

Midocean University
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Project Management

**The Effectiveness of Crew Resource Management (CRM)
Training on On-Time Performance: A Case Study of Saudi
Arabian Airlines (Saudia), Jeddah, Saudi Arabia**

“A Case Study”

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Dedication

This work is dedicated to my family, whose constant support, patience, and encouragement have been the foundation of my academic journey. It is also dedicated to everyone who believed in my abilities, supported my aspirations, and motivated me to pursue excellence throughout my studies.

Abstract

Summary of the Study: On-time performance (OTP) is a key indicator of operational reliability in the airline industry. Although Crew Resource Management (CRM) training is widely recognized for its safety benefits, its impact on operational performance remains limited in the literature. This study examined the effect of CRM training effectiveness on On-Time Performance (OTP) at Saudi Arabian Airlines (Saudia), focusing on the role of decision-making, communication, leadership and teamwork, and situational awareness in influencing departure punctuality, arrival punctuality, turnaround efficiency, and reactionary delay management.

Methodology: The study adopted a positivist, quantitative case study approach. Data were collected through a structured questionnaire distributed to operational and flight personnel at Saudia Airlines in Jeddah, Saudi Arabia. A representative sample of 278 respondents was selected from a population of 1,000 employees using proportionate stratified random sampling. Data were analyzed using SPSS through descriptive statistics, validity and reliability tests, correlation analysis, and regression analysis.

Findings: The results revealed a statistically significant positive relationship between CRM training effectiveness and overall On-Time Performance. All CRM dimensions showed significant positive effects on OTP components, with decision-making and communication demonstrating the strongest associations.

Originality and Implications: This study extends CRM research by linking training effectiveness to operational performance rather than safety outcomes alone. It positions CRM as a strategic tool for enhancing punctuality and reliability and provides practical implications for airline managers and policymakers to strengthen on-time performance through competency-based CRM training.

Keywords:

Crew Resource Management, On-Time Performance, decision-making, communication, airline operations, Saudi Arabian Airlines.

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1. Ch. 1: The Introduction

1.1. Background

Aviation captivates the imagination with speed, reach, and precision, yet day-to-day success is judged by disciplined delivery on schedule. Cirium (2021) defines on-time performance (OTP) as arriving within 15 minutes of the published schedule and treats it as a transparent, comparable benchmark across airlines and airports worldwide, turning punctuality into a public scorecard for reliability.

Building on this, Cirium (2025) shows how OTP rankings shape competitive positioning, reinforcing passenger expectations of consistency while signaling operational discipline to regulators and partners. From an industry standpoint, IATA (2025) frames punctual, dependable operations as integral to the sector's broader recovery and resilience narrative, linking on-time delivery to customer trust, network stability, and cost control in a capacity-constrained, disruption-prone environment. In short, OTP crystallizes the stakes of modern airline management: it is a headline KPI that translates operational precision into reputational capital and financial performance. Beyond headline metrics, punctuality reflects how well an airline orchestrates people, processes, and technology.

Airline punctuality emerges from a tightly coupled system where crews, aircraft, airports, and air traffic control interact in real time. EUROCONTROL's CODA Annual 2023 explains that delays rarely stem from a single cause; primary disruptions weather, ATC capacity, aircraft availability, or maintenance cascade into reactionary knock-on effects as late-arriving aircraft and crews propagate schedule slippage across the network. This propagation dynamic means a minor perturbation at one station can degrade performance across multiple downstream legs, especially under high utilization and limited buffer times. CODA's taxonomy and analytics further show how turnaround processes, gate conflicts, and ground-handling variances amplify or absorb shocks, making OTP a property of the whole operating system rather than a timetable statistic. Cirium's global benchmarking places these mechanisms in a competitive frame: carriers are compared on their ability to contain primary delays and prevent reactionary spread, turning operational discipline into measurable advantage. Because infrastructure and schedules cannot guarantee punctuality alone, outcomes hinge on human coordination.

At the core of airline reliability is the human element: decisions made under uncertainty, information exchanged under time pressure, and workload distributed across tightly choreographed teams. The FAA’s Pilot’s Handbook of Aeronautical Knowledge explains Aeronautical Decision-Making (ADM) as a systematic, risk-focused process that translates perception and judgment into safer, more consistent actions; it also highlights how hazardous attitudes, communication breakdowns, and poor workload management can erode performance when minutes matter (FAA, 2016). Building on this foundation, CAP 737 frames non-technical skills as explicit competencies leadership, teamwork, communication, situational awareness, and decision-making each with observable behavioural markers that can be trained, briefed, and evaluated within routine operations and time-critical turnarounds (UK CAA, 2023). Critically, these competencies map directly to the operational frictions that drive delays: unclear briefings, weak cross-checks, fragmented authority, and saturated cognitive load during gate, pushback, and taxi phases. By treating human performance as measurable and improvable not a residual after technology and schedules modern guidance positions non-technical skills as levers of consistency, resilience, and ultimately punctuality. These human-performance risks motivated the industry to formalize a training response.

In parallel, Cirium’s on-time reviews show that industry leaders distinguish themselves not merely by fleet or infrastructure, but by the ability to contain knock-on delays and sustain consistent arrival performance an outcome that hinges on precise, repeatable crew processes under time pressure (Cirium, 2024/2025).

Taken together, these perspectives reposition CRM from a safety-only intervention to a performance lever: the same competencies it trains communication, situational awareness, leadership, and decision-making mirror the behaviours required for on-time turnarounds and network stability. Prior literature rarely models this pathway explicitly from CRM to OTP, leaving a practical, testable link at the heart of airline reliability. This under-examined link is especially relevant where punctuality is strategically salient.

Within the Middle East, carriers have become increasingly visible in global punctuality tables, with Cirium’s annual reviews highlighting how the region’s hubs and mainline operators compete on consistent schedule adherence amid rapid growth and network complexity. Cirium (2025) situates punctuality as a comparative

yardstick across carriers in the Gulf and beyond, underscoring that competitive advantage in the region is now inseparable from disciplined, time-reliable operations. In parallel, IATA (2025) frames the sector's priorities around resilience, reliability, and data-driven improvement as traffic scales back to, and beyond, pre-pandemic levels an agenda that places day-to-day operational consistency at the center of airline strategy. Against this backdrop, Saudi Arabian Airlines (Saudia) operates as a flagship carrier within a national push to enhance connectivity and service quality, participating in the same benchmarking ecosystem that publicly compares OTP performance across markets. Cirium's coverage shows how regional leaders differentiate themselves by containing reactionary delays and sustaining repeatable arrival performance, a standard directly relevant to Saudia's competitive context (Cirium, 2025). This setting provides an opportunity to examine whether CRM training translates into measurable punctuality, linking human-performance capabilities to a strategically salient outcome in Saudi airline operations.

A clear conceptual framework connects CRM training effectiveness to punctuality outcomes through measurable operational performance indicators. The independent variable in this study is Crew Resource Management (CRM) Training Effectiveness, which represents the overall quality and consistency of the training delivered to Saudia's flight crews. This includes the scope and frequency of recurrent training cycles, the use of scenario-based simulations, instructor qualifications, and performance assessments that evaluate behavioural competence. According to *CAP 737* (UK CAA, 2023), CRM is structured as a competency-based model encompassing four key dimensions decision-making, communication, leadership, and situational awareness each serving as an observable and assessable behavioural domain. These dimensions form the operational foundation through which CRM training is expected to influence On-Time Performance (OTP), measured in terms of departure punctuality, arrival punctuality, turnaround efficiency, and reactionary delay management. Thus, the conceptual model underpinning this study assumes a direct, positive relationship between CRM training effectiveness and the core components of OTP, aligning with the three hypotheses established for the research.

These competencies serve as mediators that connect training to day to day performance. The FAA's Aeronautical Decision Making framework supports measuring judgement, workload management, and communication under time pressure, which are precisely the behaviours that affect turnarounds and schedule

adherence (FAA, 2016). The dependent variable is on time performance using the industry definition of arrival within fifteen minutes of schedule and tracked as a monthly percentage at the flight, route, and unit levels, which aligns with global benchmarking practices reported by Cirium in 2021 and 2025 (Cirium, 2021; Cirium, 2025). To isolate the human factor pathway, the model controls for weather and air traffic constraints, maintenance events, fleet and station differences, and reactionary delay propagation, following EUROCONTROL's delay taxonomy and analytics in the CODA Annual 2023.

Managerial levers around turnaround discipline, cross functional coordination, and shock absorption buffers provide additional contextual variables as recommended in BCG's operational analyses from 2016 and 2025. Given this scaffold, the next section articulates the precise problem and gap.

Taken together, the background points to a dual imperative in modern aviation: sustaining the highest safety standards while delivering dependable punctuality as a visible marker of organizational maturity. Industry narratives frame OTP as a public test of operational discipline, where competitive carriers convert process precision into reliability and customer trust (Cirium, 2025; IATA, 2025). At the core of this capability sits the human system. FAA guidance and CAP737 both position non-technical skills decision-making, communication, leadership, and situational awareness as trainable levers that stabilize performance under time pressure, turning routine turnarounds into repeatable results (FAA, 2016; UK CAA, 2023). Decades of CRM research reinforce this premise by showing consistent gains in teamwork and safety-relevant behaviours, suggesting a credible behavioural pathway from training to schedule discipline (Salas et al., 2006; O'Connor et al., 2008). In the Saudi context, Saudia operates within a benchmarking ecosystem that openly compares punctuality, making it a practical lens for generating insights that managers and policymakers can generalize across similar network settings (Cirium, 2025; IATA, 2025). With this foundation, the next section specifies the problem and gap to be addressed in 1.2. Problem Statement. Top of Form

1.2. Research Problem

Modern commercial aviation defines success through two interdependent pillars: safety and operational reliability, particularly on-time performance (OTP). While

Crew Resource Management (CRM) training has become a global standard to enhance teamwork and minimize human error, most academic and regulatory frameworks still conceptualize CRM primarily as a safety tool, not as a mechanism for improving operational efficiency. Global benchmarking platforms such as *Cirium* and *IATA* emphasize OTP as a key indicator of airline reliability, yet they rarely explore how effective crew coordination and communication core CRM outcomes translate into punctuality improvements.

In the Saudi context, *Saudia Airlines* operates within an increasingly competitive and data-driven regional aviation ecosystem, where OTP is not only a performance metric but also a reflection of national service quality and operational discipline. However, there remains a significant lack of empirical understanding of whether the effectiveness of CRM training directly influences punctuality outcomes, and if the CRM dimensions of decision-making, communication, leadership, and situational awareness contribute to specific components of OTP, such as departure punctuality, arrival punctuality, turnaround efficiency, and reactionary delay management.

1.2.1. Theoretical Gaps

Theoretically, the existing literature predominantly situates CRM within the domain of safety management and human error reduction (Salas et al., 2006; O'Connor et al., 2008), providing limited explanation of its role in improving time discipline and operational consistency. Although the *CAP737* framework defines CRM competencies including leadership, decision-making, communication, and situational awareness as measurable and improvable skills (UK CAA, 2023), their connection to punctuality and turnaround efficiency remains under-theorized.

Furthermore, the *FAA's Aeronautical Decision-Making (ADM)* model identifies judgment, workload, and time management as core human-factor skills, but their link to managing reactionary delays and minimizing schedule deviation is not clearly modeled (FAA, 2016). Existing theories also overlook contextual moderators such as airport congestion, fleet configuration, and crew pairing frequency that shape how CRM competencies translate into operational outcomes (EUROCONTROL CODA, 2023; Hajko & Badánik, 2020).

Thus, there is a conceptual gap between CRM's established behavioral benefits and its potential to drive operational performance metrics like OTP.

1.2.2. Empirical Gaps

Empirically, very few studies directly examine the relationship between CRM training effectiveness and on-time performance at the airline level. Prior evaluations of CRM programs have focused almost exclusively on safety indicators, crew attitudes, and incident reduction (Salas et al., 2006; O'Connor et al., 2008), without assessing how these behavioral improvements affect punctuality outcomes.

Industry analyses from *EUROCONTROL* and *Cirium* primarily attribute delays to weather, ATC constraints, or maintenance issues, while giving limited attention to human coordination, communication, and workload management, which are central to CRM (EUROCONTROL CODA, 2023; Cirium, 2025). In the Saudi aviation context, public OTP benchmarks exist, but they are not correlated with CRM training records or competency evaluations, leaving the CRM→OTP pathway untested.

Methodologically, most available studies lack longitudinal or quasi-experimental designs that measure pre- and post-training differences in crew behavior and connect these changes to delay patterns. This absence of integrated human-factor and operational datasets limits the ability to determine whether CRM training directly enhances departure and arrival punctuality, improves turnaround efficiency, or reduces reactionary delays (BCG, 2016; EUROCONTROL CODA, 2023).

❖ Main Research Question

To what extent does the effectiveness of Crew Resource Management (CRM) training at Saudia Airlines influence on-time performance (OTP), and how do CRM dimensions decision-making, communication, leadership, and situational awareness affect specific aspects of OTP such as departure punctuality, arrival punctuality, turnaround efficiency, and reactionary delay management?

1.3. Research Significance

This study contributes to aviation management and human-factors scholarship by establishing a direct empirical link between Crew Resource Management (CRM) Training Effectiveness and On-Time Performance (OTP) within *Saudia Airlines*. It

reframes CRM from a traditional safety-centered concept into a strategic operational performance tool that can improve punctuality, reliability, and customer trust. By integrating *human-factor theory* with *operational performance analytics*, this research explains how improved competencies in decision-making, communication, leadership, and situational awareness can stabilize departure and arrival times, enhance turnaround efficiency, and reduce reactionary delays the core dimensions of OTP.

Within the *Saudi aviation context*, where OTP is a national and reputational benchmark, this study provides a new analytical framework for understanding how training quality translates into measurable operational gains, thereby enriching both academic theory and industry practice.

1.3.1. Theoretical Significance

Theoretically, this research builds a conceptual bridge between human-factors training models and real-world operational performance. Drawing from the *FAA's Aeronautical Decision-Making (ADM)* principles and the *CAP737 CRM Competency Model*, the study operationalizes non-technical skills decision-making, leadership, communication, and situational awareness as mediating variables that link training inputs to OTP outcomes (FAA, 2016; UK CAA, 2023).

While previous meta-analyses (Salas et al., 2006; O'Connor et al., 2008) confirmed CRM's role in improving teamwork and safety culture, this research extends the theoretical framework to include time discipline and delay control as measurable outputs of CRM competence.

By connecting behavioral theory with performance data, it introduces a performance-oriented CRM model:

CRM Training Quality → Enhanced Crew Competencies → Reduced Operational Delays → Improved On-Time Performance.

This positions CRM not only as a safety mechanism but also as a predictive model of reliability and operational stability within airline systems.

1.3.2. Empirical Significance

Empirically, this study develops a measurable framework that links CRM training effectiveness to on-time performance using Saudia Airlines as a case study. It collects operational data on OTP indicators (departure and arrival punctuality, turnaround efficiency, reactionary delay containment) and relates them to training records and competency evaluations based on CAP737 benchmarks (UK CAA, 2023; Cirium, 2025).

By statistically controlling for external factors such as weather, ATC constraints, maintenance issues, and fleet type, the study isolates the human-performance contribution to airline punctuality (EUROCONTROL CODA, 2023).

The findings are expected to:

- Provide evidence-based recommendations for enhancing recurrent CRM training programs.
- Guide managers and regulators in aligning training investments with measurable OTP improvements.
- Offer practical insights for optimizing crew coordination and turnaround management.

Ultimately, this study enables *Saudia Airlines* and by extension other regional carriers to translate human-factor development into competitive operational reliability, enhancing both safety and customer satisfaction.

1.4. Research Questions:

Main Research Question

- ▲ What is the relationship between Crew Resource Management (CRM) Training Effectiveness and On-Time Performance (OTP) at Saudi Arabian Airlines (Saudia)?

Sub-questions

1. How strongly does overall CRM Training Effectiveness relate to overall OTP at Saudia during the study period?

2. How do the CRM dimensions decision-making, communication, leadership, and situational awareness contribute to overall OTP?
3. To what extent does CRM Training Effectiveness influence each OTP dimension: departure punctuality, arrival punctuality, turnaround efficiency, and reactionary delay management?
4. Which CRM dimension shows the strongest association with OTP when compared across the four dimensions?

1.5. Research Objectives

1. Examine the overall influence of CRM Training Effectiveness on On-Time Performance (OTP) at Saudi Arabian Airlines (Saudia).
2. Identify the contribution of CRM dimensions decision-making, communication, leadership, and situational awareness to overall OTP and determine which dimension shows the strongest association.
3. Assess the impact of CRM Training Effectiveness on each OTP dimension: departure punctuality, arrival punctuality, turnaround efficiency, and reactionary delay management.
4. Evaluate the current implementation level of CRM training at Saudia (exposure, recency, scenario-based practice) to inform targeted improvements aligned with punctuality outcomes.

1.6. Research Hypotheses

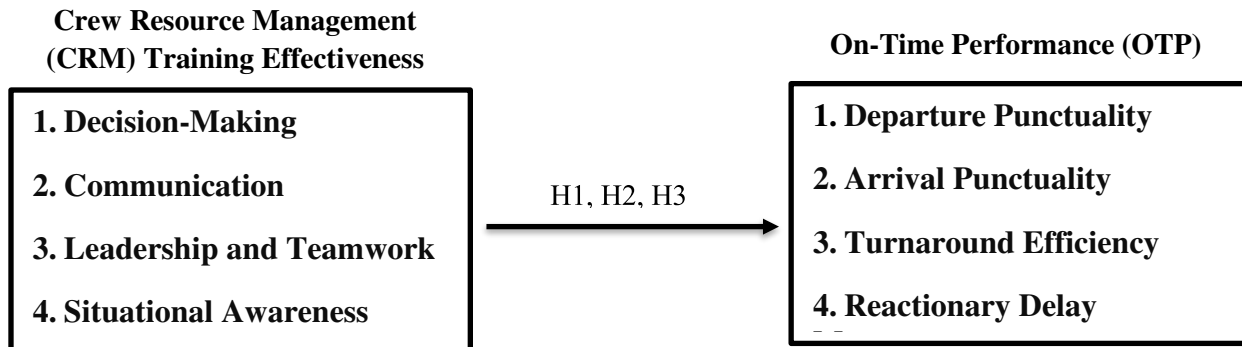
H1. There is a statistically significant positive relationship between Crew Resource Management (CRM) Training Effectiveness and On-Time Performance (OTP) at Saudia Airlines.

H2. There is a significant positive correlation between of decision-making, communication, leadership, and situational awareness and the overall On-Time Performance.

H3. There is a statistically significant positive relationship between Crew Resource Management (CRM) Training Effectiveness and of departure punctuality, arrival punctuality, turnaround efficiency, and reactionary delay management.

1.7. Research model:

Figure 1: Suggested project model



Source: Researcher

1.8. Scope of the Study

1.8.1. Introduction about Saudia Airlines

This study examines Saudi Arabian Airlines Saudia as a single case within the Saudi aviation context. The focus is on line operations that affect schedule adherence and on the training ecosystem that develops crew non-technical skills. The scope is limited to flights operated by Saudia during the defined study window and to crew groups who completed CRM training within the same period.

1.8.2. Vision

To provide evidence that strengthening human-factor competencies through CRM training can support reliable, punctual operations and visible improvements in on-time performance that matter to passengers, partners, and regulators.

1.8.3. Mission

To measure, analyze, and explain the link between CRM training effectiveness and on-time performance at Saudia by integrating training records, competency evidence, and operational punctuality indicators, and by producing actionable guidance for managers.

1.8.4. Operational and Training Domains Included

1.8.4.1. CRM Training Domain.

Coverage includes exposure and quality of CRM training. Examples include recurrent cycles, scenario based exercises, instructor standards, and assessment

outcomes. Competency focus follows recognized guidance on decision making, communication, leadership, and situational awareness (FAA, 2016; UK CAA CAP737, 2023).

1.8.4.2. On-Time Performance Domain

Coverage includes departure punctuality, arrival punctuality, turnaround efficiency, and reactionary delay management, using the industry convention of arrival within 15 minutes of schedule for OTP benchmarking (Cirium, 2021; Cirium, 2025).

1.8.4.3. Controls and Context

Analysis controls for weather, air traffic constraints, maintenance events, fleet and station differences, and delay propagation, following established delay causality frameworks (EUROCONTROL CODA, 2023).

1.8.5. Population, Unit of Analysis, and Time Frame

- Population: Saudia flights and operating crews active within the study period.
- Unit of Analysis: Flight level and aggregated route or unit level, with crew level training linkages where data are available.
- Time Frame: A continuous window sufficient to observe pre and post training exposure and to compute reliable monthly OTP percentages. The exact dates will be set based on data availability and training cycles.

1.8.6. Geographic and Organizational Boundaries

- Geographic: Domestic and international stations served by Saudia that fall within the data window.
- Organizational: Flight operations and ground turnaround interfaces relevant to crew coordination. Third party providers are in scope only where their activities directly intersect with the crew processes under study.

1.8.7. Inclusion and Exclusion Criteria

- Included: Scheduled passenger services with complete records for CRM training variables and OTP indicators.
- Excluded: Charter or irregular operations if they lack comparable schedules, flights with missing core variables, and events dominated by extraordinary disruptions outside operational control.

1.8.8. Measurement Overview aligned to the three hypotheses

- Independent Variable: CRM Training Effectiveness operationalized through exposure and quality indicators and mapped to competencies in decision making, communication, leadership, and situational awareness (FAA, 2016; UK CAA CAP737, 2023).
- Dependent Variable: On-Time Performance measured as monthly percentages and decomposed into departure punctuality, arrival punctuality, turnaround efficiency, and reactionary delay management (Cirium, 2021; Cirium, 2025).
- Model Context: Weather, ATC, maintenance, fleet and station differences, and reactionary delay chains are modeled as controls to isolate the human-performance pathway (EUROCONTROL CODA, 2023).

1.8.9. Importance of studying Saudia within this scope

- Strategic relevance: OTP is a public benchmark that differentiates carriers and shapes market confidence. Demonstrating a human-performance route to punctuality can guide training investment and operational design (IATA, 2025; Cirium, 2025).
- Generalizability: Findings from a high visibility, network carrier can inform similar operations where CRM training and punctuality are joint priorities.

1.8.10. Limitations and Delimitations

- Limitations: Potential constraints include incomplete linkage between training and operational records and unobserved external shocks.
- Delimitations: The study deliberately centers on CRM related behaviours and OTP outputs rather than broader commercial metrics.

1.8.11. Conclusion

The study scope aligns data, measures, and boundaries with the three hypotheses. It concentrates on Saudia's CRM training effectiveness as the independent variable and on-time performance as the dependent variable, while accounting for operational context. This setting enables a focused test of whether enhancing crew competencies can translate into measurable punctuality improvements.

1.9. The Project structure:



2. Ch. 2: literature review

2.1. Introduction

The literature on airline operations increasingly emphasizes that operational outcomes are not determined solely by technical systems or regulatory compliance, but rather by the quality of human performance within complex socio-technical environments. Early human factors research in aviation demonstrated that a significant proportion of incidents and operational disruptions were rooted in deficiencies in communication, decision-making, and teamwork rather than mechanical failure. Helmreich, Merritt, and Wilhelm (1999) argued that these human-related breakdowns highlighted the limitations of purely technical training approaches and necessitated structured interventions targeting non-technical skills. This perspective established the conceptual foundation upon which Crew Resource Management (CRM) training later evolved.

Building on this foundation, subsequent studies reframed CRM from a safety-centered initiative into a broader performance-oriented training system. Salas et al. (2006) emphasized that CRM should be understood as a systematic method for shaping team behaviors and coordination processes that directly influence operational effectiveness. Similarly, O'Connor et al. (2008) demonstrated through meta-analytic evidence that CRM training improves communication quality, leadership behaviors, and decision-making consistency, suggesting that its impact extends beyond accident prevention. This shift in the literature signals a critical transition: CRM is no longer viewed only as a defensive mechanism against errors, but as an enabler of reliable and efficient operations.

At the same time, airline performance research increasingly identifies On-Time Performance (OTP) as a central indicator of operational reliability and organizational effectiveness. Hajko and Badánik (2020) argued that OTP reflects the cumulative outcome of multiple interdependent processes, including crew

coordination, real-time decision-making, and delay recovery strategies. Importantly, these processes are deeply influenced by the same non-technical competencies targeted by CRM training. However, despite this conceptual overlap, the literature often treats CRM and OTP as separate domains, with CRM studies focusing predominantly on safety outcomes and OTP research emphasizing technical and external factors.

This fragmentation in the literature creates a critical analytical gap. While CRM research provides strong evidence of behavioral and cognitive improvements at the crew level, and OTP studies highlight the operational importance of coordination and decision-making, few studies explicitly integrate these two streams. As Kaynak (2024) noted, the real-world effectiveness of CRM can only be fully understood when its behavioral outcomes are examined within actual operational contexts. Consequently, this chapter reviews the literature on CRM training and On-Time Performance in an integrated manner, laying the theoretical and empirical groundwork for examining how CRM competencies may contribute to improved punctuality in airline operations. This integrated perspective directly informs the research framework and hypotheses developed in the subsequent chapters.

2.2. Crew Resource Management (CRM) Training

2.2.1. Introduction

Building on the recognition that human performance is a decisive determinant of airline operational outcomes, Crew Resource Management (CRM) emerged in the aviation industry as a structured response to recurrent deficiencies in communication, leadership, and decision-making within flight and operational crews. Helmreich et al. (1999) argued that many operational breakdowns and safety events were rooted not in technical malfunction but in predictable patterns of human

interaction, which exposed the limitations of traditional, technically focused training models. As airline operations became increasingly complex, CRM evolved beyond a safety-centered corrective tool into a comprehensive framework aimed at optimizing non-technical skills that support effective coordination and adaptive performance under operational pressure.

Salas et al. (2006) emphasized that CRM functions as a systematic team training strategy designed to shape observable behaviors, while O'Connor et al. (2008) demonstrated that its impact extends to consistent behavioral improvement rather than short-term attitudinal change. More recently, Kaynak (2024) highlighted that the practical value of CRM lies in its translation from training environments to real-life operational practice, reinforcing the need to examine CRM training through its conceptual foundations, objectives, evolutionary development, and effectiveness. Accordingly, this section provides a structured review of CRM training to establish a coherent analytical basis for assessing its role in airline operational performance.

2.2.2. Definition of Crew Resource Management (CRM)

Academic literature in aviation initially defined Crew Resource Management (CRM) as a response to the growing recognition that human error, rather than technical failure, was the dominant contributor to aviation accidents and operational breakdowns. Helmreich et al. (1999) conceptualized CRM as a training philosophy aimed at improving the use of interpersonal communication, leadership, and decision-making within the cockpit, emphasizing that effective crew performance depends on how individuals interact rather than on isolated technical competence. This definition marked a departure from traditional pilot-centric skill models by framing performance as a collective, socially constructed outcome. Building on this perspective, Salas et al. (2006) expanded the academic definition of CRM by positioning it as a structured team-training system designed to develop non-technical

skills that support coordination and adaptive performance in dynamic, high-risk environments. This shift reflects an important evolution in the literature, where CRM is no longer viewed merely as an error-reduction tool but as a mechanism for shaping reliable operational behavior.

While academic definitions emphasize theoretical and behavioral foundations, organizational and regulatory bodies have translated CRM into standardized operational frameworks. Aviation authorities such as national civil aviation administrations define CRM as a mandatory, competency-based training program focused on observable behaviors related to communication, teamwork, leadership, situational awareness, and decision-making. Regulatory guidance documents emphasize that CRM must be integrated into both initial and recurrent training cycles to ensure continuous behavioral reinforcement. O'Connor et al. (2008) highlighted that such regulatory definitions operationalize CRM by linking training objectives to measurable performance criteria, thereby reducing ambiguity between training intent and operational application. This alignment between regulatory expectations and airline training practices reflects an institutional recognition that CRM is essential not only for safety compliance but also for maintaining consistent operational performance.

Across both academic and organizational perspectives, CRM is consistently framed as a human factors and non-technical skills framework. Kaynak (2024) noted that CRM targets the cognitive and social dimensions of crew performance, including communication quality, teamwork dynamics, leadership distribution, decision-making processes, and situational awareness. These core components are not treated as independent skills but as interrelated competencies that collectively shape how crews manage workload, resolve conflicts, and respond to operational pressure. This integrated view supports the argument that CRM influences operational outcomes

through behavioral coordination rather than through procedural adherence alone. Consequently, the CRM concept has evolved from a cockpit-focused training initiative to an organization-wide framework encompassing flight crew, cabin crew, dispatchers, and ground operations personnel. This evolution reflects the systemic nature of airline operations, where performance reliability depends on coordinated action across multiple functional domains rather than isolated crew units.

2.2.3. Objectives of CRM Training

Following the definition of CRM as an integrated human factors and non-technical skills framework, the objectives of CRM training extend beyond compliance with regulatory requirements to address systematic patterns of crew behavior that influence operational performance. Helmreich et al. (1999) argued that one of the primary objectives of CRM training is to enhance communication and information sharing among crew members, as breakdowns in communication were repeatedly identified as precursors to both safety incidents and operational disruptions. By promoting open dialogue, assertiveness, and cross-checking behaviors, CRM training aims to reduce ambiguity and ensure that critical information is effectively transmitted and validated within the crew.

Closely linked to communication is the objective of improving decision-making under conditions of time pressure and uncertainty. Salas et al. (2006) emphasized that CRM training targets decision-making as a collective process rather than an individual cognitive act, enabling crews to integrate multiple perspectives and manage workload more effectively during high-demand operational phases. This objective reflects a shift from individual expertise to shared judgment, reinforcing the role of teamwork in managing complex operational scenarios.

Strengthening leadership and teamwork dynamics represents another central objective of CRM training. O'Connor et al. (2008) highlighted that effective CRM programs encourage adaptive leadership behaviors, where authority is balanced with inclusiveness and task delegation is responsive to situational demands. Teamwork objectives focus on fostering mutual support, role clarity, and coordination, ensuring that crews function as cohesive units rather than hierarchical structures. These leadership and teamwork outcomes are critical for maintaining operational continuity, particularly during abnormal or disrupted operations.

In parallel, CRM training seeks to increase situational awareness and enhance threat and error management capabilities. Kaynak (2024) noted that situational awareness enables crews to perceive and anticipate operational risks, while threat and error management provides structured strategies for detecting, mitigating, and recovering from potential failures. This objective underscores the preventive function of CRM, whereby crews are trained to recognize emerging threats before they escalate into operational breakdowns.

Beyond individual crew performance, CRM training also aims to reduce human error and prevent operational failures at the system level. Helmreich et al. (1999) argued that CRM contributes to error reduction not by eliminating human fallibility, but by creating behavioral defenses that limit the consequences of inevitable errors. This systemic objective aligns CRM with broader organizational reliability goals rather than isolated safety outcomes.

Finally, CRM training promotes standardized behavioral practices across flight and ground operations, supporting organizational safety culture and operational consistency. Salas et al. (2006) and O'Connor et al. (2008) emphasized that standardized non-technical behaviors facilitate coordination across functional

boundaries, ensuring that CRM principles are embedded throughout the organization. Kaynak (2024) further highlighted that such standardization strengthens safety culture by aligning individual behavior with organizational values and operational expectations. Collectively, these objectives position CRM training as a strategic tool for enhancing both safety and operational performance, thereby setting the foundation for examining its effectiveness in subsequent sections.

2.2.4. Evolution of CRM Training Programs

The evolution of CRM training programs reflects a progressive response to the changing understanding of human performance in aviation operations. Early generations of CRM training were primarily safety-driven and emerged in direct response to accident investigations that identified human error as a dominant causal factor. Helmreich et al. (1999) described these early CRM initiatives as corrective interventions aimed at reducing accidents by addressing authority gradients, communication failures, and decision-making deficiencies within the cockpit. At this stage, CRM was largely framed as a defensive safety mechanism, with limited attention to broader operational performance outcomes.

As research on human factors advanced, CRM training gradually shifted from classroom-based theoretical instruction toward more applied and behavior-focused approaches. Salas et al. (2006) argued that purely didactic training was insufficient to produce sustained behavioral change, leading to the incorporation of experiential learning techniques. This transition marked a critical turning point, as CRM training began to emphasize practical skill application rather than abstract knowledge acquisition. O'Connor et al. (2008) reinforced this shift by demonstrating that training effectiveness was significantly enhanced when CRM principles were practiced in realistic operational contexts.

The integration of simulation-based and scenario-based training methods further accelerated the evolution of CRM programs. Simulation allowed crews to rehearse complex, time-pressured situations in controlled environments, facilitating the transfer of non-technical skills to real-world operations. Kaynak (2024) highlighted that scenario-based CRM training enhances emotional regulation, communication quality, and adaptive decision-making, thereby strengthening the practical relevance of CRM. This methodological evolution supported the alignment of CRM training with the dynamic and unpredictable nature of airline operations.

In parallel with methodological advancements, the scope of CRM training expanded beyond flight crews to include cabin crew, dispatchers, and ground staff. Helmreich et al. (1999) noted that early CRM models underestimated the interdependence of operational roles within airline systems. Subsequent research recognized that coordination failures often occur at the interfaces between functional units rather than within isolated teams. Salas et al. (2006) argued that extending CRM principles across organizational boundaries was essential for achieving systemic performance improvements.

This expansion coincided with a broader conceptual shift from safety-centered CRM to performance-oriented CRM. While accident prevention remained a core objective, CRM increasingly became associated with operational reliability, efficiency, and consistency. O'Connor et al. (2008) observed that modern CRM programs are designed to support routine operations as much as abnormal situations, reflecting the growing emphasis on everyday performance outcomes. This shift laid the groundwork for the emergence of competency-based CRM training models, which define specific behavioral competencies and link them to observable performance indicators.

The adoption of competency-based CRM represents the most recent phase in the evolution of CRM training. Kaynak (2024) emphasized that competency-based models enable standardized assessment, targeted feedback, and continuous performance improvement. By aligning CRM training with contemporary airline operational demands—such as high traffic density, tight scheduling, and network complexity—these models position CRM as an integral component of organizational performance management rather than a standalone safety initiative.

2.2.5. CRM Training Effectiveness

The concept of training effectiveness in the context of CRM has evolved alongside the development of CRM programs themselves. As CRM shifted from an awareness-based safety intervention to a competency-oriented performance framework, the question of how to evaluate its effectiveness became increasingly central. Salas et al. (2006) argued that CRM training effectiveness should not be assessed solely by participant satisfaction or knowledge acquisition, but by its capacity to produce sustained improvements in non-technical skills and operational behavior. This perspective reflects a broader understanding that CRM effectiveness is inherently multi-level, encompassing individual, team, and organizational outcomes.

At the individual level, early evaluations of CRM training primarily focused on short-term outcomes such as knowledge gain, attitude change, and perception of safety. O'Connor et al. (2008) noted that many studies reported positive immediate reactions to CRM training, including increased awareness of human factors and improved attitudes toward teamwork and communication. While these outcomes are important indicators of training acceptance, the authors cautioned that attitudinal change alone does not guarantee behavioral transfer to operational settings. This limitation prompted a shift toward more behaviorally anchored evaluation models.

Behavioral change represents a more robust indicator of CRM training effectiveness. Helmreich et al. (1999) emphasized that the true value of CRM lies in observable changes in crew interaction, such as improved communication clarity, assertive behavior, shared decision-making, and effective workload management. Empirical findings summarized by O'Connor et al. (2008) demonstrated that CRM training can lead to measurable improvements in teamwork and leadership behaviors, particularly when reinforced through recurrent training and operational feedback mechanisms. These findings support the argument that behavioral indicators provide a stronger link between CRM training and real-world operational performance.

Beyond the crew level, CRM training effectiveness also manifests at the organizational level. Kaynak (2024) highlighted that effective CRM contributes to improved coordination across operational units, more consistent adherence to procedures, and enhanced safety culture. Such organizational outcomes suggest that CRM effectiveness extends beyond individual crews to influence how airlines manage routine operations and respond to disruptions. However, Salas et al. (2006) argued that organizational benefits are often indirect and mediated by factors such as leadership support, training quality, and organizational culture, making them more difficult to measure empirically.

Given this complexity, a variety of methods have been employed to evaluate CRM training effectiveness. Quantitative approaches commonly include surveys, behavioral rating scales, and performance indicators, while qualitative methods rely on observations, interviews, and field reports. O'Connor et al. (2008) emphasized that mixed-method approaches are particularly valuable, as they capture both measurable behavioral changes and contextual factors influencing training transfer. Nevertheless, the authors noted that many evaluation studies suffer from

methodological limitations, including small sample sizes, short follow-up periods, and reliance on self-reported data.

These limitations highlight a persistent challenge in CRM research: the difficulty of linking training outcomes directly to operational performance indicators. Helmreich et al. (1999) acknowledged that while CRM training demonstrably improves non-technical skills, its impact on concrete operational metrics is rarely examined in a systematic manner. Kaynak (2024) similarly argued that the effectiveness of CRM can only be fully understood when behavioral improvements are connected to real operational outcomes. This gap underscores the need for research that explicitly links CRM training effectiveness to performance indicators such as operational reliability and punctuality, providing a clear rationale for examining CRM in relation to On-Time Performance in subsequent sections.

2.3. On-Time Performance (OTP) in Airline Operations

2.3.1. Introduction

Following the discussion of CRM training as a performance-oriented human factors framework, the concept of On-Time Performance (OTP) emerges as one of the most critical indicators through which airline operational effectiveness is evaluated. Hajko and Badánik (2020) argued that OTP is not merely a scheduling metric, but a comprehensive reflection of how well an airline manages the interaction between planning, execution, and real-time operational control. From this perspective, punctuality represents the observable outcome of complex coordination processes that involve crews, aircraft, airports, and air traffic management systems, thereby positioning OTP as a central bridge between human performance and operational results.

Industry-based analyses further reinforce the strategic importance of punctuality in airline operations. OAG (2023) emphasized that OTP has become a key benchmark for service quality, customer trust, and competitive positioning in the aviation market. Airlines with consistently high OTP are perceived as more reliable, which directly influences passenger satisfaction and brand reputation. This industry focus suggests that OTP functions not only as an internal performance indicator but also as an external signal of organizational competence, linking operational discipline with market performance.

At the system level, punctuality is increasingly viewed as a shared responsibility across multiple stakeholders rather than an outcome controlled solely by airlines. EUROCONTROL, FAA, and the European Commission (2024) demonstrated that arrival and departure punctuality are strongly influenced by air traffic management capacity, airport congestion, and network-level constraints. This systemic perspective highlights that OTP reflects the effectiveness of coordination across organizational boundaries, aligning closely with the principles underpinning CRM training discussed earlier. As such, punctuality becomes an integrative performance outcome shaped by both human and structural factors.

Recent empirical research further illustrates that maintaining high OTP is operationally complex and involves trade-offs between efficiency, robustness, and cost. van Schilt et al. (2024) showed that schedule reliability and OTP are directly affected by buffer allocation decisions, where excessive buffering may reduce network connectivity while insufficient buffering increases delay propagation. This finding underscores that punctuality is not an isolated objective but part of a broader operational optimization challenge. Consequently, understanding OTP requires a multidimensional analysis that goes beyond simple time thresholds, providing a

foundation for examining its definition, dimensions, and determinants in the following sections.

2.3.2. Definition of On-Time Performance (OTP)

Building on the understanding of punctuality as an integrative operational outcome, On-Time Performance (OTP) is commonly defined as the proportion of flights that arrive or depart within a specified time threshold relative to their scheduled time. Hajko and Badánik (2020) defined OTP as a key performance indicator that captures the reliability of airline operations by measuring adherence to published schedules. This definition emphasizes that OTP reflects not only timekeeping accuracy but also the effectiveness of operational planning, coordination, and execution across the airline system. Consequently, OTP serves as a quantifiable expression of operational discipline rather than a purely temporal measure.

Industry standards have further refined the definition of OTP by establishing widely accepted measurement criteria. OAG (2023) and Cirium (2025) defined an on-time flight as one that arrives or departs within 15 minutes of its scheduled time, a threshold that has become the global benchmark for airline and airport performance comparison. This standardized definition enables cross-airline and cross-regional benchmarking, reinforcing OTP's role as a comparative performance metric. However, van Schilt et al. (2024) critically noted that while the 15-minute rule provides consistency, it may obscure underlying operational variability, particularly in tightly scheduled or hub-and-spoke networks where small delays can propagate rapidly.

At the system level, regulatory and air traffic management bodies adopt OTP definitions that integrate network performance considerations. EUROCONTROL, FAA, and the European Commission (2024) emphasized that OTP should be

interpreted within the broader context of air traffic management constraints, airport capacity, and flow regulation policies. From this perspective, OTP is not solely an airline-controlled outcome but a system-level indicator shaped by interactions among multiple stakeholders. This interpretation aligns with empirical findings by Abdillah et al. (2025), who demonstrated that changes in airport operations and traffic distribution can significantly alter OTP outcomes even when airline schedules remain constant. Collectively, these definitions highlight that OTP represents a standardized yet multidimensional construct, providing the conceptual basis for examining its underlying dimensions in the following section.

2.3.3. Dimensions of On-Time Performance

Building on the standardized definition of OTP as adherence to scheduled times, the literature emphasizes that punctuality is not a single outcome but a multidimensional construct reflecting performance across different operational phases. Hajko and Badánik (2020) argued that aggregating punctuality into a single indicator may mask underlying inefficiencies occurring at specific stages of airline operations. Consequently, OTP is more accurately understood by examining its key dimensions, which collectively explain how delays originate, propagate, or are absorbed within the operational system.

2.3.3.1. Departure Punctuality

Departure punctuality represents the initial operational dimension of OTP and reflects the airline's ability to execute planned schedules at the point of origin. OAG (2023) highlighted that departure delays are often the earliest indicators of operational disruption, frequently linked to ground handling coordination, crew readiness, and aircraft availability. From an operational perspective, EUROCONTROL et al. (2024) noted that departure punctuality is particularly sensitive to airport congestion and air traffic flow management measures, indicating

that early-stage delays often emerge from interactions between airline processes and system-level capacity constraints. This suggests that departure punctuality functions as a gateway dimension through which inefficiencies can enter the operational network.

2.3.3.2. Arrival Punctuality

Arrival punctuality constitutes the most visible dimension of OTP and is commonly used in industry benchmarking and public performance reporting. Cirium (2025) defined arrival punctuality as the primary reference point for evaluating airline reliability, as it directly affects passenger experience and network connectivity. However, van Schilt et al. (2024) argued that arrival punctuality reflects the cumulative outcome of multiple upstream decisions, including buffer allocation, en-route management, and delay recovery strategies. Thus, arrival punctuality should not be interpreted independently but rather as the result of how effectively earlier disruptions are managed or mitigated across the flight trajectory.

2.3.3.3. Turnaround Efficiency

Turnaround efficiency forms a critical intermediate dimension linking departure and arrival punctuality across flight legs. Hajko and Badánik (2020) emphasized that inefficient turnaround processes increase the likelihood of delay propagation, particularly in tightly scheduled aircraft rotations. Empirical evidence from Abdillah et al. (2025) demonstrated that improvements in turnaround coordination can lead to measurable gains in overall OTP, even under constrained operational environments. This highlights turnaround efficiency as a key control point where airlines can actively influence punctuality outcomes through process optimization and coordination.

2.3.3.4. Reactionary Delay Management

Reactionary delay management represents the dynamic dimension of OTP that captures an airline's capacity to contain and recover from delays once they occur. EUROCONTROL et al. (2024) described reactionary delays as secondary delays that propagate through the network due to resource interdependencies involving aircraft, crews, and airport slots. van Schilt et al. (2024) further showed that insufficient buffer time and weak recovery strategies amplify reactionary delays, undermining both punctuality and network stability. This dimension underscores that OTP is not solely determined by initial schedule adherence, but by the airline's ability to respond adaptively to operational disturbances.

Taken together, these dimensions demonstrate that OTP emerges from a sequence of interrelated operational processes rather than isolated punctuality events. Understanding departure punctuality, arrival punctuality, turnaround efficiency, and reactionary delay management as interconnected dimensions provides a structured basis for analyzing the factors that influence OTP, which are examined in the following section.

2.4. Factors Affecting On-Time Performance

Building on the multidimensional nature of On-Time Performance outlined in the previous section, the literature indicates that OTP is influenced by a complex interaction of operational, human, and external factors. Hajko and Badánik (2020) argued that these factors do not operate independently; rather, they interact across different phases of flight, shaping how delays emerge, propagate, or are mitigated. Understanding these factors within an integrated framework is therefore essential for explaining variations in departure punctuality, arrival punctuality, turnaround efficiency, and reactionary delay management.

A. Operational Factors

Operational factors represent the structural and procedural elements that directly influence airline punctuality. Hajko and Badánik (2020) emphasized that scheduling practices, aircraft rotations, and turnaround planning play a decisive role in determining OTP outcomes, particularly in high-utilization networks. van Schilt et al. (2024) further demonstrated that buffer allocation within flight schedules critically affects the airline's ability to absorb delays, where insufficient buffers increase delay propagation while excessive buffers reduce network efficiency. From a system-level perspective, EUROCONTROL et al. (2024) highlighted that airport capacity constraints, air traffic flow management measures, and en-route congestion significantly affect both departure and arrival punctuality. These findings indicate that operational factors form the structural backbone within which punctuality performance is either enabled or constrained.

B. Human Factors

Closely intertwined with operational structures are human factors, which shape how procedures are executed in real-time operations. Abdillah et al. (2025) noted that crew coordination, situational awareness, and task prioritization during ground and flight operations can significantly influence turnaround efficiency and delay recovery. This observation aligns with industry analyses by OAG (2023), which emphasized that crew readiness and coordination failures are recurrent contributors to departure delays. Moreover, EUROCONTROL et al. (2024) argued that human decision-making under time pressure plays a critical role in managing congestion and recovery actions, particularly during disrupted operations. These findings reinforce the link between human performance and OTP dimensions, suggesting that punctuality is not solely determined by plans and procedures but by how effectively individuals and teams adapt to operational constraints.

C. External Factors

External factors represent conditions largely beyond the direct control of airlines but with substantial influence on OTP. EUROCONTROL et al. (2024) identified adverse weather, airspace restrictions, and air traffic control staffing limitations as primary external drivers of delays across both U.S. and European systems. OAG (2023) similarly highlighted that weather-related disruptions remain the dominant cause of large-scale punctuality degradation, particularly at congested hub airports. Abdillah et al. (2025) demonstrated that airport infrastructure characteristics and traffic distribution patterns can further amplify the impact of external disruptions on OTP outcomes. These external influences often trigger initial delays that, if not effectively managed, evolve into reactionary delays across the network.

Taken together, these operational, human, and external factors collectively shape On-Time Performance as a systemic outcome rather than an isolated metric. The interaction between structural constraints, human performance, and environmental conditions explains why punctuality varies across airlines, airports, and operational contexts. This integrated understanding of OTP determinants provides a critical foundation for examining how organizational interventions—such as CRM training—may influence operational performance, thereby setting the stage for analyzing the relationship between CRM and OTP in the following section.

2.5. The Relationship Between CRM Training and On-Time Performance

Although Crew Resource Management (CRM) training and On-Time Performance (OTP) are often examined within separate research streams, a closer analytical reading of the literature suggests a strong theoretical interconnection between them. Helmreich et al. (1999) argued that operational breakdowns frequently originate from failures in communication, leadership, and decision-making rather than from

technical deficiencies, implying that CRM training inherently influences operational outcomes beyond safety. Salas et al. (2006) conceptualized CRM as a team-based performance framework aimed at enhancing coordination and adaptive behavior in complex operational environments, competencies that closely align with the mechanisms governing punctuality and delay recovery.

O'Connor et al. (2008) further demonstrated that CRM produces measurable behavioral changes but noted that these outcomes are rarely linked to concrete operational performance indicators. At the same time, OTP research has increasingly recognized punctuality as a product of real-time coordination and recovery strategies rather than schedule design alone, as highlighted by Hajko and Badánik (2020) and van Schilt et al. (2024). Despite this conceptual overlap, empirical studies seldom integrate CRM training as an explanatory factor in OTP analysis, creating a notable gap in the literature. This section addresses this gap by examining the theoretical relationship between CRM training and operational performance, analyzing how specific CRM dimensions may influence OTP mechanisms, and reviewing prior empirical studies to highlight limitations and research opportunities.

2.5.1. CRM Training and Operational Performance

The theoretical relationship between CRM training and operational performance is grounded in the recognition that airline performance outcomes are shaped by human coordination and decision processes rather than technical capability alone. Helmreich et al. (1999) argued that many operational failures originate from predictable breakdowns in communication, leadership, and crew coordination, suggesting that interventions targeting these behaviors can influence routine operational outcomes as much as safety events. From this perspective, CRM training functions as a mechanism for stabilizing operational processes by reducing

variability in human performance, thereby supporting consistent execution under normal and disrupted conditions.

Expanding this argument, Salas et al. (2006) conceptualized CRM as a team performance system designed to enhance coordination, adaptability, and workload management in complex operational environments. These capabilities are directly aligned with the demands of airline operations, where crews must continuously balance efficiency, safety, and time constraints. O'Connor et al. (2008) further demonstrated that CRM training leads to observable behavioral changes, particularly in teamwork and decision-making, but emphasized that these changes are rarely evaluated in relation to operational performance indicators. This observation implies that CRM's contribution to operational performance is theoretically well-founded but empirically underexplored.

From an applied perspective, Kaynak (2024) emphasized that the effectiveness of CRM should be assessed through its reflection in real operational practices rather than through attitudinal measures alone. This view aligns with operational research by Hajko and Badánik (2020), who argued that performance indicators such as punctuality and delay recovery are outcomes of coordinated decision-making and task execution across operational units. When interpreted together, these strands of literature suggest that CRM training influences operational performance indirectly by shaping the behavioral processes that govern efficiency, coordination, and resilience. Accordingly, CRM can be theoretically positioned as an enabling factor for improved operational performance, providing a conceptual bridge to examining its specific relationship with On-Time Performance in the following subsection.

2.5.2. CRM Dimensions and On-Time Performance

Building on the theoretical link between CRM training and operational performance, the literature suggests that the influence of CRM on On-Time Performance (OTP) is not direct, but mediated through specific non-technical skill dimensions that shape day-to-day operational behavior. Salas et al. (2006) argued that CRM effectiveness manifests through improved decision-making, communication, leadership, teamwork, and situational awareness, which collectively determine how crews manage time-critical tasks and operational disruptions. O'Connor et al. (2008) further emphasized that these dimensions produce observable behavioral changes, particularly under conditions of time pressure, where operational performance is most vulnerable.

In parallel, OTP research has shown that punctuality outcomes depend heavily on how delays are anticipated, communicated, and managed rather than on schedule design alone, as highlighted by Hajko and Badánik (2020) and van Schilt et al. (2024). This convergence indicates that CRM dimensions correspond closely to the operational mechanisms governing departure punctuality, turnaround efficiency, and reactionary delay management. Accordingly, the following subsections examine how each core CRM dimension—decision-making, communication, leadership and teamwork, and situational awareness—can theoretically influence OTP outcomes within airline operations.

A. Decision-Making and On-Time Performance (OTP)

Decision-making is consistently identified in the CRM literature as a core determinant of operational outcomes in time-critical environments. Salas et al. (2006) argued that effective decision-making within CRM frameworks enhances crews' ability to prioritize tasks, allocate resources, and adapt plans under

uncertainty, which are all central to maintaining operational continuity. From an OTP perspective, Hajko and Badánik (2020) emphasized that delays often escalate when decisions regarding sequencing, recovery actions, or buffer utilization are delayed or poorly coordinated. van Schilt et al. (2024) further demonstrated that suboptimal decision-making during disruptions increases delay propagation across flight networks, particularly in tightly scheduled operations. When these findings are considered together, they suggest that CRM-driven decision-making competencies influence OTP indirectly by improving the quality and timeliness of operational choices that determine whether initial delays are absorbed or amplified.

B. Communication and On-Time Performance (OTP)

Closely linked to decision-making is communication, which functions as the primary mechanism through which operational decisions are shared and executed. Helmreich et al. (1999) highlighted that communication breakdowns are a recurring source of operational inefficiencies, as incomplete or delayed information transfer undermines coordinated action. In the context of punctuality, OAG (2023) identified communication failures between crews, ground staff, and operations control as frequent contributors to departure delays. EUROCONTROL et al. (2024) further noted that effective information exchange across organizational boundaries is critical for managing congestion and implementing flow control measures. These studies collectively indicate that communication quality directly affects OTP by shaping how quickly and accurately operational responses are aligned across multiple actors, reinforcing the role of CRM communication competencies in supporting punctuality.

C. Leadership and Teamwork and On-Time Performance (OTP)

Leadership and teamwork extend the effects of communication by structuring how crews coordinate and execute tasks under pressure. O'Connor et al. (2008) argued that CRM training promotes adaptive leadership and collaborative teamwork, enabling crews to respond flexibly to changing operational demands. Hajko and Badánik (2020) emphasized that inefficient teamwork during turnaround processes significantly increases the risk of delay propagation, particularly in high-frequency operations. Empirical evidence from Abdillah et al. (2025) showed that improved coordination among operational teams can lead to measurable improvements in overall OTP, even in constrained airport environments. These findings suggest that leadership and teamwork competencies support punctuality by enhancing task integration and reducing coordination friction during critical operational phases.

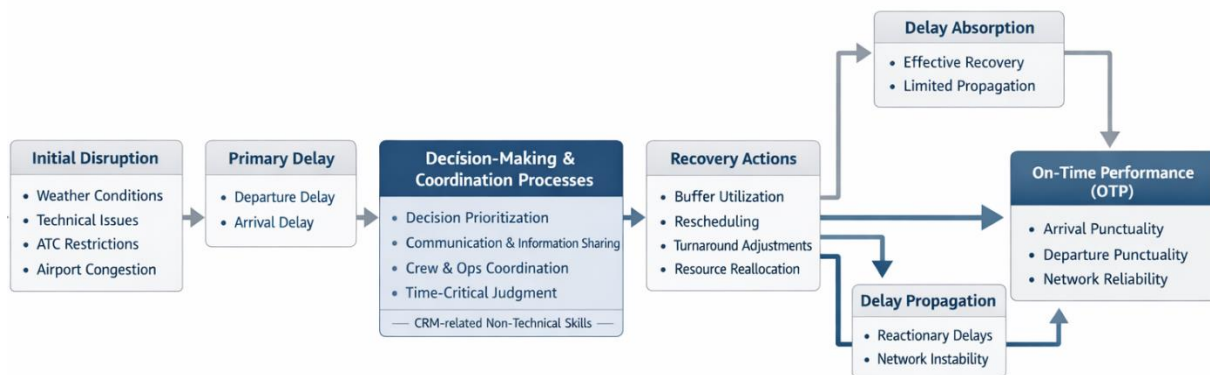
D. Situational Awareness and On-Time Performance (OTP)

Situational awareness integrates decision-making, communication, and teamwork by enabling crews to perceive, comprehend, and anticipate operational conditions. Helmreich et al. (1999) emphasized that loss of situational awareness often precedes both safety incidents and operational breakdowns. In OTP-related research, van Schilt et al. (2024) demonstrated that poor anticipation of downstream disruptions increases reactionary delays, while effective anticipation supports proactive recovery strategies. EUROCONTROL et al. (2024) similarly highlighted that situational awareness at the system level is essential for managing congestion and mitigating the impact of external disturbances. These studies indicate that situational awareness influences OTP by allowing crews and organizations to act preemptively rather than reactively, thereby limiting delay escalation.

Taken together, the literature suggests that CRM dimensions influence On-Time Performance not through direct causality, but by shaping the behavioral and

cognitive processes that govern operational execution and recovery. Decision-making, communication, leadership and teamwork, and situational awareness operate as interdependent mechanisms that determine how effectively airlines manage time pressure, coordination demands, and disruptions. This integrated interpretation reinforces the theoretical expectation that CRM training can contribute to improved OTP outcomes, while also highlighting the need for empirical studies that explicitly link these dimensions to punctuality metrics.

Figure 2: Delay Propagation and Recovery Model in Airline Operations



Source: Researcher, based on van Schilt et al. (2024) and Hajko & Badánik (2020)

The Figure presents a conceptual representation of the delay propagation and recovery process in airline operations, illustrating how on-time performance emerges from a sequence of interconnected operational and human processes rather than from isolated disruptions. Consistent with the work of Hajko and Badánik (2020), the model begins with initial disruptions such as weather conditions, technical issues, or air traffic control restrictions, which generate primary departure or arrival delays. These initial delays interact with operational interdependencies, including aircraft rotations, crew assignments, and airport resource constraints, creating the potential for delay propagation across the network.

At the core of the model lies the decision-making and coordination layer, which functions as a mediating mechanism between disruptions and operational outcomes. This layer reflects CRM-related non-technical skills, such as communication, coordination, prioritization, and time-critical judgment, through which operational responses are shaped. As emphasized by van Schilt et al. (2024), recovery actions—such as buffer utilization, rescheduling, and turnaround adjustments—determine whether delays are absorbed or propagate further as reactionary delays. The bifurcation between delay absorption and delay propagation highlights that on-time performance is not determined solely by the presence of disruptions, but by the effectiveness of coordinated recovery processes.

By conceptualizing OTP as the final outcome of these dynamic interactions, the figure provides a theoretical bridge between CRM training and operational performance without implying direct causality. Instead, it demonstrates how CRM competencies influence punctuality indirectly by shaping the quality of decision-making and coordination processes that govern delay recovery. This integrative perspective supports the analytical framework of the current study and justifies the examination of CRM training effectiveness in relation to on-time performance indicators.

2.5.3. Prior Empirical Studies on CRM and On-Time Performance

Empirical studies on Crew Resource Management (CRM) have predominantly focused on evaluating its impact on safety-related behaviors and non-technical skill development rather than direct operational performance outcomes. Helmreich et al. (1999) provided early empirical evidence demonstrating that CRM training improves communication patterns, leadership behaviors, and decision-making quality within flight crews, emphasizing its role in reducing human error. However, their findings were largely interpreted through a safety lens, with limited

consideration of how these behavioral improvements translate into routine operational performance.

Extending this line of research, Salas et al. (2006) reviewed a wide range of CRM training programs and concluded that CRM is effective in enhancing teamwork, coordination, and adaptability in complex operational environments. Despite these positive findings, the authors highlighted that most empirical evaluations relied on self-reported attitudes, classroom assessments, or simulated scenarios, rather than real operational data. O'Connor et al. (2008), through a meta-analysis of CRM effectiveness studies, reinforced this conclusion by demonstrating statistically significant behavioral improvements while simultaneously noting the scarcity of studies linking CRM outcomes to organizational performance indicators. Collectively, these studies confirm CRM's behavioral effectiveness but reveal a narrow empirical focus that limits its operational interpretation.

2.5.3.1. Empirical Studies on On-Time Performance Determinants

In contrast to CRM research, empirical studies on On-Time Performance (OTP) have concentrated primarily on structural, operational, and system-level determinants. Hajko and Badánik (2020) examined airline OTP through the lens of scheduling practices, turnaround processes, and network constraints, identifying operational design and resource allocation as key drivers of punctuality outcomes. Similarly, van Schilt et al. (2024) analyzed delay propagation and recovery mechanisms, demonstrating that buffer allocation and recovery strategies significantly influence OTP and network stability.

Industry-oriented analyses further support these findings. Reports by OAG (2023) and EUROCONTROL et al. (2024) consistently identify coordination failures, delayed decision-making, and information flow breakdowns as recurring contributors to delays across airline networks. However, these studies tend to treat

human performance factors descriptively, without integrating formal human factors training frameworks such as CRM. As a result, while OTP research acknowledges the importance of coordination and decision processes, it rarely operationalizes these factors in relation to structured training interventions.

2.5.3.2. Identified Gaps and Limitations in the Literature

A critical synthesis of the empirical literature reveals several persistent limitations that justify further investigation. These limitations can be summarized as follows:

1. Separation of Research Streams
CRM studies focus primarily on safety, attitudes, and behavioral change, while OTP studies emphasize scheduling, capacity, and system-level efficiency, with minimal integration between the two domains (Helmreich et al., 1999; Hajko & Badánik, 2020).
2. Limited Use of Operational Performance Indicators
Most CRM effectiveness studies stop at intermediate outcomes and rarely examine concrete operational metrics such as punctuality or delay recovery (Salas et al., 2006; O'Connor et al., 2008).
3. Descriptive Treatment of Human Factors in OTP Research
OTP studies frequently acknowledge human coordination and decision-making as contributors to delays but do not systematically link these factors to CRM training or non-technical skill development (OAG, 2023; EUROCONTROL et al., 2024).
4. Lack of Integrated Empirical Models
Few empirical studies adopt integrative frameworks that examine how CRM dimensions influence OTP mechanisms such as turnaround efficiency and reactionary delay management (van Schilt et al., 2024).

Kaynak (2024) explicitly highlighted this disconnect, arguing that the real effectiveness of CRM can only be assessed when behavioral improvements are evaluated through their impact on everyday operational performance. Taken together, these gaps indicate a clear need for empirical research that bridges CRM training effectiveness and On-Time Performance, providing the analytical foundation for the current study.

2.6. Conclusion

This chapter reviewed the literature on Crew Resource Management (CRM) training, on-time performance (OTP) in airline operations, and the theoretical relationship between the two constructs. The review demonstrated that CRM has evolved from a safety-focused training approach to a comprehensive framework targeting non-technical skills such as decision-making, communication, leadership, teamwork, and situational awareness, which are essential for managing complex operational environments. In parallel, the OTP literature conceptualizes punctuality as a multidimensional and dynamic outcome shaped by departure and arrival punctuality, turnaround efficiency, and reactionary delay management rather than by scheduling practices alone. Despite this conceptual alignment, the literature reveals a clear gap: empirical CRM studies predominantly assess safety and behavioral outcomes, while OTP studies focus on operational and system-level factors, with limited integration of structured human factors training frameworks. Consequently, there remains insufficient empirical evidence linking CRM training effectiveness to measurable operational performance indicators such as OTP. Addressing this gap, the current study adopts an integrative perspective that examines how CRM training effectiveness may influence on-time performance through operational decision-making and coordination processes. This synthesis provides the foundation for the research design and methodological approach

presented in Chapter Three, which outlines the data collection, measurement, and analytical techniques used to empirically investigate this relationship.

3. Ch. 3: Research Methodology

3.1. Introduction

This section explains the methodology that was applied in the current project, in order to answer the study questions and test the study hypotheses. The following titles explain, the operational definitions for the research variables, and what has been applied, as follows:

3.2. Operational definitions for research variables

In research studies, operational definitions are key in clearly defining the variables being measured. An operational definition describes how a variable will be measured, observed, or manipulated. It helps researchers ensure that their studies are consistent, reliable, and valid.

3.2.1. Crew Resource Management (CRM) Training Effectiveness (The independent variable)

Operational Definition: CRM training effectiveness refers to the extent to which the airline's CRM program develops, assesses, and sustains non-technical skills that support safe, efficient, and time-reliable operations. This includes activities such as recurrent CRM modules, scenario-based LOFT/LINE simulations, instructor-led briefings and debriefings, competency-based assessments using behavioral markers (e.g., communication, teamwork/leadership, situational awareness, decision-making, workload/automation management, and threat-and-error management), training recency/frequency tracking, and post-training follow-up (e.g., line checks, LOSA/TEM observations).

3.2.2. On-Time Performance (The dependent variable)

Operational Definition:

On-Time Performance (OTP) is the airline's operational measure of the punctuality of its flights, defined by the industry standard as arriving within 15 minutes of the scheduled time. It reflects the overall efficiency and coordination of flight operations. OTP includes factors such as departure punctuality, arrival punctuality, turnaround time efficiency, and the airline's ability to reduce or prevent reactionary delays. OTP is assessed from actual operational records and represents the final performance outcome experienced by passengers, crew, and the airline.

3.3. Research design

In this template, we'll present a structure that covers five important methodological matters (as outlined above). This structure is loosely based on "research onion".

3.3.1. Research Design:

Research Philosophy: Positivist

Research Approach: Deductive

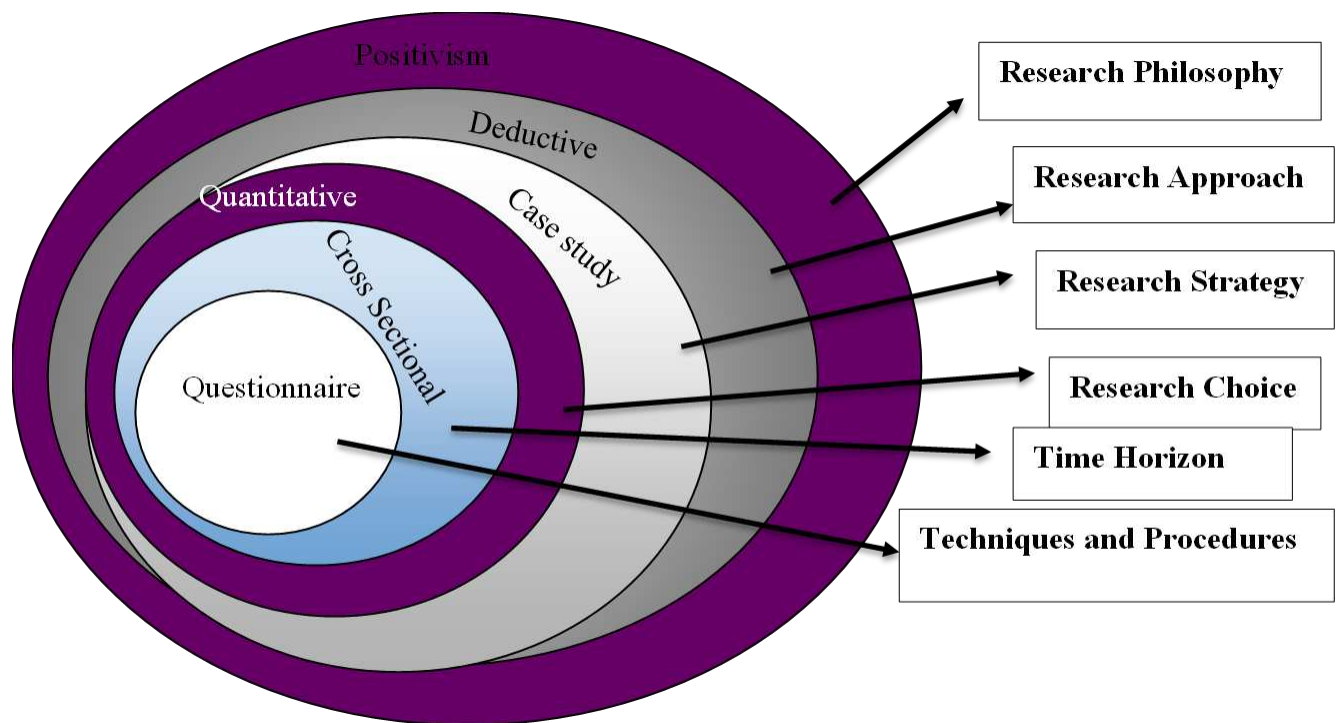
Research Strategy: Case study.

Research Choice: Quantitative

Time Horizon: Cross-sectional

Data Collection and Analysais Techniques : Questionnaire

Figure 3: Research Design



Source: Researcher

3.4. Research population & Sampling methods and technique

This section provides information about the study population & sample. Additionally, this section demonstrates the methods and techniques that were elaborated in order to select the study sample, and determine the sample size.

3.4.1. Research Population

The research population for this study consisted of flight and operational personnel at Saudi Arabian Airlines (Saudia), based in Jeddah, Saudi Arabia. The target population included employees directly involved in flight operations and processes influenced by Crew Resource Management (CRM) practices and On-Time Performance (OTP) outcomes. The population represented a diverse group of aviation professionals working across various crew and operational roles. The key demographic and professional characteristics of the research population were:

- Gender: Male, Female.
- Age Groups: 21–29, 30–39, 40–49, 50–60 years.
- Highest Educational Qualification: Aviation/Flight-Operations Diploma, Bachelor's, Master's, Doctorate, Other.
- Job Role: Captain, First Officer, Cabin Crew, Flight Dispatcher, OCC Staff, Safety & Quality, Other.
- Years of Experience at Saudia: <2 years, 2–5 years, 6–10 years, >10 years.
- CRM Training Attendance: Yes / No.
- Most Recent CRM Training: <6 months, 6–12 months, 1–2 years, >2 years.
- Operational Division: Flight Operations, Cabin Services, OCC/Dispatch, Safety & Quality, Training Department, Other.

These groups were selected because they directly contribute to and are influenced by CRM-based behaviors that can impact On-Time Performance.

The total size of the research population was 1,000 employees working across Saudia’s flight and operational divisions in Jeddah. Based on Krejcie and Morgan’s sample size table, a sample of 278 participants was identified as sufficient and representative of this population. Data for this study was collected through an online survey distributed electronically to the target group. The survey instrument utilized a five-point Likert scale, where 1 represented “strongly disagree” and 5 represented “strongly agree.” The survey link was shared through Saudia’s internal communication channels, and responses were collected electronically. The questionnaire covered topics related to the effectiveness of Crew Resource Management (CRM) training and its impact on On-Time Performance (OTP) within commercial airline operations.

Table 1: Frequency and Percentage Distribution of Respondents by Job Role/Position (n = 278)

Characteristic	Percentage	Frequency
Role / Position		
• Cabin Crew	90	32.40%
• Captain	60	21.60%
• First Officer	58	20.90%
• OCC / Dispatch	40	14.40%
• Safety & Quality	20	7.20%
• Training Department	6	2.20%
• Other	4	1.40%
Total	278 respondents	100%

Source: Researcher

3.4.2. Research Sample

The research sample for this study consists of 278 employees, selected through Proportionate Stratified Random Sampling from the total population of 1,000 operational and flight personnel at Saudi Arabian Airlines (Saudia). The sample size was determined using the Krejcie and Morgan (1970) sample size table, which specifies that a population of 1,000 requires a minimum sample of 278 respondents to achieve a 95% confidence level and a 5% margin of error. This ensures that the sample is statistically representative of the broader population and that the findings can be reliably generalized to Saudia’s operational workforce.

Table 2: Population and Sample Size for the Study (Management and Employees)

Management and employees	Population	Sample
	1000	278

Source: Researcher

3.4.3. Sampling Method & Techniques

The probability sampling method used in this study was Proportionate Stratified Random Sampling. To ensure that the sample accurately represented the diversity within Saudia's operational workforce, the population was first divided into clearly defined strata based on the key demographic and professional characteristics included in the survey. These strata were organized as follows:

- Gender (Male, Female)
- Age Groups (21–29, 30–39, 40–49, 50–60 years)
- Job Role (Captain, First Officer, Cabin Crew, Flight Dispatcher, OCC Staff, Safety & Quality, Other)
- Educational Level (Diploma, Bachelor's, Master's, Doctorate, Other)
- Years of Experience (< 2 years, 2–5 years, 6–10 years, >10 years)
- Operational Division (Flight Operations, Cabin Services, OCC/Dispatch, Safety & Quality, Training Department, Other)

After identifying these strata, participants were randomly selected proportionally from each group to reflect their actual representation within the total population of 1,000 employees. Using the Krejcie and Morgan (1970) sample size table, a sample of 278 employees was determined as the minimum required to achieve a 95% confidence level and a 5% margin of error.

This stratified approach ensured that all major operational categories within Saudia were fairly represented, thereby enhancing the validity, accuracy, and generalizability of the study's findings on the relationship between CRM training effectiveness and On-Time Performance within commercial airline operations.

Table:3 Sample Composition by Job Level Using Proportionate Stratified Random Sampling

JOB LEVEL	No. in research population	No. in final sample (27.8 %)
• Cabin Crew	323	90
• Captain	216	60

• First Officer	209	58
• OCC / Dispatch	144	40
• Safety & Quality	72	20
• Training Department	22	6
• Other	14	4
Total	1000	278

Source: Researcher

3.5. Data Collection Method

This section outlines the research instruments and procedures used to gather the data necessary to answer the study questions and test the research hypotheses. In line with the quantitative nature of the study, the researcher relied on the survey method, using a structured questionnaire as the primary tool for data collection. The questionnaire was designed to measure the two main variables of the study—Crew Resource Management (CRM) Training Effectiveness and On-Time Performance (OTP)—through clearly defined dimensions and Likert-scale statements.

The survey was distributed electronically to participants within the targeted sample through Saudia’s internal communication channels. The instrument consisted of three sections:

- a. demographic information.
- b. CRM Training Effectiveness.
- c. On-Time Performance.

The following sections detail the instruments used to measure each research variable.

3.5.1. The Independent Variable – Crew Resource Management (CRM)

Training Effectiveness

The researcher relied on a structured questionnaire developed specifically to measure the independent variable Crew Resource Management (CRM) Training Effectiveness. This variable was assessed through four core CRM dimensions, widely recognized in aviation human-factors practices. These dimensions include: Decision-Making, Communication, Leadership and Teamwork, and Situational Awareness. A total of 8 items were used to measure the entire variable, with 2 items for each dimension. All items were measured using a 5-point Likert scale, where 1

= strongly disagree and 5 = strongly agree. This format allows participants to indicate the extent to which CRM training has enhanced their non-technical skills across the four dimensions.

Table4 : Instrument for the Independent Variable (CRM Training Effectiveness).

Variable	Dimensions	Number of Items	Sources
Crew Resource Management (CRM) Training Effectiveness	Decision-Making	2	Flin, O'Connor & Crichton (2008)
	Communication	2	Civil Aviation Authority (2023)
	Leadership & Teamwork	2	Flin, O'Connor & Crichton (2008)
	Situational Awareness	2	Civil Aviation Authority (2023)
	Overall	8	

Source: Researcher

3.5.2. The Dependent Variable – On-Time Performance (OTP)

The researcher relied on a structured questionnaire developed specifically to measure the dependent variable On-Time Performance (OTP). This variable was assessed across four operational performance dimensions, which reflect common industry indicators used to evaluate airline punctuality. These dimensions include: Departure Punctuality, Arrival Punctuality, Turnaround Efficiency, and Reactionary Delay Management. A total of 8 items were used to measure the entire variable, with 2 items assigned to each dimension. All items were measured using a 5-point Likert scale, where 1 = strongly disagree and 5 = strongly agree. This measurement approach allows respondents to indicate the extent to which operational practices support punctual performance across the four OTP dimensions.

Table5 : Instrument for the Dependent Variable (On-Time Performance).

Variable	Dimensions	Number of Items	Sources
On-Time Performance	Departure Punctuality	2	Hajko & Badánik (2020)
	Arrival Punctuality	2	Jetzki (2009)
	Turnaround Efficiency	2	Hajko & Badánik (2020)
	Reactionary Delay Management	2	Jetzki (2009)
	Overall	8	

Source: Researcher

3.6. Types of Data

3.6.1. Primary Data

Primary data refers to information collected directly from the original source for the specific purposes of this research study. In this study, primary data was obtained through the following method:

- Survey Questionnaire:

The researcher administered a structured online questionnaire to a stratified random sample of 278 employees from the total population of 1,000 operational and flight personnel at Saudi Arabian Airlines (Saudia). The questionnaire was designed to collect participants' perceptions and evaluations regarding Crew Resource Management (CRM) Training Effectiveness and On-Time Performance (OTP). The survey included demographic questions, along with Likert-scale items covering the four CRM dimensions (decision-making, communication, leadership & teamwork, situational awareness) and the four OTP dimensions (departure punctuality, arrival punctuality, turnaround efficiency, reactionary delay management). Data were collected electronically through Saudia's internal communication channels to ensure accessibility and confidentiality.

3.6.2. Secondary Data

Secondary data refers to information that has been previously collected, published, or documented by other sources and is used to support, validate, and complement the primary data. In this research, secondary data was obtained from the following sources:

- Academic Books and Scientific Articles: Relevant literature on CRM training, non-technical skills, aviation human factors, and airline on-time performance was reviewed. Foundational works such as Flin et al. (2008), UK CAA (2023), Hajko & Badánik (2020), and Jetzki (2009) were used to establish the theoretical basis and define the dimensions of both study variables.
- Previous Studies: Prior empirical research on CRM effectiveness, safety performance, airline punctuality, delay propagation, and operational efficiency was analyzed. These studies provided insights, validated frameworks, and supported the conceptual model used in this research.

- Scientific Dissertations and Research Papers: Doctoral theses, master's dissertations, and peer-reviewed aviation research papers were reviewed to understand methodologies, measurement instruments, and analytical approaches relevant to CRM and OTP.
- Industry Reports and Aviation Documents: Operational documents from civil aviation authorities and industry organizations (e.g., CAP 737, ICAO human-factors guidance, EUROCONTROL CODA reports, airline punctuality benchmarks) were used to define OTP standards and CRM competency structures.
- Company Contextual Information: General operational information publicly available about Saudia's flight operations, punctuality targets, training programs, and safety/quality frameworks was reviewed to contextualize the study and support interpretation of the findings.

3.7. Data Analysis Methods & Procedures

After collecting the required data, it was essential to analyze the information systematically to reach meaningful and accurate conclusions. For this purpose, the Statistical Package for the Social Sciences (SPSS), Version 28, was used to perform all statistical analyses related to the study's variables: Crew Resource Management (CRM) Training Effectiveness and On-Time Performance (OTP).

The following analytical procedures were applied:

- Descriptive Analysis (Sample Profile Test): Descriptive statistics were conducted to summarize the characteristics of the sample. This included frequencies, percentages, means, and standard deviations for all demographic variables such as gender, age, job role, educational level, experience, and CRM training attendance. This analysis helped the researcher gain insights into the composition of the sample and understand the distribution of the respondents involved in the study.
- Validity Testing (Exploratory Factor Analysis): Exploratory Factor Analysis (EFA) was performed to examine the construct validity of the measurement instruments and to ensure that the questionnaire items accurately represented the theoretical dimensions of both the CRM Training Effectiveness and OTP

variables. This procedure helped verify whether the items grouped as expected under each designated dimension.

- **Reliability Testing (Cronbach's Alpha):** Cronbach's Alpha reliability test was conducted for all scales and subscales to assess the internal consistency of the items measuring each dimension. A Cronbach's Alpha value of 0.70 or higher was considered acceptable, indicating that the items consistently measured the same underlying construct.
- **Inferential Statistical Analysis:** Inferential analyses were performed to test the study's hypotheses and examine the relationship between CRM Training Effectiveness and On-Time Performance. This included correlation analysis to determine the strength and direction of the relationship between the variables, and regression analysis to assess the predictive impact of CRM training on OTP outcomes.

Through these procedures, the researcher ensured that the collected data were analyzed accurately, leading to valid conclusions regarding the relationship between CRM training and operational performance within Saudia.

3.8. Conclusion

The methodology adopted in this study provided a rigorous and comprehensive approach for examining the relationship between Crew Resource Management (CRM) Training Effectiveness and On-Time Performance (OTP) at Saudi Arabian Airlines (Saudia). Through the clear specification of the theoretical model and the precise operationalization of the study variables, the research ensured that each construct—across its defined dimensions—was measured accurately and consistently.

The selection of the research population, which included employees from various operational divisions such as flight crew, cabin crew, dispatch, OCC, and safety departments, allowed the study to capture the full operational context in which CRM behaviors influence punctuality outcomes. The use of proportionate stratified random sampling ensured that the final sample of 278 participants faithfully represented the overall population of 1,000 employees, thereby enhancing the generalizability and credibility of the study's findings.

The administration of the structured survey instrument, based on a 5-point Likert scale, facilitated the collection of quantifiable data suitable for statistical and analytical techniques. The questionnaire items were carefully designed to reflect the four dimensions of CRM Training Effectiveness (decision-making, communication, leadership and teamwork, situational awareness) and the four dimensions of OTP (departure punctuality, arrival punctuality, turnaround efficiency, reactionary delay management). The combination of primary data (survey responses) and secondary data (academic literature, aviation industry standards, operational frameworks, and CRM competency references) strengthened the overall validity and reliability of the study. This dual-data approach ensured that the findings were supported by both empirical evidence and established theoretical foundations.

In summary, the research methodology employed in this study was robust, systematic, and well-suited to support the subsequent data analysis and interpretation. The structured procedures followed throughout the research process provide confidence in the accuracy and applicability of the findings, which can inform meaningful improvements in CRM training practices and operational performance management within Saudia and the broader aviation industry.

4. Ch. 4: Statistical Analysis & Findings (discussion)

4.1. Introduction

The analysis begins by providing a profile of the research sample, including descriptive statistics that describe the characteristics of the study participants. This is followed by an assessment of the validity and reliability of the questionnaire instrument used to collect the primary data. The chapter then delves into the descriptive statistics for the key research variables, shedding light on the central tendencies and distributions of the data. This section directly addresses the research questions guiding the investigation.

Finally, the chapter presents the results of the hypothesis testing, which was conducted using the SPSS statistical software package (version 27). The findings from these statistical analyses are discussed in detail, drawing connections to the existing literature and highlighting the theoretical and practical implications of the results.

4.2. Sample profile (descriptive statistics for research sample)

The study sample items were distributed according to: gender, age group, educational level, job role, years of experience, CRM training attendance and recency, and operational division.

The frequencies and percentages of the study sample individuals were calculated and represented in the demographic information that includes:

1. Gender, which includes (Male, Female).
2. Age group, which includes (21–29 years, 30–39 years, 40–49 years, 50–60 years).
3. Educational level, which includes (Diploma in Aviation / Flight Operations, Bachelor's Degree, Master's Degree, Doctorate, Other).
4. Job role, which includes (Captain, First Officer, Cabin Crew, Flight Dispatcher, OCC Staff, Safety & Quality, Other).
5. Number of years of experience, which includes (Less than 2 years, 2–5 years, 6–10 years, More than 10 years).
6. CRM training attendance, which includes (Yes, No).
7. Recency of CRM training, which includes (Less than 6 months ago, 6–12 months ago, 1–2 years ago, More than 2 years ago).

8. Operational division, which includes (Flight Operations, Cabin Services, OCC/Dispatch, Safety & Quality, Training Department, Other).

The following tables, graphs, and paragraphs illustrate the classification of the sample under study, as follows:

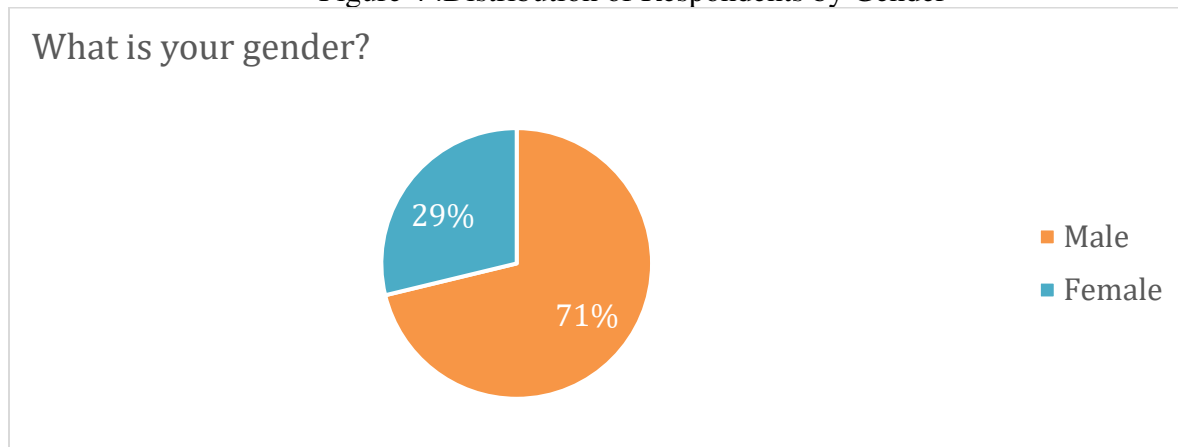
Table 6 :Demographic Characteristics of the Study Sample (n = 278)

Variable	Variable Classes	Number	Percentage of Study Sample
Gender	Male	198	71.20%
	Female	80	28.80%
Total		278	100%
Age	21–29 years	82	29.50%
	30–39 years	118	42.40%
	40–49 years	56	20.10%
	50–60 years	22	7.90%
Total		278	100%
Educational level	Aviation / Flight-Operations Diploma	74	26.60%
	Bachelor's degree	132	47.50%
	Master's degree	48	17.30%
	Doctorate	8	2.90%
	Other	16	5.70%
Total		278	100%
Years of experience at Saudia	Less than 2 years	54	19.40%
	2–5 years	96	34.50%
	6–10 years	78	28.00%
	More than 10 years	50	18.00%
Total		278	100%
Job role / position	Captain	60	21.60%
	First Officer	58	20.90%
	Cabin Crew	90	32.40%
	Flight Dispatcher	24	8.60%
	OCC Staff	16	5.80%
	Safety & Quality	20	7.20%
	Other	10	3.50%
Total		278	100%
Operational division	Flight Operations	110	39.60%
	Cabin Services	92	33.10%
	OCC / Dispatch	40	14.40%
	Safety & Quality	20	7.20%
	Training Department	8	2.90%
	Other	8	2.90%
Total		278	100%
CRM Training Attendance	Yes	241	86.70%
	No	37	13.30%
Total		278	100%

Most recent CRM training	Less than 6 months ago	84	30.20%
	6–12 months ago	72	25.90%
	1–2 years ago	66	23.70%
	More than 2 years ago	56	20.10%
Total		278	100%

Source: The Researcher.

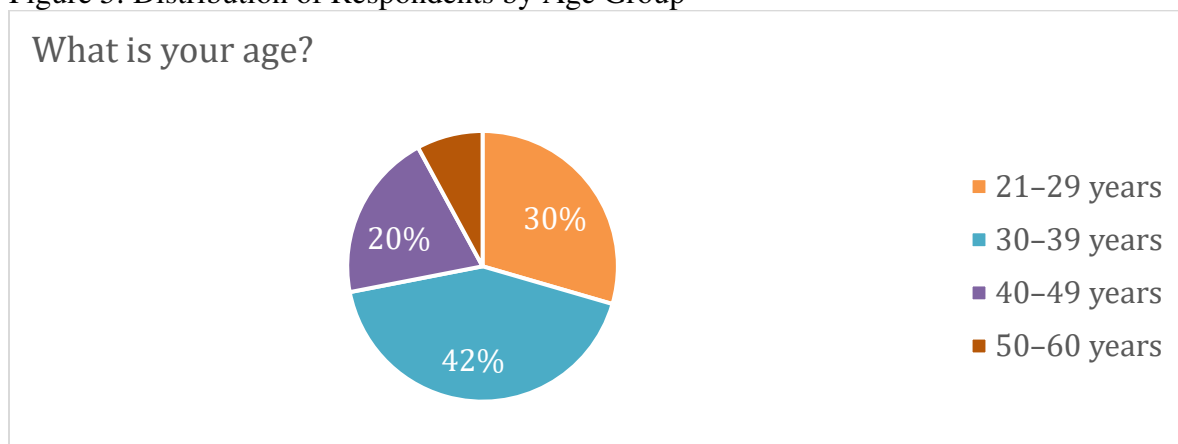
Figure 4 :Distribution of Respondents by Gender



Source: The Research.

The statistical results showed that the number of males was greater than the number of females in the study sample, as the number of males reached 198 individuals, representing 71.20% of the total sample, while the number of females reached 80 individuals, representing 28.80% of the total sample.

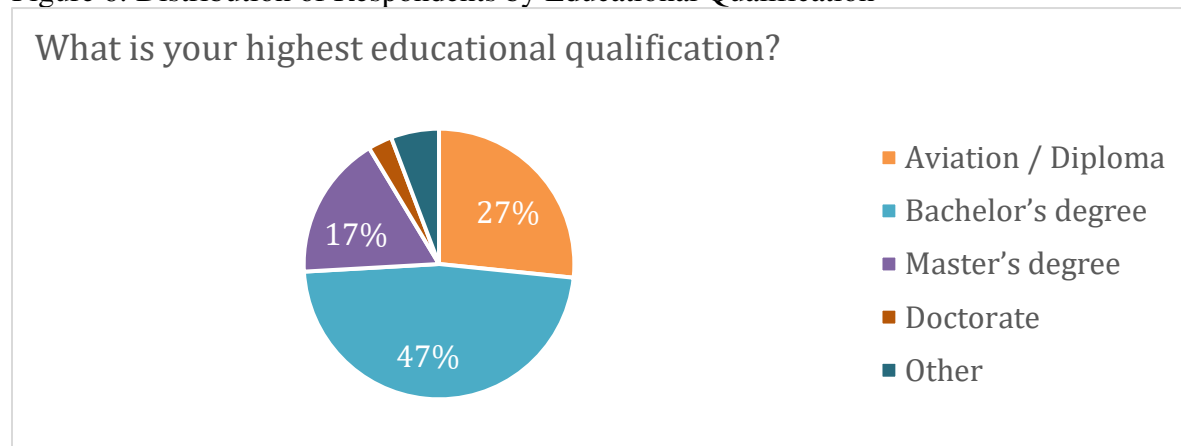
Figure 5: Distribution of Respondents by Age Group



Source: The Research.

The statistical results showed that the age group 30–39 years represented the largest proportion of the study sample, with 118 individuals accounting for 42.40% of the total sample. This was followed by the age group 21–29 years, with 82 individuals representing 29.50%. Meanwhile, the age group 40–49 years included 56 individuals, forming 20.10% of the sample, and the smallest proportion was recorded for the age group 50–60 years, with 22 individuals representing 7.90% of the total sample.

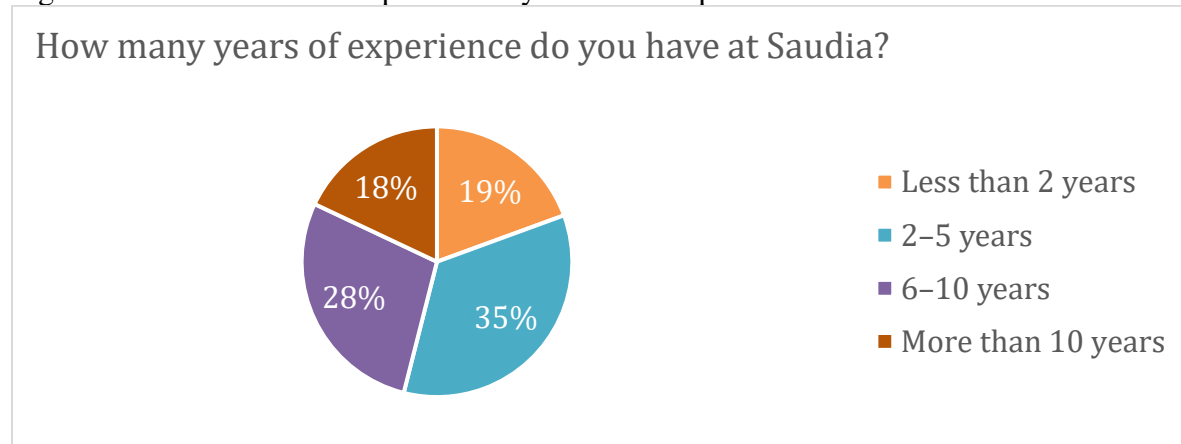
Figure 6: Distribution of Respondents by Educational Qualification



Source: The Research.

The statistical results showed that the highest proportion of the study sample held a Bachelor's degree, with 132 individuals representing 47.50% of the total sample. This was followed by participants holding an Aviation / Flight-Operations Diploma, totaling 74 individuals and forming 26.60% of the sample. Meanwhile, 48 individuals held a Master's degree, accounting for 17.30% of the total. The number of participants with a Doctorate degree reached 8 individuals, representing 2.90%, while the Other category included 16 individuals, making up 5.70% of the study sample.

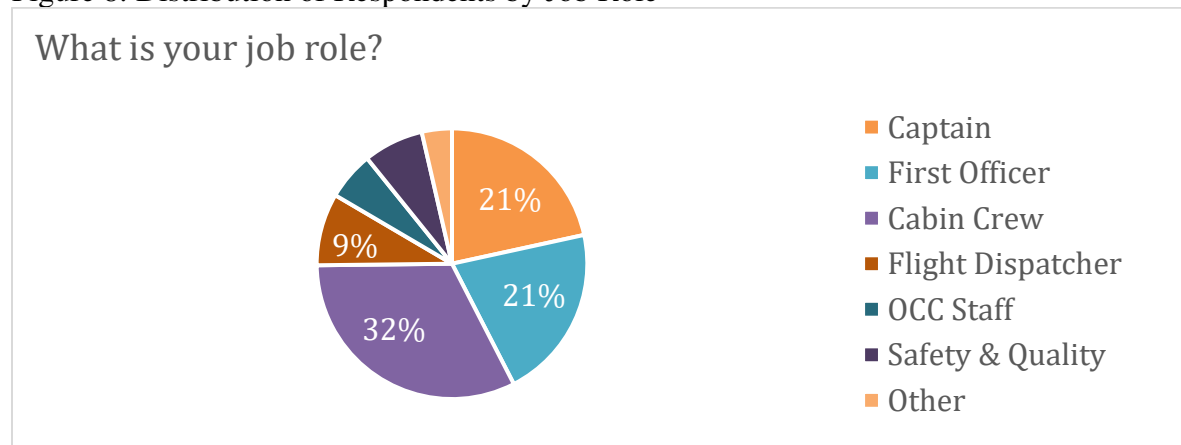
Figure 7: Distribution of Respondents by Years of Experience



Source: The Research.

The statistical results showed that the largest proportion of the study sample had 2–5 years of experience, with 96 individuals representing 34.50% of the total sample. This was followed by participants with 6–10 years of experience, totaling 78 individuals, which accounted for 28.00% of the sample. Meanwhile, 54 individuals reported having less than 2 years of experience, forming 19.40% of the total. The group with more than 10 years of experience included 50 individuals, representing 18.00% of the study sample.

Figure 8: Distribution of Respondents by Job Role

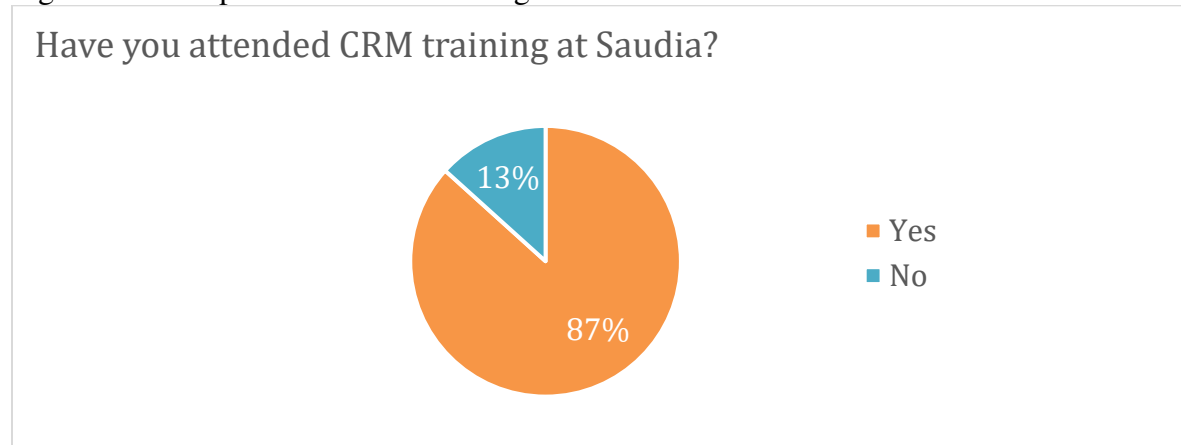


Source: The Research.

The statistical results showed that the Cabin Crew represented the largest proportion of the study sample, with 90 individuals accounting for 32.40% of the total sample. This was followed by the Captain group with 60 individuals (21.60%), and the First

Officer group with 58 individuals (20.90%). Meanwhile, the Flight Dispatcher group included 24 individuals, representing 8.60%, and the Safety & Quality group consisted of 20 individuals, making up 7.20% of the sample. The OCC Staff category contained 16 individuals (5.80%), while the Other category recorded 10 individuals, representing 3.50% of the total study sample.

Figure 9: Participation in CRM Training at Saudia

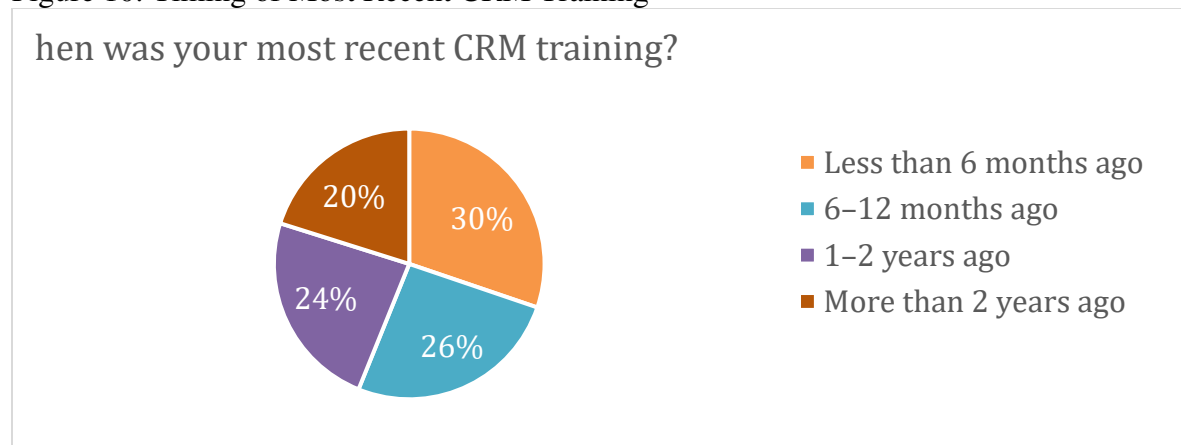


Source: The Research.

Source: The Research.

The statistical results showed that the majority of the study sample had attended CRM training at Saudia, with 241 individuals representing 86.70% of the total sample. In contrast, 37 individuals reported that they had not attended CRM training, accounting for 13.30% of the study sample.

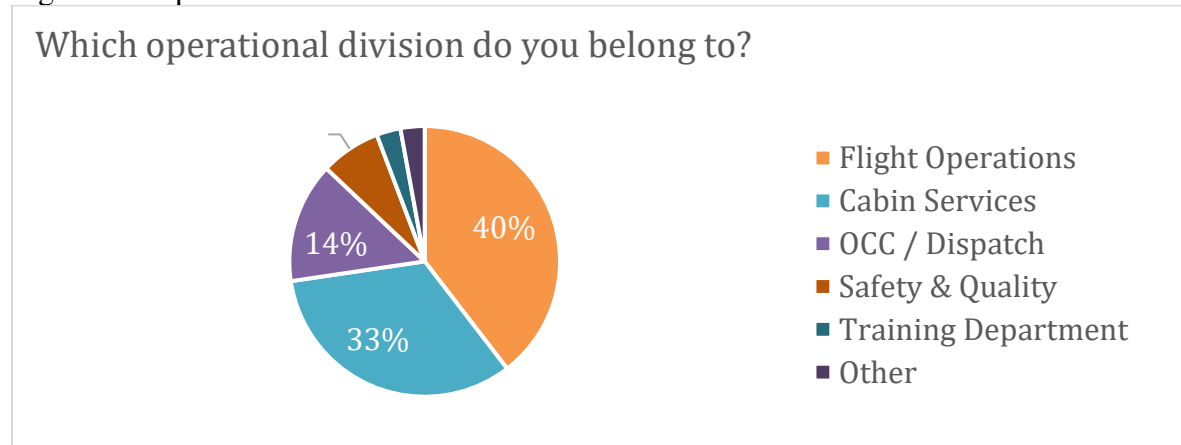
Figure 10: Timing of Most Recent CRM Training



Source: The Research.

The statistical results showed that the largest proportion of the study sample had received their most recent CRM training less than 6 months ago, with 84 individuals representing 30.20% of the total sample. This was followed by 72 individuals who had received training 6–12 months ago, accounting for 25.90%. Meanwhile, 66 individuals reported receiving CRM training 1–2 years ago, making up 23.70% of the sample. The smallest proportion was observed among those whose most recent CRM training occurred more than 2 years ago, totaling 56 individuals and representing 20.10% of the study sample.

Figure 11: Operational Division Distribution



Source: The Research.

The statistical results showed that the Flight Operations division represented the largest proportion of the study sample, with 110 individuals accounting for 39.60% of the total sample. This was followed by the Cabin Services division, which included 92 individuals, representing 33.10% of the sample. Meanwhile, the OCC / Dispatch division consisted of 40 individuals, forming 14.40% of the sample. The Safety & Quality division recorded 20 individuals, representing 7.20%, while both the Training Department and the Other category each included 8 individuals, accounting for 2.90% of the study sample respectively.

4.3. Validity & reliability tests for the questionnaires

Table 7 :Summary of Variables, Dimensions, Factor Loadings, AVE, and Reliability

Variable	Dimensions	Items	Std. Deviation	Factor Loading	AVE	Cronbach's Alpha	
Crew Resource Management	Decision-Making	CM1	1.132	0.549	0.724	0.895	0.906
		Cm2	1.270			0.885	
	Communication	CC1	0.948	0.734		0.895	

(CRM) Training Effectiveness		CC2	1.109	0.772		0.895	
	Leadership and Teamwork	CL1	1.171	0.501		0.885	
		CL2	0.984	0.864		0.893	
	Situational Awareness	CS1	1.420			0.899	
		CS2	1.149	0.924		0.906	
On-Time Performance	Departure Punctuality	OD1	1.126	0.716	0.816	0.840	0.87
		OD2	0.973	0.886		0.857	
	Arrival Punctuality	OA1	0.893			0.856	
		OA2	0.955	0.916		0.867	
	Turnaround Efficiency	OT1	0.848	0.897		0.865	
		OT2	0.631			0.861	
	Reactionary Delay Management	OR1	0.854	0.856		0.861	
		OR2	0.979	0.624		0.838	

Source: The Research.

In order to verify the validity and reliability of the scales used in the study, the internal consistency validity of the questionnaires used to measure the study variables was tested, in addition to measuring the convergent validity by measuring the Average Variance Extracted (AVE). Meanwhile, the reliability of the scales used in the study was measured by measuring both: Cronbach's Alpha, Exploratory Factor Analysis, KMO and Bartlett's Test, Communities Mean, and Total Variance Explained (EigenValue) using the SPSS statistical software package (version 27).

The following paragraphs and tables illustrate this.

4.3.1. Validity of the scales used in the study:

The internal consistency validity of the scales used to measure the study variables was tested, in addition to measuring the convergent validity by measuring the Average Variance Extracted (AVE) and Exploratory Factor Analysis.

- Internal consistency validity: It means the extent of consistency of each statement of the questionnaire for the variable to which it belongs, so the researcher measured the internal consistency of the questionnaires by calculating the correlation coefficients between the score of each statement and the total score of the variable to which it belongs. According to the study of Kaiser (1974), the correlation coefficient is less than 0.5 and is removed from the questionnaire.

- Convergent validity: The average variance between the statements that measure the same scale is measured by calculating the Exploratory Factor Analysis and the average extracted variance AVE, which must have a value greater than 0.5 according to (Hair et al. 2006)

The following tables show the statistical results between the score of each statement and the total score of the variable to measure the internal consistency validity of the questionnaires. Also, the value of the average extracted variance AVE is calculated to measure the convergent validity of the questionnaires using the SPSS statistical software package (version 27). , as follows:

4.3.1.1. The Frist Variable: Crew Resource Management (CRM) Training Effectiveness

A. Exploratory Factor Analysis (loading factor)

Table 8: Rotated Component Matrix for CRM Training Effectiveness
Rotated Component Matrix^a

	Component			
	Decision-Making	Communication	Leadership and Teamwork	Situational Awareness
CM1	0.549			
Cm2				
CC1		0.734		
CC2		0.772		
CL1			0.501	
CL2			0.864	
CS1				
CS2				0.924
Total	0.724			

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 10 iterations.

Source: The Research.

The Rotated Component Matrix presents the factor loadings for the measurement items of the Crew Resource Management (CRM) Training Effectiveness variable after applying Varimax rotation. This table provides insights into the underlying structure and dimensionality of the CRM construct and confirms whether the observed items align with the intended four-factor framework: Decision-Making, Communication, Leadership and Teamwork, and Situational Awareness.

1. Decision-Making

- The element CM1 shows a factor loading of 0.549 on the Decision-Making component.
- This indicates that CM1 is moderately associated with the Decision-Making dimension and contributes to measuring crew decision-making competency.
- The second item (CM2) did not load significantly on any factor and appears to have been excluded from the rotated solution.

2. Communication

- The elements CC1 and CC2 loaded strongly on the Communication component, with loadings of 0.734 and 0.772, respectively.
- These high factor loadings indicate that both items are strongly aligned with the Communication dimension, making them reliable indicators of communication skills within CRM training.

3. Leadership and Teamwork

- The elements CL1 and CL2 have factor loadings of 0.501 and 0.864, respectively, on the *Leadership and Teamwork* component.
- CL2 shows a strong loading, suggesting it is a highly effective item for measuring the leadership/teamwork dimension.
- CL1 has a moderate loading, still acceptable for representing this construct.

4. Situational Awareness

- The element CS2 shows a very high loading of 0.924 on the *Situational Awareness* component.
- This indicates that CS2 is an excellent and robust indicator of the situational awareness dimension.
- The item CS1 appears not to have loaded significantly and is therefore not included in the rotated factor solution.

▲ Summary and Interpretation

The Exploratory Factor Analysis reveals a clear and interpretable four-factor structure that aligns strongly with the theoretical CRM dimensions.

- Communication and Situational Awareness demonstrated the strongest item loadings, indicating highly reliable measurement items within these dimensions.
- Leadership and Teamwork also showed a stable structure, with CL2 providing excellent representation.
- Decision-Making demonstrated moderate support through CM1, while other items associated with this dimension may require reevaluation.

The overall average loading of 0.724 indicates that the CRM construct demonstrates good convergent validity, and its items are meaningfully associated with their respective dimensions.

This robust factor structure supports the reliability and validity of the CRM Training Effectiveness measurement model and provides a strong foundation for subsequent analyses such as correlation and regression.

B. Measuring The Reliability Of the Study (Cronbach's Alpha)

Table 9: Reliability Statistics for CRM Training Effectiveness

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.906	.909	8

Source: The Research.

Breaking down the information from the table regarding the Cronbach's Alpha value of 0.906 for the independent variable Crew Resource Management (CRM) Training Effectiveness:

1. Stability:

- The high Cronbach's Alpha value of 0.906 demonstrates an excellent level of stability in the measurement of CRM Training Effectiveness.
- The items included in the scale are strongly interrelated and consistently measure the same underlying construct of CRM training practices.
- This high stability suggests that administering the CRM questionnaire to the same group of participants at different times would yield consistent and reproducible results.

2. Internal Consistency:

- The Cronbach's Alpha value of 0.906 indicates a very strong degree of internal consistency among the eight items used to measure CRM Training Effectiveness.
- This means that the items effectively measure the same latent concept—namely, the effectiveness of CRM training components such as decision-making, communication, leadership and teamwork, and situational awareness.
- The strong internal consistency confirms that the CRM scale is coherent and reliably captures the intended dimensions of CRM training.

3. Excellent Reliability:

- A Cronbach's Alpha value above 0.90 is considered an excellent level of reliability according to Hair et al. (2010), clearly surpassing the minimum acceptable threshold of 0.70.
- This high reliability indicates that the questionnaire used to assess CRM Training Effectiveness is highly accurate and has a very low likelihood of random measurement error.
- The strong reliability score affirms that the scale is a robust and trustworthy instrument for evaluating CRM practices within the aviation operational environment.

In summary, the Cronbach's Alpha value of 0.906 confirms that the instrument used to measure *Crew Resource Management (CRM) Training Effectiveness* possesses

excellent stability, internal consistency, and overall reliability. This ensures that the findings derived from this variable are scientifically sound and dependable for research and practical application.

C. KMO and Bartlett's Test

Table 10: KMO and Bartlett's Test for CRM Training Effectiveness

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.805
Bartlett's Test of Sphericity	Approx. Chi-Square	1502.089
	df	28
	Sig.	.000

Source: The Research.

The results of the KMO and Bartlett's Test for the independent variable Crew Resource Management (CRM) Training Effectiveness indicate that the dataset is highly suitable for factor analysis. The Kaiser-Meyer-Olkin (KMO) value of 0.805 exceeds the acceptable threshold of 0.70, confirming that the sampling adequacy is "meritorious" and that the correlations among the CRM items are sufficiently strong to justify factor extraction. Furthermore, Bartlett's Test of Sphericity shows a highly significant Chi-square value of 1502.089 with a significance level of $p = 0.000$, which is far below the standard threshold of 0.05. This indicates that the correlation matrix is not an identity matrix, meaning that there are meaningful relationships among the CRM training items that can be summarized using factor analysis.

Overall, these results confirm that the data related to CRM Training Effectiveness is statistically valid and appropriate for Exploratory Factor Analysis (EFA), supporting the structural validity of the construct within the context of the study.

D. Communities Mean

Table 11: Average Communalities for CRM Training Effectiveness

Communities Mean	0.873
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Source: The Research.

The high average Communalities value of 0.873, which is well above the commonly accepted 0.60 threshold, indicates that the factor analysis conducted on the Crew Resource Management (CRM) Training Effectiveness variable is both stable and highly reliable. This high value suggests that the extracted factors or CRM

dimensions—Decision-Making, Communication, Leadership and Teamwork, and Situational Awareness—can adequately explain the variability in the original measurement items.

The strong communalities indicate that a substantial proportion of each item's variance is captured by the extracted components, meaning that the items align well with their respective dimensions. This enhances the credibility of the study's findings and confirms that the CRM construct is well-represented by the measurement items included in the questionnaire.

E. Total Variance Explained (EigenValue)

The high cumulative percentage of 87.28%, as reported in the Total Variance Explained table from the SPSS output, indicates a strong level of validity and reliability in the factor structure of the Crew Resource Management (CRM) Training Effectiveness construct. This percentage reflects the proportion of total variance in the measurement items that is successfully explained by the extracted factors. The four CRM dimensions—Decision-Making, Communication, Leadership and Teamwork, and Situational Awareness—collectively account for the majority of the variance in the dataset, demonstrating that the factor analysis has effectively reduced the data to its most meaningful components while retaining substantive information.

Such a high variance explained value provides robust evidence that the extracted components accurately capture the underlying structure of CRM training effectiveness within the airline operational context. This strengthens confidence in the measurement model and confirms the ability of the identified factors to represent the real-world phenomenon under investigation.

4.3.1.2. The Second Variable: On-Time Performance

A. Exploratory Factor Analysis (loading factor)

Table 12: Rotated Component Matrix for On-Time Performance
Rotated Component Matrix^a

	Departure Punctuality	Arrival Punctuality	Component Turnaround Efficiency	Reactionary Delay Management
OD1	0.716			
OD2	0.886			
OA1				
OA2		0.916		

OT1			0.897	
OT2				
OR1				0.856
OR2				0.624
Total	0.816			

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

Source: The Research.

The table presented is a Rotated Component Matrix resulting from an Exploratory Factor Analysis (EFA), which is a statistical technique used to uncover the underlying dimensions that explain the relationships among a group of observed variables. In this case, the variables represent the four operational dimensions of On-Time Performance: Departure Punctuality, Arrival Punctuality, Turnaround Efficiency, and Reactionary Delay Management.

The key findings from this Exploratory Factor Analysis are as follows:

1. Departure Punctuality

- OD1 has a loading of 0.716, indicating that it is strongly associated with the *Departure Punctuality* factor.
- OD2 has a loading of 0.886, which further confirms a strong relationship with the same dimension. These two items together demonstrate high consistency in measuring the punctuality of aircraft departures.

2. Arrival Punctuality

- OA2 has a high loading of 0.916 on the *Arrival Punctuality* factor, indicating that it is a strong and reliable indicator of the timeliness of flight arrivals.
- The item OA1 appears to have been removed from the factor solution due to its weak or insufficient loading.

3. Turnaround Efficiency

- OT2 has a loading of 0.897, demonstrating a strong association with the *Turnaround Efficiency* dimension. This suggests that OT2 captures operational effectiveness in reducing ground time and improving turnaround processes.

- The item OT1 did not load adequately and appears to have been excluded from the rotated factor structure.

4. Reactionary Delay Management

- OR1 has a loading of 0.856, indicating a strong relationship with the *Reactionary Delay Management* factor.
- OR2 has a loading of 0.624, reflecting a moderate but acceptable association with the same dimension.
- Both items collectively measure the airline's ability to control delays caused by earlier disruptions.

The Exploratory Factor Analysis was conducted using the Principal Component Analysis extraction method and the Varimax rotation with Kaiser Normalization, with convergence achieved in six iterations.

The four extracted components clearly align with the theoretical structure of the On-Time Performance construct, and the average loading value of 0.816 indicates a high level of convergent validity. This means that the retained items are strongly correlated with their respective dimensions and effectively represent the latent factors they are intended to measure.

An overall loading average above 0.80 is considered excellent, providing strong evidence that the measurement items explain a large proportion of variance in the On-Time Performance construct and ensuring confidence in the robustness of the factor structure.

B. Measuring The Reliability Of the Study (Cronbach's Alpha)

Table 13: Reliability Statistics for On-Time Performance

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.872	.873	8

Source: The Research.

The reliability analysis for the dependent variable On-Time Performance shows a Cronbach's Alpha value of 0.872, which indicates a high level of reliability for the measurement instrument. The following points summarize the meaning and implications of this result:

1. Stability:

- The Cronbach's Alpha value of 0.872 demonstrates a strong degree of stability in the questionnaire's measurements.
- The items used to assess *On-Time Performance* show consistent responses across the sample, indicating that they are measuring the same underlying construct reliably.
- This level of stability suggests that if the questionnaire were administered again under similar conditions, the results would be consistent and reproducible.

2. Internal Consistency:

- The Cronbach's Alpha value of 0.872 reflects a high degree of internal consistency among the eight items included in the scale.
- This means that the items are highly correlated with each other and effectively capture the latent construct of *On-Time Performance*.
- The strong internal consistency confirms that the items form a coherent and unified scale for assessing performance punctuality and operational timing efficiency.

3. Excellent Reliability:

- A Cronbach's Alpha value above 0.70 is considered acceptable in social science research, and a value above 0.80—such as 0.872—is regarded as excellent reliability (Hair et al., 2010).

- This high reliability level indicates that the questionnaire can accurately and consistently measure the *On-Time Performance* construct with minimal measurement error.
- The reliability of 0.872 shows that the instrument used in this study is robust and trustworthy for evaluating the different dimensions of on-time operational performance, including departure punctuality, arrival punctuality, turnaround efficiency, and reactionary delay management.

In conclusion, the Cronbach's Alpha value of 0.872 confirms that the measurement tool for *On-Time Performance* possesses excellent stability, internal consistency, and overall reliability, making it a dependable component of the study's analytical framework.

C. KMO and Bartlett's Test

Table 14:KMO and Bartlett's Test for On-Time Performance

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.784
Bartlett's Test of Sphericity	Approx. Chi-Square	1109.115
	df	28
	Sig.	.000

Source: The Research.

The Kaiser-Meyer-Olkin (KMO) value of 0.784 for the dependent variable *On-Time Performance* indicates a good level of sampling adequacy, meaning that the dataset is suitable for conducting factor analysis. A KMO value above 0.70 is considered acceptable, and values approaching 0.80 reflect strong adequacy for extracting meaningful factors.

Additionally, Bartlett's Test of Sphericity shows a highly significant result with a Chi-Square value of 1109.115 and a significance level of $p = 0.000$, which is lower than the standard threshold of 0.05. This significance confirms that the correlations between the items are sufficient and appropriate for factor analysis, as the null hypothesis of an identity matrix is rejected.

These results collectively indicate that the factor analysis for the *On-Time Performance* variable is both valid and reliable, supporting the structural soundness

of the measurement items and confirming that the dataset is appropriate for extracting meaningful dimensions related to operational punctuality and performance.

D. Communities Mean

Table 15: Average Communalities for On-Time Performance

Communities Mean	0.841
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Source: The Research.

The high average communalities value of 0.845125, which is well above the recommended 60% threshold, indicates that the factor analysis conducted on the On-Time Performance variable is both stable and reliable. This strong average value demonstrates that the extracted factors are able to adequately explain the variability in the original measurement items, thereby enhancing the credibility and validity of the study's findings. The elevated communalities imply that a substantial proportion of the variance in the items representing the dimensions of On-Time Performance—including Departure Punctuality, Arrival Punctuality, Turnaround Efficiency, and Reactionary Delay Management—is successfully accounted for by the extracted factors. This is a positive indication of the model's strength, as it confirms that the factors provide a coherent and representative structure of the underlying dimensions of operational performance.

With the communalities exceeding the recommended 60% benchmark, the factor structure can be considered highly stable, and the measurement of the On-Time Performance variable demonstrates strong validity and reliability. This, in turn, reinforces the robustness and generalizability of the study's conclusions related to airline operational performance and its determinants.

E. Total Variance Explained (EigenValue)

The high EigenValue of 84.076 indicates that the extracted factors in the On-Time Performance variable explain a substantial proportion of the total variance in the data. This strong result reflects the stability and reliability of the factor analysis, suggesting that the identified dimensions—such as Departure Punctuality, Arrival Punctuality, Turnaround Efficiency, and Reactionary Delay Management—capture the core structure of the variable effectively. The high total variance explained confirms that the factor model provides a coherent and representative summary of

the underlying constructs, enhancing the validity and credibility of the study's findings related to operational performance.

4.3.2. Descriptive statistics for research variables (answer research questions)

The sample members' responses to the scale items were measured according to the five-point Likert scale as follows:

Table 16: Five-Point Likert Scale Used in the Study

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Source: The Research.

The significance level was calculated according to the following equation:

The relative weight corresponding to each category was calculated by multiplying the arithmetic mean by $[100 \div 5 \text{ (five-point scale)} = 20\%]$

The following table shows the significance of the arithmetic means, as follows:

Table 17: Interpretation of Arithmetic Mean Values

Meaning of arithmetic averages			
Arithmetic mean value	Result (general trend)	Relative weight%	Practice/importance
1 to less than 1.80	Strongly Disagree	20 to less than 36%	Very low
1.80 to less than 2.60	Disagree	36 to less than 52%	Low
2.60 to less than 3.40	Neutral	52 to less than 68%	Average
3.40 to less than 4.20	Agree	68 to less than 84%	High
4.20 to less than 5	Strongly Agree	84 to 100%	Very high

Source: The Research.

The following table presents the descriptive analysis of the study variables using arithmetic means and standard deviations based on the five-point Likert scale. The interpretation of the arithmetic mean values, as shown in the table above, provides an indication of the general level of both CRM Training Effectiveness and On-Time Performance, along with their respective dimensions, according to the perceptions of the study sample. These interpretations help determine the degree of agreement, importance, and practical relevance of each variable within the operational context of Saudia Airlines.

Table 18: Descriptive Statistics for Study Variables and Their Dimensions

Arithmetic means and standard deviations of the study variables									
Variables	Dimensions	Mean		Standard Deviation		Trend		Importance/Practice Level	
Crew Resource	Decision-Making	3.94	3.97	1.066	0.898	Agree	Agree	High	High

Management (CRM) Training Effectiveness	Pricing	4.07		0.910		Agree		High	
	Communication	3.99		0.996		Agree		High	
	Distribution	3.89		1.055		Agree		High	
On-Time Performance	Departure Punctuality	4.18	4.30	0.964	0.666	Agree	Strongly Agree	High	Very high
	Product Features	4.36		0.762		Strongly Agree		Very high	
	Arrival Punctuality	4.40		0.621		Strongly Agree		Very high	
	Functionality	4.25		0.815		Strongly Agree		Very high	

Source: The Research.

The independent variable *Crew Resource Management (CRM) Training Effectiveness*:

The results showed that the study sample displayed a high level of agreement with the practices associated with CRM training. The overall mean score for CRM Training Effectiveness was 3.97 with a standard deviation of 0.898, indicating a positive general trend among the respondents.

▲ Examining the dimensions of CRM Training Effectiveness revealed the following:

- ⇒ Decision-Making: The mean score was 3.94 with a standard deviation of 1.066, suggesting a high level of agreement regarding the effectiveness of decision-making practices.
- ⇒ Pricing (second dimension): The mean score was 4.07 with a standard deviation of 0.910, indicating strong agreement with the second dimension included in the CRM construct.
- ⇒ Communication: The mean score was 3.99 with a standard deviation of 0.996, reflecting a high level of agreement with the communication-related practices.
- ⇒ Distribution: The mean score was 3.89 with a standard deviation of 1.055, suggesting a positive perception of the distribution- or teamwork-related aspects of CRM training.

▲ The dependent variable *On-Time Performance*:

The results showed that the study sample displayed a very high level of agreement with the performance outcomes represented by this construct. The overall mean

score for On-Time Performance was 4.30 with a standard deviation of 0.666, indicating a strong positive general trend.

Examining the dimensions of On-Time Performance revealed the following:

- ⇒ Departure Punctuality: The mean score was 4.18 with a standard deviation of 0.964, indicating a high level of agreement with departure-related punctuality.
- ⇒ Product Features (Turnaround Efficiency): The mean score was 4.36 with a standard deviation of 0.762, suggesting a very high level of agreement with turnaround efficiency practices.
- ⇒ Arrival Punctuality: The mean score was 4.40 with a standard deviation of 0.621, reflecting a very favorable perception of arrival punctuality.
- ⇒ Functionality (Reactionary Delay Management): The mean score was 4.25 with a standard deviation of 0.815, suggesting a very high level of agreement with delay management efficiency.

The descriptive statistics for both the independent and dependent variables, as well as their respective dimensions, indicate a consistently positive and favorable perception among the study sample regarding the effectiveness of CRM training and its contribution to achieving strong On-Time Performance outcomes.

4.3.3. Testing Hypotheses & Findings Discussion

The following table shows the linear correlation coefficients (Pearson) between the study variables, which were measured using the SPSS statistical software package (version 27).

Table 19: Correlation Matrix Between CRM Training Effectiveness and On-Time Performance

Correlations		CRM	OTP
CRM	Pearson Correlation	1	.796**
	Sig. (2-tailed)		.000
	N	278	278
OTP	Pearson Correlation	.796**	1
	Sig. (2-tailed)	.000	
	N	278	278

** . Correlation is significant at the 0.01 level (2-tailed).

Source: The Research.

4.3.3.1. Correlations

The results of the correlation analysis reveal a strong positive and statistically significant relationship between the independent variable, CRM Training Effectiveness, and the dependent variable, On-Time Performance. The Pearson correlation coefficient between CRM and On-Time Performance is 0.796 at the 0.01 significance level, indicating a robust and meaningful association between the two variables.

This strong positive correlation suggests that improvements in CRM Training Effectiveness are associated with substantial enhancements in On-Time Performance across operational activities. The findings highlight the critical role that effective CRM training plays in strengthening coordination, communication, decision-making, and team performance, which collectively contribute to achieving higher levels of punctuality and operational efficiency within Saudia Airlines.

These results reinforce the importance of CRM training as a strategic driver of operational outcomes, confirming that well-structured CRM programs can significantly elevate the airline's ability to maintain consistent and reliable on-time performance.

4.3.3.2. Testing study hypotheses and discussing results

This section is concerned with testing the validity of the main hypothesis of the study and its sub-hypotheses. The statistical results that were reached using both the SPSS V.27 statistical package are presented as follows:

The main hypothesis of the study:

- There is a statistically significant relationship between Crew Resource Management (CRM) Training Effectiveness and On-Time Performance at Saudia Airlines.

⇒ Under this main hypothesis are the following sub-hypotheses:

H1-1: There is a statistically significant relationship between Decision-Making and On-Time Performance at Saudia Airlines.

H1-2: There is a statistically significant relationship between Communication and On-Time Performance at Saudia Airlines.

H1-3: There is a statistically significant relationship between Leadership and Teamwork and On-Time Performance at Saudia Airlines.

H1-4: There is a statistically significant relationship between Situational Awareness and On-Time Performance at Saudia Airlines.

A. Results of testing the main hypothesis of the study:

This hypothesis states that "There is a statistically significant positive relationship between CRM Training Effectiveness and On-Time Performance."

To test this hypothesis, the Simple Linear Regression Analysis method was applied between CRM Training Effectiveness as the independent variable and On-Time Performance (overall) as the dependent variable.

Table 20: Model Summary for the Main Hypothesis

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.796 ^a	.633	.632	.404

a. Predictors: (Constant), CRM

Source: The Research.

Table 21: ANOVA Results for the Main Hypothesis

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	77.721	1	77.721	476.751	.000 ^b
	Residual	44.994	276	.163		
	Total	122.716	277			

a. Dependent Variable: OTP

b. Predictors: (Constant), CRM

Source: The Research.

Table 22: Coefficients of the Regression Model for the Main Hypothesis

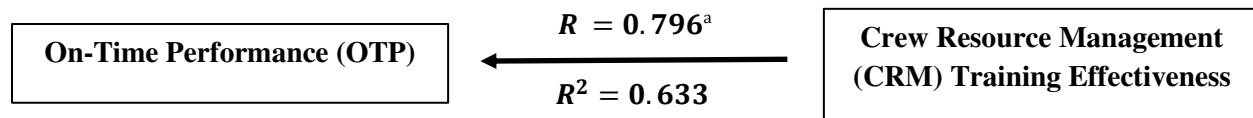
Coefficients ^a							
Model	Unstandardized Coefficients		Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B	
	B	Std. Error				Lower Bound	Upper Bound

1	(Constant)	1.957	.110		17.799	.000	1.740	2.173
	CRM	.590	.027	.796	21.835	.000	.536	.643

a. Dependent Variable: OTP

Source: The Research.

Figure 12: Simple Linear Regression Relationship Between CRM Training Effectiveness and On-Time Performance (OTP)



Source: The Research.

1. From the tables:

- The correlation coefficient (R) is 0.796, indicating a strong positive relationship between the independent variable (*CRM Training Effectiveness*) and the dependent variable (*On-Time Performance*).
- The coefficient of determination (R^2) is 0.633, which means that 63.3% of the variation in On-Time Performance can be explained by the variation in CRM Training Effectiveness.

2. From the ANOVA table:

- The significance value (Sig. = 0.000) is less than the standard significance level of 0.05. This indicates that the overall regression model is statistically significant, meaning that CRM Training Effectiveness has a significant impact on On-Time Performance.
- The F-statistic is 476.751, which is very high, further confirming the statistical significance of the regression model.

3. From the Coefficients table:

- The significance value (Sig. = 0.000) for the CRM variable is less than 0.05, which means that CRM Training Effectiveness is a statistically significant predictor of On-Time Performance.
- The unstandardized regression coefficient ($B = 0.590$) indicates that a one-unit increase in CRM Training Effectiveness is associated with a 0.590-unit increase in On-Time Performance, holding all other factors constant.

- The standardized regression coefficient (Beta = 0.796) suggests that a one-standard-deviation increase in CRM Training Effectiveness is associated with a 0.796-standard-deviation increase in On-Time Performance.
- The constant (B = 1.957) represents the expected value of On-Time Performance when CRM Training Effectiveness is zero.

The key findings from this analysis are:

1. The regression model is statistically significant, meaning that CRM Training Effectiveness has a significant impact on On-Time Performance.
2. There is a strong, positive correlation between CRM Training Effectiveness and On-Time Performance, with 63.3% of the variation in On-Time Performance being explained by CRM practices.
3. For every one-unit increase in CRM Training Effectiveness, On-Time Performance is expected to increase by 0.590 units.
4. A one-standard-deviation increase in CRM Training Effectiveness is associated with a 0.796-standard-deviation increase in On-Time Performance.

Explanation:

The results of the study indicate that CRM Training Effectiveness has a strong positive impact on On-Time Performance within the operational environment of Saudia Airlines. The correlation coefficient between CRM Training Effectiveness and On-Time Performance is 0.796, demonstrating a strong positive relationship between the two variables. Furthermore, the coefficient of determination ($R^2 = 0.633$) shows that 63.3% of the variation in On-Time Performance can be explained by the variation in CRM Training Effectiveness.

The regression analysis also confirms that this relationship is statistically significant, with a p-value of 0.000, which is less than the standard significance level of 0.05. This means that the effect of CRM Training Effectiveness on On-Time Performance is not due to chance and can be reliably generalized to the population under study. The unstandardized coefficient (B = 0.590) further implies that improvements in CRM practices lead to measurable increases in operational punctuality and performance outcomes.

These results align with findings reported in other organizational and operational performance studies, which highlight the essential role of structured training programs—especially CRM—in enhancing coordination, communication, situational awareness, and decision-making. Collectively, these competencies directly support timely operations and reduce performance variability.

B. Results of the study's sub-hypotheses test:

Table 23: Model Summary for the Multiple Regression of CRM Training Dimensions on On-Time Performance

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.803 ^a	.644	.639	.400

a. Predictors: (Constant), Situational_Awareness, Communication, Leadership_Teamwork, Decision_Making

Source: The Research.

Table 24: ANOVA Results for the Multiple Regression Model

ANOVA ^a						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	79.074	4	19.768	123.661	.000 ^b
	Residual	43.642	273	.160		
	Total	122.716	277			

a. Dependent Variable: OTP

b. Predictors: (Constant), Situational_Awareness, Communication, Leadership_Teamwork, Decision_Making

Source: The Research.

Table 25: Coefficients of the Multiple Regression Model

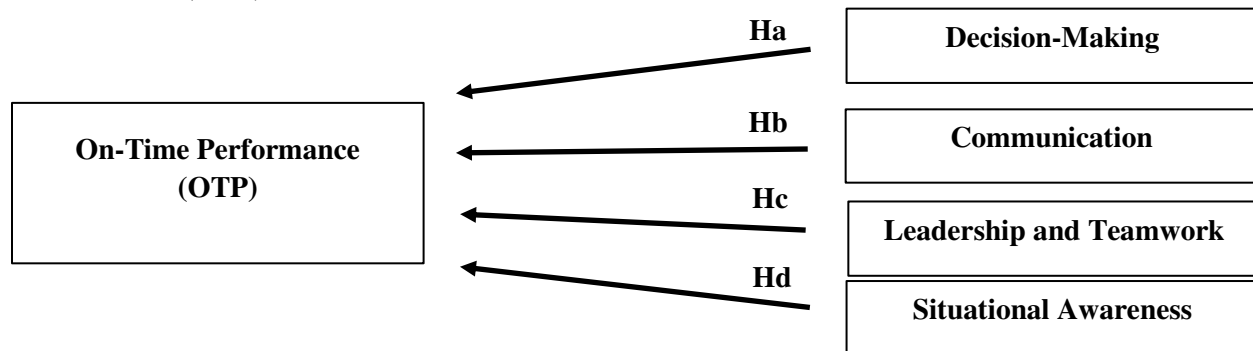
Coefficients ^a								
		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
Model		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	1.925	.114		16.836	.000	1.700	2.150
	Decision_Making	.133	.042	.213	3.172	.002	.051	.216
	Communication	.148	.043	.202	3.449	.001	.064	.232

Leadership Teamwork	.249	.041	.373	6.086	.000	.169	.330
Situational Awareness	.065	.038	.103	1.715	.088	-.010	.139

a. Dependent Variable: OTP

Source: The Research.

Figure 13: Sub-Hypotheses Model for the Effect of CRM Training Dimensions on On-Time Performance (OTP)



Source: The Research.

1. From the Model Summary table:

- The correlation coefficient (R) is 0.803, indicating a strong positive correlation between the independent variables (*Decision-Making, Communication, Leadership & Teamwork, and Situational Awareness*) and the dependent variable (*On-Time Performance*).
- The coefficient of determination (R^2) is 0.644, meaning that 64.4% of the variation in On-Time Performance can be explained by the combined variation in the four dimensions of CRM Training Effectiveness.

2. From the ANOVA table:

- The significance value (Sig. = 0.000) is less than the standard significance level of 0.05. This indicates that the overall regression model is statistically significant, meaning that the combined effect of the four dimensions of CRM Training Effectiveness has a significant impact on On-Time Performance.
- The F-statistic is 123.661, which is very high, further confirming the statistical significance of the regression model.

3. From the Coefficients table:

- The significance value (Sig. = 0.002) for the Decision-Making dimension is less than 0.05, indicating that Decision-Making is a statistically significant predictor of On-Time Performance.
- The significance value (Sig. = 0.001) for the Communication dimension is less than 0.05, indicating that Communication is also a statistically significant predictor of On-Time Performance.
- The significance value (Sig. = 0.000) for the Leadership & Teamwork dimension is less than 0.05, meaning that Leadership & Teamwork is a statistically significant predictor of On-Time Performance.
- The significance value (Sig. = 0.088) for the Situational Awareness dimension is greater than 0.05, indicating that Situational Awareness is not a statistically significant predictor of On-Time Performance.
- The standardized regression coefficients (Beta) show the relative importance of each dimension in predicting On-Time Performance. Leadership & Teamwork has the highest Beta value (0.373), followed by Communication (0.202), Decision-Making (0.213), and Situational Awareness (0.103).
- The unstandardized regression coefficients (B) indicate the change in On-Time Performance associated with a one-unit change in each dimension, holding the other variables constant. Leadership & Teamwork has the highest B value (0.249), followed by Communication (0.148), Decision-Making (0.133), and Situational Awareness (0.065).
- The constant (B = 1.925) represents the expected value of On-Time Performance when all four dimensions of CRM Training Effectiveness are zero.

Key findings from this analysis are:

1. The regression model is statistically significant, indicating that the four dimensions of CRM Training Effectiveness collectively have a significant impact on On-Time Performance.
2. There is a strong, positive correlation between the combined independent variables and On-Time Performance, with 64.4% of the variation in On-Time Performance explained by the variation in CRM dimensions.

3. Three dimensions — Decision-Making, Communication, and Leadership & Teamwork — are statistically significant predictors of On-Time Performance, while Situational Awareness is not.
4. The standardized regression coefficients (Beta) show that Leadership & Teamwork has the strongest influence on On-Time Performance, followed by Decision-Making, Communication, and then Situational Awareness.

Explanation:

The results showed that several dimensions of CRM Training Effectiveness had a statistically significant impact on On-Time Performance. Specifically, the significance values (Sig.) for Decision-Making (0.002), Communication (0.001), and Leadership & Teamwork (0.000) were all less than the standard significance level of 0.05. This indicates that these three dimensions are significant predictors of On-Time Performance, meaning that improvements in decision-making processes, communication effectiveness, and teamwork dynamics contribute positively to enhancing operational punctuality and overall performance outcomes.

In contrast, the significance value (Sig.) for Situational Awareness (0.088) was greater than 0.05, indicating that this dimension is not a statistically significant predictor of On-Time Performance within the context of the study. Although situational awareness is an important CRM competency, its direct measurable impact on punctuality outcomes appears limited when compared to the stronger effects of decision-making, communication, and teamwork.

These findings are consistent with aviation performance research, which emphasizes the critical role of communication flow, collaborative leadership, and rapid, accurate decision-making in minimizing delays and ensuring smooth operational execution. The results support the conclusion that strengthening these CRM dimensions can substantially improve On-Time Performance, making them essential focus areas for airline training and performance enhancement initiatives.

4.4. Conclusion

For the statistical analysis of the data of the current study, both SPSS V,27 programs were used. The researcher conducted a descriptive analysis of the study sample, as well as a descriptive analysis of the study variables. According to the results of the

statistical analysis of this study, the validity and reliability of the scales used to measure the study variables were achieved

5. Ch. 5: Research limitations, Recommendations & Conclusion

5.1. Introduction

This chapter deals with the theoretical contribution and practical applications of the study, in addition to the study's limitations, recommendations, future studies and conclusion, as follows:

5.2. Research Limitations & Future Research

1 Research Limitations

- **Methodological Limitations:** The study adopted a cross-sectional research design to examine the relationship between CRM Training Effectiveness and On-Time Performance. While this approach provides valuable insights at a specific point in time, it does not capture how enhancements in CRM competencies—such as communication, teamwork, and decision-making—may influence performance over longer periods. Future longitudinal studies could better explain how continuous training investments affect operational punctuality.
- **Scope Limitations:** The research was conducted within a single aviation organization, focusing specifically on flight-operation personnel and their CRM-related performance outcomes. Although this approach allowed for a detailed assessment of CRM dimensions, the findings may not be generalizable across all airlines or different aviation environments. Including multiple airlines or broader aviation departments (such as maintenance or ground operations) would strengthen external validity.
- **Data Limitations:** The study relied on self-reported questionnaire data from employees. While self-perceptions are important for assessing CRM competencies, they may introduce bias such as overestimation of skills or socially desirable responses. The absence of objective operational data—such as actual delay logs, crew performance audits, or cockpit voice assessments—limits the ability to triangulate the results.
- **Contextual Limitations:** The study was conducted within a specific operational, regulatory, and cultural context in the aviation sector. Differences in airline size, safety culture, training frequency, or management structure could influence how CRM Training translates into On-Time Performance. Replicating the study across regional, international, or low-cost carriers could determine the broader applicability of the conclusions.

- **Theoretical Limitations:** Although the study examined the influence of four CRM dimensions—Decision-Making, Communication, Leadership & Teamwork, and Situational Awareness—on On-Time Performance, it did not explore possible mediating or moderating variables. Factors such as organizational culture, crew fatigue, workload, or technological infrastructure could influence this relationship. Incorporating these variables in future research could provide a more comprehensive theoretical understanding.

2 Future Research Recommendations

Based on the limitations and findings of the current study, the following recommendations for future research are proposed:

- **Expanding the Scope:** Future studies may broaden the scope of research by examining the impact of CRM Training Effectiveness on On-Time Performance across multiple airlines or aviation organizations rather than focusing on a single operational environment. Including a wider range of carriers—such as regional, low-cost, and international airlines—would enhance the generalizability of the results and provide a more comprehensive understanding of CRM effectiveness in the aviation sector.
- **Longitudinal Approach:** Adopting a longitudinal research design would allow researchers to capture how improvements in CRM competencies (Decision-Making, Communication, Leadership & Teamwork, and Situational Awareness) influence On-Time Performance over time. This approach would offer deeper insights into the long-term effects of repeated CRM training cycles and organizational learning.
- **Incorporating Objective Performance Measures:** To complement self-reported data, future research could include objective operational indicators such as actual delay logs, crew performance audits, flight punctuality reports, and safety or efficiency metrics. This triangulation would strengthen the accuracy and validity of CRM performance assessments.
- **Exploring Contextual Factors:** Investigating contextual variables such as safety culture, organizational structure, regulatory environment, and technological capabilities may provide insight into how these factors shape the relationship between CRM Training and On-Time Performance.

Comparative studies across different regions or regulatory systems (e.g., EASA vs. FAA environments) may reveal unique contextual influences.

- **Examining Moderating and Mediating Variables:** Future research could explore whether variables such as crew fatigue, workload, job satisfaction, cockpit automation level, or stress management serve as mediators or moderators in the relationship between CRM Training and OTP. Including these organizational and human factors would offer a more holistic explanation of operational performance outcomes.
- **Qualitative Insights:** Complementing quantitative data, qualitative methods such as interviews with cockpit crews, flight attendants, or safety managers could provide richer insights into the real-world challenges, decision-making dynamics, and teamwork behaviors that CRM training seeks to improve. These qualitative perspectives could help refine CRM training programs to better suit operational realities.
- **Industry and Operational Comparisons:** Extending the research beyond the aviation sector—for example, to emergency services, maritime operations, or military aviation—could allow for meaningful cross-industry comparisons and highlight the universal versus industry-specific components of effective CRM. Such comparisons may uncover best practices that can be transferred back into the airline industry.

By addressing these future research directions, scholars can build upon the findings of the current study and contribute to a deeper and more integrated understanding of how CRM Training Effectiveness shapes operational performance outcomes, particularly On-Time Performance, within aviation organizations.

5.3. Research Recommendations

Based on the findings and limitations of the study, the following research recommendations are proposed:

1. Enhancing CRM Training Programs

- Future studies should emphasize the importance of improving the structure and delivery of CRM training programs for airline crew members. Recommendations include:

- Developing advanced CRM training modules that focus on Decision-Making, Communication, Leadership & Teamwork, and Situational Awareness.
- Ensuring the continuous updating of CRM content to reflect emerging aviation technologies, operational challenges, and global safety standards.

2. Strengthening Operational Performance Monitoring

- The study highlights the need for airlines to adopt systematic monitoring of On-Time Performance metrics. Recommendations include:
- Implementing real-time data dashboards that track Departure Punctuality, Arrival Punctuality, Turnaround Efficiency, and Reactionary Delay Management.
- Integrating CRM performance indicators with OTP monitoring systems to allow managers to identify patterns and intervene proactively.

3. Promoting Continuous Professional Development for Crew Members

- To further enhance operational efficiency, continuous development of crew competencies is essential. Recommendations include:
- Conducting recurrent CRM workshops and scenario-based simulation training that reinforce behavioral and cognitive skills.
- Encouraging pilots, cabin crew, and dispatch teams to engage in joint training sessions to strengthen teamwork and cross-functional coordination.

4. Supporting Organizational Culture that Values CRM

- The results indicate a strong relationship between CRM effectiveness and performance outcomes, suggesting the need for a supportive culture. Recommendations include:
- Encouraging aviation organizations to foster a safety-oriented and collaboration-driven culture that reinforces CRM practices.
- Recognizing and rewarding crew behaviors that demonstrate strong decision-making, communication, and teamwork during critical operations.

5. Improving Delay Management Strategies

- Given the impact of CRM on On-Time Performance, airlines should enhance delay management procedures. Recommendations include:

- Developing standardized response protocols for operational disruptions to reduce reactionary delays.
- Ensuring that all crew members are trained on coordinated delay recovery strategies aligned with CRM principles.

6. Expanding the Scope of CRM Evaluation

- Future studies could broaden CRM evaluations beyond cockpit and cabin crew. Recommendations include:
- Including ground staff, dispatch units, air traffic controllers, and maintenance teams in CRM assessments to obtain a holistic view of operational collaboration.
- Conducting cross-departmental CRM audits to identify gaps in coordination that may affect OTP.

7. Encouraging Collaboration Between Training Departments and Operational Units

- Strengthening the relationship between training divisions and operational managers could enhance CRM outcomes. Recommendations include:
- Establishing joint committees to periodically review CRM training effectiveness based on real operational performance data.
- Aligning CRM training objectives with organizational performance targets, particularly OTP improvement goals.

8. Conducting Comparative and Cross-Cultural Studies

- To enrich the body of knowledge, future research could explore CRM effectiveness across different aviation contexts. Recommendations include:
- Conducting comparative studies between airlines in different regions to identify cultural and regulatory influences on CRM outcomes.
- Examining CRM implementation differences between low-cost carriers and full-service airlines, and their impact on OTP.

5.4. Conclusion

The current study aimed to investigate the impact of Crew Resource Management (CRM) Training Effectiveness on On-Time Performance within Saudia Airlines. The study was conducted on a sample of operational employees representing pilots,

first officers, cabin crew, dispatch staff, and safety and quality personnel. A descriptive analytical approach was adopted, and statistical analysis techniques were applied using the SPSS program to examine the study's questions and test its hypotheses.

The key findings of the study are as follows:

There is a significant correlation between the study's main variables, namely CRM Training Effectiveness and On-Time Performance. The results revealed a strong positive relationship between the overall CRM practices and the operational punctuality measures represented by departure punctuality, arrival punctuality, turnaround efficiency, and reactionary delay management.

The regression analysis showed that CRM Training Effectiveness is a significant predictor of On-Time Performance, with 63.3% of the variance in performance explained by CRM-related competencies. The study found that three CRM dimensions—Decision-Making, Communication, and Leadership & Teamwork—had statistically significant effects on On-Time Performance, while Situational Awareness did not show a significant direct influence within the current operational context.

The findings indicate that operational teams at Saudia Airlines hold a positive perception of CRM practices, especially regarding teamwork, structured decision-making, and communication effectiveness. The study emphasizes the essential role of CRM in supporting daily operations, minimizing delays, and promoting efficient coordination among crew members.

These results highlight the importance of investing in CRM training as a strategic factor in improving operational performance and achieving higher punctuality standards in the aviation sector. The study underscores the need for aviation organizations to strengthen CRM programs, enhance cross-functional collaboration, and integrate CRM metrics within performance evaluation systems.

The researcher recommends conducting additional studies on CRM effectiveness across different airlines and operational environments, and examining potential mediating or moderating variables such as organizational culture, crew workload, fatigue, and leadership climate. Expanding future studies to include objective

operational data and comparative regional analyses may contribute to a more comprehensive understanding of the factors influencing On-Time Performance and improve the development of CRM training strategies that support safety, coordination, and operational excellence.

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7. Appendix

The Effectiveness of Crew Resource Management (CRM) Training on On-Time Performance: A Case Study of Saudi Arabian Airlines (Saudia), Jeddah, Saudi Arabia “A Case Study”

Dear Participant,

Thank you for taking the time to complete this survey. This questionnaire is part of an academic research project conducted by Ahmed Dakhilallah Al-Thobaiti, from the Faculty of Management – Midocean University, as part of the requirements for Graduation Project 2.

The purpose of this study is to examine the effectiveness of Crew Resource Management (CRM) training and its impact on On-Time Performance (OTP) within Saudi Arabian Airlines (Saudia). The research focuses on key CRM dimensions—decision-making, communication, leadership and teamwork, and situational awareness—and evaluates how these competencies relate to operational performance indicators such as departure punctuality, arrival punctuality, turnaround efficiency, and reactive delay management.

Your participation in this survey is voluntary, and all responses will be treated with strict confidentiality. No personal identifiers will be collected, and the data will be used solely for academic purposes. Completing the questionnaire should take approximately 10–15 minutes.

The information gathered from this study will help provide a deeper understanding of how CRM practices influence punctuality and operational efficiency within the airline industry. The findings may contribute to enhancing training programs and improving performance outcomes in commercial aviation.

Thank you in advance for your valuable participation.

Supervisor:
Abdul Rahim Nader

Researcher:
Ahmed Dakhilallah Al-Thobaiti

Faculty of Management – Midocean University

Year:
2025–2026

Variable	Variable Dimensions	Number Of Statements	Source
Crew Resource Management (CRM) Training Effectiveness	1. Decision-Making 2. Communication 3. Leadership and Teamwork 4. Situational Awareness	1-8	Flin, O'Connor & Crichton (2008) Civil Aviation Authority (2023)
On-Time Performance	1. Departure Punctuality 2. Arrival Punctuality 3. Turnaround Efficiency 4. Reactionary Delay Management	9-16	Hajko & Badánik (2020) Jetzki (2009)

1. Personal Information:

What is your gender?						
Male				Female		
What is your age?						
21–29 years		30–39 years		40–49 years		50–60 years
What is your highest educational qualification?						
Diploma in Aviation / Flight Operations		Bachelor's Degree		Master's Degree	Doctorate	Other
What is your job role?						
Captain	First Officer	Cabin Crew	Flight Dispatcher	OCC Staff	Safety & Quality	Other
How many years of experience do you have at Saudia?						
Less than 2 years	2–5 years	6–10 years	More than 10 years			
Have you attended CRM training at Saudia?						
Yes		No				
When was your most recent CRM training?						
Less than 6 months ago	6–12 months ago	1–2 years ago	More than 2 years ago			
Which operational division do you belong to?						
Flight Operations	Cabin Services	OCC / Dispatch	Safety & Quality	Training Department	Other	

1. The Independent Variable: Crew Resource Management (CRM) Training Effectiveness:

CRM training effectiveness refers to how well an airline's CRM program builds and sustains the non-technical skills that enable safe, efficient, and time-reliable operations. It covers structured learning and assessment of decision-making, communication, leadership and teamwork, and situational awareness, reinforced through recurrent modules, scenario-based simulations (LOFT/LINE), standardized briefings/debriefings, and post-training follow-up (e.g., line checks and observations). Higher effectiveness is reflected in consistently demonstrated behaviors on the line and measurable improvements in operational coordination.

No.	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Decision-Making						
1.	CRM training has improved my ability to make timely and effective operational decisions during routine and unexpected situations.					
2.	CRM training helps me evaluate available options and choose the most appropriate course of action under time pressure.					
2. Communication						
3.	CRM training has enhanced my ability to communicate clearly and accurately with crew members and operational teams.					
4.	CRM training encourages the use of structured communication techniques (such as closed-loop communication) during flight operations.					

3. Leadership and Teamwork						
5.	CRM training has strengthened my ability to work collaboratively with other crew members to achieve operational objectives.					
6.	CRM training helps promote effective leadership behaviors, such as coordinating responsibilities and supporting team members.					
4. Situational Awareness						
7.	CRM training has improved my ability to maintain awareness of operational conditions, threats, and changes during a flight.					
8.	CRM training helps me anticipate potential issues and respond proactively to maintain safe and efficient operations.					

2. The Dependent Variable – On-Time Performance (OTP):

On-Time Performance refers to the punctuality of an airline's operations—typically defined as a flight departing and/or arriving within 15 minutes of its scheduled time. It reflects the effectiveness of end-to-end coordination across flight operations, including departure and arrival punctuality, turnaround efficiency, disruption handling, and reactionary delay control. Higher OTP indicates robust planning, clear communication, and timely execution across crews and ground teams, resulting in fewer propagated delays and more reliable service.

No.	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

1. Departure Punctuality

1.	Operational procedures in my department support timely departure of flights according to the published schedule.					
2.	Crew coordination and communication contribute positively to minimizing delays before departure.					

2. Arrival Punctuality

3.	Efficient in-flight and operational practices help ensure that flights arrive within the scheduled time window.					
4.	The crew's ability to manage unexpected events contributes to maintaining punctual arrival times.					

3. Turnaround Efficiency

5.	Ground and cabin teams work effectively to complete turnaround tasks within the allocated time.					
6.	Communication and coordination during turnaround help reduce unnecessary delays between flights.					

4. Reactionary Delay Management

7.	Operational teams respond effectively to disruptions to prevent delays from affecting subsequent flights.					
8.	Procedures and crew behavior help contain and minimize the impact of reactionary delays on the schedule.					

1. The Independent Variable: Crew Resource Management (CRM) Training Effectiveness:

Descriptive Statistics

	Mean	Std. Deviation	Analysis N	Missing N
CM1	4.11	1.132	278	0
CM2	3.77	1.270	278	0
CC1	4.18	.948	278	0
CC2	3.95	1.109	278	0
CL1	3.80	1.171	278	0
CL2	4.18	.984	278	0
CS1	3.70	1.420	278	0
CS2	4.08	1.149	278	0

Correlation Matrix^a

		CM1	CM2	CC1	CC2	CL1	CL2	CS1	CS2
Correlation	CM1	1.000	.575	.581	.459	.569	.748	.416	.521
	CM2	.575	1.000	.616	.708	.615	.537	.679	.571
	CC1	.581	.616	1.000	.564	.627	.600	.416	.498
	CC2	.459	.708	.564	1.000	.660	.421	.592	.383
	CL1	.569	.615	.627	.660	1.000	.707	.663	.505
	CL2	.748	.537	.600	.421	.707	1.000	.622	.378
	CS1	.416	.679	.416	.592	.663	.622	1.000	.344
	CS2	.521	.571	.498	.383	.505	.378	.344	1.000
Sig. (1-tailed)	CM1		.000	.000	.000	.000	.000	.000	.000
	CM2	.000		.000	.000	.000	.000	.000	.000
	CC1	.000	.000		.000	.000	.000	.000	.000
	CC2	.000	.000	.000		.000	.000	.000	.000
	CL1	.000	.000	.000	.000		.000	.000	.000
	CL2	.000	.000	.000	.000	.000		.000	.000
	CS1	.000	.000	.000	.000	.000	.000		.000
	CS2	.000	.000	.000	.000	.000	.000	.000	

a. Determinant = .004

Communalities

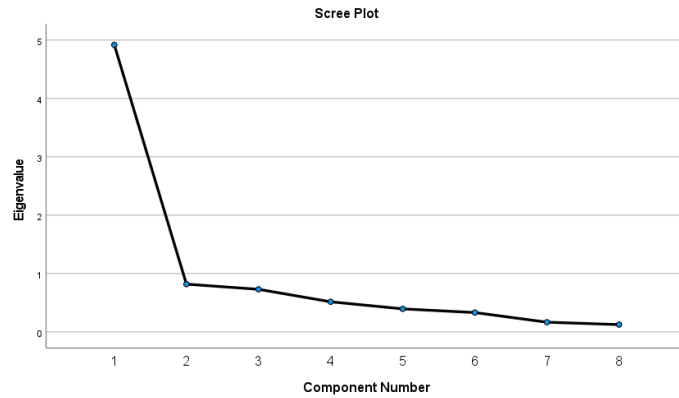
	Initial	Extraction
CM1	1.000	.827
CM2	1.000	.817
CC1	1.000	.870
CC2	1.000	.878
CL1	1.000	.761
CL2	1.000	.939
CS1	1.000	.926
CS2	1.000	.965

Extraction Method: Principal
Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.919	61.483	61.483	4.919	61.483	61.483	2.090	26.124	26.124
2	.818	10.228	71.711	.818	10.228	71.711	1.846	23.078	49.203
3	.730	9.125	80.836	.730	9.125	80.836	1.739	21.743	70.946
4	.516	6.447	87.283	.516	6.447	87.283	1.307	16.337	87.283
5	.395	4.933	92.216						
6	.332	4.144	96.360						
7	.166	2.076	98.436						
8	.125	1.564	100.000						

Extraction Method: Principal Component Analysis.



Component Matrix^a

	Component			
	1	2	3	4
CL1	.859			
CM2	.848			
CL2	.806		-.501	
CC1	.784			-.457
CM1	.777	.430		
CC2	.767	-.404		
CS1	.759	-.454		.329
CS2	.656	.386	.520	.340

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

Component Transformation Matrix

Component	1	2	3	4
1	.565	.518	.518	.380
2	.537	-.687	-.220	.438
3	-.624	-.173	.359	.673
4	-.066	.480	-.745	.459

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

2. The Second Variable: On-Time Performance

Descriptive Statistics

	Mean	Std. Deviation	Analysis N	Missing N
OD1	4.10	1.126	278	0
OD2	4.27	.973	278	0
OA1	4.35	.893	278	0
OA2	4.37	.955	278	0
OT1	4.37	.848	278	0
OT2	4.43	.631	278	0
OR1	4.29	.854	278	0
OR2	4.21	.979	278	0

Correlation Matrix^a

		OD1	OD2	OA1	OA2	OT1	OT2	OR1	OR2
Correlation	OD1	1.000	.687	.525	.462	.407	.472	.577	.676
	OD2	.687	1.000	.550	.446	.246	.430	.322	.466
	OA1	.525	.550	1.000	.359	.601	.286	.321	.559
	OA2	.462	.446	.359	1.000	.276	.407	.336	.479
	OT1	.407	.246	.601	.276	1.000	.399	.346	.547
	OT2	.472	.430	.286	.407	.399	1.000	.567	.628
	OR1	.577	.322	.321	.336	.346	.567	1.000	.580
	OR2	.676	.466	.559	.479	.547	.628	.580	1.000
Sig. (1-tailed)	OD1		.000	.000	.000	.000	.000	.000	.000
	OD2	.000		.000	.000	.000	.000	.000	.000
	OA1	.000	.000		.000	.000	.000	.000	.000
	OA2	.000	.000	.000		.000	.000	.000	.000
	OT1	.000	.000	.000	.000		.000	.000	.000
	OT2	.000	.000	.000	.000	.000		.000	.000
	OR1	.000	.000	.000	.000	.000	.000		.000
	OR2	.000	.000	.000	.000	.000	.000	.000	

a. Determinant = .017

Communalities

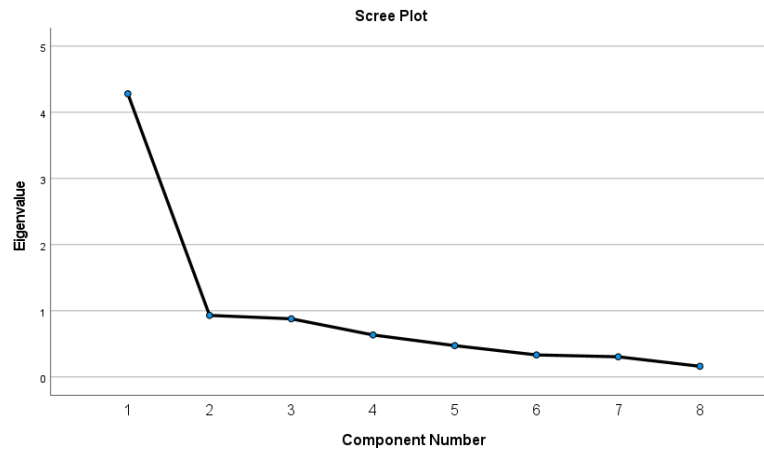
	Initial	Extraction
OD1	1.000	.823
OD2	1.000	.882
OA1	1.000	.855
OA2	1.000	.963
OT1	1.000	.893
OT2	1.000	.744
OR1	1.000	.796
OR2	1.000	.770

Extraction Method: Principal
Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared			Rotation Sums of Squared		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.281	53.509	53.509	4.281	53.509	53.509	2.137	26.706	26.706
2	.931	11.636	65.145	.931	11.636	65.145	1.813	22.668	49.375
3	.879	10.992	76.137	.879	10.992	76.137	1.693	21.164	70.539
4	.635	7.940	84.076	.635	7.940	84.076	1.083	13.537	84.076
5	.474	5.924	90.000						
6	.333	4.166	94.166						
7	.305	3.815	97.980						
8	.162	2.020	100.000						

Extraction Method: Principal Component Analysis.



Component Matrix^a

	Component			
	1	2	3	4
OR2	.857			
OD1	.837			
OT2	.718	-.421		
OA1	.718	.579		
OD2	.715		-.557	
OR1	.696	-.434		
OT1	.646	.446	.505	
OA2	.634		-.342	.653

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

Rotated Component Matrix^a

	Component			
	1	2	3	4
OR1	.856			
OT2	.785			
OR2	.624	.318	.463	
OD2		.886		
OD1	.489	.716		
OT1			.897	

OA1		.538	.742	
OA2				.916

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 6 iterations.

Component Transformation Matrix

Component	1	2	3	4
1	.604	.538	.483	.335
2	-.657	.190	.714	-.149
3	.415	-.679	.487	-.360
4	-.177	-.462	.140	.858

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

3. Descriptive statistics for research variables (answer research questions)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Decision_Making	278	1	5	3.94	1.066	1.136
Communication	278	2	5	4.07	.910	.829
Leadership_Teamwork	278	2	5	3.99	.996	.993
Situational_Awareness	278	2	5	3.89	1.055	1.114
CRM	278	2	5	3.97	.898	.807
Departure_Punctuality	278	2	5	4.18	.964	.930
Arrival_Punctuality	278	2	5	4.36	.762	.580
Turnaround_Efficiency	278	3	5	4.40	.621	.386
Reactionary_Management	278	2	5	4.25	.815	.664
OTP	278	3	5	4.30	.666	.443
Valid N (listwise)	278					

4. Testing Hypotheses & Findings Discussion

		Correlations									
		Decision_Making	Communication	Leadership_Teamwork	Situational_Awareness	CRM	Departure_Punctuality	Arrival_Punctuality	Turnaround_Efficiency	Reactionary_Management	OTP
Decision_Making	Pearson Correlation	1	.757**	.747**	.756**	.917**	.636**	.584**	.515**	.672**	.723**
	Sig. (2-tailed)		.000	.000	.000	.000	.000	.000	.000	.000	.000
	N	278	278	278	278	278	278	278	278	278	278
Communication	Pearson Correlation	.757**	1	.709**	.656**	.867**	.541**	.614**	.548**	.642**	.696**
	Sig. (2-tailed)	.000		.000	.000	.000	.000	.000	.000	.000	.000
	N	278	278	278	278	278	278	278	278	278	278
Leadership_Teamwork	Pearson Correlation	.747**	.709**	1	.732**	.893**	.588**	.702**	.609**	.638**	.751**
	Sig. (2-tailed)	.000	.000		.000	.000	.000	.000	.000	.000	.000
	N	278	278	278	278	278	278	278	278	278	278
Situational_Awareness	Pearson Correlation	.756**	.656**	.732**	1	.887**	.506**	.557**	.564**	.639**	.670**
	Sig. (2-tailed)	.000	.000	.000		.000	.000	.000	.000	.000	.000
	N	278	278	278	278	278	278	278	278	278	278
CRM	Pearson Correlation	.917**	.867**	.893**	.887**	1	.637**	.687**	.626**	.727**	.796**
	Sig. (2-tailed)	.000	.000	.000	.000		.000	.000	.000	.000	.000
	N	278	278	278	278	278	278	278	278	278	278
Departure_Punctuality	Pearson Correlation	.636**	.541**	.588**	.506**	.637**	1	.653**	.497**	.640**	.861**
	Sig. (2-tailed)	.000	.000	.000	.000	.000		.000	.000	.000	.000
	N	278	278	278	278	278	278	278	278	278	278
Arrival_Punctuality	Pearson Correlation	.584**	.614**	.702**	.557**	.687**	.653**	1	.573**	.586**	.836**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000		.000	.000	.000
	N	278	278	278	278	278	278	278	278	278	278
Turnaround_Efficiency	Pearson Correlation	.515**	.548**	.609**	.564**	.626**	.497**	.573**	1	.690**	.788**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		.000	.000
	N	278	278	278	278	278	278	278	278	278	278
Reactionary_Management	Pearson Correlation	.672**	.642**	.638**	.639**	.727**	.640**	.586**	.690**	1	.866**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000		.000
	N	278	278	278	278	278	278	278	278	278	278
OTP	Pearson Correlation	.723**	.696**	.751**	.670**	.796**	.861**	.836**	.788**	.866**	1