing the company's offering against competitors on the same requirements. Customers rate the company and competitors for each WHAT using a numerical scale, and ratings are aggregated to assess relative competitive positions (Chan & Wu, 2002, p. 29). Hauser and Clausing (1988) describe this as a "perceptual map" that can reveal improvement opportunities and support strategic positioning (p. 6). Chan and Wu (2002) further describe this step as a planning matrix where realistic goals and "sales points" (typically 1.5 = strong, 1.25 = moderate, 1 = none) are assigned based on competitive gaps and opportunities, producing a final strategic importance ranking of customer needs (Chan & Wu, 2002, p. 29).

3. **Technical characteristics (HOWs):** Customer requirements are translated into objective and measurable technical or design characteristics (often described as the Voice of the Engineer) that specify how customer requirements will be fulfilled (Franceschini, 2001, p. 44). Engineering characteristics should be stated in measurable terms and plausibly influence customer perceptions (Hauser & Clausing, 1988, p. 6). Each customer requirement should link to at least one technical characteristic; conversely, a characteristic that affects no customer requirement may be redundant, and a customer requirement with no supporting characteristic signals a gap requiring further analysis (Franceschini, 2001, p. 44; Hauser & Clausing, 1988, p. 6). Chan and Wu (2002) also emphasize specifying units and a "direction of improvement" (more is better / less is better / target is best) to support evaluation and planning (p. 30).

4. **Relationship matrix (WHATs × HOWs):** The relationship matrix—WHATs listed vertically and HOWs horizontally—constitutes the analytical core of the HoQ because it makes explicit how strongly each technical characteristic contributes to satisfying each customer requirement (Franceschini, 2001, pp. 28–29). Relationship strength is typically

expressed through categorical levels (none/weak/medium/strong), represented with symbols and/or semi-quantitative scoring such as 0–1–3–9 (Chan & Wu, 2002, p. 30). The team seeks consensus using engineering experience, customer responses, and available data (Franceschini, 2001, p. 45; Hauser & Clausing, 1988, pp. 6–7). Entire blank rows or columns can highlight unmet requirements or redundant characteristics (Hauser & Clausing, 1988, pp. 6–7; Franceschini, 2001, p. 45).

5. **Correlation matrix (HoQ roof):** The "roof" captures interactions among HOWs, showing where improving one characteristic supports or conflicts with another. Chan and Wu (2002) describe five typical types of correlations (strong/moderate positive, none, moderate/strong negative), usually represented with symbols and derived from engineering analysis and experience (p. 30). This component is particularly valuable for identifying bottlenecks and trade-offs because technical characteristics often influence one another in both positive and negative directions (Chan & Wu, 2002, p. 30). Hauser and Clausing (1988) similarly note that the roof often contains the most critical information for engineers because it makes trade-offs explicit and highlights collateral impacts (p. 7).

6. **Technical importance ranking and targets (HOW MUCHes):** Finally, the HoQ produces a technical importance ranking by aggregating relationships across customer requirements, weighted by their importance, providing a measure of each technical characteristic's overall contribution to customer satisfaction (Chan & Wu, 2002, p. 31). This phase commonly includes competitive technical assessment and the definition of performance targets ("HOW MUCHes"), considering both strategic importance and technical capabilities. Finally, the feasibility or difficulty of achieving each target is evaluated, allowing the most critical and achievable HOWs to be selected for further deployment in subsequent QFD phases (Chan & Wu, 2002, p. 31). Franceschini (2001) adds that targets serve both as the declared intent for development and as reference values for guiding subsequent planning and checking progress (pp. 29–30).

Hauser and Clausing (1988) also stress that teams often custom-build their houses—for example, adding customer complaint histories alongside requirements or adding the costs of servicing complaints alongside technical characteristics—depending on the decision context (p. 7). Still, Franceschini (2001) argues that defining WHATs, HOWs, and HOW MUCHes remains the core "spark" of QFD, providing a "structured and information-rich framework" that supports coherent development decisions (Franceschini, 2001, p. 32).

Although QFD originated in product planning, several authors argue that its translation logic is highly relevant for **services,** where customer expectations also need to be converted into controllable design and process elements. Fitzsimmons and Fitzsimmons (2011) state that the HoQ provides a framework to translate customer satisfaction into identifiable specifications and explicitly note that "its application to the design of service delivery systems is very appropriate" (p. 123). In their service-oriented procedure, customer expectations form the rows, service elements under managerial control form the columns, and the matrix expresses the strength of association between them (Fitzsimmons & Fitzsimmons, 2011, pp. 123–124).

Across the literature, QFD is linked to both **qualitative and quantitative benefits**. Chan and Wu (2002) summarize qualitative benefits (drawn from multiple studies) in three main areas: improved customer orientation, more effective product development, and improved internal communication and teamwork (p. 33). Franceschini (2001) adds that QFD reduces misinterpretations across departments, supports cross-functional involvement throughout development, and creates a reusable knowledge base through structured documentation (pp. 31–32). Quantitatively, Chan and Wu (2002) report that Bicknell and Bicknell (1995) document reductions in engineering changes, shorter design cycles, lower start-up costs, and fewer warranty claims, attributing these improvements to QFD's ability to anticipate conflicts before production or prototyping (Chan & Wu, 2002, p. 32).

At the same time, **implementation challenges** are recurrent. HoQ matrices can become too large and difficult to manage; teams may confuse customer needs with technical measures; and estimating relationship strengths can be difficult when customer input is vague or data are limited (Chan & Wu, 2002, p. 24; Franceschini, 2001, p. 31). Hauser and Clausing (1988) also stress that there is no "cookbook" procedure—teams frequently adapt layouts and symbols—so the value of the HoQ depends strongly on disciplined facilitation and high-quality inputs (p. 8).

In this thesis, QFD is not applied in its full multi-phase deployment logic. Instead, its relationship-matrix mechanism is selectively adapted to represent how operational failure modes connect to customer-perceived quality dimensions. This adaptation preserves QFD's core principle of making customer-oriented relationships explicit and actionable within decision-making (Chan & Wu, 2002, pp. 24–25) and aligns with service-oriented adaptations that translate customer expectations into controllable service elements (Fitzsimmons & Fitzsimmons, 2011, pp. 123–124).

## 2.4 Synthesis and implications for the proposed methodology

The models reviewed in this chapter offer complementary perspectives on how service quality is formed, perceived, translated, and managed within service systems. Although they differ in scope, level of abstraction, and methodological orientation, together they provide a coherent understanding of service quality as a perceptual outcome shaped by interactions, expectations, and organizational design rather than by purely technical performance.

Across the literature, a consistent insight emerges: service quality is not inherent in the service itself but arises from a customer-centered evaluation process in which operational performance is interpreted through perceptual dimensions. Grönroos's Total Perceived Service Quality model (1984) emphasizes the dual role of technical and functional quality and the importance of process interactions. The GAP Model (Parasuraman et al., 1985) demonstrates how misalignments between understanding, design, delivery, and communication create discrepancies between expected and perceived service. Extensions such as the zone of tolerance further stress that expectations are dynamic, heterogeneous, and context-dependent.

Measurement instruments such as SERVQUAL (Parasuraman et al., 1988) operationalize these theoretical insights by structuring customer evaluations around a limited set of perceptual dimensions. Although SERVQUAL is widely used, critiques and alternatives such as SERVPERF (Cronin & Taylor, 1992) and E-S-QUAL (Parasuraman et al., 2005) highlight the need for contextual adaptation, particularly across different service types and technological environments. What remains consistent across these approaches is the idea that customers rely on structured interpretive dimensions to evaluate service experiences and failures.

Quality Function Deployment (QFD) (Akao, 1990) complements these perceptual models by introducing a structured mechanism for translating customer requirements into organizational design and operational elements. While originally developed for product planning, QFD's relationship-matrix logic demonstrates how customer-oriented dimensions can be systematically connected to internal processes and technical characteristics. In this sense, QFD bridges the conceptual gap between customer expectations and controllable organizational variables, reinforcing the idea that quality is constructed through explicit relational mappings rather than isolated performance indicators.

Taken together, these perspectives imply that service-related risks cannot be assessed or prioritized solely on the basis of operational severity. The impact of a failure depends on how it is perceived through the quality dimensions that customers use to evaluate the service. At the same time, understanding perception alone is insufficient unless it can be systematically connected to operational structures and controllable causes.

Rather than prescribing a specific measurement instrument, this chapter establishes a conceptual foundation for treating service quality dimensions as analytical lenses that connect operational performance with customer-perceived consequences. The integration of perceptual models (SERVQUAL and related frameworks) with translation mechanisms (QFD) provides the theoretical justification for a methodology capable of linking service processes and failure modes to perceptual outcomes.

This logic underpins the PRISM Framework developed in Chapter 5, where service quality dimensions are not treated as performance metrics per se, but as structured prioritization criteria through which operational risks are redistributed and evaluated in terms of their expected customer-perceived impact.

# 3. Risks in Service Management

## 3.1 Identification and classification of service-related risks

In service management, risk is not only a managerial concern but an inherent component of how value is created and experienced by customers. According to ISO 31000, risk is defined as the "*effect of uncertainty on objectives",* typically described in terms of sources, events, consequences, and likelihood (ISO 31000:2018, pp. 1–2). This definition highlights two key elements: uncertainty and its potential impacts, which may be either negative or positive. Professional bodies adopt similar views. For example, the Institute of Risk Management defines risk as the combination of the probability of an event and its consequences, while the Institute of Internal Auditors stresses the uncertainty of events that may affect the achievement of organizational objectives.

Uncertainty is inherent in service contexts because of the intrinsic characteristics of services (intangibility, heterogeneity, inseparability, and perishability). These features not only affect how services are produced and delivered, but also how risks emerge, propagate, and are perceived. Since services are produced and consumed simultaneously and cannot be fully tested or store in advance, failures tend to occur in real time and to be directly visible to customers. As a result, service risks are not confined to internal organizational processes; they frequently materialize at the interface between the organization and the customer, where value is co-created during service encounters.

This distinguishes service risks from many manufacturing-related risks, which can often be detected, corrected, or absorbed internally before reaching the customer. In services, operational disruptions are more likely to translate immediately into negative customer experiences, affecting satisfaction, trust, and perceived service quality. Consequently, risk identification in service management cannot be limited to internal process failures alone, but must also account for how such failures are experienced and interpreted by customers.

Once identified, risks can be grouped according to their source, nature, impacted component, or consequences (Hopkin, 2017, p. 21). Risk management literature emphasizes the importance of adopting a risk classification system that is aligned with the organization's objectives, context, and risk profile (Hopkin, 2017, pp. 17, 140). In service management, this implies complementing general enterprise risk frameworks with service-specific perspectives that explicitly consider customer participation, real-time delivery, and experiential outcomes.

### *3.1.1 Limitations of general enterprise risk frameworks in service contexts*

General enterprise risk management frameworks provide structured and well-established classifications of organizational risks. One influential approach proposed by Hopkin (2017) groups risks according to their nature and impact on organizational objectives, distinguishing four broad categories:

- **Compliance risks,** which arise from the need to meet legal, regulatory, and ethical requirements. In many service industries, compliance represents a "license to operate" and failures can lead to financial penalties as well as reputational damage (Hopkin, 2017, pp. 26, 43).
- **Hazard risks,** referring to events that can only result in negative outcomes, such as accidents, theft, or system breakdowns. These risks are usually managed within defined tolerance levels and are often addressed through preventive controls and insurance mechanisms (Hopkin, 2017, pp. 17, 38, 42).
- **Control risks,** which are linked to uncertainty about outcomes rather than the occurrence of specific events. They are particularly relevant in projects and change initiatives, where costs, time, and benefits are difficult to predict (Hopkin, 2017, pp. 17, 38, 40).
- **Opportunity risks**, which are deliberately taken to address organizational or customer needs and enhance value creation, for example through innovation, market expansion, partnerships, or the adoption of new technologies (ISO 9001:2015, clause 6.1.2). Although they involve uncertainty, they are essential for long-term competitiveness and growth (Hopkin, 2017, pp. 18, 38).

On this basis, Hopkin (2017) defines risks as *"any event with the ability to impact (inhibit, enhance, or cause doubt about) the effectiveness and efficiency of an organization's core processes"* (p.17). In general terms, organizations try to minimize compliance risks, mitigate hazard risks, manage control risks, and selectively embrace opportunity risks.

A complementary lens focuses on **the time horizon of impact.** Hopkin (2017) distinguishes between short-, medium-, and long-term risks, corresponding respectively to operational, tactical, and strategic levels (pp. 35, 132–133). In service settings, *short-term* risks are events with immediate effects on service delivery, such as system outages, staff absenteeism, or accidents, and typically threaten operational continuity. *Medium-term* risks are often associated with projects or change programs (e.g., implementing new IT systems, redesigning service processes), where impacts become visible over months. *Long-term* risks are associated with strategic decisions, including service portfolio choices or market positioning, and may take years to fully materialize.

In services, long-term risks are particularly critical since strategic failures can gradually erode customer trust and hurt long-term relationships.

Another useful classification is provided by Rejda and McNamara (2017), who define **enterprise risk**, as the full range of risks faced by an organization, including pure risks, speculative risks, strategic risks, operational risks, and financial risks (pp. 24). **Strategic risk** refers to uncertainty regarding the firm's financial goals and objectives (e.g., entering a new market segment), **operational risk** results from the day-to-day business activities (e.g., cyberattacks in online banking services), and **financial risk** refers to the uncertainty of loss because of adverse changes in commodity prices, interest rates, foreign exchange rates, and the value of money (Rejda and McNamara, 2017, p. 89).

Within this framework, the distinction between **pure risks** and **speculative risks** becomes particularly relevant, especially when discussing financial risk transfer mechanisms such as insurance. Pure risks involve situations that can only result in loss or no loss (e.g., accidents, property damage, system failures), whereas speculative risks involve the possibility of both gain and loss (e.g., market or innovation risks) and are more difficult to insure because outcomes are more difficult to measure and predict (Rejda & McNamara, 2017, pp. 23–24; Haksever, 2025, pp. 433–434).

Rejda and McNamara (2017) further identify several categories of pure risks that are especially relevant for service organizations (pp. 30–31), including property risks, liability risks, loss of business income, cyber and crime risks, as well as human resource, foreign, intangible property, and regulatory risks. These categories provide a granular view of exposures that directly threaten the financial viability of service firms and are often managed through insurance and risk transfer solutions.

To support systematic risk identification, organizations frequently rely on formal structured tools. The **FIRM scorecard** classifies risks according to their primary impact on Financial, Infrastructure, Reputational, or Marketplace dependencies providing a practical way to analyze how risks affect the key dependencies that support core processes (Hopkin, 2017, pp. 134–136). *Financial* and *infrastructure* risks are internal to the organization and relate to profitability and process efficiency, while *reputational* and *marketplace* risks are mostly external and influenced by customer perceptions, with direct implications for retention and market performance. Complementary, the **PESTLE framework** (Political, Economic, Social, Technological, Legal, Environmental/Ethical) is widely used to analyze external risks, particularly in dynamic and regulated environments (Hopkin, 2017, pp. 138–139). Although these tools are not service-specific, they are valuable as they help identify similar risks across the organization, clarify responsibilities, and support more informed control decisions.

As can be seen, these general enterprise risk frameworks are primarily designed to assess risk from an organizational and objective-centric perspective. Risks are evaluated mainly in terms of their impact on financial performance, operational continuity, compliance, or strategic goals and, while reputational and marketplace risks are acknowledged, customer perceptions typically appear as secondary effects rather than as central analytical dimensions. In service contexts, where value is co-created during real-time interactions and failures are directly experienced by customers, complementary approaches may be necessary when the objective is to understand, assess, and prioritize service-related risks that manifest at the customer interface.

### *3.1.2 Operational, reputational and perceived risk in services*

General enterprise risk frameworks provide a necessary foundation for risk identification and classification, but they do not fully capture the distinctive nature of services, where operational performance and customer experience are tightly intertwined.

A central category is **operational risk**, defined as the *"risk of loss resulting from inadequate or failed internal processes, people, systems, or external events"* (Basel Committee on Banking Supervision, 2003, p. 8). These risks typically fall under the broader group of hazard risks and are closely related to infrastructure risks described in the FIRM risk scorecard. Hopkin (2017) adopts a similar logic, describing operational risk as any event that "disrupts normal everyday activities" and explicitly linking it to failures in processes, people, systems, and external dependencies (pp. 360–361).

In service settings, operational risk refers to the probability of failure in service delivery processes. Its impact is amplified by high customer contact and strong dependence on frontline employees, but it becomes truly critical because production and consumption occur at the same time. As Fitzsimmons and Fitzsimmons (2011) note, services operate as open systems in which disruptions are transmitted directly to customers, leaving little opportunity to buffer errors through inventory or rework (p. 19). Consequently, operational breakdowns are not just internal inefficiencies; they materialize immediately as delays, inconsistencies, or visible service failures.

To maintain a service-specific focus, operational risk can be usefully decomposed into a set of interrelated sub-risks that reflect how services are designed and delivered:

- **People risk** arises because service employees are often "the service" from the customer's perspective. Variability in employee attitudes, skills, and behaviors therefore becomes a major driver of risk. Fitzsimmons and Fitzsimmons (2011) note that a single employee can generate disproportionate damage when they are the firm's "sole contact" with the customer, echoing Marriott's well-known idea that satisfied customers cannot be created with unhappy employees (p. 21). Grönroos (2015) further argues that even in high-tech settings, human interaction tends to occur at critical moments of truth, such as complaints or system failures, where opportunities for recovery are limited, and employee service orientation becomes decisive (p. 64).

- **Process and service design risk** reflects the way poorly designed processes translate into slow, bureaucratic, or unreliable service delivery. Lovelock and Wirtz (2016) emphasize that ineffective process design not only wastes time and frustrates customers but also makes it harder for employees to do their jobs well (p. 74). From an operational perspective, process design directly influences failure probability, recovery capability, and execution consistency under real conditions (Fitzsimmons & Fitzsimmons, 2011, pp. 18–21).

- **Technology and system risk** refers to failures or inadequacies in information systems, digital platforms, self-service technologies, and supporting IT infrastructures. Research on self-service technologies shows that system downtime, confusing interfaces, and technical errors substantially increase customer frustration and abandonment, especially when customers are required to co-produce the service (Meuter et al., 2000; Parasuraman, Zeithaml & Malhotra, 2005, p. 8). From a service quality perspective, technology risk extends beyond internal reliability to include customers' ability to use and trust the system. Parasuraman et al. (2005) explicitly identify system availability and privacy as core dimensions of electronic service quality, stressing that even brief interruptions or perceived data insecurity can severely damage customer evaluations (pp. 8–9). This means technology risk is both technical and perceptual: a minor incident can escalate into reputational damage if customers feel uncertain, lose control, or fear negative consequences.

- **Demand–capacity risk:** stems from the perishability of service capacity because, unlike manufacturing, services cannot store output to buffer demand fluctuations. Fitzsimmons and Fitzsimmons (2011) explain that variation in demand is absorbed directly by the system, making queue and waiting-time management the functional equivalent of inventory control (pp. 19–20). They also describe how cyclic demand patterns generate peaks and valleys (for instance, lunchtime rushes), forcing managers to balance utilization against waiting time (p. 20). Grönroos (2015) illustrates capacity perishability with the classic airline example (empty seats cannot be stored) and notes that firms sometimes "keep customers in stock" by managing waiting, such as holding restaurant guests at the bar until a table is free (p. 62). This category includes the risk of customer abandonment, service overload, and reputational spillovers caused by visible congestion and delays.

- **Customer participation risk** arises because service outcomes depend partly on customer inputs and behaviors, introducing variability that is hard to fully control. Sampson and Chase (2022) argue that although more participation can empower customers, excessive participation may compromise quality, depersonalize service relationships, and undermine efficiency (pp. 3, 25). Earlier service operations research likewise highlights that customer presence introduces both opportunities and operational challenges, including efficiency losses and increased exposure to scrutiny (Mercha, 1990, p. 1).

- **Supplier and partner risk** reflects growing dependence on external actors such as IT vendors, outsourced service providers, logistics partners, and digital platforms. These dependencies fall naturally under "external events" mentioned in the Basel definition (Basel Committee on Banking Supervision, 2003, p. 8) and under Hopkin's category of external risks, which includes unsatisfactory performance by service providers and other third-party disruptions (Hopkin, 2017, p. 361). What makes this risk particularly critical is that customers often attribute the failure to the focal brand, even when the root cause lies with a partner.

Taken together, these sub-categories anchor operational risk in how services actually run: real-time production, high customer contact, perishable capacity, customer co-production, and strong reliance on people and systems (Fitzsimmons & Fitzsimmons, 2011, pp. 18–21; Grönroos, 2015, p. 64).

Closely related to operational risk is **reputational risk**. Because services are experiential and evaluated subjectively, negative encounters can quickly spread through negative word-of-mouth and damage corporate image. Grönroos (2015) emphasizes that image acts as a filter through which customers interpret service experiences; repeated operational failures can erode trust and make even minor mistakes appear more serious (p. 96). In this sense, operational issues rarely remain isolated events; they can escalate into broader reputational risks that threaten long-term customer relationships.

Hopkin (2017) describes reputation as one of an organization's most valuable assets, constructed through its capabilities, activities, service standards, and ethical conduct (pp. 240–241). Core capabilities (such as strategic planning, operational execution, compliance, and consistency) along with day-to-day activities, contribute to define the organization's internal identity. Externally, reputation is strongly influenced by perceived service quality, standards, ethical behavior and integrity, which are demonstrated through performance monitoring and continuous improvement.

Beyond firm-centered risks, services are also shaped by **perceived risk**, defined as "*uncertainty based on a person's mental condition or state of mind"* (Rejda & McNamara, 2017, p.21). Mitchell (1999) synthesizes multiple conceptualizations of perceived risk and shows that it consistently combines uncertainty and the possibility of negative outcomes (pp. 167–173). He further argues that uncertainty arises from several sources, including consumers' difficulties in evaluating attributes before purchase, forming overall brand judgments, and assessing one's own ability to judge outcomes accurately (Mitchell, 1999, p. 172).

Because services are intangible and experiential, they tend to intensify perceived risk. As Lovelock and Wirtz (2016) observe, "services are often difficult to visualize and understand, and customers perceive greater risk and uncertainty" (p. 73), especially when services are high in experience and credence attributes, and "the harder it is to evaluate a service, the higher is the perceived risk associated with that decision" of purchasing it (pp.107-109). As result of this higher uncertainty, empirical studies consistently show that services are generally perceived as riskier than goods (Guseman, 1981; Lewis, 1976; Mitchell & Greatorex, 1993). Mitchell (1999) argues that uncertainty is the dominant component of perceived risk (p. 184), implying that reducing it through information, signaling, and trust-building is just as important as reducing the likelihood of actual failures.

Marketing and service management literature identifies several dimensions of perceived risk in service consumption including **functional (**e.g., will this training course really help me get a better job?), **financial** (e.g., will repairing my car cost more than the original estimate?), **temporal** (e.g., will service at this restaurant be so slow that I will be late for my afternoon meeting?), **physical** (e.g., will the contents of this package get damaged during shipping?), **psychological** (e.g., how can I be sure that this aircraft will not crash?), **social** (e.g., will my business colleagues disapprove if I choose an unknown law firm?), and **sensory** risks (e.g., will I be kept awake by noise from the guests in the room next door?) (Lovelock & Wirtz, 2016, p. 109).

Moreover, a key insight from Mitchell's review is that consumers are "more motivated to avoid mistakes than to maximize utility" making perceived risk a powerful driver of behavior (Mitchell, 1999, p. 163). Rejda and McNamara (2017) add that subjective risk perceptions vary across individuals: people facing the same situation may assess risk differently and adjust their behavior accordingly (p. 21). High perceived risk is typically associated with more cautious, conservative behavior, whereas lower perceived risk tends to encourage more relaxed decisions.

Customers therefore actively engage in risk-reduction strategies (Lovelock & Wirtz, 2016, p. 110). They seek information from trusted personal sources, compare alternatives through online channels, read reviews or social media discussions, and build relationships with providers. They may also rely on firms with strong reputations, look for guarantees or warranties, visit facilities to inspect tangible cues, or test parts of the service before committing fully. As relationships develop and trust increases, perceived risk tends to decrease, highlighting the importance of relational continuity in services (Mitchell, 1999, p. 174).

Distinguishing between **operational risk** and **perceived risk** is thus essential in service management. Operational risk concerns the likelihood of failures within service processes, while perceived risk captures how these failures, or even the possibility of them, are interpreted by customers. A service may exhibit relatively low operational risk yet still be perceived as risky due to lack of trust or information. Conversely, effective communication, strong service quality signals, and consistent delivery can reduce perceived risk even in complex service systems. Both dimensions are deeply interconnected: operational failures can increase perceived risk, while high perceived risk can amplify the negative impact of even minor service shortcomings.

## 3.2 Risk assessment approaches in service systems

Risk assessment constitutes a core element of the risk management process and provides the analytical basis for informed decision-making in service organizations.

According to ISO 31000:2018, **risk management** consists of the "*coordinated activities to direct and control an organization with regard to risk*" (p. 1), with the purpose of creating and protecting value, improving performance, encouraging innovation, and supporting the achievement of organizational objectives (ISO 31000:2018, p. 4). Similarly, the Institute of Risk Management (IRM) defines risk management as the *"process which aims to help organizations understand, evaluate and take action on all their risks with a view to increasing the probability of success and reducing the likelihood of failure"* (Hopkin, 2017, p. 46).

Within this broader framework, risk management typically include communicating and consulting, establishing the context, and assessing, treating, monitoring, reviewing, recording, and reporting risk (ISO 31000:2018, pp. 8–9). Aven (2016) further emphasizes that risk management encompasses all measures and activities used to manage and govern risk, including decision-making and policy formation, balancing the exploration of opportunities with the avoidance of losses, accidents, and disasters, to achieve desirable outcomes (p. 7).

Among these components, **risk assessment** plays a pivotal role because it structures uncertainty in a way that allows comparison, prioritization, and appropriate mitigation or treatment strategies. Aven (2012) defines risk assessment as the *"systematic process to identify risk sources, threats, hazards, and opportunities; understand how these can occur and what their consequences can be; represent and express uncertainties and risk; and determine the significance of the risk using relevant criteria"* (p. 7). ISO 31000 summarizes this perspective by defining risk assessment as the overall process of risk identification, risk analysis, and risk evaluation (ISO 31000:2018, p. 11; Hopkin, 2017, p. 119).

The first step, **risk identification**, aims to recognize and describe events or conditions that may affect the achievement of objectives. This includes identifying risk sources, causes, vulnerabilities, capabilities and potential consequences (ISO 31000:2018, p. 11). In service contexts, such sources often include inherent variability, human behavior, organizational structures, technological systems, customer participation or external disruptions, many of which are difficult to predict and control. Basically, causes can be associated with any event, decision, action, process, or situation (favorable or unfavorable) where outcomes are uncertain (ISO/IEC 31010:2019, pp. 11, 20).

Second, **risk analysis** seeks to understand the nature and characteristics of each identified risk by examining uncertainties, likelihood, causes, consequences, existing controls, and their effectiveness in greater detail (ISO 31000:2018, p. 12). The depth pf the analysis depends on the purpose, decision context, data availability reliability, and organization's resources. In practice, risk analysis transforms descriptive risk statements into structured representations that enable comparison.

The third step, **risk evaluation**, compares analyzed risks against predefined criteria in order to judge their significance and decide whether further action is needed (ISO 31000:2018, p. 12). This step supports decisions such as accepting the risk, selecting treatment options, maintaining/strengthening existing controls, or conducing further analysis. In practice, priorities rankings are often based on an overall risk measure derived from combining a representative impact level with its likelihood of occurrence and frequently visualized using a consequence–likelihood matrix (ISO/IEC 31010:2019, p. 27).

However, risk evaluation should not be interpreted as a purely mechanical output. Aven warns that, even when confidence in the assessment is high, managers "need to see beyond" and integrate analytical results with economic factors, reputation and value-based judgment, such as contextual knowledge, stakeholder perspectives, and strategic priorities (Aven, 2012, p.11; 2016, p. 3). Accordingly, ISO 31000 stresses that risk assessment should be systematic, iterative, and collaborative, rather than a one-time technical exercise (ISO 31000:2018, p. 12), and should not be treated as an end in itself, but as a means to support informed decision-making regarding whether risks should be accepted, treated, monitored, or further analyzed (ISO 31000:2018, p. 12; Hopkin, 2017, p. 119).

Hopkin (2017) also notes that organizations must decide whether risk assessment is conducted through **a top-down** or **bottom-up approach**. *Top-down approaches*, led by a senior management, facilitate rapid identification of strategic risks but may overlook operational details and interdependencies. *Bottom-up approaches*, beginning at the operational level, may provide richer insight into process-level and frontline risks but require greater coordination and time. In practice, many organizations combine both approaches, designing assessment protocols that best match their size, complexity, and objectives.

In service systems, risk assessment present additional challenges because many risks arise dynamically during service delivery and are strongly shaped by human interaction, customer participation, and real-time interactions. As discussed in Section 3.1, simultaneous production and consumption mean failures are immediately visible to customers, leaving limited opportunity for detection and correction before impact.

For this reason, risk assessment in services must go beyond identifying technical failures. It must also support **prioritization under conditions of variability and perceptual sensitivity**, where the same operational disruption may generate different levels of customer impact depending on the service context. This reinforces the need for assessment approaches that are structured enough to allow comparison, yet flexible enough to capture service-specific characteristics.

### *3.2.1 Qualitative, semi-quantitative, and quantitative assessment*

Risk assessment techniques are designed to support informed decision-making by structuring uncertainty and clarifying its potential consequences. Within the overall risk management process, these techniques contribute not only to identifying and analyzing risks, but also to comparing alternative response strategies that may involve different trade-offs between cost, performance, and exposure (ISO/IEC 31010:2019, p. 11).

ISO/IEC 31010:2019 outlines a wide range of techniques that can be applied throughout the assessment process. These methods can be used to identify risks, determine sources, causes and drivers, analyze consequences and likelihood, evaluate the effectiveness of existing controls, understand interactions and dependencies, and derive a structured measure of risk (ISO/IEC 31010:2019, pp. 18–25). Importantly, the standard does not prescribe a universally “best” method; rather, it emphasizes that technique selection should be adapted to the specific decision context.

A common classification distinguishes between qualitative, semi-quantitative, and quantitative approaches. These differ in terms of data requirements, degree of precision, underlying assumptions, analytical complexity, and type of output. No single approach is suitable for all situations; instead, techniques should be selected according to the purpose of the assessment, stakeholder needs, the operating environment and system complexity, data availability and reliability, legal and regulatory requirements, time constraints, and the importance of the decision to be supported (ISO/IEC 31010:2019, p. 29). In many cases, combining more than one technique can provide complementary insights and a more robust understanding of risk.

**Qualitative techniques** are useful in early stages assessments or in contexts characterized by high uncertainty and limited data. They rely mainly on expert judgment and experience and typically use descriptive (nominal) or ranking (ordinal) scales to assess likelihood (e.g., rare, possible, likely) and consequences (e.g., low, medium, high) (ISO/IEC 31010:2019, p. 22). In service systems, where risks are frequently shaped by human behavior, customer participation, and situational variability, qualitative approaches play a critical role in capturing experiential insights. Even though they do not generate precise numerical estimates, they are highly valuable for building shared understanding, facilitating communication among stakeholders, and supporting the initial prioritization and screening of risks in dynamic service environments.

**Quantitative techniques**, by contrast, express both likelihood and consequences using numerical values on ratio scales, typically in terms of probabilities, frequencies, and measurable impacts such as financial loss, downtime, or number of affected users/units (ISO/IEC 31010:2019, pp. 23–24). These methods can provide more precise estimates, enable formal comparisons between alternatives and support optimization or cost-based decision-making. However, they require high-quality data and strong modelling assumptions; conditions that are often difficult to satisfy in services characterized by variability, intangibility, customer co-production and real-time delivery that makes data incomplete and context sensitive.

Sitting between these two extremes, **semi-quantitative approaches** are especially relevant for service management. They combine structured scoring systems with qualitative judgment to approximate likelihood and impact, allowing risks to be compared and prioritized without requiring fully statistical models. For instance, likelihood may be estimated numerically while consequences are rated on defined ordinal scales, or both dimensions may be assigned discrete numerical bands supported by qualitative descriptions. Risk indices and consequence–likelihood matrices fall into this category and are widely used in practice to rank and compare risks across service operations (ISO/IEC 31010:2019, pp. 22–23, 102, 113–116).

In service management, combining qualitative and quantitative approaches to risk assessment is particularly valuable because it allows organizations to capture and prioritize both; measurable operational risks (e.g., delays, system failures, financial losses), and experiential or perceptual risks shaped by customer participation, human interaction, and reputational exposure. In fact, Aven (2012) argues that "risk is more than that which is captured by the probabilistic quantities" (p. 9). Probability expresses uncertainty, but it does not capture the values at stake, so it is necessary to integrate qualitative understanding with quantitative indicators (Aven, 2016, p. 4).

Across all three approaches, risk is most commonly conceptualized as a combination of the probability (or likelihood) of an event and the severity of its consequences. However, Aven (2016) argues that this two-dimensional representation may be incomplete if it ignores the strength of the knowledge base supporting the assessment. He proposes that risk characterization should also consider the robustness of assumptions and background knowledge, since weak or uncertain knowledge reduces confidence in numerical estimates (Aven, 2016, p. 4). As a result, regardless of the technique used, risk assessment outputs should never be interpreted mechanically. Managerial judgment remains essential to account for epistemic uncertainty, data limitations, contextual factors, and other issues that may not be fully captured by the formal analysis (Aven, 2016, p. 6).

Table 3.1 summarizes selected risk assessment techniques drawn from ISO/IEC 31010 that may be relevant for service-based organizations. The techniques included cover different stages of the assessment process and vary in analytical depth, data requirements, and degree of formalization. While ISO/IEC 31010 presents a comprehensive catalogue, not all tools are equally suited to the analysis of service systems, where risk assessment approaches must not only identify hazards or estimate probabilities, but also allow a structured examination of service failure mechanisms and their potential impact on value co-creation and perceived quality.

The comparison provided in Table 3.1 therefore serves as a basis for understanding the relative strengths and limitations of different techniques, and for justifying the selection of those most appropriate for analyzing service failures in customer-facing environments.

**Table 3.1** *Selected risk assessment techniques relevant to service systems*

| Category | Technique | Main Purpose | Strengths | Limitations | Approach |
|---|---|---|---|---|---|
| Risk identification | Brainstorming / Interviews / Checklists / Surveys / Questionnaires | Early identification of service risks, process failures and uncertainties, causes, consequences, controls and treatments | Simple, easy, inexpensive, and useful when data are limited. Brainstorming promotes creativity and team engagement, interviews capture in-depth information, and surveys enables scalable and consistent data collection that can be analyzed statistically | Subjective; may overlook interdependencies. Some are time-consuming and dependent on participant expertise. Response quality varies. | Qualitative |
| Structured "What-if" analysis | SWIFT / HAZOP (Hazard and Operability Study) | Identification of deviations and weaknesses in service processes and assessment of existing controls | Structured and quick; suitable for workshops. | Depends on facilitator expertise. SWOT is less detailed while HAZOP super detailed | Qualitative |
| Causal analysis | Ishikawa (Fishbone) | Root cause analysis of service failures or complaints | Visual, simple, supports systematic thinking | No direct assessment of likelihood or impact | Qualitative |
| Failure-based analysis | FMEA / FMECA | Systematic identification, analysis and prioritization of failure modes based on severity, occurrence, and detectability. | Structured, prioritization-oriented, integrates cause–effect logic, existing controls and detection mechanisms, widely accepted. Suitable when failures can be defined and linked to service process steps. | Requires time and expert input; scoring can be subjective | Semi-quantitative |
| Probabilistic analysis | Fault Tree Analysis (FTA) / Event Tree Analysis (ETA) | Modeling combinations of critical failures and probabilities to identify potential causes or consequences | Rigorous; supports probability estimation, identifies dependencies | Requires reliable probability data less suitable in variable, human-centered service environments | Quantitative |

| Category | Technique | Main Purpose | Strengths | Limitations | Approach |
|---|---|---|---|---|---|
| Impact-focused analysis | Business Impact Analysis (BIA) / Scenario Analysis | Evaluation of service continuity impacts within plausible future scenarios | Strong for resilience and recovery planning | Focuses on impact rather than failure mechanisms. Requires expertise | Qualitative / Semi-quantitative |
| Control-focused analysis | Bow-Tie Analysis | Understanding and communicating controls, linking causes, consequences and mitigations. | Simple and strong visualization; it does not need a high level of expertise to use | It can over-simplify complex situations. | Qualitative |
| Risk prioritization | Risk Matrix / Heat Map | Ranking risks by likelihood and consequence | Simple, widely understood; supports communication | May oversimplify risk; results depend on scale design and consistency of scoring criteria. | Semi-quantitative |
| Comparison of alternatives | Cost-Benefit Analysis (CBA) / Multi-Criteria Analysis (MCA) | Evaluation of risk treatment options using costs and benefits, or multiple weighted criteria, to choose the most effective. | Supports rational, decision-making incorporating qualitative and quantitative factors. Helps achieve agreement among stakeholders. | Intangible impacts difficult to quantify. Weighting can be subjective. | Quantitative / qualitative / Semi-quantitative |
| Reliability analysis | Human reliability analysis (HRA) | Evaluate a person's contribution to system reliability and safety | It provides a formal mechanism to include human performance when considering risks. | Best suited to routine tasks. Quantification often relies on expert judgment. | Qualitative / quantitative |
| Privacy and data protection analysis | Privacy impact analysis (PIA) / Data protection impact analysis (DPIA) | Analyze how incidents could affect a person's privacy and personal data. | They help organizations comply with the requirements of the data protection regulators. | There can be underestimated calculation of the severity of risk. Can be subjective. | Qualitative |

***Note.*** Adapted from ISO/IEC 31010:2019 – Annex B

### *3.2.2 Common risk assessment techniques in services*

Service organizations operate in environments characterized by high uncertainty, real-time delivery, and strong dependence on human behavior and system interactions; consequently, risk assessment techniques are used not only to estimate likelihood and consequences but also to support learning, stakeholder participation, and managerial judgment. In practice, qualitative and semi-quantitative methods are frequently applied, particularly in early stages when uncertainty is high and reliable numerical data are limited. Although these approaches facilitate participation and the incorporation of experiential knowledge, they are inherently exposed to cognitive and social biases—such as likelihood overestimation, clustering illusion, and group conformity effects—which may compromise the reliability of the analysis (ISO/IEC 31010:2019, p. 40).

Common qualitative tools include **questionnaires**, **checklists, workshops**, and **brainstorming** sessions (Hopkin, 2017, pp. 123–124). These methods provide structured and efficient ways to gather information and explore potential risks affecting objectives, core processes, or key dependencies. Frameworks such as **SWOT** and **PESTLE** are often used to structure discussion and link risk identification to strategic analysis. While flexible and inclusive, their effectiveness depends strongly on facilitator expertise and participant knowledge, and emerging risks may remain unidentified.

Process-oriented techniques are particularly relevant in services. Although they can be time-consuming and detailed, **flowcharts analysis** help identify critical activities and interdependencies (Hopkin, 2017, p. 124). A service-specific extension is **service blueprinting**, which visually maps frontstage and backstage activities, customer touchpoints, and supporting processes. Blueprinting facilitates the identification of potential operational and experiential failure points before they materialize (Lovelock & Wirtz, 2016, pp. 441–443; Bitner et al., 2008) and it supports redesign efforts aimed at preventing errors or introducing improvements and innovations (Kingman-Brundage, 1989; George & Gibson, 1991; Bitner et al., 2008). However, these approaches primarily support visualization and understanding rather than systematic prioritization.

Once risks have been identified, organizations often rely on tools that support structuring, analysis, and prioritization. **Risk registers** provide a systematic record of identified risks, including short descriptions, sources, likelihood, consequences, existing controls, and current status (ISO/IEC 31010:2019, pp. 111–113). They are particularly useful for tracking operational and customer-related risks across multiple processes and touchpoints, and for clarifying ownership and accountability.

To analyze causes and interdependencies, cause-and-effect techniques are widely used. **Ishikawa (fishbone) diagrams** help structure potential causes across broad categories (such as people, processes, technology, and environment) and visually represent their relationship as branches and sub-branches connected to a central spine that leads to a central effect (Figure 3.1). Although primarily qualitative, these diagrams encourage participation, leverage collective knowledge, and offer a clear graphical output that can be used both to investigate past events and to anticipate factors that might drive future outcomes. However, their effectiveness depends on the choice of categories as potential causes outside the selected categories may be overlooked (ISO/IEC 31010:2019, pp. 58–60).

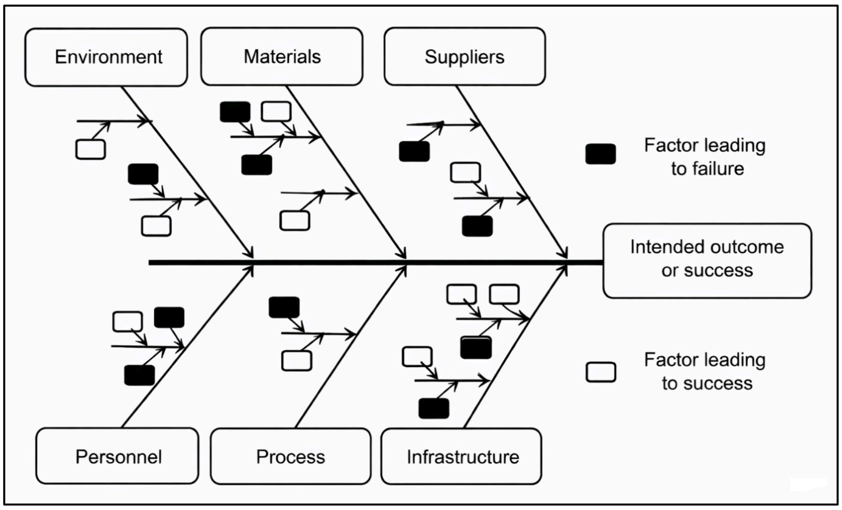



**Figure 3.1.** *Example of Ishikawa (fishbone) diagram*. Adapted from ISO/IEC 31010:2019 (p.59).

The Ishikawa diagram provide a strong foundation for **root cause analysis (RCA)**, defined by Haksever (2025) as a "*systematic investigative procedure for identifying the true sources that lead to failures in services and service processes"* (p. 443). RCA techniques have been widely adopted in healthcare and other critical service sectors, making them particularly valuable for learning and continuous improvement. However, these tools do not directly quantify likelihood or severity.

The **bow-tie diagram** integrates causes, a central risk event, consequences, and the controls that influence both likelihood and impact, into a single visual representation (ISO/IEC 31010:2019, pp. 60–62). Figure 3.2 shows a general bowtie; the central "knot" represents the event of interest; potential sources of risk appear on the left, connected to the event through causal pathways, with preventive barriers shown as vertical controls. On the right, pathways extend from the event to possible consequences, where mitigative or reactive controls are displayed. Escalation factors that may weaken controls, together with measures to address them, can also be incorporated, as well as supporting management activities such as training or inspection.

In service risk management, bow-tie analysis is a powerful tool for communicating complex risk structures and clarifying barriers and escalation factors. It supports proactive and retrospective assessment by clearly visualizing preventive and mitigative controls but remains largely qualitative and depends on the completeness and accuracy of identified pathways.

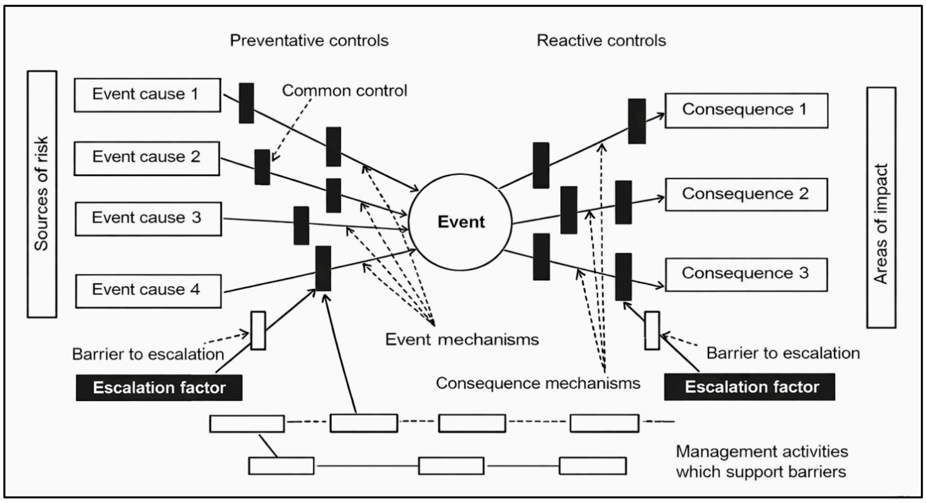



**Figure 3. 2.** *Example of bow-tie diagram*. Adapted from ISO/IEC 31010:2019 (p.61).

For risk evaluation and prioritization, **risk matrices** remain one of the most widely used tools to visualize and communicate risk exposure. They plot likelihood against consequence using customized qualitative, semi-quantitative, or quantitative scales defined by the organization (ISO/IEC 31010:2019, pp. 113–116). Typically, cells are colored to indicate the magnitude of risk and provide a rapid ranking into different significance levels (Figure 3.3).

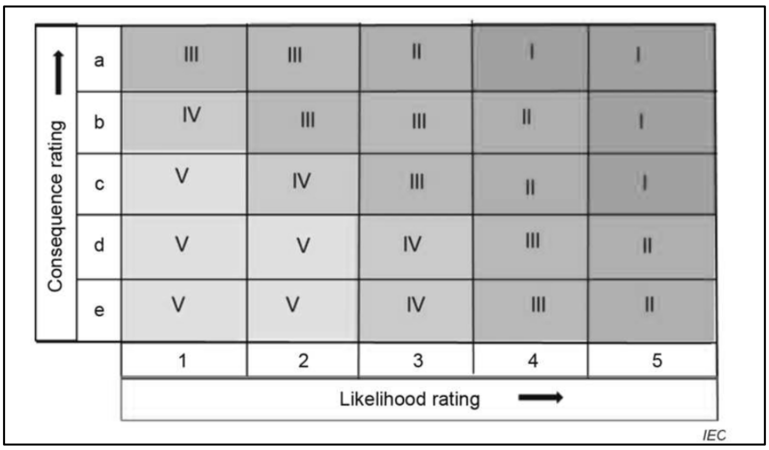



**Figure 3.3.** *Example of consequence/likelihood matrix*. Adapted from ISO/IEC 31010:2019 (p.115)

By positioning individual risks within this matrix, organizations can visualize and compare their relative importance, assess whether they fall within acceptable limits, and align risk responses with their risk appetite and capacity (Hopkin, 2017, pp. 21, 143–144). Nevertheless, results are sensitive to how scales are defined and interpreted, so outputs remain subjective and should be used with caution (ISO/IEC 31010:2019, p. 116).

Alongside risk matrices, Risk indices and Pareto charts are often used as complementary tools to rank and focus on the most significant issues. **Risk indices** use scoring approaches and ordinal scales for comparing risks. Relevant factors that are believed to influence risk magnitude are identified, scored, and combined through an equation intended to represent their relationship (in the simplest formulations, factors that increase risk are multiplied together and divided by those that reduce it) (ISO/IEC 31010:2019, p. 102). **Pareto charts**, instead, are based on the 80/20 principle to construct a graph that helps identify the small number of failure causes responsible for the majority of service problems or costs and allowing corrective actions to focus on the most impactful issues (Haksever, 2025, p. 443).

Among structured approaches, **HAZOP** systematically examines deviations from design intent guidewords to identify possible causes and consequences (ISO/IEC 31010:2019, pp. 51–52). Although it was originated in industrial and process-engineering contexts, it can be adapted to service processes, especially during design or redesign phases, to identify risks arising from procedural changes, human actions, and complex interactions. However, it can be resource-intensive and more suitable for detailed design reviews than for dynamic, high-variability service environments.

**Fault Tree Analysis (FTA)** and **Event Tree Analysis (ETA)** are structured logical techniques that model how events lead to specific outcomes. FTA uses a top-down deductive approach to identify combinations of basic failures that cause a defined "top event," while ETA follows a forward logic, starting from an initiating event and tracing sequences of control successes and failures to estimate possible consequences (ISO/IEC 31010:2019, pp. 74–78). While these techniques provide rigorous analysis for technical systems, they require clearly defined events, reliable data and strong Boolean modeling assumptions, which is difficult to satisfy in service contexts characterized by human variability and experiential outcomes.

Failure-oriented approaches such as **FMEA** and **FMECA** has gained particular importance ins service management. They provide a structured method to identify potential failure modes, analyze their causes, effects and controls, and prioritize them based on severity, occurrence, and detection criteria (ISO/IEC 31010:2019, pp. 49-50). Unlike purely qualitative tools, they integrate cause–effect logic with systematic prioritization. At the same time, they do not require the full probabilistic modeling demanded by FTA or ETA, making them particularly suitable for complex service processes where data may be limited but structured analysis is still required.

Finally, risk assessment results are often complemented by decision-support techniques such as **cost–benefit analysis (CBA)** and **multi-criteria analysis (MCA).** Both tools assist in comparing alternative treatment options; CBA evaluates their expected costs and benefits, which can be assessed qualitatively, quantitatively, or using a mixed approach (ISO/IEC 31010:2019, pp. 104–105), while MCA builds a matrix to systematically compare multiple options based on a defined set of criteria that are weighted according to their relative importance and later aggregated into an overall performance score (ISO/IEC 31010:2019, pp. 109–111). Together, these techniques help compare alternative risk treatment options by making trade-offs between economic, operational, and qualitative factors explicit, including aspects such as reputation and customer experience (ISO/IEC 31010:2019, pp. 104–111; Aven, 2016, p. 6). However, they do not replace the need for a structured identification and prioritization of failure mechanisms.

Taken together, these techniques illustrate that service risk assessment ranges from exploratory qualitative tools to highly quantitative modeling approaches. However, not all methods are equally suited to contexts where operational breakdowns must be systematically linked to customer-perceived consequences. In such settings, approaches that explicitly connect service process, failure modes, causes, controls, and impact (while allowing structured prioritization) are particularly relevant.

For this reason, the following subsection examines Failure Modes, Effects and Criticality Analysis (FMECA) in greater depth and discusses its suitability for the proposed methodology. Subsequently, service blueprinting is analyzed as a complementary process-mapping tool that supports the structured identification of failure modes in service contexts.

### *3.2.3 Failure Mode and Effects (and Criticality) Analysis in services*

**Failure Mode and Effects Analysis (FMEA)** is a structured and systematic technique originally developed in engineering and manufacturing contexts to anticipate how a system or process may fail, understand the consequences of those failures, and support preventive decision-making. IEC 60812:2018 defines FMEA as *"a systematic method of evaluating an item or process to identify the ways in which it might potentially fail, and the effects of the mode of failure upon the performance of the item or process and on the surrounding environment and personnel"* (p. 8). Its purpose is to support decisions aimed at reducing the likelihood of failures and/or their impact, contributing to outcomes such as improved reliability, reduced costs, and enhanced organizational reputation (IEC 60812, 2018, p. 8).

A key strength of the method is its flexibility. In IEC terminology, the "item" under analysis may consist of hardware, software, process, people, or any combination thereof (IEC 60812, 2018, p. 10). This makes FMEA applicable beyond purely technical systems and suitable for service operations, where failures often emerge from human behavior, information flows, system interfaces, or process breakdowns. As a matter of fact, a well-known practical classification of FMEA types distinguishes system, design, process, and service FMEA, where **service-FMEA** focuses on identifying failures before they reach the customer (Ng et al., 2017, p. 1). In service settings, this is particularly relevant because service quality is difficult to standardize and failures may trigger negative customer responses such as complaints, switching, or negative word-of-mouth (Tang et al., 2021, pp. 2–4).

FMEA relies on a consistent vocabulary that supports traceability from risk identification to action. IEC 60812 defines a **failure mode** as the *"manner in which failure occurs"* (IEC 60812, 2018, p. 9) and a failure effect as the "*consequence of a failure, within or beyond the boundary of the failed item"* (IEC 60812, 2018, p. 10). The analysis also considers **failure causes** (the circumstances that lead to failure), and how failures may be anticipated or managed through **controls and treatments** (existing provisions and actions that prevent or reduce likelihood, and/or mitigate effects) and through **detection methods** (means by which a failure mode or incipient failure becomes evident) (IEC 60812, 2018, pp. 11–12).

In practical terms, the item or process is decomposed into elements, functions and potential failure modes for each element are identified, their effects are described locally and at a broader system level, and actions are proposed to prevent failures or reduce their consequences (IEC 60812, 2018, p. 14). When prioritization of failure modes is required to support decisions about treatment, particularly under resource constraints, the analysis is extended to **Failure Mode, Effects and Criticality Analysis (FMECA)** (IEC 60812, 2018, pp. 8–9). Criticality assessment introduces a structured evaluation of the relative importance of failure modes, typically combining measures of three parameters (IEC 60812, 2018, pp. 19, 26–27):

- **Severity** (seriousness of consequences on the objectives and functions).
- **Occurrence** (likelihood that the failure occurs and leads to the stated consequences).
- **Detectability** (ability to detect the failure in time to prevent or mitigate effects).

These parameters may be assessed **quantitatively** when reliable data are available (e.g., expressing consequences as the economic cost of a failure, or using operating/test data to assign failure rates) or, more commonly in service contexts, through **qualitative or ordinal scales** when data are limited

(IEC 60812, 2018, pp. 32, 38–39). IEC recognizes multiple ways to express criticality and explicitly notes there is no universally applicable method (IEC 60812, 2018, p. 19; IEC 31010:2019, p. 50).

Two widely used approaches are the criticality matrix and the Risk Priority Number (RPN). The **criticality matrix** refers to the same consequence/likelihood matrix illustrated in Figure 3.3, created by combining severity and occurrence values into a ranked grid used to produce a measure of importance and prioritize treatments. IEC also warns that extending matrices to multiple dimensions can become complex and not cost-effective, since each combination requires assessment (IEC 60812, 2018, pp. 40–41), so some graphical tricks to embed detectability are using different font size, background colors or increasingly large bubbles while representing the associated failure modes.

The **Risk Priority Number (RPN)** is a semi-quantitative index calculated by multiplying ordinal ratings of Severity (S), Occurrence (O), and Detection (D) (IEC 60812, 2018, p. 43):

$$\mathrm{RPN} = \mathrm{S} \times \mathrm{O} \times \mathrm{D} \qquad (2)$$

The RPN can be applied at the level of failure modes or at the level of cause–effect–detection combinations (Snee & Rodebaugh, 2007, p. 1), and provides values ranging from 1 to 1000 when standard 1−10 ordinal scales are used for each parameter (IEC 60812, 2018, p. 43), with 10 representing a catastrophic outcome, a highly probable occurrence or virtually impossible detection before its effects occur. Higher RPN values indicate higher relative priority for action, and when similar RPN values occur, IEC recommends using severity as an additional discriminator (IEC 60812, 2018, p. 44). However, IEC also highlights important limitations: because S, O, and D are ordinal and equally weighted, the RPN scale is not continuous, ratios between values have no strict proportional meaning, and small changes in one parameter can create large shifts in RPN (IEC 60812, 2018, pp. 43–44). RPN should therefore be interpreted as a relative prioritization signal, rather than a precise quantitative measure of risk magnitude.

Moreover, IEC 60812 states that “severity or criticality need not be the only consideration when deciding priorities for treatment”; decisions should also consider feasibility, cost-effectiveness, implementation difficulty, and potential impacts elsewhere in the system (IEC 60812, 2018, p. 32).

To conduct a FMECA, IEC 60812:2018 outlines a sequence of structured steps (pp. 22–29, 38-39):

1. **Subdivision of the item** or process into elements or steps, with the appropriate level of detail determined by the context and objectives of the study, balancing analytical depth and effort.

2. **Identification of functions and performance standards** for each element, clearly distinguish acceptable performance from failure in the context of use of the item or process, and preferably using unambiguous and, where possible, quantitative criteria.
3. **Identification of failure modes** by describing all credible ways in which each element may fail to meet its performance requirements, and relevant to the objective of the analysis, drawing on prior analysis, experience, databases, tests, checklists and expert knowledge.
4. **Identification of existing controls and detection methods** for each failure mode, including mechanisms that prevent, mitigate, or detect failures.
5. **Identification of failure effects**, both at the local and at the overall system level, in sufficient detail to enable an accurate severity assessment, and having into account that the same failure effect might be caused by one or more failure modes of one or more elements.
6. **Identification of failure causes,** considering technical, human, organizational, and environmental factors, as well as possible common cause failures (i.e., when more than one element fails simultaneously). While FMECA does not require full causal analysis, understanding failure mechanisms supports the selection of effective risk treatments.
7. **Evaluation of relative importance or criticality**, using severity, occurrence, and, when applicable, detectability ratings. These scales must be clearly defined, meaningful in the analytical context, aligned with available data, and consistently applied to support reliable prioritization. This step result is a ranked and prioritized list of all failure modes, typically based on RPN values or a Criticality Matrix.
8. **Identification of improvement actions**, aimed at eliminating failure modes, reducing their likelihood, improving their detection or mitigating their effects. It might be necessary to reassess the analysis to check if treatment actions have been effective, introduce new failure modes or shift criticality, enabling the team to reduce levels of risk for the most critical factors over time (IEC 60812, 2018, pp. 28-29; Snee & Rodebaugh, 2007, p. 1).

FMECA is usually performed by a cross-functional team with expert knowledge, and documented through a structured worksheet containing failure modes, causes, effects, controls, criticality ratings, and recommended actions (IEC 31010:2019, p. 50). For practical efficiency, Snee and Rodebaugh (2007) suggest limiting sessions to a few hours and completing the worksheet across multiple working meetings (p. 2).

As a decision-support tool, FMECA offers significant **advantages,** including adaptability across industries, systematic risk identification and prioritization, and iterative reassessment after improvements (IEC 60812, 2018, pp. 8, 14). It is therefore widely used to improve existing products and processes and during design stages to reduce failure risks (Snee & Rodebaugh, 2007, pp. 1–2). Tang, Cen, and Lin (2021) describe FMEA as “useful quality management technique for enhancing the reliability and safety of systems, products, processes, and services”, emphasizing its preventive nature and its usefulness in prioritizing improvement investments and mitigating workflow failures through proactive measures (pp. 3–4). In service contexts, this supports a shift from reactive recovery to preventive risk management by identifying weaknesses that could lead to delays, errors, unmet expectations, or inappropriate employee behavior. Similarly, Haksever (2015) highlights that proactive application increases resilience by detecting vulnerabilities before failures occur, while also serving retrospectively to analyze failures and develop countermeasures (pp. 442–444).

Nevertheless, important **limitations** must be acknowledged. IEC 60812 notes that FMEA primarily addresses single failure modes and is less suited to modelling complex combinations of interdependent failures, for which complementary techniques such as fault tree analysis may be appropriate (IEC 60812, 2018, pp. 14, 25; IEC 31010:2019, p. 50). Additionally, the method can be time-consuming and, when quantitative data are missing, FMECA depends heavily on expert judgment and semi-quantitative scales, introducing subjectivity and variability (IEC 60812, 2018, pp. 32, 38–39, Tang et al., 2021, p.2). Finally, service studies emphasize that traditional FMEA can overrepresent the provider's perspective and underrepresent the customer's perspective, motivating integration with customer-oriented tools such as QFD or SERVQUAL (Ng et al., 2017, p. 2; Tang et al., 2021, pp. 4–5, Sutrisno & Lee, 2011, p.26).

In services, FMEA aligns naturally with process-based thinking and service mapping approaches, such as **service blueprinting,** as both techniques focus on understanding how value is created and where breakdowns may occur along the service delivery process. Evidence from logistics services also shows that service blueprinting can be used to clarify the service process and identify likely failure points before FMEA scoring (Tang et al., 2021, p. 6). Accordingly, empirical studies, particularly in healthcare and logistics services, show that combining FMEA with complementary tools such as root cause analysis (RCA) and Pareto charts enhances risk identification and prioritization (Haksever, 2015, pp. 443–444).

Within the methodological framework developed in this thesis, FMECA is adopted as the core technique for operational risk assessment, obtaining a ranking of service failure modes based on their operational criticality. These results then become the input for the subsequent stages of the framework, where failure modes are linked to SERVQUAL dimensions to support prioritization that explicitly incorporates how operational risks are expected to materialize from the customer's perspective. This integration enables the development of a perceptual risk evaluation (PRE), extending conventional FMECA beyond internal reliability assessment toward a dual operational–experiential risk framework designed for service systems.

To ensure that failure modes are systematically identified before being assessed through FMECA, a structured representation of the service process is required. For this reason, the next subsection examines service blueprinting as a foundational tool for process mapping and risk identification in service systems.

### *3.2.4 Service Blueprinting as a process mapping tool for risk identification*

Service blueprinting is a process-oriented visualization technique used to represent service delivery systems by mapping customer actions, frontstage and backstage activities, support processes, and the physical evidence experienced along the service journey. It creates a structured overview that captures the service experience as it unfolds over time, from service initiation to the final delivery of the desired benefit, which may involve multiple steps and service employees across different departments (Lovelock & Wirtz, 2016, p. 440). In this sense, blueprinting provides a common language to analyze services as integrated systems rather than isolated tasks.

Bitner, Ostrom and Morgan (2008) describe service blueprinting as a customer-focused mapping tool that visualizes the service process, contact points, and physical evidence "from a customer's point of view," helping organizations identify failure points, areas for improvement, and innovation opportunities (Bitner et al., 2008, p. 11). The technique was originally introduced by Shostack (1984) as a service design and process control tool to "explore all the issues inherent in creating or managing a service" by making service processes explicit and analyzable (Shostack, 1984, p. 134). Over time, service blueprinting evolved toward a more customer-oriented representation, including explicit distinctions between onstage and backstage activities, clearer interfaces across departmental lines, and a stronger alignment between customer processes and organizational structures (Bitner et al., 2008, p. 5; Kingman-Brundage, 1989, pp. 30–33).

A typical service blueprint includes five core components (Bitner et al., 2008, p. 6):

a. **Customer actions**, depicted chronologically across the top of the blueprint, forming the backbone of the service experience and framing all supporting activities.
b. **Onstage (visible) contact employee actions**, representing frontline activities performed in direct interaction with customers.
c. **Backstage (invisible) contact employee actions**, which support service delivery but remain unseen by customers, such as preparation activities or non-visible interactions (e.g., telephone calls).
d. **Support processes**, performed by internal units or systems that enable service delivery but do not directly interact with customers (e.g., information systems or supply-related processes).
e. **Physical evidence**, including all tangible cues to which customers are exposed and that influence their service quality perceptions. Shostack (1984) emphasizes their role as

"circumstantial evidence" through which customers evaluate services; tangibles can reinforce or contradict the lived experience (Shostack, 1984, p. 136).

Blueprints are structured through conceptual boundaries such as the **line of interaction**, which separates customer actions from onstage employee actions, and the **line of visibility**, which distinguishes visible from invisible organizational activities. **Vertical connections** link customer-facing touchpoints with backstage and support mechanisms, while links crossing the line of interaction help identify critical "moments of truth" in the service experience (Bitner et al., 2008, p. 6). As Grönroos (2015) notes, blueprinting depicts subprocesses and their relationships to customer contact points, establishing interdependencies between frontstage interactions and back-office activities in order to analyze how services can be designed to support customer-perceived service quality (Grönroos, 2015, p. 393).

The construction of a service blueprint typically begins with a clear definition of the service process (or subprocess) under analysis and the relevant customer segment. Customer actions are mapped first, followed by onstage and backstage employee actions, then support processes, and finally physical evidence (Bitner et al., 2008, p. 7). One of the key strengths of blueprinting is its flexibility: it can be developed at different levels of detail depending on the purpose and complexity of the service, ranging from high-level conceptual representations to detailed operational maps of individual process steps (Bitner et al., 2008, p. 4; Shostack, 1984, p. 134).

As an illustration, Figure 3.4 presents a blueprint for a one-night hotel stay that captures customer actions (e.g., check-in, receiving room service, check-out), visible contact employee actions, invisible employee activities, supporting systems (e.g., reservation and registration), and physical evidence shaping customer quality perceptions (Bitner et al., 2008, pp. 7–9).

Service blueprinting is ideally conducted through cross-functional teams, often involving frontline employees and, when possible, customers. This collaborative approach enhances shared understanding of the service system and facilitates alignment across organizational functions (Bitner et al., 2008, p. 7). Combined with discussions with customers and frontline employees, blueprinting helps organizations identify which service attributes and process characteristics are most relevant to customers at each touchpoint (Lovelock & Wirtz, 2016, p. 454).

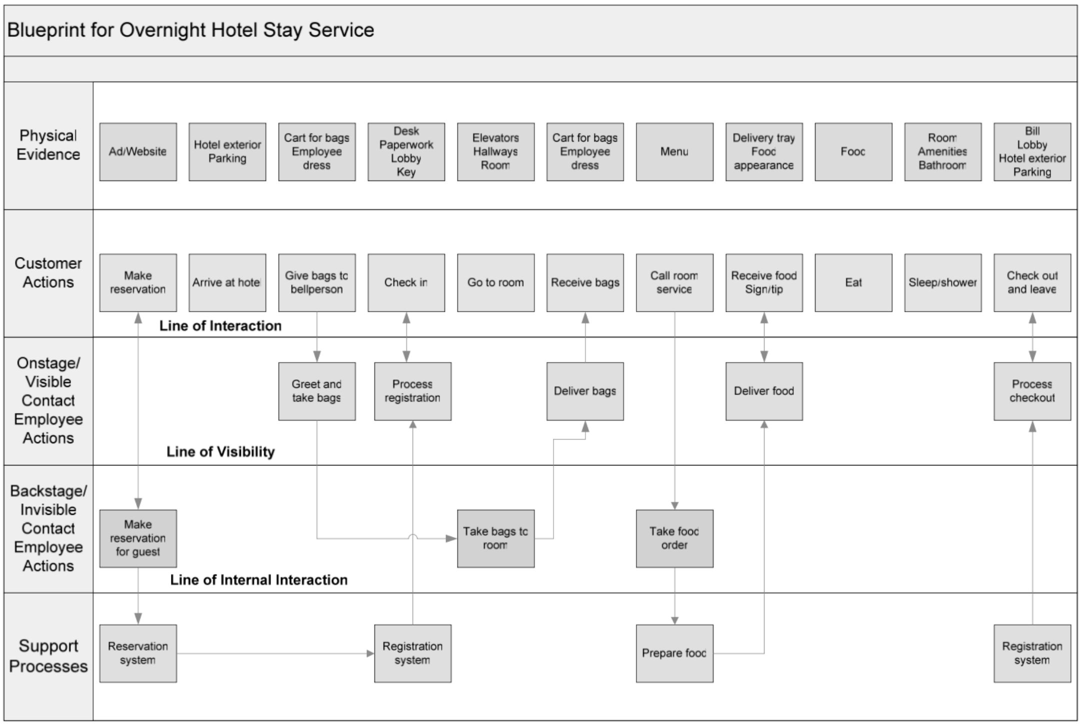



**Figure 3.4.** *Example of a Service Blueprint for a hotel service*. Adapted from Bitner et al. (2008, p. 9).

A central managerial value of service blueprinting lies in its ability to **identify where services may fail** and where customers may experience delays or inconsistencies. Shostack (1984) explicitly frames blueprinting as a way to "isolate fail points" and design fail-safe subprocesses, arguing that the consequences of service failures can be reduced and execution quality enhanced by analyzing vulnerabilities during the design stage (Shostack, 1984, pp. 135–136). Lovelock and Wirtz (2016) similarly argue that "a good blueprint should draw attention to the points in service delivery where things are particularly at risk of going wrong" and highlight stages where customers commonly wait, including potentially excessive waiting times (Lovelock & Wirtz, 2016, p. 452). Once fail points are identified, further analysis may reveal opportunities for fail-proofing (e.g., poka-yoke), service recovery procedures, and process redesign aimed at eliminating failure causes or mitigating their impact (Lovelock & Wirtz, 2016, pp. 441–443, 453).

In many service blueprints, **service standards** (such as expected completion times and acceptable waiting times) are defined for individual activities to guide service delivery teams and ensure alignment with customer expectations. These standards support performance measurement, quality control, and productivity improvement (Shostack, 1984, p. 135; Lovelock & Wirtz, 2016, pp. 441–443).

Tang, Chen and Lin (2021) argue that service blueprint is an essential tool for a service process analysis as it "helps solve incomplete descriptions, oversimplified service process, failures, or other problems during the service delivery process" (p.6). Service blueprinting is widely used for service innovation, quality improvement, customer experience design, and strategic customer-focused change, as it provides a shared visualization that is easy for different stakeholders to understand and discuss (Bitner et al., 2008, pp. 3–5, 13–18). Shostack (1984) highlights that blueprints are more precise than verbal definitions, reduce ambiguity and misinterpretation, encourage proactive problem solving, and reduce inefficiencies in service development (Shostack, 1984, p. 139). Bitner et al. (2008) further emphasize its versatility, and the organizational benefits observed in practice, including improved service performance, increased customer satisfaction and loyalty, and cost efficiencies (Bitner et al., 2008, p. 10).

However, service blueprinting remains largely qualitative and **relies on process knowledge and expert input**. For highly variable or complex services, blueprints can become detailed and difficult to manage. Moreover, while blueprinting is effective for identifying fail points and critical touchpoints, it does not by itself quantify risk criticality or prioritize improvement actions; it is therefore most effective when combined with structured risk assessment tools.

In this thesis, service blueprinting provides the foundational step of the PRISM Framework by structuring the service delivery system into phases, process steps, and customer touchpoints. This enables the systematic identification of potential failure modes at risk-bearing points of the service experience, which constitute the input for subsequent risk assessment and prioritization stages (FMECA), ensuring that managerial decision-making is grounded in a clear and customer-centered understanding of the service process. This application is supported by prior literature recommending the development of a structured process map before undertaking an FMECA analysis (Snee & Rodebaugh, 2007, pp. 1–2), and more explicitly studies on logistics services that shows how service blueprinting can be used to clarify the service process and identify likely failure points before FMEA scoring (Tang et al., 2021, p. 6).

## 3.3 Risk response strategies in service operations

Once service-related risks have been identified and assessed, organizations must review existing controls and determine whether further actions are required (Hopkin, 2017, p. 175). According to ISO 31000:2018, the purpose of risk treatment is to "select and implement options for addressing risk" (p. 13). These options may involve reducing likelihood, mitigating consequences, removing risk sources, sharing risk, retaining risk by informed decision, or even increasing risk to pursue an opportunity. The choice among these alternatives requires balancing expected benefits against costs, effort, and potential unintended consequences (ISO 31000:2018, p. 13; ISO 9001:2015, clause 6.1.2). Importantly, risk treatment actions themselves may introduce new risks, which must also be identified, monitored, and managed.

In service operations, risk treatment is particularly complex because services are produced and consumed simultaneously, rely on human interaction, and are directly evaluated by customers. As a result, mitigation strategies must address not only operational reliability but also customer-facing impact and perceived quality. ISO 9001:2015 reinforce this logic through its emphasis on **risk-based thinking**, requiring organizations to determine and address risks and opportunities that may affect service conformity and customer satisfaction (ISO 9001:2015, clauses 4.4.1, 5.1.1, 6.1). Although the standard does not mandate formal risk management techniques, it places responsibility on organizations to ensure that actions are proportionate to the potential impact of risks (ISO 9001:2015, pp. 5, 21). As Haksever (2025) summarizes, "identifying, analyzing, assessing, treating, and managing risks is part of the risk management duty of service managers" (p. 432).

Risk treatment decisions should be aligned with the risk assessment results. Within the methodological framework developed in this thesis, treatment strategies are informed by the structured identification of service failure modes and their relative operational criticality, while also recognizing that service failures may have differentiated implications for customer-perceived quality. Accordingly, response strategies are grounded in systematic assessment rather than intuition alone.

### 3.3.1 Risk treatment aligned with failure mode prioritization

Building on his risk classification, Hopkin (2017) explains that **hazard risks** are typically managed through a tolerance-based approach, **control risks** through the management of variability and uncertainty (e.g., contingency time or financial buffers), and **opportunity risks** through an investment appetite aligned with the organization's risk capacity (pp. 40–43, 17). **Compliance risks**, in contrast, are minimized by embedding controls into core processes to ensure adherence to rules and regulations (p. 150).

Opportunity risk management is closely linked to hazard risk management, since pursuing favorable situations (e.g., new services, productivity improvements) may introduce additional exposures (ISO 9001:2015, clause 0.3.3). Accordingly, opportunity risks are embraced while carefully balancing risk and reward (Hopkin, 2017, p. 18). Hopkin (2017) identifies four strategic responses—**explore, expand, exploit, and exit**—depending on risk appetite, capacity, and organizational maturity (pp. 182–185): start-ups typically explore high-risk, low-return opportunities; growing firms expand to pursue higher rewards; mature firms exploit lower-risk, high-return opportunities; and organizations may eventually exit markets where both risk and reward decline.

For **hazard risks,** Hopkin (2017) emphasizes preventing losses, limiting damage, and containing recovery costs (p. 43). He summarizes response options through the well-known “4Ts” framework (pp. 176–182):

- **Tolerate (accept)**: retain risk within defined tolerance levels.
- **Treat (reduce)**: reduce likelihood and/or consequences through controls.
- **Transfer (share)**: shift part of the risk to third parties (e.g., insurance, outsourcing).
- **Terminate (avoid)**: discontinue activities generating unacceptable risk.

Hopkin links these responses to risk significance using a risk matrix logic: low-likelihood/low-impact risks are typically tolerated; high-likelihood/low-impact risks are treated; low-likelihood/high-impact risks are transferred; and high-likelihood/high-impact risks are avoided or terminated (Hopkin, 2017, p. 148). Consequently, the selection among response options depends on risk significance, and must remain consistent with the organization’s risk appetite, risk capacity, and actual risk exposure.

Haksever (2025) argues that reducing, avoiding, or transferring risks is central to decreasing vulnerability and increasing resilience in service systems (p. 432). However, in service environments, complete avoidance is often unrealistic due to inherent variability, customer participation, and real-time delivery. Consequently, treatment strategies tend to focus primarily on risk reduction and mitigation, complemented by selective transfer and the acceptance of low-impact or unavoidable risks.

Hazard risk mitigation is operationalized through **controls**, defined by ISO 31000:2018 as *“measures that maintain and/or modify risk”* (p. 2). Hopkin (2017) classifies controls into four categories (pp. 186–195):

- **Preventive controls:** reduce the likelihood of failure (the most effective).
- **Corrective controls**: limit consequences and facilitate recovery.
- **Directive controls:** guide behavior through rules, policies, and training, though heavily dependent on compliance.
- **Detective controls**: identify failures after occurrence and are appropriate when residual losses are acceptable.

The bow-tie representation helps visualize this structure, distinguishing preventive controls (acting before the central event) from corrective and detective controls (acting after the event), while directive controls may support both prevention and mitigation (Hopkin, 2017, p. 188).

Within a FMECA-based framework, these control types align with the three scoring dimensions; actions reducing **occurrence** correspond to preventive controls; those that improve **detectability** to detective controls; and actions reducing **severity** to corrective or recovery measures. Although criticality results help prioritize failure modes and guide mitigation efforts, treatment decisions should not rely solely on the index. Instead, underlying drivers of criticality should be analyzed to determine whether preventive, detective, corrective, or combined controls are most appropriate.

In **service settings**, controls typically include standardized procedures, defined roles, training programs, capacity planning, and error-proofing mechanisms. In customized services, excessive standardization may reduce flexibility and negatively affect customer experience, requiring a balance between consistency and adaptability. On the other hand, in systems with time-perishable capacity and fluctuating demand, mitigation measures often involve demand smoothing (e.g., reservations or differential pricing), flexible capacity management (e.g., part-time staff or self-service technologies), and waiting management practices (Fitzsimmons & Fitzsimmons, 2011, p. 20). However, since these operational controls may introduce experiential or reputational risks if customers perceive waiting as unfair or poorly managed, effective risk treatment must also balance operational stability with customer experience considerations.

### *3.3.2 Operational resilience and service recovery*

Beyond traditional control-based mitigation, service risk management increasingly emphasizes the importance of vulnerability, robustness and resilience. The Society for Risk Analysis Glossary defines **vulnerability** as *the degree to which a system is affected by a risk source*; **resilience** as the *ability to sustain or restore functionality following a disruptive event*, including its absorptive, adaptive, and restorative capabilities; and **robustness** as the *ability to achieve goals despite large uncertainty,* often considered the opposite of vulnerability (SRA, 2018, pp. 6-7). Strengthening robustness and resilience while reducing vulnerability is therefore essential for defending service systems against risk (Haksever, 2025, p. 440).

Resilience improvement is widely regarded as an integral component of risk management (Haimes, 2009). In service contexts, robust processes reduce variability and enhance reliability, which in turn strengthens customer satisfaction (Weiss & Goldberg, 2019). Common resilience-enhancing strategies include redundancy (e.g., backup systems or alternative suppliers), flexible and modular process design, secure information systems, and continuous monitoring of emerging risks (Haksever, 2025, pp. 440–441). Error-proofing techniques such as poka-yoke (Shingo, 1986), when adapted to services and combined with tools like service blueprinting, aim to prevent errors or detect them immediately so corrective action can be taken (Haksever, 2025, pp. 441–442). Together, these mechanisms reduce the probability that small deviations escalate into systemic failures.

These approaches align with Aven's (2016) distinction between risk-informed, cautionary (or precautionary), and discursive strategies. **Risk-informed** strategies rely on structured assessment results to guide treatment decisions. **Cautionary strategies** emphasize safety margins, redundancy, flexibility, and early detection to cope with deep uncertainty. **Discursive strategies** focus on building trust through communication, stakeholder involvement, and transparency (Aven, 2016, pp. 6–7). Effective risk management typically requires a combination of these approaches rather than reliance on a single logic (Aven, 2012, p. 7).

However, even robust and resilient systems cannot eliminate all service failures. Because services are co-produced and involve human interaction, breakdowns are inevitable, and service recovery becomes a central mitigation mechanism. **Service recovery** refers to the *"systematic efforts by a firm to correct problems following service failures and retain customer goodwill"* (Lovelock & Wirtz, 2016, p. 740). Rather than representing passive risk acceptance, recovery constitutes a deliberate strategy to limit the consequences of failure.

Service recovery serves both relational and operational purposes. It seeks not only to restore satisfaction but to maintain and potentially strengthen long-term customer relationships (Grönroos, 2015, p. 141). At the same time, recovery processes generate data that provide valuable insight into failure causes and system weaknesses, supporting continuous improvement and the design of more reliable service systems (Tax & Brown, 1998).

Research consistently shows that dissatisfaction often stems less from the initial failure than from how the firm responds. Bitner, Booms, and Tetreault (1990) demonstrate that frontline employee behavior during recovery strongly shapes whether customers perceive an encounter as satisfactory or dissatisfactory (p.74). Inadequate reactions—such as blaming the customer or failing to apologize—may produce a "double deviation," where both the initial service that failed and the recovery are perceived negatively, amplifying negative evaluations (Bitner et al., 1990, pp. 74–80).

Effective recovery therefore requires speed, fairness, empathy, and appropriate compensation (Grönroos, 2015; Lovelock & Wirtz, 2016). Systems should facilitate easy feedback, train and empower frontline employees, rely on planned recovery procedures for recurrent failures, and integrate systematic learning from incidents (Lovelock & Wirtz, 2016, pp. 742–748). Responses should also be calibrated to failure severity, as more serious incidents require stronger managerial involvement and corrective action (Johnston & Fern, 1999).

The literature discusses the **service recovery paradox**, which suggests that customers who experience a failure followed by excellent recovery may report higher satisfaction than those who experience no failure at all. Hart, Heskett, and Sasser (1990) argue that effective recovery can transform dissatisfied customers into loyal ones and generate more goodwill than flawless service (p. 148), leading some authors to frame failures as opportunities to enhance satisfaction (Berry & Parasuraman, 1991, cited in Johnston, 1999, p. 70).

However, empirical evidence indicates that this effect is context-dependent and far from universal (Lovelock & Wirtz, 2016, pp. 741–742). McCollough, Berry, and Yadav (2000) find little general support for the paradox, showing that customers typically prefer reliable, error-free service, as faultless performance reinforces trust and confidence (pp. 122, 133). Therefore, recovery should not be viewed as a substitute for prevention but as a complementary resilience mechanism.

Within service risk management, resilience and recovery are tightly interconnected. Robust design reduces the likelihood of failure; resilient structures enable adaptation and containment; and effective recovery limits reputational damage while generating organizational learning. Together, these elements transform mitigation from a purely preventive exercise into a dynamic capability that supports long-term reliability, adaptability, and customer trust.

### *3.3.3 Perceived risk mitigation and learning cycles*

Many of the most critical service risks emerge during service encounters, defined as the interactions between customers and service employees through which service evaluations are formed (Bitner, Booms & Tetreault, 1990, pp. 71–72). These encounters constitute key "moments of truth," where minor issues can escalate into reputational damage if handled inadequately. Research shows that dissatisfaction is often shaped less by the initial failure itself than by the employee's response to unexpected situations, special requests, or customer concerns (Bitner et al., 1990, pp. 74–76). Consequently, mitigation in services cannot rely solely on technical reliability or controls; it must also address behavioral competence, relational skills, and frontline empowerment.

Because services are intangible and cannot be fully evaluated before consumption, customers often rely on reputation, visible cues, and credibility signals (Fitzsimmons & Fitzsimmons, 2011, p. 20). Lovelock and Wirtz (2016) explicitly note that "customers are risk-averse and will choose the service with the lower perceived risk" (p. 110). Reducing perceived risk therefore functions both as a defensive mechanism and as a competitive strategy that strengthens trust and long-term relationships.

Service firms can proactively reduce perceived risk through previews or trials, clear communication of service benefits, professional credentials, tangible evidence management, visible safety procedures, real-time status information, and guarantees (Lovelock & Wirtz, 2016, pp. 110–112). Over time, consistent risk-reducing signals build confidence and "peace of mind," reinforcing loyalty even when price differentials exist (Fitzsimmons & Fitzsimmons, 2011, p. 42). In regulated industries, licensing and certification further reduce perceived uncertainty, although excessive regulation may constrain flexibility and innovation.

Effective mitigation also depends on continuous monitoring, feedback, and organizational learning. ISO 9001:2015 explicitly states that "the organization shall plan actions to address risks and opportunities and how to evaluate the effectiveness of these actions" (clause 6.1.2). In service contexts, failures, complaints, near-misses, and recovery episodes provide valuable information about process weaknesses, communication gaps and recurring issues. Grönroos (2015) emphasizes that "it is important that the firm analyses the root cause of a problem and corrects the underlying processes or attitudes" (p.146). When this information is systematically analyzed and integrated into process redesign, training, and standards, mitigation evolves from reactive correction to proactive improvement. This learning-oriented approach reinforces the idea that risk management is a continuous cycle of identification, response, evaluation, and improvement. As Rajda and McNamara (2017) emphasize, a risk management program must "be periodically reviewed and evaluated to determine whether the objectives are being attained or if corrective actions are needed" (p. 77).

Customer-perceived mitigation and learning cycles are therefore mutually reinforcing. Effective encounters reduce immediate dissatisfaction and reputational exposure, while structured learning improves future reliability and consistency. Importantly, because failures are ultimately evaluated through customer perceptions of quality, mitigation priorities cannot be based exclusively on operational considerations. The perceived impact of failures across different quality dimensions may alter the relative importance of improvement actions. Integrating structured operational assessment with customer-oriented evaluation therefore supports more balanced and strategically aligned mitigation decisions.

Overall, this chapter has conceptualized risk in service systems as a multidimensional phenomenon that affects both operational performance and customer perception. **Section 3.1** showed that traditional enterprise risk classifications must be adapted to the distinctive characteristics of services, where failures materialize at the customer interface. **Section 3.2** examined structured assessment approaches and identified FMECA as an appropriate foundation for analyzing and prioritizing operational failure modes, while acknowledging the limitations of purely criticality-based measures. **Section 3.3** expanded the discussion toward treatment strategies, emphasizing that effective mitigation in services requires preventive controls, resilience-enhancing mechanisms, recovery capabilities, perceived risk reduction, and continuous learning processes.

Together, these insights justify the need for an integrated methodological approach in which operational criticality assessment is complemented by explicit evaluation of customer-perceived impact to guide improvement actions aimed at continuously enhance service systems. The PRISM framework developed in Chapter 5 builds directly on this foundation by combining structured failure mode analysis with perceptual evaluation to support more coherent and strategically informed risk mitigation decisions.

# 4. Integrating Service Quality into Risk Prioritization

## 4.1 Risk materialization and perceptual allocation mechanism

Quality management and risk management seem to converge in service systems through a common underlying driver: **variability.** While quality management seeks to meet or exceed customer expectations and risk management aims to reduce uncertainty and potential losses, both ultimately attempt to control variability in service performance. Deming (1986) famously argues that uncontrolled variability is the "central problem of management" (p. 20), as it generates failures, inefficiencies, and rework with clear economic consequences. In service systems, this variability does not remain confined to internal operations; it immediately shapes customer experience.

Core characteristics of services (intangibility, heterogeneity, inseparability, and perishability) limit the possibility of inspection, buffering, or correction before delivery (Fitzsimmons & Fitzsimmons, 2011, p. 19; Grönroos, 2015, p. 50). Failures therefore materialize in real time and are immediately experienced by customers rather than remaining internal process deviations. A delayed order, incorrect information, billing error, or unfriendly interaction is not only an operational deviation but also a perceived quality deficiency. As Grönroos (2015) notes, service failures may originate not only from provider errors but also from customer actions or contextual factors (p. 141), further reinforcing the complexity of risk materialization in co-produced environments.

Operational risk assessment tools such as FMECA provide a structured and internally consistent representation of failure criticality by evaluating likelihood, severity, and detectability (IEC 60812, 2018). This approach supports rational prioritization of mitigation efforts within the service system. However, because services are co-created and evaluated subjectively, the consequences of a failure are not exhausted by their technical or operational effects but filtered through customer perceptions of service quality.

Service quality research has long emphasized that customers evaluate services across multiple dimensions. The SERVQUAL framework conceptualizes perceived service quality as a multidimensional construct comprising reliability, assurance, tangibles, responsiveness, and empathy (Parasuraman et al., 1988). Similarly, Grönroos (2015) distinguishes between technical quality (what is delivered) and functional quality (how it is delivered), arguing that both influence overall customer evaluations (pp. 95–100). Moreover, because services are difficult to evaluate prior to consumption, customers rely on visible cues of competence, reliability, and trustworthiness to reduce uncertainty (Lovelock & Wirtz, 2016, pp. 109–110).

As a result, **operational failures are translated into perceived quality deficits along evaluative dimensions**. A delay may be interpreted as unreliability; unclear communication may undermine assurance; indifferent behavior may erode empathy. The same operational event can generate different perceptual consequences depending on the dimension through which it is experienced. This distinction has direct implications for risk prioritization. Two failure modes with similar operational criticality may differ substantially in how they affect customer perceptions. Conversely, a failure mode with moderate operational risk may concentrate its perceptual impact strongly on a dimension that customers consider highly salient. Evaluating risk exclusively through internal criticality metrics may therefore overlook how that risk is actually experienced, interpreted, and remembered by customers.

In service systems, risk does not fully materialize until it is perceived. Quality failures simultaneously generate operational, reputational, and perceptual consequences. As Grönroos (2015) emphasizes, "word of mouth can only be managed indirectly, by eliminating mistakes and negative customer experiences, and when service failures sometimes happen, by recovering the failure properly in a customer-centric manner" (p. 318). Operational variability becomes reputational exposure when filtered through customer evaluations of quality.

Rather than conceptualizing service quality dimensions as causal drivers of risk, this thesis treats them as **perceptual lenses through which operational failures materialize** in the customer experience. Integrating quality evaluation into risk assessment does not replace internal criticality analysis but complements it by allocating perceptual impact across evaluative dimensions. This perceptual allocation mechanism makes explicit how operational variability translates into customer-perceived consequences and clarifies where operational risk becomes most visible and potentially most damaging.

This conceptual bridge provides the foundation for the PRISM Framework developed in Chapter 5, where operational failure modes identified through service blueprinting and prioritized through FMECA are further examined in terms of their perceptual impact using a structured relationship matrix inspired by QFD logic. Through this integration, risk prioritization becomes not only technically grounded but also perceptually informed, aligning mitigation decisions with both operational criticality and customer-experienced impact.

## 4.2 Economic implications of quality and perceptual alignment

The economic implications of service quality have long been a central concern in both quality management and service management literature. While quality-related activities—such as training, process redesign, preventive controls, and monitoring—were traditionally viewed as costs that erode short-term profitability, contemporary quality and risk management perspectives argue that poor quality is considerably more expensive than investing in improvement. In this sense, quality is not merely an operational attribute, but an economic and strategic variable closely linked to risk exposure.

Deming (1986) explicitly challenges the belief that better quality inevitably increases costs. On the contrary, he argues that quality improvement initiates a **"chain reaction"** in which fewer mistakes, reduced rework, and more effective use of resources lead to lower costs, higher productivity, and greater competitiveness (pp. 15–17). He emphasizes that defects and errors are not free, "the further a mistake goes without correction, the greater the cost to correct it" (Deming, 1986, p. 174), and that when processes are unstable, organizations operate in a state of unpredictability. In services, where failures are experienced directly by customers, these costs are amplified by reputational damage and lost future business. As Deming (1986) notes, the "multiplying effect of an unhappy customer" is largely unknown and uncontrollable (p. 24).

Juran formalizes this logic through the **Cost of Poor Quality (COPQ) framework**, which categorizes quality-related costs into prevention, appraisal, and failure costs (Juran & Godfrey, 1999, pp. 8.4–8.8). Failure costs—both internal (rework, downtime, corrections) and external (complaints, penalties, customer defections)—typically represent the largest share and may exceed total profits, making them the primary target for cost reduction and for eliminating sources of dissatisfaction. From a risk management perspective, failure costs correspond to realized risk outcomes, while prevention costs (planning, design, process control, supplier quality, training) represent proactive investments in reducing the likelihood and severity of adverse events. As root causes are eliminated, appraisal costs (inspection, testing, audits, and review activities) can also decline (Juran & Godfrey, 1999, p. 8.10).

In service contexts, the economic impact of poor quality extends beyond visible operational losses. Juran highlights the existence of **"hidden costs"** such as lost sales, reputational damage, customer churn, system downtime and variability-driven inefficiencies (Juran & Godfrey, 1999, p. 8.11). These are difficult to quantify and may be several times larger than recorded failure costs. Grönroos (2015) similarly argues that the assumption that mistakes are inevitable undermines improvement efforts (p.127) and that high quality does not inherently imply higher costs; in many service organizations, a significant share of operating costs stems from error correction and inefficient processes (p. 159). Improving quality therefore often reduces total costs while strengthening market performance.

However, in service systems, economic consequences are not determined solely by the technical magnitude of failures but by how those failures are perceived and interpreted by customers. Service quality strongly influences loyalty, retention, and word-of-mouth behaviors (Lovelock & Wirtz, 2016, p. 136). Very satisfied customers repurchase more, stay loyal longer, and recommend more actively, while dissatisfied customers can generate disproportionate negative effects, particularly in digitally connected environments (Grönroos, 2015, pp. 159–161). This means that beyond cost reduction, improving quality also has a direct impact on **revenue generation** as it increases customer satisfaction, repeat purchases, and positive word-of-mouth (Juran & Godfrey, 1999, p. 7.2).

This perspective reinforces the importance of perceptual alignment in risk prioritization. If operational risk assessments focus exclusively on internal criticality metrics, organizations may allocate resources toward failures that are technically severe but perceptually less salient, while underinvesting in failures that strongly affect dimensions customers consider central. Misalignment between operational prioritization and customer-perceived impact can therefore distort resource allocation, weaken return on quality (ROQ), and reduce the effectiveness of mitigation efforts.

Juran's notion of **"return on quality" (ROQ)** emphasizes that quality investments should be evaluated in terms of their economic returns or expected benefits (Juran & Godfrey, 1999, p. 8.15). From a risk management perspective, quality investments operate as economic risk controls. Preventive improvements reduce the probability of failures; effective recovery and interactional competence limit the severity of consequences; and a strong corporate image built on sustained positive quality perceptions stabilize demand and customer relationships over time. When operational risk analysis is aligned with customer-perceived impact, investments are more likely to target failure modes that simultaneously reduce internal costs and protect revenue streams.

Overall, the economic argument supports recognizing quality as a strategic investment and integrating perceptual evaluation into risk management decisions. In service organizations, risk materializes not only through operational losses but through customer interpretation and behavioral response. Ensuring that mitigation priorities reflect both technical criticality and perceptual impact increases the likelihood that quality investments generate tangible economic returns, protect organizational value, and support long-term competitiveness.

# 5. Methodological Proposal

This chapter introduces the **PRISM Framework (Perceptual Risk Integration for Service Management)**, a structured decision-support tool that assists managers in prioritizing improvement actions aimed at reducing service-related operational risks by explicitly integrating customer-perceived service quality dimensions into the risk assessment process.

Figure 5.1 illustrates the conceptual logic underlying PRISM. At the **operational level**, service-related risks originate from root causes that generate failure modes within service delivery processes. These failure modes give rise to operational risk and impact customer experience. At the **perceptual level**, such impacts are filtered through service quality dimensions, which function as evaluative channels through which operational risk materializes in the customer's experience. At the **management level**, the perceived distribution of risk across these dimensions informs decision priorities and guides improvement actions aimed at mitigating failure causes, thereby reducing customer-perceived manifestations of operational risk.

To illustrate this logic, consider a restaurant setting. A failure cause such as inadequate staff scheduling (operational level) may generate a failure mode such as long waiting times. Internally, this may be assessed as a moderate operational risk. However, from the customer's perspective (perceptual level), waiting time may strongly affect the reliability and responsiveness dimensions. If these dimensions are highly salient for customers, the perceptual impact of this failure may be disproportionately large relative to its internal criticality score. At the management level, the framework reallocates attention toward this failure mode, prioritizing scheduling adjustments or capacity redesign to reduce both operational variability and customer-perceived dissatisfaction.

Through this three-level structure—operational, perceptual, and managerial—the methodology ensures that risk prioritization remains technically grounded while explicitly incorporating how failures are experienced and evaluated by customers.

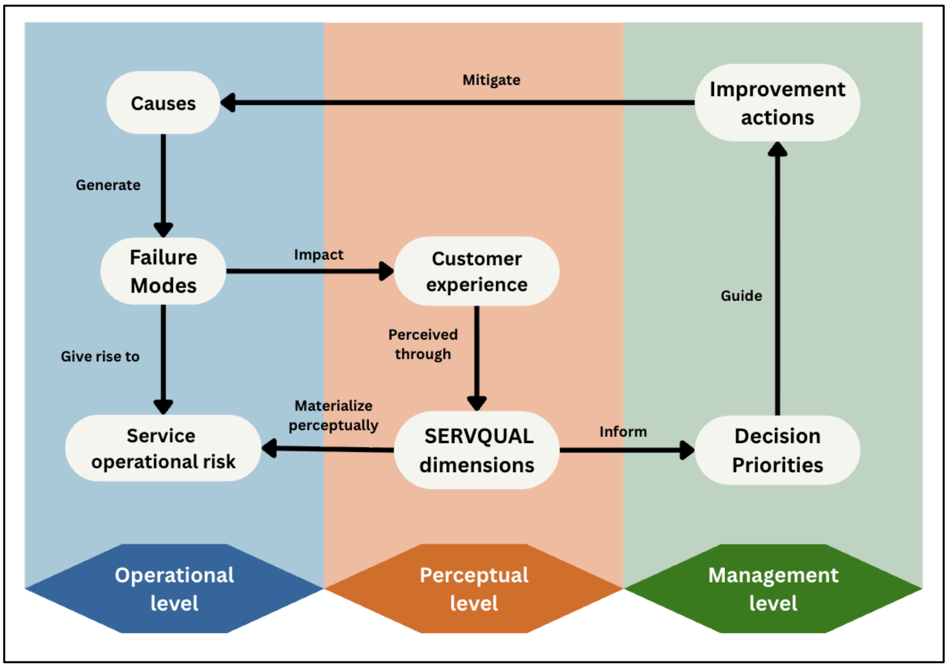



**Figure 5.1.** *Conceptual logic behind the proposed methodology; linking service operational risk, customer perceptions, and management decisions.*

The PRISM Framework integrates established tools from service operations management, risk analysis, and quality management, namely Service Blueprinting (Shostack, 1984; Bitner et al., 2008), Failure Mode, Effects and Criticality Analysis (IEC 60812, 2018), SERVQUAL (Parasuraman et al., 1988), and Quality Function Deployment (Akao, 1990; Chan & Wu, 2002; Franceschini, 2001). Rather than testing causal relationships, the methodology is designed to support structured managerial decision-making under uncertainty by combining internal operational criticality assessment with perceptual impact allocation.

The framework is named **PRISM** because, much like a prism refracts white light into its constituent spectral colors, the proposed methodology "refracts" operational risk criticality through multiple dimensions of perceptual service quality. In doing so, it makes visible how internal failures are experienced across customer-relevant evaluative channels. PRISM thus enables managers to examine operational risk not solely from an internal reliability perspective, but through a structured perceptual lens that reveals where its impact is most salient in the customer experience.

## 5.1 Objective, scope, and underlying assumptions

The objective of the proposed methodology is to provide a structured decision-support framework that **helps managers prioritize improvement actions** aimed at reducing service-related operational risks. It integrates service process analysis, structured risk assessment, and customer-perceived service quality dimensions to support informed decision-making under conditions of uncertainty and limited resources, consistent with risk management principles outlined in ISO 31000:2018 (pp. 8–9) and Aven's (2016) view of risk-informed decision support (pp. 6–8).

The scope of the methodology is restricted to **service-related operational** risks arising from failures in service delivery processes that negatively affect customers and organizational performance (e.g., inefficiencies, human or system issues, design limitations). Non-operational categories such as strategic or financial risks are explicitly excluded. As discussed in Chapter 4, because of the real-time and co-produced nature of service delivery, operational failures are immediately experienced by customers. Therefore, the PRISM Framework intents to evaluate risks not only in terms of internal criticality but also in terms of how they are perceived by customers across service quality dimensions, which function as perceptual channels through which operational risk becomes materialized in the customer experience.

The proposed methodology does not aim to statistically test causal relationships between service quality and risk, nor to predict risk occurrence or quantify financial losses. Instead, it is designed to support relative prioritization by identifying critical service failures, assessing their risk levels, and highlighting the service quality dimensions through which those risks are most strongly perceived, so that improvement efforts target areas expected to yield the greatest reduction in customer-perceived operational risk. This approach aligns with risk assessment practices designed for structured comparison and prioritization rather than precise probabilistic forecasting (ISO/IEC 31010:2019, pp. 18–29; Hopkin, 2018, p. 122–127).

The PRISM Framework is developed under the following **assumptions:**

- Service delivery processes can be described and decomposed into phases and steps, using Service Blueprinting (Shostack, 1984; Bitner et al., 2008).
- Potential service failures and their underlying causes can be systematically identified at critical touchpoints along the service process (Bitner et al., 2008).
- The severity, occurrence, and detectability of service failures can be assessed using expert judgment and/or available operational data, consistent with FMECA guidelines (IEC 60812, 2018).
- Customer-perceived service quality can be described using the SERVQUAL dimensions (Parasuraman et al., 1988, p.23).
- The relationships between service failure modes and service quality dimensions can be assessed qualitatively using a structured QFD-style relationship matrix (Akao, 1990, pp. 6–

7; Chan & Wu, 2002, p.30, Franceschini, pp. 27–29), supported by expert judgment and, when available, customer perception data.

The methodology combines **qualitative** and **quantitative** inputs, depending on context and data availability. In its core application, both risk assessment and perceptual allocation rely primarily on structured expert judgment supported by ordinal scales, consistent with semi-quantitative risk assessment approaches (ISO/IEC 31010:2019, pp. 22–23). When available, operational indicators and customer perception data may enhance the robustness of the analysis.

Importantly, **SERVQUAL dimensions** are not treated as causal drivers of failures, but as analytical lenses capturing how operational failure effects are experienced and interpreted by customers. Improvement actions are directed toward failure causes and modes, while service quality dimensions guide the prioritization of such actions by indicating where operational risk becomes most visible and most damaging from the customer's perspective.

Finally, risk prioritization is assumed to be **context-dependent and dynamic.** The framework is therefore designed for iterative application, allowing reassessment after improvement actions are implemented, in line with the continuous improvement principles of risk management processes emphasized in ISO 31000:2018 (p. 8).

## 5.2 Methodological structure and analytical steps

The PRISM Framework is structured as a sequence of six analytical stages (Sections A-F) that progressively link operational risk assessment with customer-perceived service quality considerations and translate this analysis into managerial decision priorities. Each stage builds on the outputs of the previous ones, as depicted in Figure 5.2 and summarized in Table 5.1.

**Table 5.1.** *Methodological stages, inputs, activities and outputs.*

| Section | Analytical stage | Main inputs | Core activities | Main outputs |
|---|---|---|---|---|
| **A** | Service Process and Failure Mode Identification | Service Blueprint; expert knowledge | Identification of service phases, process steps, touchpoints, and potential failure modes within the service delivery process. | List of identified failure modes |

| Section | Analytical stage | Main inputs | Core activities | Main outputs |
|---|---|---|---|---|
| **B** | Risk Assessment (FMECA) | Failure modes (Section A); expert judgment and/or operational data; ordinal S–O–D scales | Assessment of severity (S) at failure mode level; identification of failure causes; evaluation of occurrence (O) and detectability (D); computation of RPN values | RPN values for each failure mode; ranking of service-related operational risks |
| **C** | QFD Relationship Matrix | Failure modes; SERVQUAL dimensions; expert judgment and/or customer perception data | Evaluation of the qualitative relationships between failure modes and service quality dimensions using a QFD-based matrix | QFD relationship scores ($r_{f,d}$) |
| **D** | Normalized Contribution Weights | QFD relationship scores (Section C) | Normalization of relationship scores to derive relative contribution weights per failure mode and SERVQUAL dimension | Normalized contribution weights ($w_{f,d}$) |
| **E** | Perceived Risk Exposure (PRE) by SERVQUAL dimensions | RPN values (Section B); normalized contribution weights (Section D) | Integration of operational risk criticality and perceptual impact by computing PRE values, aggregation of risk contributions by SERVQUAL dimension | PRE values by service quality dimension; relative PRE shares |
| **F** | Managerial Prioritization and Decision Rules | PRE results (Section E); RPN values and failure causes (Section B) | Identification of priority service quality dimensions; selection of key failure modes and critical causes; definition of improvement actions | Priority ranking of dimensions; prioritized failure modes and causes; managerial decision rules |

***Section A: Service Process and Failure Mode Identification***

At the initial stage, the service delivery process is analyzed using Service Blueprinting principles (Shostack, 1984; Bitner et al., 2008) to identify critical service phases, frontstage and backstage activities, risk-bearing process steps, and potential failure modes as deviations from expected service performance. This stage establishes the operational boundary of the study and produces the set of service failure modes to be evaluated in subsequent stages.

***Section B: Risk Assessment (FMECA)***

In section B, a structured risk assessment is performed using Failure Mode, Effects and Criticality Analysis (FMECA) (IEC 60812, 2018). For each identified failure mode in Section A, the effects on service outcomes and customer experience are described, and the severity (S) of the failure mode is assessed. Failure causes are then identified and evaluated in terms of their likelihood of occurrence (O) and detectability (D), allowing the computation of Risk Priority Numbers (RPN). The objective of this stage is to prioritize service failures based on their relative operational criticality within the analyzed service context.

***Section C: QFD Relationship Matrix***

Section C introduces the perceptual layer by linking service failure modes to service quality dimensions. A QFD-based relationship matrix is used to assess the expected impact of each failure mode on the SERVQUAL dimensions (reliability, responsiveness, assurance, empathy, and tangibles) (Parasuraman et al., 1988, p.23). The matrix structure follows the logic of the House of Quality (Akao, 1990; Chan & Wu, 2002). Relationships are evaluated using expert judgment and/or supported by customer perception data, on a standard and consistent ordinal scale (0–1–3–9), indicating how strongly each failure mode is expected to negatively affect customer-perceived service quality.

***Section D: Normalized Contribution Weights***

To enable meaningful comparison across dimensions, the relationship scores obtained from the QFD matrix are normalized to derive relative contribution weights for each service quality dimension per failure mode. The Lyman normalization is used (Franceschini, 2001, p.71) to ensure that the perceptual impact of each failure mode is distributed proportionally across quality dimensions, avoiding distortions due to absolute scoring levels.

***Section E: Perceived Risk Exposure by SERVQUAL dimension***

Section E integrates the operational and perceptual analyses by combining the RPN values obtained from FMECA (Section B) with the normalized contribution weights derived from the QFD analysis (Section D). This computation results in the **Perceived Risk Exposure (PRE)** for each SERVQUAL dimension, representing the aggregated share of operational risk that materializes through each evaluative channel of service quality.

***Section F: Managerial Prioritization and Decision Rules***

Finally, Section F translates analytical results into managerial guidance. Service quality dimensions are ranked based on their share of total PRE, the most relevant failure modes and causes linked to each dimension are identified, and improvement actions are defined at the level of failure causes, with quality dimensions used as prioritization lenses rather than direct intervention targets. The objective of this final stage is to support the selection and prioritization of managerial actions aimed at reducing customer-perceived manifestations of service-related operational risk.

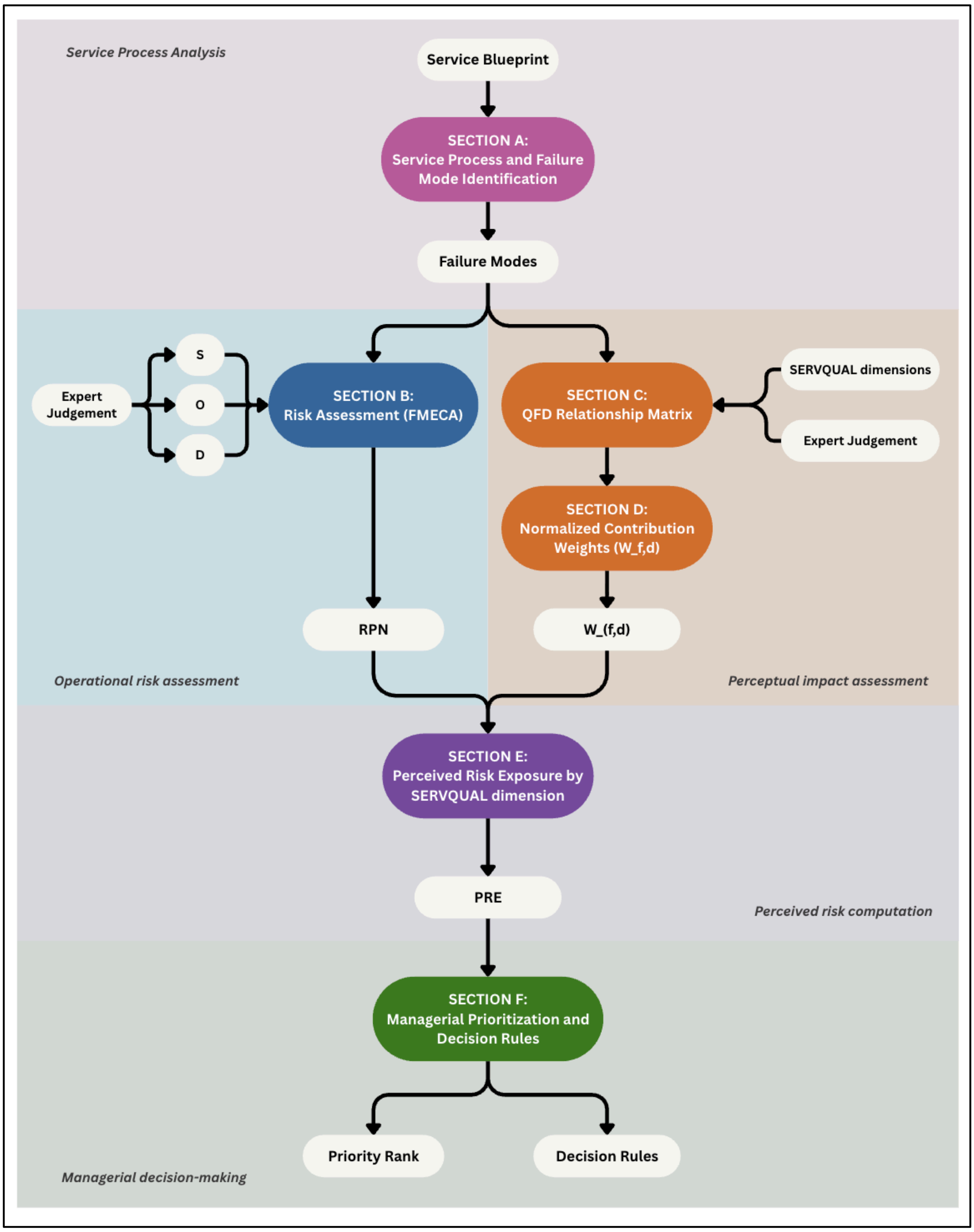



**Figure 5.2.** *Methodological structure of the PRISM Framework.*

In short, the main outputs of the methodology include:

- a ranking of operational risks, based on RPN values;
- a ranking of service quality dimensions based on their contribution to overall perceived risk exposure (share of total PRE);
- the identification of perceptual prioritization levers (i.e., the dimensions through which service-related operational risk is most strongly manifested to customers);
- the identification of high-impact failure modes and causes;
- guidance for prioritizing managerial actions aimed at preventing and mitigating service failures and their underlying causes.

## 5.3 Operational computation and support template

To support the application of the PRISM Framework, a decision-support template was developed by integrating principles from Service Blueprinting, FMECA, and SERVQUAL–QFD analysis into a structured assessment tool divided into the six analytical sections described in Section 5.2.

The design of the template is grounded in established best practices from service operations management, risk analysis, and quality function deployment. Service Blueprinting provides a systematic method for mapping service processes and identifying potential breakdown points (Shostack, 1984; Bitner et al., 2008). FMECA offers a structured approach to failure analysis and prioritization based on severity, occurrence, and detectability (IEC 60812, 2018). SERVQUAL provides a validated multidimensional structure for analyzing customer-perceived service quality (Parasuraman et al., 1988), while QFD contributes a formal relationship-matrix logic for translating qualitative relationships into structured decision inputs (Akao, 1990; Chan & Wu, 2002).

Rather than introducing new analytical constructs, the PRISM template recombines these established tools into an integrated sequence aimed at supporting managerial prioritization under uncertainty, consistent with structured risk-informed decision-making practices (ISO 31000:2018; Aven, 2016). Its **purpose** is to guide analysts and managers through the systematic identification of service processes and failure modes, the structured assessment of service-related operational risks, and the prioritization of improvement actions based on how these risks materialize perceptually through service quality dimensions.

Figure 5.3 presents an overview of the complete template, while the following subsections describe each component in detail, including its objective, methodological basis, and interpretation guidelines. The template is illustrated through a simplified example of a generic service restaurant, with the sole purpose of clarifying the structure, logic, and practical application of the methodology.

Three usage principles should be emphasized:

1. The PRISM template is designed for implementation in spreadsheet software or equivalent decision-support tools.
2. It is conceived as a flexible artefact that can be adapted to different service contexts and data availability conditions.
3. It supports iterative application over time, enabling reassessment of perceptual risk exposure after improvement actions have been implemented, in line with continuous risk management principles (ISO 31000:2018).

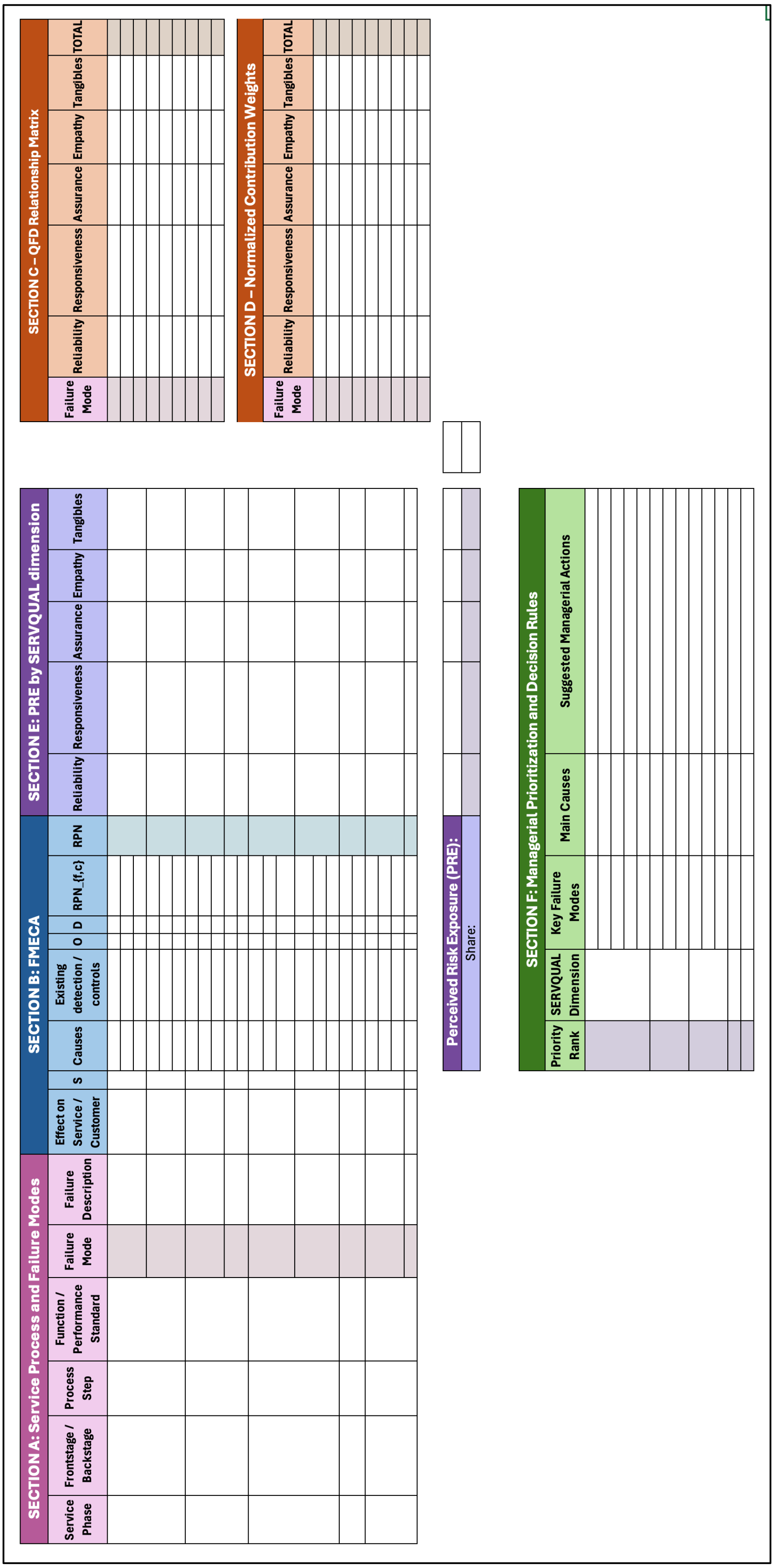



**Figure 5.3.** *Service Risk – Quality Decision-Support Template.*

### *5.3.1 Section A – Service Process and Failure Mode Identification*

**Objective:** to systematically identify risk-bearing service processes and potential failure modes along the service delivery system, using a structured representation of the service process.

This stage establishes the operational foundation of the PRISM Framework by mapping service phases, process steps, and interaction points between the organization and the customer. The objective is to identify where deviations from expected service performance may occur, recognizing that in services such deviations are experienced in real time and directly influence customer perceptions due to the simultaneity of production and consumption (Fitzsimmons & Fitzsimmons, 2011, pp. 19–20; Grönroos, 2015, pp. 50–52).

Service Blueprinting is recommended as the primary structuring tool due to its service-specific focus, flexibility, and explicit differentiation between frontstage and backstage activities (Shostack, 1984; Bitner et al., 2008). However, alternative process modeling tools such as BPMN (ISO/IEC 19510:2013) may be used and adapted to this template when more convenient and aligned with organizational standards, provided that customer interaction points remain clearly identifiable.

**Table 5. 2.** *Section A – Service Process and Failure Mode Identification.* Illustrative example.

| SECTION A: Service Process and Failure Mode Identification | | | | | |
|---|---|---|---|---|---|
| **Service Phase** | **Frontstage / Backstage** | **Process Step** | **Function / Performance Standard** | **Failure Mode** | **Failure Description** |
| Arrival & Seating | Frontstage | Guest reception | Guests are greeted promptly and seated within X minutes according to reservation or availability policy. | A: Long waiting time | Waiting time exceeds defined standard. |
| | | | | B: Unfriendly greeting | Staff shows lack of courtesy or attention (interaction does not meet defined courtesy standard). |
| Ordering | Frontstage | Order taking | Orders are accurately recorded and menu information is clearly communicated. | C: Wrong order recorded | Incorrect dish or modifications registered |
| | | | | D: Incomplete information | Staff unable to explain menu or allergens |
| Food Preparation | Backstage | Kitchen preparation | Meals are prepared according to order specifications and within target preparation time. | E: Order delay | Preparation time exceeds expected duration |
| | | | | F: Incorrect dish prepared | Kitchen prepares wrong item |
| Service Delivery | Frontstage | Food serving | Food is delivered at appropriate temperature and presentation standard. | G: Cold food | Food temperature not adequate at delivery |
| Payment | Frontstage | Billing | Billing is accurate and payment systems operate without interruption. | H: Billing errors | Incorrect bill or overcharge |
| | | | | I: POS system down | Payment system temporarily unavailable |

**Guidelines:**

- Information related to the service process should be collected through internal documentation, direct observation, interviews with service managers and frontline employees, and analysis of historical records or complaint databases when available, consistent with structured risk identification practices (IEC 60812, 2018, pp. 23–24; ISO/IEC 31010, 2019, pp. 46–55).
- When convenient, the Service Blueprint should be used to structure the analysis, distinguishing service phases, process steps, frontstage and backstage activities, and failure modes, although alternative process-mapping tools may be used.
- For each process step, the function and/or performance standard should be identified, preferably using unambiguous and, where possible, quantitative criteria (60812, 2018, p. 23).
- Service failures are identified through expert workshops, interviews, checklists based on generic failure modes, and analysis of historical records or databases when available (IEC 60812, 2018, p. 23).
- Failure modes should be defined as observable deviations from expected service performance standards at a specific process step, consistent with FMECA terminology (IEC 60812, 2018, p. 23). Each failure mode must be clearly distinguishable and operationally meaningful. Typical examples include excessive waiting times, inaccurate information, system breakdowns, or inappropriate employee behavior.
- Each service phase can include one or more process steps, and each process step can present several failure modes. Each failure mode should be recorded separately, identifying all credible failure modes relevant for the analysis objectives (IEC 60812, 2018, p. 23).
- Failure modes should be defined independently of their causes, which are analyzed in detail in Section B during the FMECA stage.
- The level of detail should be sufficient to support meaningful risk assessment and prioritization, while avoiding excessive fragmentation of failure modes. This aligns with cost-effectiveness considerations in IEC 60812 (2018, p. 25).

### *5.3.2 Section B – Risk Assessment (FMECA)*

**Objective:** to assess the criticality of each identified failure mode by evaluating its severity, occurrence, and detectability, in order to prioritize service-related operational risks within the analyzed service system.

This section applies a structured **Failure Mode, Effects and Criticality Analysis (FMECA),** consistent with IEC 60812 (2018), as the operational criticality layer of the PRISM Framework. It provides a systematic and internally consistent prioritization of operational risks before perceptual redistribution in later stages. This application explicitly distinguishing failure modes from their underlying causes, allowing multiple causes to be associated with a single failure mode, with the purpose of enhancing analytical precision, managerial traceability and the definition of targeted improvement actions.

**Table 5.3.** *Section B – Risk Assessment (FMECA).* Illustrative example.

| | SECTION B: FMECA | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Failure Mode | Effect on Service / Customer | S | Causes | Existing detection / controls | O | D | RPN_{f,c} | RPN |
| A: Long waiting time | Customer frustration; abandonment; negative reviews | 4 | A1: Understaffing at peak hours | Host visual check; reservation list | 4 | 3 | 48 | 48 |
| | | | A2: Poor table turnover (slow clearing/payment) | Floor supervision (ad hoc) | 3 | 3 | 36 | |
| | | | A3: Overbooking / inaccurate reservation pacing | Reservation system view; manual adjustments | 2 | 4 | 32 | |
| B: Unfriendly greeting | Lower perceived welcome; reduced satisfaction; negative word-of-mouth | 3 | B1: Lack of training / service culture | Manager observation (sporadic) | 3 | 4 | 36 | 36 |
| | | | B2: Workload/stress at peak | Ad hoc floor support | 4 | 3 | 36 | |
| | | | B3: Hiring mismatch / attitude issues | Customer complaints after event | 2 | 5 | 30 | |
| C: Wrong order recorded | Wrong dish delivered; rework; longer cycle time; dissatisfaction | 4 | C1: No repeat-back / confirmation of order | Repeat-back (inconsistent) | 3 | 3 | 36 | 48 |
| | | | C2: Complex modifiers / POS interface issues | POS review at kitchen pass | 2 | 4 | 32 | |
| | | | C3: Noise + multitasking (busy floor) | Usually detected only at delivery | 3 | 4 | 48 | |
| D: Incomplete information | Reduced trust; perceived risk; potential safety concern; dissatisfaction | 3 | D1: Missing standardized allergen info / unclear menu | Detected when customer asks | 2 | 4 | 24 | 24 |
| | | | D2: Staff knowledge gaps | Manager intervention when escalated | 2 | 4 | 24 | |
| E: Order delay | Long time-to-serve; customer irritation; table turnover loss | 4 | E1: Bottleneck / line imbalance (hot vs cold station) | Ticket times (if monitored); expo supervision | 4 | 3 | 48 | 48 |
| | | | E2:Insufficient prep (mise en place) | Informal checks pre-service | 3 | 3 | 36 | |
| | | | E3: Equipment downtime / limited capacity | Staff reporting; reactive maintenance | 2 | 4 | 32 | |
| F: Incorrect dish prepared | Wrong meal served; waste; re-prep; dissatisfaction | 4 | F1: Ticket misread / unclear modifiers | Expo check (if present) | 2 | 3 | 24 | 32 |
| | | | F2: Breakdown in FOH–BOH communication | Usually detected at delivery | 2 | 4 | 32 | |
| | | | F3: No final check at pass | Detected only by customer | 1 | 5 | 20 | |
| G: Cold food | Lower perceived quality; complaints; reduced repurchase | 3 | G1: Food waiting at pass (no runner available) | Visual check (rare) | 3 | 3 | 27 | 27 |
| | | | G2: Slow runner / understaffing FOH | Customer complaint after serving | 2 | 4 | 24 | |
| H: Billing errors | Perceived unfairness; distrust; complaints; dispute at checkout | 4 | H1: Manual entry errors / split bills complexity | Customer checks bill; manager override | 2 | 4 | 32 | 32 |
| | | | H2: Discounts/promos applied incorrectly | End-of-shift audit (post-event) | 2 | 4 | 32 | |
| | | | H3: Incorrect POS mapping/menu items | Periodic admin review | 1 | 5 | 20 | |
| I: POS system down | Payment delays; frustration; potential lost sales | 3 | I1: Network issues | Immediate system error | 1 | 5 | 15 | 15 |

**Guidelines:**

- For each failure mode identified in Section A, the potential effects on the service process (operational consequences) and on the customer experience (service outcome consequences) should be clearly described.
- A severity score (S) should be assigned to each failure mode, reflecting the seriousness of its effects assuming the failure occurs (IEC 60812, 2018, p. 19).
- For each failure mode, the underlying causes and existing detection or control mechanisms should be identified, including mechanisms that prevent, mitigate, or detect failures (IEC 60812, 2018, pp. 23–26).
- Failure modes may originate from operational inefficiencies, human factors, system-related issues, inadequate service design, or customer-induced disruptions (Grönroos, 2015, p. 141; Fitzsimmons & Fitzsimmons, 2011, p. 122).
- When appropriate, cause-identification techniques such as Ishikawa diagrams (ISO/IEC 31010:2019, pp. 58–60) or Root Cause Analysis (Haksever, 2025, p. 443) may be used to support structured analysis.
- For each failure cause associated with a failure mode, an occurrence score (O) and a detectability score (D) should be assigned (IEC 60812, 2018, p. 19).
- Predefined and appropriate ordinal scales should be used to evaluate severity, occurrence, and detectability, considering quantitative data when available (IEC 60812, 2018, p. 32).
- The Risk Priority Number (RPN) for each failure mode–cause pair should be computed as (IEC 60812, 2018, p. 42):

$$RPN_{f,c} = S_f \times O_{f,c} \times D_{f,c} \quad (3)$$

- When multiple causes are associated with a single failure mode, the overall RPN of the failure mode is determined as:

$$RPN_f = \text{maximum}\ (RPN_{f,c,}) \quad (4)$$

  This reflects the most critical contributing cause and supports targeted managerial intervention.

It is important to acknowledge the well-known **limitations of the RPN.** Evaluations of S, O, and D are based on ordinal scales and expert judgement, which may introduce subjectivity and ambiguity, and which multiplicative aggregation to compute the RPN does not imply ratio-scale properties. As noted by Hassan et al. (2009); “the three indices used for RPN are ordinal scale variables that preserve rank but the distance between the values cannot be measured since a distance function does not exist, thus, the RPN is not meaningful” (p. 294).

Similarly, IEC 60812 (2018), highlights that the RPN scale is not continuous, numerical ratios between RPN values have no strict proportional meaning, different S–O–D combinations may yield identical RPN values despite representing different risk profiles, and small changes in one parameter may lead to disproportionate variations in RPN (Annex B.4.2).

For these reasons, in the PRISM Framework, RPN values are not interpreted as absolute measures of risk magnitude, but exclusively as relative indicators to rank failure modes within the same service context. RPN therefore serves as a prioritization device rather than a precise quantification of risk, which is consistent with the methodological positioning established in Section 5.1: the framework supports structured decision-making under uncertainty rather than probabilistic risk prediction.

IEC 60812 (2018, Annex B.4.3) proposes other formulations such as the Alternative Risk Priority Number (ARPN), based on logarithmic scaling and additive aggregation (ARPN = S + O + D), that satisfies the requirement for a monotonic mapping between criticality and priority number and reduces sensitivity distortions associated with multiplicative aggregation. While such alternatives may provide improved scale consistency, it often requires quantitative measures of the criticality parameters. As a result, the present methodological proposal retains the traditional RPN for simplicity, transparency, and managerial accessibility, explicitly acknowledging its limitations.

Additionally, complementary visualization and prioritization tools may be used, such as a **criticality matrix** combining severity and occurrence (IEC 60812, 2018, pp. 40–41), or a **Pareto chart** to highlight the most critical failure modes based on RPN rankings (Haksever, 2025, p. 443). These tools can support managerial interpretation without altering the analytical logic of the framework.

Illustrative examples of **qualitative ordinal scales for S, O, and D** are presented in Tables 5.1–5.3. These are intentionally generic and service oriented. They are not intended to prescribe a specific measurement system, but rather to support consistent expert judgment, ensure transparency in scoring, and maintain internal coherence across failure modes. Alternative scales (e.g., 1–10 ranges) may be adopted depending on system complexity, data availability, and managerial preferences.

Consistent with IEC 60812 (2018), when defining the appropriate scales, it is important to consider that they should span the full relevant range of consequences, likelihood and detectability levels, provide clear and meaningful descriptions for each category; align with available data when possible; and ensure sufficient differentiation without excessive fragmentation (pp. 32–35). As recommended by IEC 60812, the number of categories should typically range between three and ten, depending on the analytical context.

**Severity (S)**

Severity reflects the seriousness of the consequences or magnitude of the impact generated by a failure mode on the service process and its outcomes, assuming that the failure occurs.

**Table 5.4.** Generic qualitative scale to assess severity (S).

| Score | Description |
|---|---|
| 1 | Negligible impact, barely noticeable by customers and without operational disruptions |
| 2 | Minor impact, limited customer dissatisfaction and inconveniences |
| 3 | Moderate impact, noticeable dissatisfaction with limited operational inefficiency |
| 4 | High impact, significant dissatisfaction, complaints and/or operational disruptions |
| 5 | Very high impact, severe operational impact, dissatisfaction or service abandonment |

**Occurrence (O)**

Occurrence reflects the likelihood or frequency with which a specific combination of failure cause and failure mode is expected to occur within the service system.

**Table 5.5.** Generic qualitative scale to assess occurrence (O).

| Score | Description |
|---|---|
| 1 | Very unlikely (rare occurrence) |
| 2 | Low frequency (remote) |
| 3 | Moderate frequency (occasional) |
| 4 | High frequency (probable) |
| 5 | Very frequent occurrence |

**Detection (D)**

Detection reflects the likelihood that a failure, when generated by a specific cause, will be detected by existing controls before affecting the customer.

**Table 5. 6.** Generic qualitative scale to assess detection (D).

| Score | Description |
|---|---|
| 1 | Failure almost always detected before affecting customer |
| 2 | High likelihood of detection |
| 3 | Moderate likelihood of detection |
| 4 | Low likelihood of detection |
| 5 | Failure rarely detected before customer impact |

***Note***. Higher D values correspond to lower detectability.

### *5.3.3 Section C – QFD Relationship Matrix*

**Objective:** to assess the expected impact of service failure modes on customer-perceived service quality dimensions.

This stage introduces the perceptual layer of the PRISM Framework by translating operational failure modes into customer-experienced consequences. While FMECA (Section B) evaluates operational criticality, Section C redistributes that criticality across perceptual dimensions. In line with the conceptual positioning established in Chapter 4, SERVQUAL dimensions—reliability, responsiveness, assurance, empathy, and tangibles (Parasuraman et al., 1988, p. 23)—are treated as analytical lenses through which operational failures are interpreted and evaluated by customers.

In line with critiques of the mechanical application of SERVQUAL, it is important to acknowledge that service quality dimensions may require contextual adaptation. As Grönroos (2015), notes, customers may rely on different evaluative criteria depending on the nature of the service (p. 104). Therefore, while the framework adopts the five SERVQUAL dimensions as a general reference structure, alternative or adapted dimensional models may be used when theoretically justified and contextually appropriate. For instance, in electronic service systems, E-S-QUAL dimensions (Parasuraman et al., 2005) may provide a more suitable perceptual categorization.

In Section C, a Quality Function Deployment (QFD) relationship matrix is constructed following the logic of the House of Quality (Chan & Wu, 2002). Unlike its traditional use in product development—where customer requirements are translated into engineering characteristics (Akao, 1990)—the matrix here functions as a risk impact allocation mechanism. The logic is intentionally inverted: operational failure modes (rows) are mapped onto SERVQUAL dimensions (columns) to identify where operational risk becomes most perceptually visible and potentially damaging from the customer's perspective.

**Table 5.7.** *Section C – QFD Relationship Matrix*. Illustrative example.

| SECTION C – QFD Relationship Matrix | | | | | | |
|---|---|---|---|---|---|---|
| **Failure Mode** | **Reliability** | **Responsiveness** | **Assurance** | **Empathy** | **Tangibles** | **TOTAL** |
| Long waiting time | 9 | 9 | 1 | 1 | 0 | 20 |
| Unfriendly greeting | 1 | 3 | 3 | 9 | 0 | 16 |
| Wrong order recorded | 9 | 3 | 3 | 0 | 0 | 15 |
| Incomplete information | 3 | 1 | 9 | 0 | 0 | 13 |
| Order delay | 9 | 9 | 1 | 0 | 0 | 19 |
| Incorrect dish prepared | 9 | 3 | 3 | 0 | 0 | 15 |
| Cold food | 3 | 1 | 1 | 0 | 9 | 14 |
| Billing errors | 9 | 1 | 9 | 0 | 0 | 19 |
| POS system down | 3 | 1 | 3 | 0 | 0 | 7 |

**Guidelines:**

- Relationships should be assessed using expert judgment, drawing on process knowledge, service design characteristics, frontline experience and typical customer reactions to service failures (Franceschini, 2001, p. 45; Hauser & Clausing, 1988, pp. 6–7).
- When available, SERVQUAL (Parasuraman et al., 1988) or SERVPERF (Cronin & Taylor, 1992) based survey data, complaint records, or customer feedback analysis may inform the assessment. However, direct empirical measurement is not required, as the purpose of this stage is structured perceptual allocation rather than statistical validation.
- Relationship scores (0–1–3–9) represent the expected perceptual negative impact of a failure mode on each service quality dimension, assuming the failure occurs.
- The assessment should consider how customers are likely to interpret the failure:
    - Does the failure undermine reliability (e.g., unmet promises)?
    - Does it affect responsiveness (e.g., slow service)?
    - Does it reduce assurance (e.g., perceived lack of competence)?
    - Does it damage empathy (e.g., perceived indifference)?
    - Does it affect tangibles (e.g., physical cues)?
- Relationship scores do not represent causal mechanisms, probabilities, performance metrics or measured satisfaction levels, and should not be interpreted as indicating that service quality dimensions generate or prevent service failures. Rather, they express how operational failures are perceptually distributed across evaluative channels.
- The resulting QFD relationship matrix provides the basis for computing normalized contribution weights in Section D.

**Relationship Scale:**

The following qualitative ordinal scale is used to assess the strength of the relationship between failure modes and service quality dimension:

- **0** = No relationship
- **1** = Weak relationship
- **3** = Moderate relationship
- **9** = Strong relationship

This scale follows conventional QFD practice, where non-linear spacing between categories helps emphasize meaningful differences between weak, moderate, and strong relationships (Chan & Wu, 2002, p.30). The scale is ordinal and reflects relative intensity rather than proportional magnitude.

### *5.3.4 Section D – Normalized Contribution Weights*

**Objective:** to derive relative contribution weights that indicate how the perceived impact of each failure mode is distributed across the different SERVQUAL dimensions.

This stage converts the qualitative relationship scores obtained in Section C into proportional weights. While the QFD matrix identifies the *intensity* of the relationship between failure modes and service quality dimensions, Section D ensures comparability across dimensions by expressing those relationships as relative contributions within each failure mode.

The normalization follows the Lyman approach commonly applied in QFD analysis (Franceschini, 2001, p. 71), allowing the perceptual impact of each failure mode to be proportionally allocated across quality dimensions.

**Table 5.8.** *Section D – Normalized Contribution Weights.* Illustrative example.

| SECTION D – Normalized Contribution Weights | | | | | | |
|---|---|---|---|---|---|---|
| **Failure Mode** | **Reliability** | **Responsiveness** | **Assurance** | **Empathy** | **Tangibles** | **TOTAL** |
| Long waiting time | 0.45 | 0.45 | 0.05 | 0.05 | 0.00 | 1 |
| Unfriendly greeting | 0.06 | 0.19 | 0.19 | 0.56 | 0.00 | 1 |
| Wrong order recorded | 0.60 | 0.20 | 0.20 | 0.00 | 0.00 | 1 |
| Incomplete information | 0.23 | 0.08 | 0.69 | 0.00 | 0.00 | 1 |
| Order delay | 0.47 | 0.47 | 0.05 | 0.00 | 0.00 | 1 |
| Incorrect dish prepared | 0.60 | 0.20 | 0.20 | 0.00 | 0.00 | 1 |
| Cold food | 0.21 | 0.07 | 0.07 | 0.00 | 0.64 | 1 |
| Billing errors | 0.47 | 0.05 | 0.47 | 0.00 | 0.00 | 1 |
| POS system down | 0.43 | 0.14 | 0.43 | 0.00 | 0.00 | 1 |

**Computation:**

For each failure mode $f$, the contribution weight associated with SERVQUAL dimension $d$ is computed as:

$$w_{f,d} = \frac{r_{f,d}}{\sum_{d=1}^{5} r_{f,d}} \tag{5}$$

where:

- $r_{f,d}$ is the QFD relationship score between failure mode $f$ and service quality dimension $d$
- $w_{f,d}$ is the normalized contribution weight.

**Interpretation guidelines:**

- For each failure mode, the sum of contribution weights across all five SERVQUAL dimensions should equal 1.
- The weights express the relative perceptual distribution of the failure's impact, independent of the absolute magnitude of the QFD relationships scores.
- Normalization ensures that failure modes with stronger overall relationship totals do not distort the proportional allocation of impact.
- Contribution weights do not represent probabilities, causal coefficients, or performance indicators. They indicate how customers are likely to interpret the impact of a failure mode across different evaluative dimensions.

In this stage, it becomes relevant to clarify that, because the 0–1–3–9 QFD scale is ordinal and non-linear, normalization does not transform it into ratio-scale data. Instead, it preserves the relative structure of expert judgment while enabling proportional redistribution of impact.

### *5.3.5 Section E – Perceived Risk Exposure (PRE) by SERVQUAL dimensions*

**Objective:** to compute and aggregate the contribution of service failure modes to service-related operational risk as perceived by customers through each service quality dimension.

This stage integrates the operational criticality results obtained through FMECA (Section B) with the normalized perceptual contribution weights derived from the QFD relationship matrix (Section D), in order to quantify how operational risk is distributed across service quality dimensions when interpreted through the customer's evaluative lens. Rather than replacing operational risk assessment, this step reallocates operational criticality according to perceptual impact, consistent with the logic articulated in Chapter 4.

**Table 5.9.** *Section E – Perceived Risk Exposure (PRE) by SERVQUAL dimension*. Illustrative example.

| SECTION E: Perceived Risk Exposure by SERVQUAL dimension | | | | | | |
|---|---|---|---|---|---|---|
| Failure Mode | RPN | Reliability | Responsiveness | Assurance | Empathy | Tangibles |
| A: Long waiting time | 48 | 21.60 | 21.60 | 2.40 | 2.40 | 0.00 |
| B: Unfriendly greeting | 36 | 2.25 | 6.75 | 6.75 | 20.25 | 0.00 |
| C: Wrong order recorded | 48 | 28.80 | 9.60 | 9.60 | 0.00 | 0.00 |
| D: Incomplete information | 24 | 5.54 | 1.85 | 16.62 | 0.00 | 0.00 |
| E: Order delay | 48 | 22.74 | 22.74 | 2.53 | 0.00 | 0.00 |
| F: Incorrect dish prepared | 32 | 19.20 | 6.40 | 6.40 | 0.00 | 0.00 |
| G: Cold food | 27 | 5.79 | 1.93 | 1.93 | 0.00 | 17.36 |
| H: Billing errors | 32 | 15.16 | 1.68 | 15.16 | 0.00 | 0.00 |
| I: POS system down | 15 | 6.43 | 2.14 | 6.43 | 0.00 | 0.00 |
| **Perceived Risk Exposure (PRE):** | | **127.50** | **74.69** | **67.81** | **22.65** | **17.36** |
| Share: | | **41%** | **24%** | **22%** | **7%** | **6%** |

**Computation:**

For each failure mode $f$ and service quality dimension $d$, the perceived risk contribution is defined as:

$$PRE_{f,d} = RPN_f \; x \; w_{f,d} \tag{6}$$

where:

- $RPN_f$ is the overall Risk Priority Number for failure mode $f$, determined as max($RPN_{f,c}$) when multiple causes c are associated with the same failure mode (Section B);
- $w_{f,d}$ is the normalized contribution weight of dimension $d$ for failure mode $f$, as defined in Section D.

The total Perceived Risk Exposure associated with each service quality dimension is then obtained by aggregating the contributions across all n identified failure modes:

$$PRE_d = \sum_{f=1}^{n} PRE_{f,d} \tag{7}$$

Finally, the relative share of perceived risk associated with each service quality dimension is:

$$Share_d = \frac{PRE_d}{\sum_{d=1}^{5} PRE_d} \tag{8}$$

**Interpretation guidelines:**

- $PRE_d$ represents the extent to which service-related operational risk is perceived by customers through that service quality dimension $d$, given the identified failure modes and their operational criticality.
- PRE values do not measure objective risk exposure, financial loss, or customer dissatisfaction levels, but provide a relative, perception-based allocation of operational risk across service quality dimensions.
- Relative PRE shares should be used to support managerial prioritization decisions, highlighting where operational risk is most strongly experienced from the customer's perspective.
- PRE results are context-specific and should be interpreted within the boundaries of the analyzed service system, having into consideration the defined scope (Section A), the expert-based criticality assessment (Section B), and the perceptual allocation structure (Section C–D).

### *5.3.6 Section F – Managerial Prioritization and Decision Rules*

**Objective:** to translate the results of the Perceived Risk Exposure (PRE) analysis into actionable managerial priorities and decision rules. By combining the ranking of service quality dimensions (based on PRE) with the identification of critical failure modes and their underlying causes, this section helps managers decide where to intervene within the service system in order to reduce customer-perceived manifestations of service-related operational risks under limited resources.

The **managerial prioritization logic** adopted in this framework is illustrated in Table 5.11 and follows a structured reasoning process that links perceptual risk concentration to operational intervention points. First, service quality dimensions are ranked according to their relative share of total PRE. In the example, Reliability emerges as the top priority, accounting for 41% of the total PRE. This indicates that reliability-related issues are the dominant perceptual channel through which customers experience operational risk.

Second, within each prioritized dimension, the most relevant failure modes are identified based on their individual contribution to that dimension's PRE. In other words, failure modes are ranked within each dimension according to their $PRE_{f,d}$ values, so managers can focus on those failures that most strongly drive customer-perceived risk. For instance, within the *Reliability* dimension, *wrong order recorded* represents the highest contributor (PRE = 28.8), followed by *order delay* (PRE = 22.74) and *long waiting time* (PRE = 21.6).

Subsequently, managerial attention shifts to the underlying causes of these key failure modes identified. Using the FMECA results from Section B, the causes associated with each selected failure mode are examined, and priority is given to the cause with the highest $RPN_{f,c}$, as it represents the most critical operational driver. For example, among the causes of *wrong order recorded*, cause C3 (high multitasking pressure) presents the highest RPN value (RPN = 48). Improvement actions are defined at the cause level, ensuring that interventions address the operational origins of risk while being guided by perceptual impact concentration identified through PRE.

This reasoning process is then repeated for the remaining prioritized dimensions and failure modes, leading to the structured output summarized in Figure 5.3.6.2.

**Table 5.10**. *Managerial Prioritization Logic.* Illustrative example.

| SECTION A: Service Process and Failure Mode Identification | | | | | | SECTION B: FMECA | | | | | | | | SECTION E: Perceived Risk Exposure by SERVQUAL dimension | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Service Phase | Frontstage / Backstage | Process Step | Function / Performance Standard | Failure Mode | Failure Description | Effect on Service / Customer | S | Causes | Existing detection / controls | O | D | RPN_{f,c} | RPN | Reliability | Responsiveness | Assurance | Empathy | Tangibles |
| Arrival & Seating | Frontstage | Guest reception | Guests are greeted promptly and seated within X minutes according to reservation or availability policy. | A: Long waiting time | Waiting time exceeds defined standard. | Customer frustration; abandonment; negative reviews | 4 | A1: Understaffing at peak hours | Host visual check; reservation list | 4 | 3 | 48 | 48 | 21.60 | 21.60 | 2.40 | 2.40 | 0.00 |
| | | | | | | | | A2: Poor table turnover (slow clearing/payment) | Floor supervision (ad hoc) | 3 | 3 | 36 | | | | | | |
| | | | | | | | | A3: Overbooking / inaccurate reservation pacing | Reservation system view; manual adjustments | 2 | 4 | 32 | | | | | | |
| | | | | B: Unfriendly greeting | Staff shows lack of courtesy or attention (interaction does not meet defined courtesy standard). | Lower perceived welcome; reduced satisfaction; negative word-of-mouth | 3 | B1: Lack of training / service culture | Manager observation (sporadic) | 3 | 4 | 36 | 36 | 2.25 | 6.75 | 6.75 | 20.25 | 0.00 |
| | | | | | | | | B2: Workload/stress at peak | Ad hoc floor support | 4 | 3 | 36 | | | | | | |
| | | | | | | | | B3: Hiring mismatch / attitude issues | Customer complaints after event | 2 | 5 | 30 | | | | | | |
| Ordering | Frontstage | Order taking | Orders are accurately recorded and menu information is clearly communicated. | C: Wrong order recorded | Incorrect dish or modifications registered | Wrong dish delivered; rework; longer cycle time; dissatisfaction | 4 | C1: No repeat-back / confirmation of order | Repeat-back (inconsistent) | 3 | 3 | 36 | 48 | 28.80 | 9.60 | 9.60 | 0.00 | 0.00 |
| | | | | | | | | C2: Complex modifiers / POS interface issues | POS review at kitchen pass | 2 | 4 | 32 | | | | | | |
| | | | | | | | | C3: Noise + multitasking (busy floor) | Usually detected only at delivery | 3 | 4 | 48 | | | | | | |
| | | | | D: Incomplete information | Staff unable to explain menu or allergens | Reduced trust; perceived risk; potential safety concern; dissatisfaction | 3 | D1: Missing standardized allergen info / unclear menu | Detected when customer asks | 2 | 4 | 24 | 24 | 5.54 | 1.85 | 16.62 | 0.00 | 0.00 |
| | | | | | | | | D2: Staff knowledge gaps | Manager intervention when escalated | 2 | 4 | 24 | | | | | | |
| Food Preparation | Backstage | Kitchen preparation | Meals are prepared according to order specifications and within target preparation time. | E: Order delay | Preparation time exceeds expected duration | Long time-to-serve; customer irritation; table turnover loss | 4 | E1: Bottleneck / line imbalance (hot vs cold station) | Ticket times (if monitored); expo supervision | 4 | 3 | 48 | 48 | 22.74 | 22.74 | 2.53 | 0.00 | 0.00 |
| | | | | | | | | E2: Insufficient prep (mise en place) | Informal checks pre-service | 3 | 3 | 36 | | | | | | |
| | | | | | | | | E3: Equipment downtime / limited capacity | Staff reporting; reactive maintenance | 2 | 4 | 32 | | | | | | |
| | | | | F: Incorrect dish prepared | Kitchen prepares wrong item | Wrong meal served; waste; re-prep; dissatisfaction | 4 | F1: Ticket misread / unclear modifiers | Expo check (if present) | 2 | 3 | 24 | 32 | 19.20 | 6.40 | 6.40 | 0.00 | 0.00 |
| | | | | | | | | F2: Breakdown in FOH–BOH communication | Usually detected at delivery | 2 | 4 | 32 | | | | | | |
| | | | | | | | | F3: No final check at pass | Detected only by customer | 1 | 5 | 20 | | | | | | |
| Service Delivery | Frontstage | Food serving | Food is delivered at appropriate temperature and presentation standard. | G: Cold food | Food temperature not adequate at delivery | Lower perceived quality; complaints; reduced repurchase | 3 | G1: Food waiting at pass (no runner available) | Visual check (rare) | 3 | 3 | 27 | 27 | 5.79 | 1.93 | 1.93 | 0.00 | 17.36 |
| | | | | | | | | G2: Slow runner / understaffing FOH | Customer complaint after serving | 2 | 4 | 24 | | | | | | |
| Payment | Frontstage | Billing | Billing is accurate and payment systems operate without interruption. | H: Billing errors | Incorrect bill or overcharge | Perceived unfairness; distrust; complaints; dispute at checkout | 4 | H1: Manual entry errors / split bills complexity | Customer checks bill; manager override | 2 | 4 | 32 | 32 | 15.16 | 1.68 | 15.16 | 0.00 | 0.00 |
| | | | | | | | | H2: Discounts/promos applied incorrectly | End-of-shift audit (post-event) | 2 | 4 | 32 | | | | | | |
| | | | | | | | | H3: Incorrect POS mapping/menu items | Periodic admin review | 1 | 5 | 20 | | | | | | |
| | | | | I: POS system down | Payment system temporarily unavailable | Payment delays; frustration; potential lost sales | 3 | I1: Network issues | Immediate system error | 1 | 5 | 15 | 15 | 6.43 | 2.14 | 6.43 | 0.00 | 0.00 |
| | | | | | | | | **Perceived Risk Exposure (PRE):** | | | | | | **127.50** | **74.69** | **67.81** | **22.65** | **17.36** |
| | | | | | | | | Share: | | | | | | **41%** | **24%** | **22%** | **7%** | **6%** |

**Table 5. 11.** *Section F – Managerial Prioritization and Decision Rules.* Illustrative example.

| SECTION F: Managerial Prioritization and Decision Rules | | | | |
|---|---|---|---|---|
| **Priority Rank** | **SERVQUAL Dimension** | **Key Failure Modes** | **Main Causes** | **Suggested Managerial Actions** |
| 41% | Reliability | C: Wrong order recorded (28.8) | C3: High multitasking pressure | Assign dedicated roles during peak periods (e.g. runner, expeditor) |
| | | E: Order delay (22.74) | E1: Kitchen bottlenecks | Redesign kitchen workflow and balance stations |
| | | A: Long waiting time (21.6) | A1: Inadequate staffing at peak hours | Adjust staffing levels based on demand forecasts |
| | | F: Incorrect dish prepared (19.2) | F2: Communication gaps FOH–BOH | Standardize FOH–BOH communication protocols |
| | | H: Billing errors (15.16) | H1:Manual entry errors<br>H2:Discounts/promos applied incorrectly | Automate billing and validation steps in the POS system |
| 24% | Responsiveness | E: Order delay (22.74) | E1: Line imbalance during peak hours | Implement real-time order tracking and ticket time monitoring |
| | | A: Long waiting time (21.6) | A1: Understaffing at peak hours | Adjust staffing levels based on demand forecasts |
| | | C: Wrong order recorded (9.6) | C3: High multitasking pressure | Assign dedicated roles during peak periods (e.g. runner, expeditor) |
| 22% | Assurance | D: Incomplete information (16.62) | D1: Lack of standardized information<br>D2: Staff knowledge gaps | Introduce standardized information materials and checklists<br>Provide targeted staff training on menu and allergens |
| | | H: Billing errors (15.16) | H1: Manual billing operations | Automate billing and validation steps in the POS system |
| | | C: Wrong order recorded (9.6) | C3: High multitasking pressure | Assign dedicated roles during peak periods (e.g. runner, expeditor) |
| 7% | Empathy | B: Unfriendly greeting (20.25) | B1: Limited service culture training<br>B2: Workload and stress at peak hours | Provide customer service and soft-skills training<br>Improve shift scheduling to reduce peak overload<br>Introduce service culture guidelines and feedback mechanisms |
| 6% | Tangibles | G: Cold food (17.36) | G1: Lack of food runners<br>G1: Delays at service pass | Assign food runners during busy periods<br>Redesign service pass layout to minimize waiting time<br>Introduce temperature-holding solutions when necessary |

**Guidelines:**

To ensure consistent application across service contexts, the following decision rules are proposed:

- Service quality dimensions are prioritized based on their relative share of total PRE; dimensions with higher PRE shares receive higher managerial priority.
- Within each prioritized dimension, failure modes are ranked according to their contribution to the PRE of that dimension.
- Failure modes characterized by both high PRE contribution and high RPN should be addressed first.
- For each selected failure mode, improvement actions should target the underlying cause associated with the highest RPN value, as it represents the most critical operational driver (Grönroos, 2015, p.146).

- Service quality dimensions serve as prioritization lenses and not as direct intervention targets; managerial actions should always address failure causes within the service system.
- Preventive actions are recommended for failure causes associated with high occurrence scores, while detection or mitigation measures may be prioritized for failure modes characterized by high severity or low detectability.
- Prioritization decisions should also consider the cost-effectiveness of available improvement actions, their implementation feasibility, and their potential effects in other parts of the service system, consistent with the practical guidance of IEC 60812 (2018, p. 26).
- The prioritization results should be periodically reassessed after improvement actions are implemented, to evaluate changes in PRE and adjust managerial priorities accordingly as suggested by IEC 60812:2018 (pp. 28-29).
- Managerial judgment remains essential in interpreting analytical results, particularly under conditions of epistemic uncertainty, limited data, and contextual complexity (Aven, 2016, p. 6). The formal outputs of the framework support structured decision-making but do not substitute professional evaluation and contextual reasoning.

## 5.4 Perceived risk exposure (PRE) as a decision-support metric

The central analytical output of the PRISM Framework is the **Perceived Risk Exposure (PRE)**, which provides a dimension-level synthesis of how service-related operational risks are manifested in customer perceptions through service quality dimensions.

PRE is conceived as a structured **decision-support metric** that integrates operational criticality with perceptual impact. On the operational side, the Risk Priority Number (RPN) obtained through FMECA (Section 5.3.2) captures the relative criticality of each service failure mode, based on its severity, occurrence, and detectability. On the perceptual side, the normalized contribution weights derived from the QFD-based relationship analysis (Sections 5.3.3–5.3.4) express how strongly each failure mode is expected to negatively affect each SERVQUAL dimension.

For each service quality dimension, PRE is computed by aggregating the RPN-weighted contributions of all identified failure modes. In this way, PRE reflects the cumulative customer-perceived manifestation of service-related operational risk associated with each dimension. Higher PRE values indicate that a larger share of the total operational criticality becomes visible to customers through that perceptual channel.

Importantly, PRE does not replace operational risk assessment, nor does it measure objective risk probability, financial exposure, or satisfaction levels. Rather, it redistributes operational criticality according to expected perceptual impact, thereby revealing where operational risk is most salient from the customer's perspective. Service quality dimensions therefore function as prioritization lenses rather than intervention targets or risks causes.

The interpretation of PRE is inherently relative and **context dependent**. PRE values are meaningful for comparison across service quality dimensions within the same service system and assessment cycle. They support managerial prioritization under limited resources by identifying which dimensions concentrate the highest share of operational risk and, consequently, which underlying failure modes and causes warrant primary attention.

Methodologically, **PRE inherits the scale-related limitations of the RPN.** Since RPN is computed using ordinal severity, occurrence, and detection scores, and PRE extends RPN through proportional perceptual weights, PRE values do not possess ratio-scale properties and should not be interpreted as absolute measure of risk magnitude. Differences between PRE values indicate relative prioritization within the same assessment context rather than proportional differences in risk exposure. This limitation, however, is consistent with the framework's decision-support orientation and does not compromise its internal coherence as a comparative prioritization tool.

By transforming detailed process-level risk information into an aggregated perceptual representation, PRE reduces analytical complexity while preserving prioritization logic. In this sense, it operates as a conceptual bridge between operational risk analysis and managerial decision-making, integrating risk management and service quality perspectives into a coherent framework aimed at reducing customer-perceived manifestations of service-related operational risk.

## 5.5 Scope of application and research implications

The PRISM Framework can be applied with two complementary analytical purposes, depending on the scope of analysis and the managerial or research objectives pursued.

First, the methodology can be used as a **single-case decision-support tool**, aimed at guiding managerial prioritization within a specific service organization. This core application was used to introduce and illustrate the proposed methodology in this chapter. As shown, the framework helps managers identify critical service quality dimensions, failure modes, and underlying causes that drive customer-perceived manifestations of service-related operational risk in a given context. The results are directly translated into prioritized improvement actions tailored to the specific service system, making the methodology particularly suitable for operational diagnosis, risk-informed decision-making, and continuous improvement initiatives at the firm level.

Second, when applied across multiple service organizations or repeated cases within the same service sector, the methodology can be used for a **comparative and exploratory analytical purpose.** By adopting standardized failure modes and consistent evaluation scales, PRE results can be aggregated and examined across cases to identify recurring structural patterns linking operational risk sources to specific service quality dimensions.

Importantly, this comparative application does not seek to measure or compare absolute levels of service quality across organizations, but to understand how operational risk is structurally translated into customer-perceived quality dimensions within comparable service contexts. By analyzing how particular failure modes and their underlying causes consistently contribute to perceived risk exposure, researchers may identify sector-level vulnerabilities and dominant perceptual channels through which operational risk tends to materialize.

In this broader application, service quality dimensions function not only as managerial prioritization lenses but also as analytical categories for examining structural relationships between operational risk and customer-perceived quality at an industry or cross-organizational level. This dual applicability strengthens the contribution of the framework, positioning it both as a practical tool for firm-level decision-making and as an exploratory instrument for service risk research.

## 5.6 Methodological validity and limitations

The validity of the PRISM framework lies in its internal logical coherence and in the structured integration of established tools from service operations management, risk analysis, and service quality literature. By combining Service Blueprinting (Shostack, 1984; Bitner et al., 2008), FMECA (IEC 60812, 2018), SERVQUAL (Parasuraman et al., 1988), and QFD (Akao, 1990; Chan & Wu, 2002; Franceschini, 2001) within a unified analytical sequence, the methodology provides a transparent and conceptually consistent mechanism to link service processes, operational risks, and customer-perceived impacts.

From a methodological perspective, the framework exhibits conceptual and structural validity, as each analytical stage addresses a clearly defined objective and is grounded in recognized theoretical and practical foundations. Service Blueprinting enables structured process representation; FMECA supports systematic operational risk assessment; SERVQUAL provides a multidimensional lens for understanding customer-perceived quality; and QFD supplies the relational logic required to allocate perceptual impact. The resulting Perceived Risk Exposure (PRE) metric preserves the distinct roles of operational risk assessment and perceptual analysis, avoiding inappropriate causal interpretations.

The framework is designed to be applicable across a wide range of service contexts, including both high-contact and low-contact services, provided that service processes can be mapped and failure modes identified. Its reliance on expert judgment allows implementation even when detailed operational or customer perception data are unavailable. When empirical data are accessible, they may strengthen the robustness of the analysis. For example, customer perceptions may be measured through SERVQUAL (Parasuraman et al., 1988) or SERVPERF (Cronin & Taylor, 1992) surveys, structured feedback systems, or online review data classified according to service quality dimensions and incorporated into the QFD relationship assessment. However, such sources may introduce biases (e.g., self-selection effects, extreme opinions, or unreliable reviews), which require careful filtering, triangulation, and critical interpretation.

Despite these strengths, several limitations should be acknowledged.

First, the PRISM framework is intended as a **decision-support tool**, rather than as a statistical or predictive model. As such, the results do not support hypothesis testing, causal inference, probabilistic forecasting or generalization beyond the analyzed service context, and do not statistically validate relationships between service quality dimensions and service-related risks.

Second, both RPN and PRE are **relative prioritization indicators**. As discussed in Section 5.3.2 and Section 5.4, they rely on ordinal scales and proportional weighting procedures. Consequently, they do not possess ratio-scale properties, and numerical differences should not be interpreted as proportional differences in objective risk magnitude. Their analytical value lies in supporting structured comparison and prioritization within a defined service context and assessment cycle. Additionally, since the framework does not explicitly incorporate improvement cost, feasibility, or implementation complexity into the PRE computation, managerial judgment remains essential to balance analytical prioritization with organizational constraints and strategic objectives.

Third, the use of qualitative ordinal scales and expert judgment for the assessment of severity, occurrence, detectability, and QFD relationships introduces **subjectivity and potential variability** across applications as these scores are inherently exposed to cognitive and social biases (ISO/IEC 31010:2019, p. 40). Results may therefore depend on the experience, composition, and perspective of the evaluators involved, making careful expert selection and clearly defined scoring procedures particularly important, especially in comparative studies.

A further limitation relates to the analytical structure of FMECA itself. As noted in IEC 60812:2018, FMEA primarily addresses individual failure modes and does not explicitly model complex combinations of interdependent or cascading failures (p. 14). In systems characterized by high interconnectivity or dynamic interactions, complementary techniques such as Fault Tree Analysis (FTA) or other system-level risk modeling approaches may be more appropriate (ISO/IEC 31010:2019, pp. 74–78). The proposed framework inherits this structural characteristic, as it evaluates failure modes individually before redistributing their perceptual impact. While this is consistent with the objective of structured prioritization, it implies that **systemic interaction effects between failure modes are not explicitly modeled.**

Moreover, the **illustrative application** presented in this chapter is based on a simplified hypothetical service example intended to demonstrate the logic and computational flow of the framework rather than to empirically validate its effectiveness. Future empirical research may apply the methodology in real service settings, refine scale calibration, and explore cross-sectoral comparability.

Finally, the PRISM Framework focuses specifically on **service-related operational risks and their customer-perceived manifestations**. Other risk categories (financial, legal, reputational, strategic, etc.) are not explicitly modeled, although they may be indirectly affected through improvements in service delivery and customer perceptions. However, because many reputational and financial consequences in services originate from customer-perceived failures, analyzing how operational risks materialize through service quality dimensions provides insight into early stages of risk propagation. This positioning highlights both the practical relevance of the framework and opportunities for future methodological extensions incorporating additional risk categories.

# 6. Application of the PRISM Framework to a Real Service Context

Chapter 5 introduced the PRISM Framework and illustrated its logic through a simplified, hypothetical restaurant case. That example, characterized by direct customer–employee interaction, was used to clarify the methodological steps in a transparent and intuitive way.

This chapter applies the framework to a real organizational context: Rcalls, a cloud-based SaaS platform supporting manufacturing SMEs in quality and product recall management. Unlike the restaurant example, Rcalls operates as a technology-mediated B2B service. Customer interaction occurs primarily through a digital interface rather than face-to-face encounters. However, operational failures within the platform (such as system errors, data inconsistencies, delays, or algorithmic inaccuracies) can still affect how customers perceive reliability, responsiveness, assurance, or other dimensions of service quality.

By applying PRISM to this context, the chapter demonstrates that the framework is not limited to high-contact services. Instead, it can also be used in digitally mediated service systems where operational risk is translated into customer perceptions through technological performance.

The structure of the analysis follows the methodological sequence defined in Chapter 5, adapted to the specific characteristics of the Rcalls service model.

## 6.1 Case Context: Rcalls

Rcalls is an innovative technology startup founded in May 2025 and headquartered in Turin, Italy, within the technological hub of the Politecnico di Torino (i3P Incubator). The company also maintains a presence in London, United Kingdom, and has received several innovation recognitions since its foundation. Rcalls operates at the intersection of quality management software, operational risk management, and Insurtech, positioning itself as a cloud-based **Software-as-a-Service (SaaS)** platform designed to remove the information asymmetry between manufacturing SMEs and insurance companies when defining the premiums for product recall insurance coverage. It acts as a black box by monitoring quality data and serving useful KPIs and evidence to insurances.

Rcalls was created to address a structural gap in the management of product recall insurance among manufacturing SMEs. In sectors such as automotive, electronics, EV charging infrastructure, and after-sales components, firms face significant financial exposure in the event of product recalls. Although insurance policies exist to mitigate this risk, premiums are often determined on the basis of incomplete, manually aggregated, or non-verifiable information, because many SMEs manage quality incidents using fragmented tools such as spreadsheets, emails, or paper-based documentation, which do not generate structured historical datasets suitable for insurance evaluation. Consequently, even firms with robust internal quality practices may be treated as high-risk clients, leading to prudential insurance premiums. Rcalls was therefore conceived as a platform that transforms unstructured quality data into traceable, objective, and verifiable evidence of risk control, enabling companies to demonstrate their operational rigor and negotiate more advantageous insurance conditions.

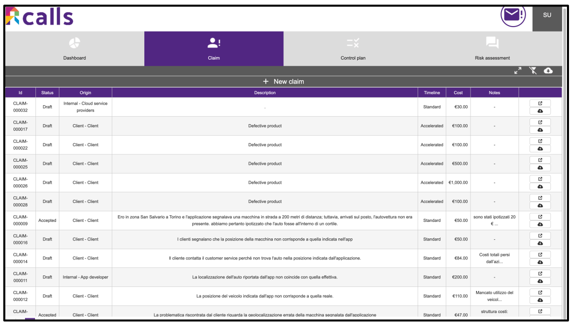
The platform operates entirely in the cloud and is accessible via web browser without installation or internal IT infrastructure. Functionally, the first version of the tool supports the full lifecycle of **quality non-conformances management** (Figure 6.1.a) through a structured workflow based on the 8D (Eight Disciplines) methodology, a widely adopted problem-solving framework in manufacturing and engineering. When a defect or non-conformity arises, company users can open a case within the system and are guided through sequential phases including team definition, problem description, containment actions, root cause analysis, development and implementation of corrective measures, prevention of recurrence, and formal closure.

Each phase is supported by predefined templates and responsibilities, ensuring traceability of decisions, deadlines, communications, and associated costs. All actions are consolidated into dynamic **control plans** (Figure 6.1.b) that remain continuously updated and exportable for audit and reporting purposes.

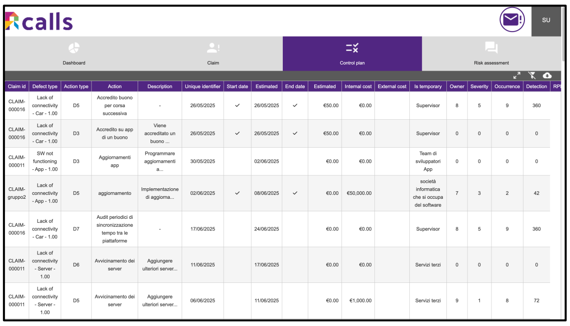
Within this workflow, a central feature is its **AI-assisted root cause analysis**. Based on established methodologies such as the 5 Whys and the Ishikawa (fishbone) diagram, the system supports users in identifying underlying causes of defects. Artificial intelligence trained on historical cases suggests probable root causes based on observed symptoms and detected patterns, accelerating diagnostic activities and increasing analytical consistency, particularly for SMEs without specialized quality engineering resources and expertise. This tool is extremely useful in defining accountability in case of an insurance claim.

Another distinctive component is the **Bill of Materials (BoM) Risk Assessment** module (Figure 6.1.c). At component level, the system applies a structured risk evaluation logic consistent with FMECA principles, assigning each defect a dynamic Risk Priority Number (RPN) based on severity, occurrence, and detection parameters. This generates a continuously updated risk map of products and supply chains, enabling firms to identify high-risk components and monitor supplier performance. By structuring and quantifying defect data, the platform provides measurable evidence of risk monitoring capability.

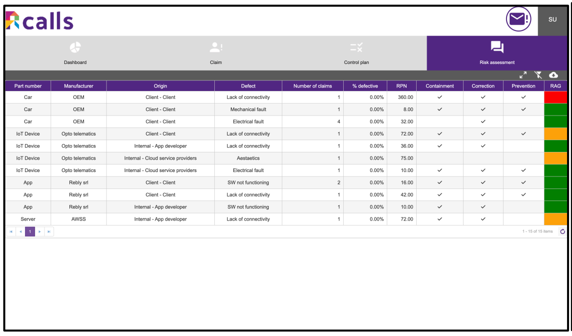
The platform also offers an integrated analytics **dashboard** (Figure 6.1.d) providing a visual overview of key performance indicators, including total number of complaints, average resolution time, cost per claim, defect incidence by component or customer, and other customized metrics. Automated generation of 8D reports, control plans, dashboards, and insurance-oriented documentation allows firms to communicate structured quality and risk information to customers, suppliers, brokers, and insurers in a standardized format.



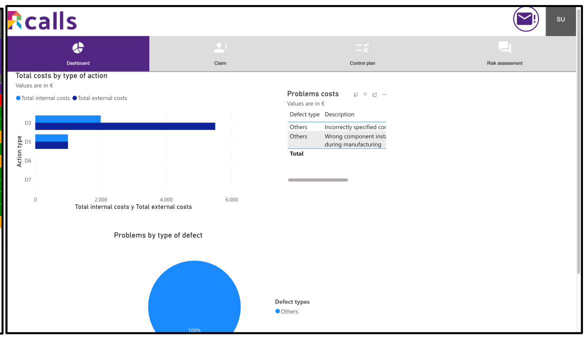
(a)



(b)



(c)



(d)

**Figure 6.1.** *Rcalls cloud-based platform.* Obtained from Rcalls demo.

Rcalls helps SMEs save on quality costs, on time employed by quality teams, and on the insurance premium, and differentiates itself from traditional Quality Management Systems (QMS) through its accessibility, simplicity, and insurance integration. Unlike complex enterprise QMS solutions, Rcalls requires no initial installation costs or dedicated IT projects and offers a subscription with a distinctive pricing model linked to the insurance savings generated for clients. By integrating quality management, defect traceability, risk scoring, and insurance-oriented reporting within a single cloud-based interface, Rcalls aims to enhance risk visibility for manufacturing SMEs and support more data-driven underwriting processes.

Although Rcalls measures and structures the operational risks of its client firms, the present study applies the PRISM Framework to Rcalls itself as a technology-mediated B2B service provider. As a SaaS platform delivering risk-sensitive outputs—such as risk scores, dashboards, and insurance-ready documentation—its own service performance directly affects customer trust, perceived reliability, and the credibility of the generated data. Operational failures within the platform, whether technological, algorithmic, or process-based, may therefore influence how customers evaluate the service across multiple quality dimensions. For this reason, Rcalls provides an appropriate and conceptually coherent case for examining how operational risks in a technology-enabled service system can be translated into customer-relevant prioritization through the PRISM Framework.

## 6.2 Methodological Application to Rcalls

The application of the PRISM Framework to this real case focuses on Rcalls as a service provider, examining potential operational failure modes within the platform itself and their manifestation across service quality dimensions. Given time and data-access constraints, the analysis relies primarily on structured expert judgment from a key informant (CEO/manager) rather than direct access to operational databases or customer survey data. This choice is consistent with the methodological positioning of PRISM as a structured decision-support tool that can operate under uncertainty and limited quantitative data, as discussed in Chapter 5.

The objective of this case application is illustrative and exploratory rather than predictive. The purpose is to demonstrate the feasibility, internal coherence, and flexibility of the PRISM Framework in a real B2B technology context, rather than to statistically validate causal relationships or generate generalizable empirical findings.

### *6.2.1 Section A: Service Process and Failure Modes Identification*

For the application of the PRISM Framework, the service process under analysis is defined as the lifecycle of a manufacturing SME (e.g., automotive or electronics suppliers) using the Rcalls platform to manage a quality non-conformity, from onboarding and account configuration to case resolution, risk assessment and reporting.

Service Blueprinting was selected as the process modeling tool, structured according to the five core components outlined in Section 3.2.4: customer actions, frontstage actions, backstage actions, supporting processes, and physical evidence. Information used to construct the blueprint was collected through internal documentation, platform demo utilization, direct observation and semi-structured interviews with the Rcalls manager. The resulting blueprint is presented in Figure 6.2.

Consistent with the theoretical role of blueprinting as a tool to isolate fail points (Shostack, 1984; Bitner et al., 2008), service phases, process steps, performance standards and potential failure modes were identified. These elements complete Section A of the PRISM template (see Table B.1 in Appendix B) and provide the structured input for the subsequent FMECA-based criticality assessment.

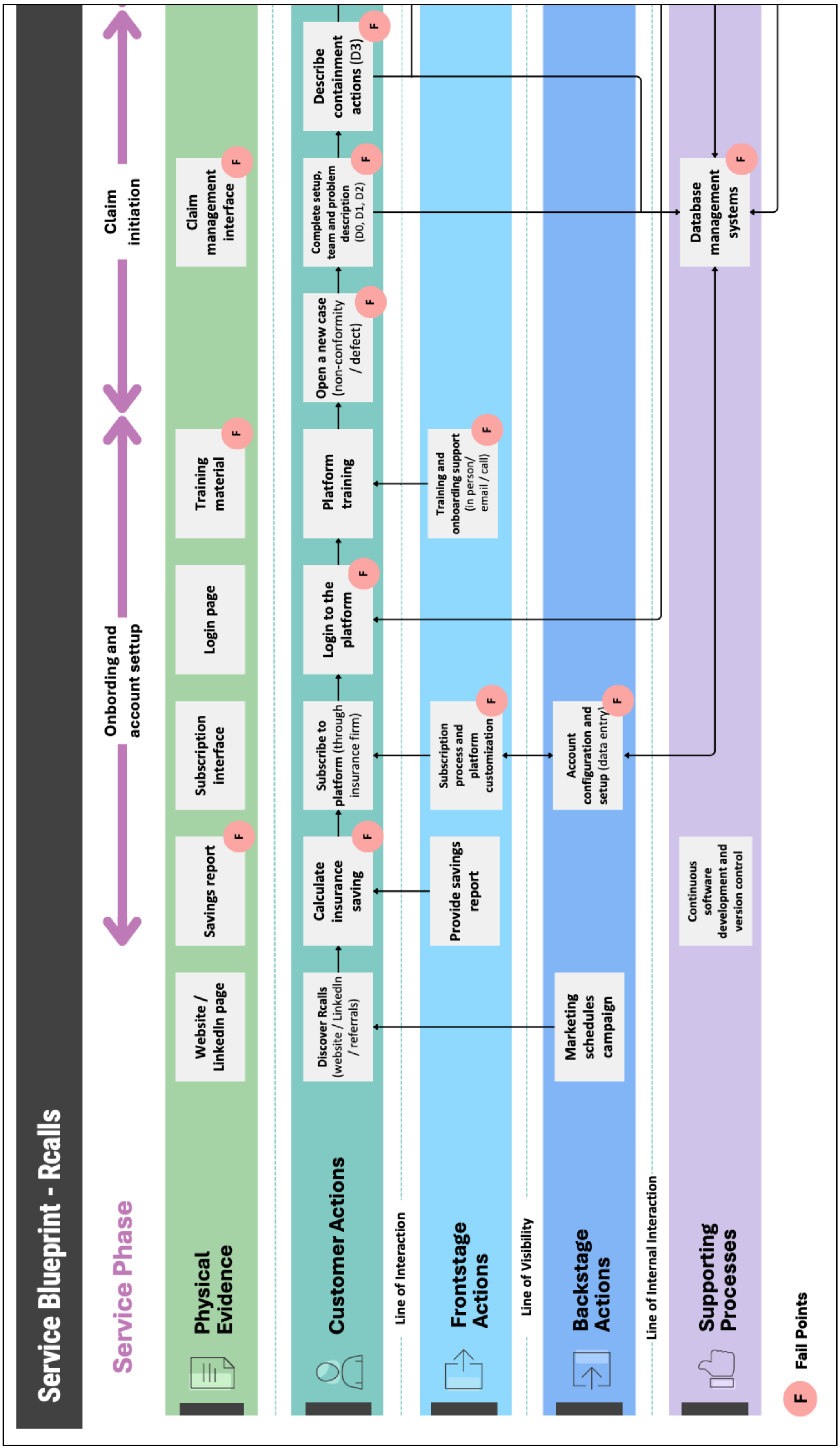



**Figure 6.2.** *Service Blueprinting for Rcalls.*

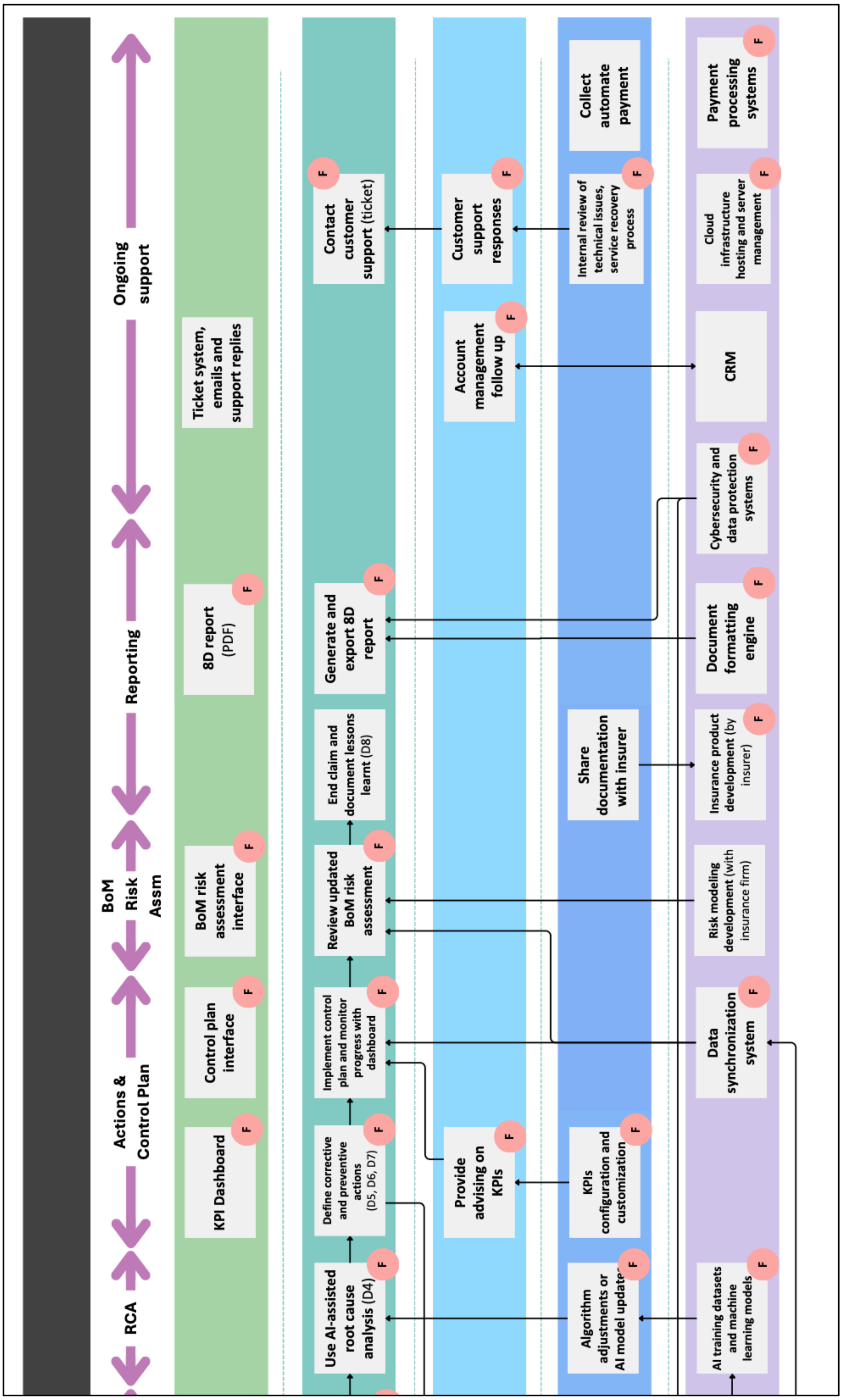



**Figure 6.2.** *Service Blueprinting for Rcalls*

### *6.2.2 Section B: Risk Assessment (FMECA)*

For each failure mode identified in Section A, an operational criticality assessment was conducted following the FMECA logic described in Chapter 5. Underlying causes and existing detection or control mechanisms were identified for each failure mode. Severity (S), occurrence (O), and detection (D) were evaluated using a qualitative 1–5 ordinal scale, adapted to the service context of Rcalls and illustrated in Figure 6.3. Given the exploratory nature of the case and time constraints, scoring was based on structured expert judgment obtained through interviews with the Rcalls manager, combined with platform observation and documentation review.

In Rcalls context, **severity (S)** captures the seriousness of the consequences generated by a failure mode, considering both operational disruptions (e.g., service continuity, data integrity, compliance exposure) and the resulting service outcomes experienced by customers (e.g., inability to manage claims, loss of trust in risk metrics and reports), assuming the failure occurs. **Occurrence (O)** reflects the expected frequency of a specific combination of failure cause and failure mode in normal platform operation. **Detection (D)** reflects the likelihood that existing controls (e.g., validation rules, monitoring, logging, QA procedures, human review) detect the failure-cause combination before it affects customers; higher D values correspond to lower detectability.

**Table 6.1.** *Assessment ordinal scales for severity (S), occurrence (O), and detection (D) adapted to Rcalls context.*

| Score | SEVERITY (S) | OCCURRENCE (O) | DETECION (D) |
|---|---|---|---|
| 1 | Negligible impact on platform functionality and customer experience. No operational disruption. | Very unlikely. Historical evidence shows failure is rare or theoretical. | Almost certain detection. Failure is automatically detected by system controls before affecting customer. |
| 2 | Minor impact; limited user inconvenience or frustration. No interruption of case management process. | Low frequency. Occurs occasionally under specific conditions. | High likelihood of detection. Failure is likely detected through monitoring or review before major impact. |
| 3 | Moderate impact; noticeable service degradation requiring customer support (tickets) or manual workaround. Limited operational inefficiency. | Moderate frequency. Observed intermittently across customers or cases. | Moderate detection. Failure is detected after partial impact or through customer feedback. |
| 4 | High impact; significant disruption of case management process, risk of SLA breach or customer dissatisfaction that may affect contract renewal. | High frequency. Recurrent issue affecting multiple customers. | Low likelihood of detection. Failure typically identified only after customer complaint or operational consequence. |

| Score | SEVERITY (S) | OCCURRENCE (O) | DETECION (D) |
|---|---|---|---|
| 5 | Severe operational impact, legal/regulatory exposure, major data breach, or high probability of customer churn and reputational damage. | Very frequent occurrence. Systemic issue regularly affecting operations. | Failure unlikely to be detected before significant customer or legal impact. |

The resulting **Risk Priority Number (RPN),** calculated as the product of severity, occurrence and detection, represents the intrinsic operational criticality of each failure mode within the service system. When multiple causes are associated with a single failure, the overall RPN of the failure mode is determined as the maximum RPN among its causes. This RPN constitutes the technical input that will subsequently be translated through perceptual service quality dimensions in Section C. The calculated S, O, D, and RPN values for the identified failure modes complete Section B of the PRISM Framework (see Table B.1 in Appendix B).

In terms of results, the highest operational criticality was observed in failure modes related to external value recognition and technical governance mechanisms. In particular, *Risk scores not recognized by insurers* (RPN = 48) emerged as one of most critical failure mode, highlighting the strategic dependency of the platform's value proposition on external stakeholder acceptance. High criticality levels were also identified in failure modes associated with data configuration, (*Misconfiguration of company data*, RPN = 48), AI-based analytical reliability (*Misleading AI RCA recommendation*, RPN = 48), reputational and relational dynamics (*Inadequate support communication tone,* RPN = 48), and information security risks (*Confidential data exposure*, RPN = 45; *Security breach*, RPN = 45).

These results indicate that the most critical risks within the Rcalls service system are not limited to isolated technical malfunctions but are concentrated around systemic dimensions such as data integrity, analytical credibility, security governance, human interaction quality, and external institutional alignment. A group of additional failure modes clustered around RPN = 36, representing structurally relevant operational vulnerabilities that, while less critical individually, contribute to overall system fragility.

### *6.2.3 Section C-D: Perceptual Risk Translation*

Following the operational risk assessment conducted in Section B, failure modes were translated into perceptual service quality implications using the QFD-based relationship matrix defined in Chapter 5.

For each failure mode, relationship scores (0–1–3–9) were assigned to the five selected service quality dimensions. These scores represent the expected negative perceptual impact on each dimension, assuming the failure occurs, and complete Section C of the PRISM Framework (see Table B.2. in Appendix B). Importantly, the assessment was performed through structured expert judgment involving the Rcalls manager, based on operational experience, customer feedback patterns, and knowledge of typical client reactions to service disruptions.

Although PRISM allows the adaptation or substitution of such dimensions depending on the specific context (e.g., E-S-QUAL for purely electronic services), SERVQUAL remains suitable in this case. Rcalls operates as a SaaS platform, but still customer evaluation extends beyond purely technical performance reliability to include tangibles, responsiveness, assurance, and support interactions throughout the lifecycle of platform adoption and use. Therefore, service quality remains multidimensional and can be coherently structured through SERVQUAL dimensions interpreted as follows:

- **Reliability** refers to system uptime, correct BoM risk scoring, consistent AI root cause identification, accurate KPI computation, and report generation integrity.
- **Responsiveness** relates to support speed, ticket handling efficiency, incident resolution time, and AI processing response time.
- **Assurance** concerns trust in generated metrics, data security, insurance credibility, regulatory robustness, and perceived analytical competence.
- **Empathy** reflects onboarding quality, account follow-up consistency, flexibility toward SME constraints, and support interaction tone.
- **Tangibles** correspond to dashboard clarity, interface usability and design, report formatting consistency, and overall professional presentation.

The resulting relationship matrix was then normalized using Lyman normalization, as described in Chapter 5. For each failure mode, relationship scores were converted into relative contribution weights across dimensions to complete Section D of the PRISM Framework (see Table B.2. in Appendix B). This normalization ensures comparability by expressing perceptual impacts as proportional distributions within each failure mode.

The normalized contribution weights provide the basis for aggregating operational criticality (RPN values from Section B) into dimension-level perceptual exposure indices, which are further analyzed in the subsequent section.

### *6.2.4 Section E- F: Perceived Risk Exposure and Managerial Prioritization*

Section E integrates the operational criticality results obtained through FMECA (Section B) with the normalized perceptual contribution weights derived from the QFD relationship matrix (Section D), enabling the translation of technical operational risk into Perceived Risk Exposure (PRE) across service quality dimensions.

For each failure mode, the overall RPN was multiplied by its normalized contribution weight for each SERVQUAL dimension. Aggregating these values across all identified failure modes produced the total PRE and the relative PRE share associated with each service quality dimension, thus completing Section E of the PRISM Framework (see Table B.1. in Appendix B). Given the exploratory nature of the case and the reliance on structured expert judgment, the quantitative results should be interpreted as decision-support indicators rather than absolute risk measurements.

In the case of Rcalls, the analysis shows that perceived risk exposure is primarily concentrated in:

- Reliability (26%)
- Assurance (25%)
- Tangibles (21%)

Together, these three dimensions account for **72% of total perceived risk exposure**, indicating that operational failures in Rcalls are predominantly experienced through technical integrity, analytical credibility, and the clarity and professionalism of system outputs, rather than through relational or interpersonal aspects of service delivery.

Section F converts these findings into managerial prioritization rules. Service quality dimensions are first ranked according to their relative PRE share. Within each prioritized dimension, the most influential failure modes are then identified based on their contribution to that dimension's PRE, and managerial attention is directed toward the underlying causes, prioritizing those with the highest $RPN_{f,c}$ values. This procedure is structured by completing the Section F of the PRISM Framework (see Table B.3. in Appendix B).

For Rcalls, the prioritization results suggest that managerial efforts should primarily focus on:

1) **Strengthening technical governance and data integrity mechanisms**, particularly configuration control, AI input validation, and synchronization robustness.
2) **Reinforcing security architecture and access control management,** including periodic RBAC audits, automated anomaly detection, and structured security governance practices.

3) **Enhancing analytical credibility and external legitimacy**, especially through insurer validation initiatives, benchmark transparency, and structured AI lifecycle management.
4) **Improving interface clarity and KPI prioritization logic**, reducing interpretative ambiguity and strengthening perceived professionalism of outputs.
5) **Optimizing support capacity planning and prioritization mechanisms,** while maintaining appropriate communication standards.

However, prioritization decisions should not rely solely on PRE magnitude. Managerial judgment must consider **implementation feasibility**, **cost–benefit trade-offs**, **interdependencies among system components**, and **potential systemic effects** of improvement actions. Furthermore, PRE should be periodically recalculated after corrective initiatives are implemented, enabling **dynamic reassessment of managerial priorities** and continuous alignment between operational performance and perceived service quality.

# 7. Results and Discussion

The application of the PRISM Framework to Rcalls reveals a structured concentration of perceived risk exposure across specific service quality dimensions. Reliability (26%), Assurance (25%), and Tangibles (21%) jointly account for 72% of total perceived risk exposure, indicating that operational failures within Rcalls are primarily interpreted by customers through dimensions related to technical integrity, analytical credibility, and clarity of system outputs.

This distribution is coherent with the structural nature of Rcalls as a technology-mediated, information-processing service system. Unlike high-touch service contexts, where relational interaction often dominates customer evaluation, Rcalls operates mainly through system configurations, analytical models, digital interfaces, and formal report outputs. As a result, risks related to data misconfiguration, security vulnerabilities, analytical validation, and system reliability emerge as the primary perceptual risk channels.

The comparatively lower PRE shares observed for Responsiveness (15%) and Empathy (13%) further support this interpretation. Although support quality and communication tone remain relevant for overall service perception, they do not represent the main mechanisms through which operational risk materializes in this context. In Rcalls, customers evaluate value primarily through data accuracy, methodological transparency, system robustness, and the credibility of analytical outputs in external environments such as insurance negotiations. Consequently, perceived risk is predominantly technology-centered rather than interaction-centered.

This finding reinforces the context-dependent nature of risk prioritization in service systems. The dominance of Reliability and Assurance in Rcalls reflects its high-tech, data-driven structure, whereas different service typologies would likely generate alternative PRE distributions. The application therefore confirms the internal coherence of the PRISM Framework and demonstrates its ability to produce structured and context-sensitive managerial insights.

An additional relevant insight concerns the recurrence of certain failure modes across multiple SERVQUAL dimensions. Confidential data exposure, security breaches, and risk score non-recognition by insurers contribute significantly to more than one perceptual dimension. This overlap highlights the presence of **structural risk nodes** (operational weaknesses that simultaneously affect multiple evaluative channels). For example, security-related failures influence Reliability through system integrity, Assurance through trust and professional credibility, and Tangibles through the perceived maturity of system outputs. Similarly, lack of external validation affects both Assurance (analytical credibility) and Tangibles (professional presentation and benchmarking of reports).

This multidimensional propagation effect suggests that operational risk does not translate into isolated perceptual consequences. Instead, certain failure modes act as leverage points whose mitigation may generate cross-dimensional perceptual improvements. From a managerial perspective, these structural nodes represent high-impact intervention priorities and enhance the potential cost-effectiveness of improvement initiatives.

In the specific case of Rcalls, the prioritization derived from PRE distribution and cause-level criticality analysis indicates the need to strengthen technical governance mechanisms, analytical validation processes, and security architecture. Actions such as reinforcing role-based access controls, implementing automated permission audits and anomaly detection systems, introducing benchmarking transparency, and adding explanatory layers to analytical reports address systemic vulnerabilities rather than isolated operational issues. At the same time, although relational dimensions are not dominant in the PRE distribution, support responsiveness and communication tone remain important for maintaining relational stability. Preventive measures such as AI-assisted ticket prioritization, workload balancing, and structured escalation procedures can help reduce secondary risk channels and prevent reputation erosion over time.

The case also illustrates the analytical value of **integrating operational risk assessment with perceptual allocation mechanisms**. Traditional FMECA alone would prioritize failures based exclusively on technical criticality. However, the incorporation of perceptual weighting through the PRISM logic reveals that some operationally severe failures generate limited perceptual exposure, while others with moderate operational severity significantly influence customer evaluation. For example, inadequate support communication tone presents a relatively high operational RPN but appears last in the perceptual priority ranking once weighted through service quality dimensions. PRE therefore functions as a translation mechanism that structures managerial attention according to perceptual leverage rather than purely technical magnitude.

Several considerations should nevertheless be acknowledged. First, the QFD relationship matrix relies on structured managerial judgment, meaning that perceptual allocation weights reflect informed interpretation rather than direct empirical customer data. Second, PRE values are relative prioritization indicators rather than absolute measures of dissatisfaction or objective risk probability. They support internal prioritization within the analyzed system but do not enable direct comparison across firms without additional normalization. Third, the framework does not explicitly incorporate improvement cost, feasibility, or implementation complexity into the PRE computation. Managerial judgment therefore remains essential to balance analytical outputs with organizational constraints and strategic objectives.

Overall, despite requiring structured analysis effort and expert involvement, the application to Rcalls demonstrates the capacity of PRISM to identify structural concentrations of perceived risk and to bridge operational diagnostics with customer-perceived impact, enabling managerial prioritization that is grounded simultaneously in operational robustness and experiential relevance.

# 8. Conclusions and Future Work

## 8.1 Conclusions

This thesis set out to address a managerial and methodological gap in service risk management. While structured operational risk assessment techniques such as FMECA allow organizations to identify and prioritize technical failures, they do not explicitly account for how those failures are experienced and evaluated by customers. In service systems, however, operational risk does not remain confined to internal processes; it materializes through perceptual channels that shape customer judgments of service quality.

The objective of this research was therefore to develop a structured decision-support framework capable of translating operational risk assessment into customer-relevant managerial priorities. The research questions guiding this study have been addressed as follows.

> **RQ1** demonstrated that service blueprinting combined with FMECA provides a systematic structure for identifying and prioritizing service-related operational risks.
>
> **RQ2** showed that the QFD relationship matrix logic can be used to integrate service quality dimensions into the operational risk assessment as perceptual allocation lenses, through which operational failures are translated into customer-relevant impacts.
>
> **RQ3** confirmed that integrating operational criticality with perceptual weighting generates a structured decision-support logic that supports managerial prioritization in risk reduction initiatives.

The result of this research is the **PRISM (Perceptual Risk Integration for Service Management) Framework**, which integrates service blueprinting (Shostack, 1984), FMECA (IEC 60812, 2018), and a QFD-based perceptual allocation mechanism structured around service quality dimensions (Akao, 1990) (Parasuraman et al., 1988).

PRISM contributes conceptually by positioning service quality dimensions not merely as measurement constructs, but as perceptual channels through which operational risk becomes visible to customers. By combining operational criticality with perceptual weighting, the framework generates the Perceived Risk Exposure (PRE) indicator, enabling managers to identify where operational failures are most strongly experienced from the customer's perspective.

The application to Rcalls demonstrates the internal coherence and practical relevance of the framework. The case shows that operational risk does not distribute evenly across perceptual dimensions. Instead, specific service typologies generate structural concentrations of perceived risk exposure. In the context analyzed, perceived risk was primarily technology-centered, concentrating in Reliability, Assurance, and Tangibles. This confirms that risk prioritization in service systems is inherently context-dependent and shaped by the structural characteristics of the service process

Beyond the specific case, the framework offers a generalizable prioritization logic. It does not replace managerial judgment, nor does it aim to measure absolute customer dissatisfaction. Rather, PRISM provides a structured mechanism for aligning improvement efforts with both technical criticality and perceptual impact under resource constraints. By doing so, it supports more economically efficient and strategically coherent allocation of quality improvement investments.

In conclusion, this thesis suggests that effective service risk management may require more than technical failure analysis. It requires understanding how operational risk is refracted through the evaluative lens of customer perception. By providing a structured methodology to perform this translation, the PRISM Framework enables managers to interpret operational risk "through the customer's prism" and to prioritize improvement actions accordingly. In doing so, it contributes to the development of more resilient, customer-aligned, and strategically grounded service systems.

## 8.2 Suggestions for further research

Future research may extend and refine the PRISM Framework along several complementary directions, addressing both methodological and empirical development opportunities.

First, **empirical applications** using real operational and customer perception data could enhance the calibration and robustness of the proposed indicators. Integrating SERVQUAL (Parasuraman et al., 1988) or SERVPERF (Cronin & Taylor, 1992) survey results with operational risk assessments would allow researchers to examine how perceptual allocation patterns vary across contexts and to evaluate the stability of the Perceived Risk Exposure (PRE) metric under different service conditions.

Second, **quantitative modeling approaches** such as regression analysis or structural equation modeling (SEM) could be employed to explore potential structural relationships between operational failure characteristics and customer-perceived quality dimensions. Although the proposed framework is not designed as a causal model, future studies could investigate whether recurring patterns of perceptual risk materialization emerge across service contexts, thereby complementing the decision-support orientation of the methodology.

Third, methodological refinements could **address known limitations of FMECA-based prioritization.** Alternative criticality indices (e.g., adjusted or logarithmic RPN), fuzzy-FMEA approaches, Bayesian risk models, or the integration of complementary techniques such as Fault Tree Analysis may improve the modeling of interdependent or cascading failures within complex service systems.

In addition, the framework could be integrated with **advanced decision-support techniques** such as multi-criteria decision-making (MCDM) methods, simulation models, or optimization approaches in order to enhance resource allocation decisions under uncertainty. Incorporating **improvement cost modeling** into the prioritization logic would enable the development of risk–impact–cost optimization models. Furthermore, **artificial intelligence** tools could support the automation of failure identification, scoring procedures, and perceptual allocation processes, increasing both efficiency and analytical consistency.

As anticipated in Section 5.5, **comparative and benchmarking studies** also represent a promising avenue. Applying the framework to larger samples of organizations operating within the same service sector would allow researchers to investigate structural patterns in how operational risk is translated into customer-perceived quality dimensions. Standardized failure classifications and consistent evaluation scales could strengthen the external validity and generalizability of the approach.

**Longitudinal research** offers another relevant direction. By applying the framework before and after targeted improvement initiatives, researchers could assess whether reductions in PRE values correspond to measurable improvements in customer experience and operational performance, thereby evaluating the practical effectiveness of PRISM in continuous improvement contexts.

Finally, the case study approach developed in Chapter 6 limits generalizability across sectors. Further applications across different service typologies—such as high-contact professional services or fully digital self-service platforms—would strengthen the robustness and adaptability of the framework. These applications may also explore adaptations of the perceptual layer by employing **alternative service quality models** (e.g., E-S-QUAL for digital services) or context-specific quality dimensions, examining how the choice of perceptual structure influences the allocation and interpretation of service-related operational risk.

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# Appendices

## Appendix A – Lovelock's service classification frameworks (1983)

This appendix presents the full set of service classification matrices proposed by Lovelock (1983). These tables are included for completeness and reference since only selected dimensions directly relevant to service risk identification and managerial prioritization are discussed in Chapter 1.

### *Customization and Judgment*

Customization in services can vary along two related dimensions:

- the degree to which the nature of the service allows customization, and
- the extent to which frontline employees exercise discretion in adapting the service to individual customer needs.

| Extent to which customer contact employees exercise judgment in meeting customer needs | Degree of Customization: High | Degree of Customization: Low |
|---|---|---|
| High | • Surgery<br>• Taxi service<br>• Gourmet restaurant | • Education (large classes)<br>• Preventive health programs<br>• Family restaurant |
| Low | • Telephone services<br>• Hotel services<br>• Retail Banking<br>• Cafeteria | • Public transportation<br>• Movie theater<br>• Spectator sports<br>• Institutional food services |

**Figure A.1.** *Customization and Judgment in Service Delivery*. Adapted from Lovelock (1983).

Even within a single industry, different segments may exhibit different levels of customization and employee judgment. The food-service sector, for example, ranges from standardized institutional catering to highly personalized fine-dining experiences (Fitzsimmons & Fitzsimmons, 2011, p. 28).

Customization represents a strategic design choice with operational implications. While higher customization can enhance perceived quality and differentiation, it may also increase cost, processing time, and variability. Service firms must therefore balance personalization and operational efficiency (Lovelock, 1983, p. 16).

***Nature of Demand and Capacity***

Another key classification dimension concerns the relationship between demand patterns and available service capacity. Services differ in:

- The extent of demand fluctuations over time (wide vs. narrow), and
- The frequency with which peak demand exceeds available capacity.

***Extent of demand fluctuations over time***

| *Extent to which demand exceeds capacity* | Wide | Narrow |
|---|---|---|
| Peak demand met without major delay | • Electricity<br>• Telephone<br>• Hospital maternity unit<br>• Police emergencies | • Insurance<br>• Legal services<br>• Banking<br>• Laundry and dry cleaning |
| Peak demand regularly exceeds capacity | • Tax preparation<br>• Passenger transportation<br>• Hotels and motels | • Fast-food restaurant<br>• Movie theater<br>• Gas station |

**Figure A.2.** *Nature of Demand for the Service Relative to Capacity*. Adapted from Lovelock (1983).

Different quadrants imply different managerial challenges. Some services must stimulate off-peak demand; others must manage recurrent capacity shortages (Lovelock, 1983, p.16). Thus, demand management and capacity planning tools—such as reservations, differential pricing, or promotional strategies—play a central role in service operations (Fitzsimmons & Fitzsimmons, 2011, p. 28).

***Method of Service Delivery***

Services can also be classified according to how and where delivery occurs. Lovelock (1983) combines:

- The geographical availability of service outlets (single vs. multiple sites), and
- The nature of interaction between the customer and the provider.

***Availability of Service Outlets***

| ***Nature of Service Delivery*** | | Single Site | Multiple Sites |
|---|---|---|---|
| | Customer travels to service firm | • Theater<br>• Barbershop | • Bus service<br>• Fast-food chain |
| | Service firm delivers | • Pest control service<br>• Taxi | • Mail delivery<br>• AAA emergency repairs |
| | Transaction at arm's length | • Credit card company<br>• Local TV station | • National TV network<br>• Telephone company |

**Figure A.3.** *Nature of Demand for the Service Relative to Capacity*. Adapted from Lovelock (1983).

Operating across multiple sites typically increases customer accessibility but introduces challenges in maintaining service consistency. Facility location decisions, process standardization, and quality control mechanisms become critical (Lovelock, 1983, p. 18).

Technological developments have expanded delivery modes to include remote channels and digital self-service systems. Many contemporary services combine physical and digital interfaces, altering customer contact patterns and operational design requirements (Fitzsimmons & Fitzsimmons, 2011, p. 29).

# Appendix B – Application of the PRISM Framework to Rcalls

Appendix B presents the complete PRISM Template resulting from the application of the framework to the Rcalls case study. It includes the structured outputs corresponding to Sections A through F, as referenced throughout Chapter 6. The appendix provides full transparency of the scoring procedures, relationship matrices, normalization calculations, and managerial prioritization results, while analytical discussion is developed in Chapters 6 and 7.

**Table B.1.** *PRISM Framework Application Results – Sections A, B and E (Rcalls Case).*

| SECTION A: Service Process and Failure Modes | | | | | | SECTION B: FMECA | | | | | | | | SECTION E: PRE by SERVQUAL dimension | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Service Phase | Frontstage / Backstage | Process Step | Function / Performance Standard | Failure Mode | Failure Description | Effect on Service / Customer | S | Causes | Existing detection / controls | O | D | RPN_{f,c} | RPN | Reliability | Responsiveness | Assurance | Empathy | Tangibles |
| Onboarding and account setup | Frontstage | Savings report creation | The savings report should accurately estimate potential insurance premium reduction and clearly communicate the financial value of adopting Rcalls. | A: Incorrect saving calculation | Estimated insurance savings are incorrectly calculated | Customer forms unrealistic expectations about insurance savings.<br>Reduced credibility of Rcalls value proposition.<br>Loss of trust when actual insurer quote differs from estimate. | 4 | A1: Incorrect input parameters | Input validation fields, manual review | 2 | 2 | 16 | 24 | 3.79 | 3.79 | 11.37 | 1.26 | 3.79 |
| | | | | | | | | A2: Calculation logic errors | Version control of calculation model | 3 | 2 | 24 | | | | | | |
| | | | | B: Savings report unclear | The savings report is difficult to understand, or it does not clearly explain assumptions, methodology, or financial implications | Difficulty understanding financial impact.<br>Perceived lack of transparency.<br>Reduced persuasion to subscribe.<br>Lower conversion rate. | 3 | B1: Poor UX/UI design. | UX review iterations. | 3 | 2 | 18 | 27 | 3.00 | 3.00 | 9.00 | 3.00 | 9.00 |
| | | | | | | | | B2: Overly technical terminology without explanations | Customer feedback | 3 | 3 | 27 | | | | | | |
| | | Subscription and account creation | Customer should complete registration smoothly and access platform without delay | C: Account activation failure | User cannot access platform after subscription | Disruption of the process.<br>Frustration and early negative perception on customers.<br>Increased support tickets. | 3 | C1: Email verification failure. | auto-resend + email deliverability monitoring | 3 | 2 | 18 | 18 | 8.53 | 2.84 | 2.84 | 2.84 | 0.95 |
| | | | | | | | | C2: Permission configuration mismatch. | Automated role validation on signup, ticket scalation | 2 | 3 | 18 | | | | | | |
| | | | | | | | | C3: Backend provisioning error. | System alerts for failed provisioning. | 2 | 2 | 12 | | | | | | |
| | | | | D: Access delay | System response time exceeds acceptable threshold | Frustration and early negative perception on customers. | 2 | D1: Server overload. | Performance monitoring dashboards. | 3 | 2 | 12 | 16 | 5.76 | 5.76 | 1.92 | 1.92 | 0.64 |
| | | | | | | | | D2: Cloud configuration limitations. | None | 2 | 4 | 16 | | | | | | |
| | Backstage | Account configuration and setup | System correctly configures company requirements, information and acess permisions | E: Misconfiguration of company data | Incorrect configuration of company profile data (inaccurate, incomplete or no traceable) | Incorrect outputs (BoM risk, reports).<br>Need for reconfiguration.<br>Wrong traceability structure. | 4 | E1: Incorrect data entry. | Input validation fields, manual review | 4 | 3 | 48 | **48** | 22.74 | 7.58 | 7.58 | 2.53 | 7.58 |
| | | | | | | | | E2: Misunderstanding of configuration fields | Structured setup wizard. | 3 | 3 | 36 | | | | | | |
| | | | | F: Unauthorized access configuration error | Incorrect user permissions assigned during account setup | Data confidentiality risk and legal exposure.<br>Internal organizational conflict. | 5 | F1: Incorrect role assigment | Role-based access control/validation | 2 | 2 | 20 | 30 | 4.74 | 1.58 | 14.21 | 4.74 | 4.74 |
| | | | | | | | | F2: Permission inheritance error. | Periodic permission audits | 2 | 3 | 30 | | | | | | |
| | | | | | | | | | Access logs | 2 | 2 | 20 | | | | | | |
| | | | | G: Data mapping error | Data is upload with wrong component associations | Incorrect outputs (BoM risk, reports).<br>Manual correction workload.<br>Wrong traceability structure. | 4 | G1: CVS format mismatch. | Data import validation rules, preview before upload | 3 | 1 | 12 | 24 | 8.64 | 2.88 | 2.88 | 0.96 | 8.64 |
| | | | | | | | | G2: Field mapping misalignment | Error messages during mapping | 2 | 3 | 24 | | | | | | |

**Table B.1.** *PRISM Framework Application Results – Sections A, B and E (Rcalls Case).*

| SECTION A: Service Process and Failure Modes | | | | | | SECTION B: FMECA | | | | | | | | SECTION E: PRE by SERVQUAL dimension | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Service Phase | Frontstage / Backstage | Process Step | Function / Performance Standard | Failure Mode | Failure Description | Effect on Service / Customer | S | Causes | Existing detection / controls | O | D | RPN_{f,c} | RPN | Reliability | Responsiveness | Assurance | Empathy | Tangibles |
| | Frontstage | Training and onboarding support | Onboarding support and training materials should provide timely, clear, and structured guidance, enabling customers to correctly use the platform autonomously. | H: unclear training material | Training documentation, FAQs, or tutorials are incomplete, poorly structured, or difficult to understand | Confusion during onboarding.<br>Incorrect platform usage.<br>Slower adoption.<br>Increased support workload.<br>Repeated clarification sessions. | 3 | H1: Overly technical terminology | Feedback from onboarding sessions | 3 | 3 | 27 | 27 | 3.24 | 1.08 | 3.24 | 9.72 | 9.72 |
| | | | | | | | | H2: Missing practical examples. | | 3 | 3 | 27 | | | | | | |
| | | | | | | | | H3: Outdated documentation. | Periodic documentation review and update | 2 | 2 | 12 | | | | | | |
| | | | | I: Inadequate onboarding support | Customer does not fully understand platform functionalities due to insufficient or delayed support during onboarding. | Customer unable to use platform autonomously.<br>Low engagement.<br>Higher churn probability.<br>Repeated training sessions | 4 | I1: Insufficient staffing | Ticket response time monitoring | 3 | 3 | 36 | 36 | 1.57 | 14.09 | 4.70 | 14.09 | 1.57 |
| | | | | | | | | I2: Untrained staff | Customer feedback | 2 | 3 | 24 | | | | | | |
| | | | | | | | | I3: Lack of structured onboarding workflow | CRM follow-up tracking | 2 | 3 | 24 | | | | | | |
| Claim initiation (D0, D1, D2) | Frontstage | Open a new claim | Customer should create case without system delay, errors or duplications | J: Case creation failure | System crash or lag during case opening | Inability to initiate quality incident process. Frustration and reduced perception of reliability.<br>Increased support tickets and response workload for IT team. | 4 | J1: Server overload or insufficient cloud resources. | Uptime monitoring system | 1 | 2 | 8 | 24 | 11.37 | 3.79 | 3.79 | 1.26 | 3.79 |
| | | | | | | | | J2: Unhandled exception in claim creation logic. | Application performance monitoring (APM). | 3 | 2 | 24 | | | | | | |
| | | | | | | | | J3: Backend timeout during database write. | Error logs and crash reporting tools. | 1 | 2 | 8 | | | | | | |
| | | | | K: Duplicate case entry | Same defect registered multiple times | Confusion in tracking claim status.<br>Inflated defect statistics.<br>Distorted risk metrics and misleading KPI dashboards.<br>Data cleanup required and increased manual effort. | 3 | K1: User confusion or double summision due to lag | Manual review of abnormal KPI spikes. | 3 | 2 | 18 | 27 | 12.79 | 4.26 | 4.26 | 4.26 | 1.42 |
| | | | | | | | | K2: Lack of duplicate detection algorithm. | | 3 | 3 | 27 | | | | | | |
| | | | | | | | | K3: Missing unique case ID validation or inconsistent master data. | Unique ID constraints | 1 | 2 | 6 | | | | | | |
| | | | | L: Error in saving a new claim | System fails to save the newly created claim | Loss of entered information.<br>Need to re-enter case details.<br>Increased support workload.<br>Trust erosion in platform stability. | 4 | L1: Session timeout | Save confirmation message. | 3 | 2 | 24 | 24 | 10.29 | 3.43 | 3.43 | 3.43 | 3.43 |
| | | | | | | | | L2: Database write failure | Database integrity checks | 2 | 2 | 16 | | | | | | |
| | | Team and problem description entry | Interface should allow clear team formation and problem documentation | M: Interface usability issue | User unable to properly describe defect and/or team | Lower quality of stored data and incomplete or unclear defect documentation.<br>Reduced effectiveness of RCA process.<br>Poor collaboration among team members.<br>Increased need for clarification. | 4 | M1: Poor UI design, non-intuitive navigation or lack of contextual help | Mandatory field validation | 3 | 2 | 24 | 36 | 12.00 | 4.00 | 4.00 | 4.00 | 12.00 |
| | | | | | | | | | UI/UX testing cycles | 3 | 2 | 24 | | | | | | |
| | | | | | | | | | Feedback from onboarding sessions | 3 | 3 | 36 | | | | | | |
| | | | | N: Missing reference data | Required master data unavailable during case creation. | Inability to complete team formation or problem description.<br>Delays in formalizing D0–D2 stages.<br>Frustration during case initiation.<br>Risk of inconsistent case documentation.<br>Need for manual data upload. | 3 | N1: Incomplete data import during setup. | Mandatory master data checks before case creation. | 3 | 2 | 18 | 18 | 6.00 | 2.00 | 6.00 | 2.00 | 2.00 |
| | | | | | | | | N2: Wrong information in database | Data completeness warnings. | 2 | 3 | 18 | | | | | | |

**Table B.1.** *PRISM Framework Application Results – Sections A, B and E (Rcalls Case).*

| SECTION A: Service Process and Failure Modes | | | | | | SECTION B: FMECA | | | | | | | | SECTION E: PRE by SERVQUAL dimension | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Service Phase | Frontstage / Backstage | Process Step | Function / Performance Standard | Failure Mode | Failure Description | Effect on Service / Customer | S | Causes | Existing detection / controls | O | D | RPN_{f,c} | RPN | Reliability | Responsiveness | Assurance | Empathy | Tangibles |
| RCA (D4) | Backstage | Data storage | System should securely store case information | O: Data loss | Case data not saved or partially lost | Loss of traceability.<br>Need to reconstruct case history.<br>Reduced confidence in system integrity.<br>Data restoration effort.<br>Compliance and audit risk. | 4 | O1: Synchronization interruption. | Automated backups | 2 | 2 | 16 | 16 | 5.33 | 1.78 | 5.33 | 1.78 | 1.78 |
| | | | | | | | | O2: Database corruption | Database integrity checks | 2 | 2 | 16 | | | | | | |
| | | | | | | | | O3: Backup failure | Redundant storage architecture | 1 | 4 | 16 | | | | | | |
| | Frontstage | AI-assisted root cause analysis | RCA is performed accurately and well doumented | P: Misleading AI RCA recommendation | AI suggests incorrect, low-relevance, or biased root causes | Investigation effort misdirected.<br>Delay in identifying real root cause.<br>Ineffective corrective actions.<br>Reduced trust in AI functionality. | 4 | P1: Training dataset bias. | Periodic retraining schedule. | 3 | 2 | 24 | 48 | 16.00 | 5.33 | 16.00 | 5.33 | 5.33 |
| | | | | | | | | P2: Model drift | Monitoring AI output consistency. | 2 | 3 | 24 | | | | | | |
| | | | | | | | | P3: Poor prompt engineering or parameter tuning. | Human validation before RCA approval, or ability to override AI suggestions | 3 | 2 | 24 | | | | | | |
| | | | | | | | | P4: Insufficient contextual data from case input. | Logging of AI recommendation patterns | 4 | 3 | 48 | | | | | | |
| | | | | Q: Attachment upload failure | User cannot upload RCA documents | Incomplete RCA documentation.<br>Delay in D4 closure.<br>Frustration during analysis phase.<br>Increased support requests.<br>Missing audit trail.<br>Potential compliance risk. | 3 | Q1: File size limit restriction. | File type validation message. | 3 | 2 | 18 | 18 | 6.00 | 2.00 | 6.00 | 2.00 | 2.00 |
| | | | | | | | | Q2: Unsupported file format. | Error message feedback. | 3 | 2 | 18 | | | | | | |
| | | | | | | | | Q3: Storage quota exceeded. | Storage monitoring alerts. | 2 | 2 | 12 | | | | | | |
| | Backstage | Algorithm processing | Model should function without computational errors | R: Algorithm malfunction | AI processing fails or produces null/inconsistent outputs. | RCA process interrupted.<br>Need to repeat analysis.<br>Perception of system instability.<br>Technical incident escalation.<br>SLA impact<br>Manual RCA workload increase. | 4 | R1: API integration failure | API health checks. | 2 | 2 | 16 | 24 | 3.79 | 1.26 | 11.37 | 3.79 | 3.79 |
| | | | | | | | | R2: Incompatible model version deployment. | Model version rollback capability. | 2 | 2 | 16 | | | | | | |
| | | | | | | | | R3: Runtime exception. | Error logs and crash monitoring. | 3 | 2 | 24 | | | | | | |
| | Backstage (support process) | AI model training | Model should be updated and calibrated | S: Outdated training data | AI suggestions based on obsolete historical cases | Recommendations not aligned with current industry context.<br>Incorrect prioritization of risks.<br>Reduced perceived intelligence of system.<br>Gradual degradation of RCA performance.<br>Misalignment with insurer expectations. | 4 | S1: Lack of retraining sc | Periodic model retraining. | 3 | 3 | 36 | 36 | 5.68 | 1.89 | 17.05 | 5.68 | 5.68 |
| | | | | | | | | S2: No feedback loop from resolved cases. | Feedback systems and expert review of AI outputs. | 2 | 3 | 24 | | | | | | |
| | | | | | | | | S3: Poor model performance monitoring | Accuracy monitoring KPIs. | 2 | 3 | 24 | | | | | | |
| | | Definition of containment, corrective and preventive actions | System should allow structured action entry and tracking | T: Poor action entry interface design | User unable to properly describe actions | Actions vaguely defined.<br>Ambiguous responsibilities.<br>Delays in containment and correction.<br>Weak audit traceability | 3 | T1: Poor UI structure or overly complex interface | Tooltips, contextual help | 3 | 3 | 27 | 27 | 9.00 | 3.00 | 3.00 | 3.00 | 9.00 |
| | | | | | | | | T2: Lack of mandatory fields. | Mandatory field validation | 2 | 2 | 12 | | | | | | |
| | | | | U: Action-to-case linkage failure | Actions are not properly linked to their corresponding case. | Loss of traceability.<br>Difficulty monitoring progress.<br>Confusion during audits.<br>Compliance risk.<br>Incorrect KPI reporting. | 4 | T3: Database relational mapping error. | Relational database constraints. | 2 | 2 | 16 | 36 | 14.09 | 1.57 | 4.70 | 1.57 | 14.09 |
| | | | | | | | | T4: User selection mistake. | Dashboard cross-check reports. | 3 | 3 | 36 | | | | | | |
| | | | | | | | | | Case ID mandatory association. | 3 | 2 | 24 | | | | | | |

**Table B.1** *PRISM Framework Application Results – Sections A, B and E (Rcalls Case).*

| SECTION A: Service Process and Failure Modes | | | | | | SECTION B: FMECA | | | | | | | | SECTION E: PRE by SERVQUAL dimension | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Service Phase | Frontstage / Backstage | Process Step | Function / Performance Standard | Failure Mode | Failure Description | Effect on Service / Customer | S | Causes | Existing detection / controls | O | D | RPN_{f,c} | RPN | Reliability | Responsiveness | Assurance | Empathy | Tangibles |
| Actions definition & control plan implementation (D3, D5, D6,D7) | Frontstage | Control plan and KPI monitoring | Dashboard should be dynamic, update in real time and provide consistent KPIs | V: Inconsistent KPI calculation or display | KPI are computed or visualized incorrectly | Misleading perception of performance.<br>Incorrect decision-making.<br>Reduced trust in analytics. | 4 | V1: Wrong formula implementation. | KPI validation rules. | 2 | 2 | 16 | 36 | 4.32 | 4.32 | 12.96 | 1.44 | 12.96 |
| | | | | | | | | V2: Incorrect data aggregation. | Periodic dashboard audits. | 3 | 3 | 36 | | | | | | |
| | | | | W: KPI update delay | Dashboard does not reflect latest action status | Belief that actions are not progressing.<br>Delayed managerial decisions.<br>Temporary reporting distortion.<br>Reduced responsiveness to emerging risks. | 3 | W1: Scheduled batch update instead of real-time. | Update timestamp display. | 3 | 3 | 27 | 27 | 8.38 | 8.38 | 0.93 | 0.93 | 8.38 |
| | | | | | | | | W2: Server performance limitation. | Manual refresh option | 2 | 3 | 18 | | | | | | |
| | | | | X: Filter malfunction | Dashboard filters fail to correctly apply selection criteria | Incomplete, inconsistent, or misleading KPI visualization.<br>Misinterpretation of case portfolio.<br>Decision errors based on filtered view. | 3 | X1: Query logic error | Cross-check with unfiltered dataset | 2 | 3 | 18 | 18 | 6.48 | 2.16 | 2.16 | 0.72 | 6.48 |
| | | | | | | | | X2: Frontend filtering not aligned with backend. | QA testing of filters | 2 | 2 | 12 | | | | | | |
| | | | Control plan and dashboard interface should be clear and easy to interprete | Y: Control plan interface ambiguity | Dashboard or control plan layout makes interpretation difficult | Misunderstanding of action status.<br>Underutilization of monitoring tools. | 3 | Y1: Too many KPIs without prioritization. | Customer feedback | 3 | 3 | 27 | 27 | 4.76 | 1.59 | 4.76 | 1.59 | 14.29 |
| | | | | | | | | Y2: Poor visualization design. | UX review sessions e iterative interface redisign | 3 | 2 | 18 | | | | | | |
| | | | | Z: Lack of guidance in KPI interpretation | Users receive insufficient contextual explanation to correctly interpret performance indicators. | KPIs misunderstood.<br>Incorrect managerial conclusions.<br>Inconsistent internal reporting | 3 | Z1: No KPI definition glossary. | KPI documentation. | 2 | 3 | 18 | 27 | 3.24 | 1.08 | 9.72 | 3.24 | 9.72 |
| | | | | | | | | Z2: No interpretation guide. | Add interpretation guide, help section or tooltips to training materials | 3 | 3 | 27 | | | | | | |
| | | | | | | | | Z3: Deficent advising support | Protocols for account follow up and support | 2 | 3 | 18 | | | | | | |
| | Backstage | KPIs configuration | KPIs should be correctly adapted to customer requirements, with changes saved on the system | AA: KPIs misconfiguration | KPI parameters are incorrectly configured, not properly saved, or insufficiently customizable | KPIs do not reflect company reality.<br>Incorrect performance measurement.<br>Poor management decisions | 3 | AA1: Configuration not saved in system | Configuration confirmation message. | 2 | 3 | 18 | 27 | 3.24 | 3.24 | 9.72 | 1.08 | 9.72 |
| | | | | | | | | AA2: Poor onboarding and collection of customer requirements | Onboarding standards, trained staff | 3 | 3 | 27 | | | | | | |
| | Backstage (support process) | System control plan management | System must accurately track action status, deadlines and completion progress. | AB: Incorrect deadline tracking | System fails to notify or highlight overdue corrective actions. | Missed corrective action deadlines.<br>Increased recurrence risk.<br>SLA breaches.<br>Escalation of unresolved cases. | 3 | AB1: Notification system failure. | Escalation rules | 2 | 3 | 18 | 18 | 2.16 | 2.16 | 6.48 | 0.72 | 6.48 |
| | | | | | | | | AB2: Incorrect deadline calculation logic. | Overdue flag in dashboard | 2 | 3 | 18 | | | | | | |

**Table B.1.** *PRISM Framework Application Results – Sections A, B and E (Rcalls Case).*

| SECTION A: Service Process and Failure Modes | | | | | | SECTION B: FMECA | | | | | | | | SECTION E: PRE by SERVQUAL dimension | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Service Phase | Frontstage / Backstage | Process Step | Function / Performance Standard | Failure Mode | Failure Description | Effect on Service / Customer | S | Causes | Existing detection / controls | O | D | RPN_{f,c} | RPN | Reliability | Responsiveness | Assurance | Empathy | Tangibles |
| | Backstage (support process) | System update | Backend must synchronize data correctly in reasonable time | AC: Synchronization error | Backend fails to update risk and dashboard metrics | Risk scores and KPIs not aligned with latest case status.<br>Incorrect perception of product/component risk and performance.<br>Poor decision-making.<br>Inconsistent reporting across modules.<br>Loss of confidence in analytical | 3 | AC1: Batch recalculation scheduling issue. | Timestamp indicators in dashboard. | 3 | 3 | 27 | 27 | 7.84 | 0.87 | 7.84 | 2.61 | 7.84 |
| | | | | | | | | AC2: Data pipeline interruption. | Monitoring of ETL/data pipeline health. | 2 | 2 | 12 | | | | | | |
| | | | | | | | | AC3: API synchronization delay. | Data synchronization logs. | 3 | 3 | 27 | | | | | | |
| BoM Risk Assessment | | | | AD: Recalculation delay | Updated data not reflected in compoent risk score and KPIs | Delayed awareness of increased risk.<br>Incorrect prioritization of actions.<br>Reduced trust in real-time capabilities.<br>Management decisions based on outdated metrics.<br>Temporary misalignment between actions and risk ranking or KPIs. | 3 | AD1: Heavy computational load. | Load balancing policies. | 3 | 2 | 18 | 27 | 10.57 | 10.57 | 3.52 | 1.17 | 1.17 |
| | | | | | | | | AD2: Scheduled periodic recalculation instead of dynamic update. | Manual refresh option. | 3 | 3 | 27 | | | | | | |
| | | | | | | | | | Scheduled recalculation monitoring. | 3 | 2 | 18 | | | | | | |
| | | | | | | | | AD3: Queue processing backlog. | KPI last-update timestamp visibility. | 3 | 3 | 27 | | | | | | |
| | Frontstage | View BoM risk score | BoM risk interface should provide accurate, transparent and interpretable risk scores at component and product level. | AE: Unclear interface | Risk scores are displayed without clear explanation of severity, occurrence, and detection components, underlying assumptions, or scale interpretation. | Misinterpretation of risk magnitude.<br>Low transparency perception.<br>Reduced adoption of BoM module.<br>Difficulty defending risk methodology to auditors or insurers.<br>Lower credibility of analytical outputs. | 3 | AE1: Missing glossary or weighting information | Tooltips explaining components / RPN methodology explanation in training materials | 2 | 3 | 18 | 27 | 3.24 | 1.08 | 3.24 | 9.72 | 9.72 |
| | | | | | | | | AE2: Poor and incomplete visualization design. | UX review sessions e iterative interface redisign | 3 | 2 | 18 | | | | | | |
| | | | | | | | | | User training sessions | 3 | 3 | 27 | | | | | | |
| | Backstage | Risk computation engine | Risk computation engine must correctly calculate RPN based on severity, occurrence and detection parameters. | AF: Calculation algorithm error | RPN formula misapplied or parameters incorrectly weighted. | Incorrect component/product risk ranking.<br>Misguided prioritization of mitigation.<br>Regulatory/audit implications<br>SLA breaches | 4 | AF1: Wrong severity/occurrence/detection mapping. | Code review before deployment. | 2 | 3 | 24 | 24 | 8.64 | 0.96 | 8.64 | 2.88 | 2.88 |
| | | | | | | | | AF2: Coding error in RPN formula. | Code review before deployment. | 2 | 3 | 24 | | | | | | |
| | | | | | | | | | Formula validation tests, or cross-verification with manual calculation samples | 2 | 2 | 16 | | | | | | |
| | | Insurer recognition | Risk assessment outputs should be credible, standardized, and acceptable to insurance companies for underwriting and coverage evaluation purposes. | AG: Risk scores are not recognized by insurers | Insurance companies do not accept or incorporate Rcalls risk metrics in underwriting decisions | No insurance premium reduction.<br>Perceived loss of financial value proposition.<br>Reduced platform adoption. | 4 | AG1: No external validation. | External validation studies. | 3 | 4 | 48 | **48** | 5.76 | 1.92 | 17.28 | 5.76 | 17.28 |
| | | | | | | | | AG2: Insurers use different risk frameworks | Alignment workshops with insurers. | 3 | 3 | 36 | | | | | | |
| | | | | | | | | AG3: Insufficient transparency. | Documentation aligned with underwriting criteria. | 2 | 3 | 24 | | | | | | |

**Table B.1.** *PRISM Framework Application Results – Sections A, B and E (Rcalls Case).*

| SECTION A: Service Process and Failure Modes | | | | | | SECTION B: FMECA | | | | | | | | SECTION E: PRE by SERVQUAL dimension | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Service Phase | Frontstage / Backstage | Process Step | Function / Performance Standard | Failure Mode | Failure Description | Effect on Service / Customer | S | Causes | Existing detection / controls | O | D | RPN_{f,c} | RPN | Reliability | Responsiveness | Assurance | Empathy | Tangibles |
| Reporting | Fronstage | Generate and export 8D report | Report should generate complete, accurate and traceable documentation aligned with case data. | AH: Lack of traceability in report documentation | Report does not clearly display timestamps, responsible users or action history. | Reduced credibility of 8D documentation.<br>Difficulty demonstrating compliance to clients or regulators.<br>Loss of audit transparency.<br>Increased manual effort during inspections. | 4 | AH1: Missing metadata mapping during export. | Manual pre-export review. | 3 | 3 | 36 | 36 | 4.32 | 1.44 | 12.96 | 4.32 | 12.96 |
| | | | | | | | | | Audit log stored in database. | 3 | 2 | 24 | | | | | | |
| | | | | | | | | AH2: Report template not linked to activity log. | Mandatory timestamp fields in case system. | 2 | 3 | 24 | | | | | | |
| | | | | AI: Report generation error | Report content incomplete, inconsistent or not aligned with case data. | Mismatch between platform data and exported document.<br>Need for manual correction.<br>Reduced trust in documentation integrity.<br>Risk during external audits.<br>Potential legal exposure. | 3 | AI1: Data mapping bug. | Data completeness validation rules. | 2 | 2 | 12 | 18 | 7.04 | 0.78 | 2.35 | 0.78 | 7.04 |
| | | | | | | | | AI2: Partial data synchronization. | Report preview before download. | 2 | 3 | 18 | | | | | | |
| | | | | | | | | AI3: Export template outdated. | Version control of report template | 2 | 2 | 12 | | | | | | |
| | | | File should be downloadable and shareable | AJ: File export failure | File cannot be downloaded or shared successfully. | Inability to share documentation with stakeholders.<br>Delay in supplier/client communication.<br>Frustration.<br>Increased support tickets. | 3 | AJ1: Storage or permission error. | Error notification. | 2 | 2 | 12 | 18 | 7.71 | 2.57 | 2.57 | 2.57 | 2.57 |
| | | | | | | | | AJ2: File generation process crash. | Retry mechanism. | 2 | 2 | 12 | | | | | | |
| | | | | | | | | AJ3: Server timeout. | Server health monitoring. | 3 | 2 | 18 | | | | | | |
| | Backstage (support process) | Document formatting engine | System must generate standardized, professionally formatted documentation suitable for external stakeholders. | AK: Formatting inconsistency | Report layout appears unprofessional or inconsistent | Reduced professional image.<br>Lower perceived platform maturity.<br>Difficulty using document externally.<br>Brand credibility risk.<br>Additional manual editing required.<br>Misalignment with client standards. | 4 | AK1: Inconsistent template design. | Standardized template. | 2 | 2 | 16 | 24 | 3.13 | 1.04 | 9.39 | 1.04 | 9.39 |
| | | | | | | | | AK2: PDF rendering engine issues. | User feedback loop. | 2 | 3 | 24 | | | | | | |
| | | | | | | | | AK3: Font or layout compatibility problems | Visual QA before deployment. | 2 | 2 | 16 | | | | | | |
| | | Data access control and report filtering | System must ensure only authorized and relevant data are included in exported reports. | AL: Confidential data exposure | Sensitive internal or third-party data unintentionally included in exported documentation. | Data breach risk.<br>Contractual or regulatory violation.<br>Severe trust erosion<br>Data breach risk.<br>Contractual or regulatory violation.<br>Severe trust erosion | 5 | AL1: Incorrect data filtering rules. | Pre-export data filtering logic. | 2 | 4 | 40 | 45 | 17.61 | 1.96 | 17.61 | 1.96 | 5.87 |
| | | | | | | | | AL2: Role-based access misconfiguration. | Role-based access control (RBAC). | 3 | 3 | 45 | | | | | | |
| | | | | | | | | AL3: Backend query not restricted by permissions. | Periodic penetration testing. | 2 | 3 | 30 | | | | | | |
| | | | | | | | | | Security audit logs. | 2 | 3 | 30 | | | | | | |
| | | Customer support (ticket sistem) | Support channel should be accessible, responsive and solution-oriented within defined service levels. | AM: Ticket system malfunction | Customer unable to open or track support request. | Inability to report issues.<br>Escalation through informal channels (email, calls).<br>Loss of traceability in support process.<br>Increased manual workload. | 3 | AM1: Ticketing platform integration failure. | Ticket system uptime monitoring. | 2 | 3 | 18 | 18 | 2.84 | 8.53 | 2.84 | 2.84 | 0.95 |
| | | | | | | | | AM2: Authentication/session issue, or database error | Error logging. | 2 | 2 | 12 | | | | | | |
| | | | | AN: Delayed response | Response time exceeds defined service level. | Perceived lack of responsiveness.<br>Reduced satisfaction.<br>Escalation or churn risk.<br>Overloaded support backlog.<br>Negative account management impact. | 4 | AN1: Insufficient support staffing. | Automated escalation rules. | 3 | 3 | 36 | 36 | 5.68 | 17.05 | 5.68 | 5.68 | 1.89 |
| | | | | | | | | AN2: Poor ticket prioritization logic. | Priority-based ticket classification. | 3 | 3 | 36 | | | | | | |
| | | | | | | | | AN3: Surge in incident volume. | Automated escalation rules. | 2 | 3 | 24 | | | | | | |

**Table B.1.** *PRISM Framework Application Results – Sections A, B and E (Rcalls Case).*

| SECTION A: Service Process and Failure Modes | | | | | | SECTION B: FMECA | | | | | | | | SECTION E: PRE by SERVQUAL dimension | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Service Phase | Frontstage / Backstage | Process Step | Function / Performance Standard | Failure Mode | Failure Description | Effect on Service / Customer | S | Causes | Existing detection / controls | O | D | RPN_{f,c} | RPN | Reliability | Responsiveness | Assurance | Empathy | Tangibles |
| Ongoing support | Fronstage | | | AO: Inadequate support communication tone | Customer perceives support interaction as dismissive or unprofessional | Trust erosion and reputation damage.<br>Reduced perceived service quality.<br>Increased dissatisfaction even if issue resolved. | 4 | AO1: Stress/workload on support team. | Customer satisfaction surveys. | 3 | 4 | 48 | 48 | 8.47 | 2.82 | 8.47 | 25.41 | 2.82 |
| | | | | | | | | AO2: No standardized communication guidelines. | Support communication guidelines. | 2 | 2 | 16 | | | | | | |
| | | | | | | | | AO3: Lack of support training. | Training programs. | 3 | 3 | 36 | | | | | | |
| | | Account management follow up | Account follow-up should be consistent, proactive and aligned with customer operational needs. | AP: Inconsistent follow-up | Customer receives irregular or absent account follow-up. | Feeling neglected.<br>Reduced engagement with platform features.<br>Missed improvement opportunities.<br>Lower retention.<br>Reduced upselling potential.<br>Weak long-term relationship | 4 | AP1: Internal team overload. | CRM tracking system. | 3 | 3 | 36 | 36 | 4.32 | 12.96 | 4.32 | 12.96 | 1.44 |
| | | | | | | | | AP2: No automated follow-up reminders. | Scheduled follow-up tasks. | 2 | 2 | 16 | | | | | | |
| | Backstage | Internal technical review | Technical issues must be diagnosed and resolved within acceptable time thresholds. | AQ: Slow bug resolution | Technical fix takes excessive time | Prolonged operational disruption.<br>Workarounds required.<br>Loss of confidence in platform reliability.<br>Accumulated technical debt.<br>Increased backlog.<br>Support escalation pressure. | 4 | AQ1: Limited development capacity. | Patch deployment protocol. | 3 | 3 | 36 | 36 | 5.68 | 17.05 | 5.68 | 1.89 | 5.68 |
| | | | | | | | | AQ2: Complex legacy code. | Sprint planning review. | 2 | 2 | 16 | | | | | | |
| | | | | | | | | AQ3: Poor bug prioritization. | Prioritization matrix. | 3 | 3 | 36 | | | | | | |
| | | | | | | | | AQ4: Dependency on third-party vendors. | Issue tracking system. | 2 | 3 | 24 | | | | | | |
| | Backstage (support process) | Cloud infrastructure | Platform uptime should remain high | AR: System downtime | Platform unavailable for users | Inability to manage active cases.<br>High frustration.<br>SLA breach.<br>Financial penalties.<br>Reputation damage. | 5 | AR1: Cloud infrastructure failure. | Cloud redundancy. | 2 | 2 | 20 | 30 | 9.31 | 9.31 | 9.31 | 1.03 | 1.03 |
| | | | | | | | | AR2: Server overload | Uptime monitoring system | 3 | 2 | 30 | | | | | | |
| | | | | | | | | AR3: Deployment failure | Incident response protocol. | 2 | 3 | 30 | | | | | | |
| | | Cybersecurity system | Data must remain secure | AS: Security breach | Unauthorized access to client data | Legal exposure.<br>Contract termination.<br>Regulatory penalties.<br>Mandatory disclosure.<br>Reputation and financial damage. | 5 | AS1: Weak authentication. | Multi-factor authentication. | 2 | 2 | 20 | 45 | 17.61 | 1.96 | 17.61 | 1.96 | 5.87 |
| | | | | | | | | AS2: Misconfigured permissions. | Role-based access control. | 3 | 3 | 45 | | | | | | |
| | | | | | | | | AS3: Vulnerable API endpoint. | Security monitoring and alerts. | 2 | 3 | 30 | | | | | | |
| | | | | | | | | | Encryption at rest and in transit. | 2 | 2 | 20 | | | | | | |
| | | Payment processing | Payment transactions should be processed securely and accurately. | AT: Payment processing error | Incorrect charge, failed transaction, or billing inconsistency. | Financial dispute.<br>Service suspension risk.<br>Refund handling.<br>Accounting reconciliation effort.<br>Revenue leakage. | 4 | AT1: Payment gateway integration failure. | Payment reconciliation | 2 | 2 | 16 | 24 | 9.39 | 1.04 | 9.39 | 3.13 | 1.04 |
| | | | | | | | | | Transaction confirmation. | 2 | 2 | 16 | | | | | | |
| | | | | | | | | AT2: Currency conversion issue. | Billing audit logs. | 2 | 3 | 24 | | | | | | |

| | Reliability | Responsiveness | Assurance | Empathy | Tangibles |
|---|---|---|---|---|---|
| **Perceived Risk Exposure (PRE):** | **346.09** | **193.76** | **338.11** | **176.61** | **276.43** |
| Share: | **26%** | **15%** | **25%** | **13%** | **21%** |

**Table B.2.** *PRISM Framework Application Results – Sections C and D (Rcalls Case).*

| SECTION C – QFD Relationship Matrix | | | | | | |
|---|---|---|---|---|---|---|
| **Failure Mode** | **Reliability** | **Responsiveness** | **Assurance** | **Empathy** | **Tangibles** | **TOTAL** |
| A: Incorrect saving calculation | 3 | 3 | 9 | 1 | 3 | 19 |
| B: Savings report unclear | 3 | 3 | 9 | 3 | 9 | 27 |
| C: Account activation failure | 9 | 3 | 3 | 3 | 1 | 19 |
| D: Access delay | 9 | 9 | 3 | 3 | 1 | 25 |
| E: Misconfiguration of company data | 9 | 3 | 3 | 1 | 3 | 19 |
| F: Unauthorized access configuration error | 3 | 1 | 9 | 3 | 3 | 19 |
| G: Data mapping error | 9 | 3 | 3 | 1 | 9 | 25 |
| H: unclear training material | 3 | 1 | 3 | 9 | 9 | 25 |
| I: Inadequate onboarding support | 1 | 9 | 3 | 9 | 1 | 23 |
| J: Case creation failure | 9 | 3 | 3 | 1 | 3 | 19 |
| K: Duplicate case entry | 9 | 3 | 3 | 3 | 1 | 19 |
| L: Error in saving a new claim | 9 | 3 | 3 | 3 | 3 | 21 |
| M: Interface usability issue | 9 | 3 | 3 | 3 | 9 | 27 |
| N: Missing reference data | 9 | 3 | 9 | 3 | 3 | 27 |

| SECTION D – Normalized Contribution Weights | | | | | | |
|---|---|---|---|---|---|---|
| **Failure Mode** | **Reliability** | **Responsiveness** | **Assurance** | **Empathy** | **Tangibles** | **TOTAL** |
| A: Incorrect saving calculation | 0.16 | 0.16 | 0.47 | 0.05 | 0.16 | 1 |
| B: Savings report unclear | 0.11 | 0.11 | 0.33 | 0.11 | 0.33 | 1 |
| C: Account activation failure | 0.47 | 0.16 | 0.16 | 0.16 | 0.05 | 1 |
| D: Access delay | 0.36 | 0.36 | 0.12 | 0.12 | 0.04 | 1 |
| E: Misconfiguration of company data | 0.47 | 0.16 | 0.16 | 0.05 | 0.16 | 1 |
| F: Unauthorized access configuration error | 0.16 | 0.05 | 0.47 | 0.16 | 0.16 | 1 |
| G: Data mapping error | 0.36 | 0.12 | 0.12 | 0.04 | 0.36 | 1 |
| H: unclear training material | 0.12 | 0.04 | 0.12 | 0.36 | 0.36 | 1 |
| I: Inadequate onboarding support | 0.04 | 0.39 | 0.13 | 0.39 | 0.04 | 1 |
| J: Case creation failure | 0.47 | 0.16 | 0.16 | 0.05 | 0.16 | 1 |
| K: Duplicate case entry | 0.47 | 0.16 | 0.16 | 0.16 | 0.05 | 1 |
| L: Error in saving a new claim | 0.43 | 0.14 | 0.14 | 0.14 | 0.14 | 1 |
| M: Interface usability issue | 0.33 | 0.11 | 0.11 | 0.11 | 0.33 | 1 |
| N: Missing reference data | 0.33 | 0.11 | 0.33 | 0.11 | 0.11 | 1 |

**Table B.2.** *PRISM Framework Application Results – Sections C and D (Rcalls Case).*

| | | | | | | |
|---|---|---|---|---|---|---|
| O: Data loss | 9 | 3 | 9 | 3 | 3 | 27 |
| P: Misleading AI RCA recommendation | 9 | 3 | 9 | 3 | 3 | 27 |
| Q: Attachment upload failure | 9 | 3 | 9 | 3 | 3 | 27 |
| R: Algorithm malfunction | 3 | 1 | 9 | 3 | 3 | 19 |
| S: Outdated training data | 3 | 1 | 9 | 3 | 3 | 19 |
| T: Poor action entry interface design | 9 | 3 | 3 | 3 | 9 | 27 |
| U: Action-to-case linkage failure | 9 | 1 | 3 | 1 | 9 | 23 |
| V: Inconsistent KPI calculation | 3 | 3 | 9 | 1 | 9 | 25 |
| W: KPI update delay | 9 | 9 | 1 | 1 | 9 | 29 |
| X: Filter malfunction | 9 | 3 | 3 | 1 | 9 | 25 |
| Y: Control plan interface ambiguity | 3 | 1 | 3 | 1 | 9 | 17 |
| Z: Lack of guidance in KPI interpretation | 3 | 1 | 9 | 3 | 9 | 25 |
| AA: KPIs misconfiguration | 3 | 3 | 9 | 1 | 9 | 25 |
| AB: Incorrect deadline tracking | 3 | 3 | 9 | 1 | 9 | 25 |
| AC: Synchronization error | 9 | 1 | 9 | 3 | 9 | 31 |
| AD: Recalculation delay | 9 | 9 | 3 | 1 | 1 | 23 |

| | | | | | | |
|---|---|---|---|---|---|---|
| O: Data loss | 0.33 | 0.11 | 0.33 | 0.11 | 0.11 | 1 |
| P: Misleading AI RCA recommendation | 0.33 | 0.11 | 0.33 | 0.11 | 0.11 | 1 |
| Q: Attachment upload failure | 0.33 | 0.11 | 0.33 | 0.11 | 0.11 | 1 |
| R: Algorithm malfunction | 0.16 | 0.05 | 0.47 | 0.16 | 0.16 | 1 |
| S: Outdated training data | 0.16 | 0.05 | 0.47 | 0.16 | 0.16 | 1 |
| T: Poor action entry interface design | 0.33 | 0.11 | 0.11 | 0.11 | 0.33 | 1 |
| U: Action-to-case linkage failure | 0.39 | 0.04 | 0.13 | 0.04 | 0.39 | 1 |
| V: Inconsistent KPI calculation | 0.12 | 0.12 | 0.36 | 0.04 | 0.36 | 1 |
| W: KPI update delay | 0.31 | 0.31 | 0.03 | 0.03 | 0.31 | 1 |
| X: Filter malfunction | 0.36 | 0.12 | 0.12 | 0.04 | 0.36 | 1 |
| Y: Control plan interface ambiguity | 0.18 | 0.06 | 0.18 | 0.06 | 0.53 | 1 |
| Z: Lack of guidance in KPI interpretation | 0.12 | 0.04 | 0.36 | 0.12 | 0.36 | 1 |
| AA: KPIs misconfiguration | 0.12 | 0.12 | 0.36 | 0.04 | 0.36 | 1 |
| AB: Incorrect deadline tracking | 0.12 | 0.12 | 0.36 | 0.04 | 0.36 | 1 |
| AC: Synchronization error | 0.29 | 0.03 | 0.29 | 0.10 | 0.29 | 1 |
| AD: Recalculation delay | 0.39 | 0.39 | 0.13 | 0.04 | 0.04 | 1 |

**Table B.2.** *PRISM Framework Application Results – Sections C and D (Rcalls Case).*

| | | | | | | |
|---|---|---|---|---|---|---|
| AE: Unclear interface | 3 | 1 | 3 | 9 | 9 | 25 |
| AF: Calculation algorithm error | 9 | 1 | 9 | 3 | 3 | 25 |
| AG: Risk scores are not recognized by insurers | 3 | 1 | 9 | 3 | 9 | 25 |
| AH: Lack of traceability in report documentation | 3 | 1 | 9 | 3 | 9 | 25 |
| AI: Report generation error | 9 | 1 | 3 | 1 | 9 | 23 |
| AJ: File export failure | 9 | 3 | 3 | 3 | 3 | 21 |
| AK: Formatting inconsistency | 3 | 1 | 9 | 1 | 9 | 23 |
| AL: Confidential data exposure | 9 | 1 | 9 | 1 | 3 | 23 |
| AM: Ticket system malfunction | 3 | 9 | 3 | 3 | 1 | 19 |
| AN: Delayed response | 3 | 9 | 3 | 3 | 1 | 19 |
| AO: Inadequate support communication tone | 3 | 1 | 3 | 9 | 1 | 17 |
| AP: Inconsistent follow-up | 3 | 9 | 3 | 9 | 1 | 25 |
| AQ: Slow bug resolution | 3 | 9 | 3 | 1 | 3 | 19 |
| AR: System downtime | 9 | 9 | 9 | 1 | 1 | 29 |
| AS: Security breach | 9 | 1 | 9 | 1 | 3 | 23 |
| AT: Payment processing error | 9 | 1 | 9 | 3 | 1 | 23 |

| | | | | | | |
|---|---|---|---|---|---|---|
| AE: Unclear interface | 0.12 | 0.04 | 0.12 | 0.36 | 0.36 | 1 |
| AF: Calculation algorithm error | 0.36 | 0.04 | 0.36 | 0.12 | 0.12 | 1 |
| AG: Risk scores are not recognized by insurers | 0.12 | 0.04 | 0.36 | 0.12 | 0.36 | 1 |
| AH: Lack of traceability in report documentation | 0.12 | 0.04 | 0.36 | 0.12 | 0.36 | 1 |
| AI: Report generation error | 0.39 | 0.04 | 0.13 | 0.04 | 0.39 | 1 |
| AJ: File export failure | 0.43 | 0.14 | 0.14 | 0.14 | 0.14 | 1 |
| AK: Formatting inconsistency | 0.13 | 0.04 | 0.39 | 0.04 | 0.39 | 1 |
| AL: Confidential data exposure | 0.39 | 0.04 | 0.39 | 0.04 | 0.13 | 1 |
| AM: Ticket system malfunction | 0.16 | 0.47 | 0.16 | 0.16 | 0.05 | 1 |
| AN: Delayed response | 0.16 | 0.47 | 0.16 | 0.16 | 0.05 | 1 |
| AO: Inadequate support communication tone | 0.18 | 0.06 | 0.18 | 0.53 | 0.06 | 1 |
| AP: Inconsistent follow-up | 0.12 | 0.36 | 0.12 | 0.36 | 0.04 | 1 |
| AQ: Slow bug resolution | 0.16 | 0.47 | 0.16 | 0.05 | 0.16 | 1 |
| AR: System downtime | 0.31 | 0.31 | 0.31 | 0.03 | 0.03 | 1 |
| AS: Security breach | 0.39 | 0.04 | 0.39 | 0.04 | 0.13 | 1 |
| AT: Payment processing error | 0.39 | 0.04 | 0.39 | 0.13 | 0.04 | 1 |

**Table B.3.** *PRISM Framework Application Results – Section F (Rcalls Case).*

| SECTION F: Managerial Prioritization and Decision Rules | | | | |
|---|---|---|---|---|
| **Priority Rank** | **SERVQUAL Dimension** | **Key Failure Modes** | **Main Causes** | **Suggested Managerial Actions** |
| 26% | Reliability | E: Misconfiguration of company data | E1: Incorrect data entry. | Introduce automated configuration consistency checks during onboarding. Add real-time configuration preview before saving. |
| | | AL: Confidential data exposure | AL2: Role-based access misconfiguration. | Implement periodic automated RBAC audits. Require dual approval for permission changes. Deploy automated permission anomaly detection alerts. |
| | | AS: Security breach | AS2: Misconfigured permissions. | Quarterly penetration testing.. Automated permission inheritance validation. Deploy automated permission anomaly detection alerts. Security incident simulation drills. |
| | | P: Misleading AI RCA recommendation | P4: Insufficient contextual data from case input. | Introduce mandatory contextual fields before AI execution. Add structured feedback loop on AI suggestion quality. |
| 25% | Assurance | AL: Confidential data exposure | AL2: Role-based access misconfiguration. | Implement periodic automated RBAC audits. Require dual approval for permission changes. Deploy automated permission anomaly detection alerts. |
| | | AS: Security breach | AS2: Misconfigured permissions. | Quarterly penetration testing. Automated permission inheritance validation. Deploy automated permission anomaly detection alerts. Security incident simulation drills. |
| | | AG: Risk scores are not recognized by insurers | AG1: No external validation. | Add benchmark comparison visualization. Verify alignment with industry frameworks. Include explanatory layer in reports. |
| | | S: Outdated training data | S1: Lack of retraining schedule. | Define mandatory AI retraining calendar. Establish model performance KPI dashboard. |
| 21% | Tangibles | AG: Risk scores are not recognized by insurers | AG1: No external validation. | Add benchmark comparison visualization. Verify alignment with industry frameworks. Include explanatory layer in reports. |
| | | Y: Control plan interface ambiguity | Y1: Too many KPIs without prioritization. | Introduce tiered KPI visualization. Implement user-customizable dashboard views. Conduct UX simplification workshop. |
| 15% | Responsiveness | AN: Delayed response | AN1: Insufficient support staffing. | Implement support capacity planning model. |
| | | | AN2: Poor ticket prioritization logic. | Add AI-assisted ticket prioritization. |
| | | AQ: Slow bug resolution | AQ1: Limited development capacity. | Allocate technical debt sprint per quarter. Implement escalation triggers for high-impact bugs. |
| | | | AQ3: Poor bug prioritization. | Add AI-assisted bug prioritization. |
| 13% | Empathy | AO: Inadequate support communication tone | AO1: Stress/workload on support team. | Rotate support shifts to reduce burnout risk. |