



# Project Management Maturity Profiles in Turkish Shipyards: A P3M3® Assessment

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## Abstract

Shipbuilding is a complex project-based production environment in which maturity scores averaged across shipyards can obscure important organizational differences. This study assesses project management maturity in 32 Turkish shipyards using the Portfolio, Programme and Project Management Maturity Model (P3M3®) version 2.1 Self-Assessment Tool and examines whether an aggregate result conceals distinct maturity configurations. One manager from each participating shipyard completed a Turkish questionnaire distributed through the Turkish Shipbuilders' Association (GİSBİR). The analysis covered 24 assessment items across project, programme and portfolio lenses and eight study dimensions, comprising the seven official process perspectives and an additional process/general dimension. Composite scores were descriptive arithmetic means used in this study, not official combinations of P3M3 maturity ratings. Besides descriptive statistics, internal consistency analysis, Friedman tests, and Spearman correlations, an exploratory hierarchical cluster analysis was performed using the Euclidean distance measure and Ward's method. The sample mean composite score was 3.06 on the five-point scale, with a standard deviation of 0.93. Three profiles emerged: lower maturity with 15 shipyards and a mean of approximately 2.24; intermediate maturity with 8 shipyards and a mean of 3.35; and higher maturity with 9 shipyards and a mean of 4.18. Financial Management had the highest descriptive score, and Management Control had the lowest, although differences among dimensions were not statistically significant. The three lens scores were strongly correlated, and no statistically significant difference among them was detected. These findings suggest that capability development among participating shipyards may benefit from differentiated, rather than uniform, improvement priorities. Given the single-respondent, voluntary-participation design, the profiles should be read as an exploratory picture rather than a validated sector-wide typology. The study offers an empirical application of P3M3 in shipbuilding and illustrates the value of examining maturity profiles alongside aggregate scores for capability-development planning.

**Keywords:** Project management maturity, shipbuilding, P3M3®, organizational capability, cluster analysis

## 1. Introduction

Shipbuilding is a capital-intensive, technically complex, and highly customized form of production in which a vessel is delivered through an integrated sequence of engineering, procurement, construction, commissioning, and regulatory

activities [1,2]. Unlike repetitive mass production, shipbuilding requires simultaneous coordination among naval architects, marine engineers, equipment suppliers, subcontractors, classification societies, shipowners, and regulatory bodies. This makes the shipyard a clear example of a project-based

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production organization in which performance depends not only on technical efficiency but also on the capability to plan, govern, and control interdependent projects [3-5].

The managerial challenge is becoming more demanding as shipyards respond simultaneously to digitalization, safety, energy efficiency, and decarbonization requirements while controlling cost, schedule, quality, supply chain reliability, and design changes [6-11]. Shipbuilding studies continue to document capacity constraints, rework, coordination problems, late changes, and supply-chain uncertainty as material sources of project disruption [2,12,13]. These conditions make organizational project management capability relevant to shipyard competitiveness, but that capability is not directly visible in conventional production indicators.

Türkiye provides a useful setting for examining this issue. Turkish shipyards undertake newbuilding, repair, conversion, and maintenance projects across specialized vessel segments and operate within a clustered industrial structure comprising design offices, suppliers, and subcontractors. Current official statistics report 85 operating shipyards with total capacity exceeding 4.79 million deadweight tonnes (DWT) [14]. This industrial expansion has increased the need for coordinated management of multiple projects, resources, and stakeholders within the same organizations. Shipbuilding capacity itself has received increasing analytical attention at the industry level, including system dynamics and optimization approaches for demand forecasting and capacity adjustment planning [15]; however, such studies address production capacity rather than the organizational management capability considered here (Figure 1).

Project management maturity models (PMMMs) offer a structured way to assess whether such organizational practices are ad hoc, repeatable, defined, measured, and continuously improved. Their appeal lies in converting a broad organizational capability into an interpretable assessment that supports benchmarking and improvement planning [16,17]. At the same time, recent maturity research has become more critical of one-size-fits-all interpretations. Al-Marri et al. [18] argue that maturity pathways in project-based organizations are context-dependent and require adaptive, context-sensitive assessment, while Bozorg Mehri et al. [19] identify rigid structures and limited adaptability as ongoing weaknesses of organizational PMMMs.

This creates a more specific research problem than the simple absence of a particular maturity tool in shipbuilding. An average maturity score across assessed shipyards may be useful as a descriptive benchmark, but aggregating across organizations can obscure multidimensional differences within the same industrial environment. Two shipyards may therefore produce a similar composite score while differing materially in governance, management control, financial discipline, stakeholder engagement, or resource management; conversely, an aggregate mean may sit near the middle of a maturity scale even when individual shipyards occupy very different positions. For a heterogeneous, project-based industry, the question is not only about the average maturity among the assessed shipyards but also whether that average adequately represents the organizations being assessed.

Shipbuilding is well-suited to examining this issue because yards share many external regulatory and market conditions while differing in project mix, production organization, and internal management capability. Existing

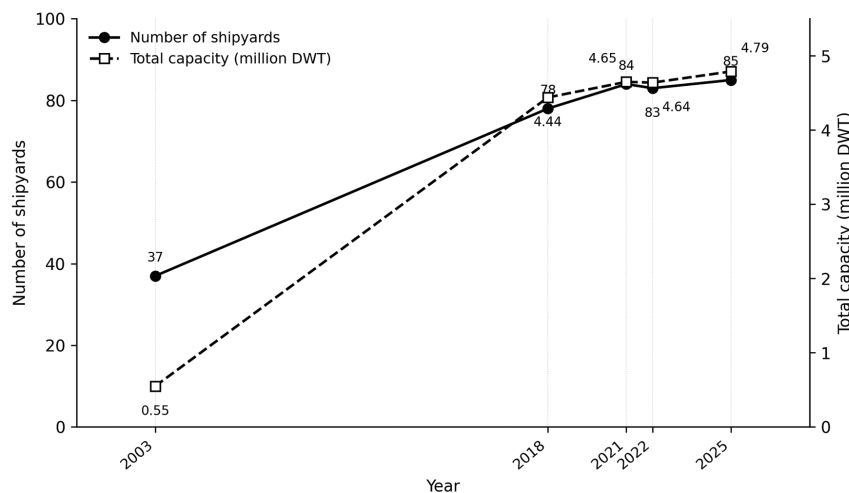


**Figure 1.** Development of the number and capacities of shipyards in Türkiye. Data source: UAB [14].

UAB: Ulaştırma ve Altyapı Bakanlığı-*Ministry of Transport and Infrastructure*

research on shipbuilding maturity has largely concentrated on technological or operational readiness, including smart-shipyards maturity. In contrast, research on project management has focused more often on individual tools and production problems than on organization-wide maturity configurations [20,21]. The present study therefore uses the official Portfolio, Programme, and Project Management Maturity Model (P3M3®) version 2.1 Self-Assessment Tool not merely to report an average maturity score, but to examine the pattern and heterogeneity underlying that score. The study addresses three research questions: RQ1: What maturity patterns are observed across assessment dimensions and P3M3 organizational lenses among the participating Turkish shipyards? RQ2: To what extent does the sample mean composite score conceal distinct organizational maturity profiles among the participating shipyards? RQ3: To what extent are project, programme and portfolio maturity assessments differentiated or closely associated within the same shipyards?

The study contributes in two ways. Empirically, it provides a P3M3®-based maturity assessment of 32 Turkish shipyards. Analytically, it shifts attention from a single-sample mean composite score toward within-sector maturity profiles and the relationships among P3M3 organizational lenses. The study features the first application of the official P3M3® version 2.1 Self-Assessment Tool to shipbuilding. Still, the principal contribution is the demonstration that an aggregate score can conceal materially different organizational configurations with different capability-development needs.

## 2. Literature Background

### 2.1. Shipbuilding and Project Management

Project management (PM) is defined as a management style that involves planning and controlling time, cost, performance, scope, budget, and schedule to ensure the successful completion of a project [22,23]. Although shipbuilding is fundamentally project-based, very few studies have examined PM practices in shipyards. One such study is that of Doğan and Helvacıoğlu [20], who examined the extent to which Project Management Institute (PMI) standards can be applied to shipbuilding activities; their study provides an important point of departure for the present study. Their findings established that, at the time, Turkish shipyards were not strictly following the standards, although the interviewees were aware of the benefits that could be derived from their application.

Ship construction and retrofitting processes consist of multiple interdependent phases, each involving uncertainties, design changes, coordination requirements, and operational constraints. Therefore, aligning project

changes with existing plans and schedules has been a central issue in PM-related shipbuilding studies. Fowler [24], for example, proposed a model addressing the practical aspects of configuration management in a UK shipyard from the perspective of shipyard managers. Lee et al. [25] presented the Daewoo Shipbuilding Scheduling project, developed jointly by Daewoo Shipbuilding and the Korea Advanced Institute of Science and Technology, to overcome planning and scheduling difficulties in the production process. More recently, Cho et al. [26] developed a production planning system for shipbuilding using a component-based development framework, and Li et al. [27] proposed a governance platform for coordinating multiple concurrent projects within a shipyard. A similar approach was proposed by Braglia and Frosolini [28] through an integrated model to enhance the applicability of Project Management Information Systems (PMIS), which was successfully implemented in the shipbuilding industry. More recent works have focused on scheduling and computational efficiency. For instance, Akan and Bayar [29] developed a model that integrates Interval Type-2 Fuzzy Sets with Program Evaluation and Review Technique methods and tested it on a PM example in shipbuilding.

The shipyard scheduling problem was addressed much more efficiently by the three-layer parallel computation model proposed by Han et al. [30], which uses GPU computation and genetic algorithms. Other studies have addressed PM-related issues such as bottleneck management, resource estimation, and work structuring in shipyards. Çelebi and Bilgili [31] applied the Theory of Constraints approach to shipyard PM and reported improvements in both operational efficiency and environmental performance. Wan Abd Rahman et al. [32] proposed a Work Breakdown Structure and a person-hour development method, highlighting person-hour estimation as a key element of PM in shipyard operations. In other words, these studies indicate that effective PM in shipbuilding is directly related to the accuracy of planning, scheduling, control, resource allocation, and process coordination.

A further stream of literature focuses on the challenges of engineer-to-order (ETO) production, which is relevant to shipbuilding given the customized, project-specific nature of ship construction. These studies generally aim to reduce delays in orders and deliveries by improving coordination among project actors and supply-chain partners. In this regard, Haji-Kazemi et al. [33] argued that implementing an Early Warning Signs procedure could help prevent product-delivery delays in shipbuilding projects. Mello et al. [34] proposed a soft systems approach to address coordination problems in ETO supply chains in the shipbuilding industry. Alfnes et al. [12] identified the sources of uncertainty affecting first-tier suppliers in shipbuilding and examined

how these uncertainties negatively influence the delivery of products manufactured under the ETO approach.

Beyond these operational and scheduling-focused studies, a growing body of recent research has examined how Industry 4.0 technologies can support shipbuilding processes. Hadžić [35] developed an analytical solution for production-line steady-state performance and applied it directly to the shipbuilding process, illustrating the potential of mathematical modeling for production planning in shipyards. Kunkera et al. [36] explored the use of Digital Twin technology in a shipbuilding project to support technical decision-making across the product life cycle, while Kunkera et al. [37] proposed a Lean tools implementation model tailored to the predominantly custom, make-to-order nature of shipbuilding production. Although these studies demonstrate the growing relevance of digital and Lean approaches to shipyard operations, they remain focused on specific technical or operational tools rather than on the systematic, organization-wide assessment of PM capability, which is the focus of the present study. This impression is reinforced by a recent systematic review of 57 studies on lean implementation across the shipbuilding value chain: it maps tools, adoption drivers, and barriers in detail but remains centered on production-level practices rather than the broader set of organizational PM dimensions—governance, financial management, stakeholder engagement, and the like—that P3M3 assesses [38].

Overall, PM-related research in shipbuilding has focused mainly on specific operational and technological problems, including scheduling, configuration management, person-hour estimation, bottleneck management, ETO supply chain coordination, and, more recently, digital and Lean production tools. These studies explain important parts of shipyard performance, but they do not establish whether organizational PM capability is homogeneous across shipyards or whether sector-level summaries mask distinct maturity configurations. That distinction is central to the present study.

## 2.2. Project Management Maturity Models

Hutson [23] states that PM applies to any organization, with core objectives including scope, quality, schedule, and cost. However, meeting these objectives has become increasingly challenging for organizations operating in project-based environments. Given the substantial consequences of poor decisions in such contexts, companies are required to adopt more systematic approaches to structuring, managing, and evaluating their project-related processes [39]. In this regard, PM Maturity (PMM) provides a framework for assessing PM practices and improving them by standardizing processes, embedding

lessons learned as a system of practice, and adapting best practices for continuous improvement [40]. For any organization that wants to develop its PM processes and achieve higher levels of maturity, it is essential first to understand its current maturity level and determine the direction for improvement, which is especially important to ensure the efficient use of limited organizational resources [41]. PMMMs have been developed for this purpose. They present organized assessment structures for PMM appraisal that can be implemented at various organizational levels, such as the entire organization, a business unit, or a project team, and can support organizational improvement planning [42]. PMMMs are historically rooted in the tradition of quality management, specifically Total Quality Management (TQM). The Software Engineering Institute's Capability Maturity Model (CMM) has also influenced many PMMMs, in addition to TQM. CMM formalized a staged approach to assessing and improving organizational process capabilities, particularly in the context of software development; the assessment logic at different maturity levels has since been adopted in many sectors to create PMMMs. A central distinction in this literature is between immature and mature organizations: immature organizations are reactive and often ad hoc, whereas mature organizations have well-defined processes, clear responsibilities, and continuous quality monitoring, with analytical decision-making and an organized approach to using historical data for future improvement [43].

Over time, a wide range of PMMMs has been developed. The traditional PMMMs date back to the late 1990s and early 2000s in the PM literature [44-46]. Other specific, industry-oriented models include the National Project Management Maturity Model [47], the Intelligent Project Management Maturity Model (IP3M) for the engineering sector in Morocco [39], and the Construction Project Management Maturity Model (CPM3) [48].

This variety demonstrates that PMMMs are not single, uniform frameworks: they vary in scope, structure, assessment logic, and intended area of application [41,46,49-52]. These differences often remain concealed, as most models seem similar due to their staged maturity levels. Yet, they can be very distinct in their assumptions, primary assessment aims, assessment criteria, and the PM domains considered [53-58]. According to Neverauskas and Railaitė [40], PMMMs differ in scope, structure, and the area of organizational PM analysis but commonly serve the general purpose of improving PM processes and increasing PM maturity. Because a detailed explanation of each model is beyond the scope of this paper, a historical comparison of selected maturity models and related frameworks is summarized in Table 1.

**Table 1.** Historical comparison of selected maturity models and related frameworks.

| Model/framework                                                       | Acronym | Structure                    | Theoretical base | CMM ideology | KPA/KPI      |
|-----------------------------------------------------------------------|---------|------------------------------|------------------|--------------|--------------|
| Organizational Project Management Maturity Model                      | OPM3    | Multi-dimensional            | Yes              | No           | Not definite |
| Maturity by Project Category Model                                    | MPCM    | Staged                       | No               | Yes          | 5            |
| Portfolio, Programme, and Project Management Maturity Model           | P3M3    | Staged and multi-dimensional | No               | Yes          | 42           |
| Projects in Controlled Environments                                   | PRINCE2 | Staged                       | No               | Yes          | 32           |
| Project Management Maturity Model for Business Management Consultants | BMC     | Staged                       | No               | Yes          | 10           |
| Software Capability Maturity Model                                    | CMM     | Staged                       | No               | Yes          | 11           |
| PM Solutions Project Management Maturity Model                        | PMMM    | Staged                       | No               | Yes          | 9            |
| Project Management Maturity Model                                     | ProMMM  | Staged                       | No               | Yes          | 4            |

Source: Adapted from [58, Table 1]. Structure indicates staged progression, a multidimensional design, or both. The theoretical base and CMM ideology reproduce the source's classifications; KPA/KPI denotes the counts of key process or performance areas reported there. These historical counts are not questionnaire item counts. PRINCE2 is included as a related PM method, not as a maturity model in its own right.

Despite their value, PMMMs are not neutral or universally transferable measurement devices. Their practical usefulness depends on the fit between the model, the organization, and the purpose of assessment. Earlier critiques noted that maturity models can be mechanistic, information-intensive, and sensitive to the framework selected [55-58]. Recent systematic reviews reinforce this concern. Al-Marri et al. [18] conclude that project-based organizations require adaptive and context-sensitive maturity assessments, while Bozorg Mehri et al. [19] identify rigid structures, limited adaptability, and insufficient attention to emerging organizational conditions as persistent limitations. These critiques make it important to examine not only the position of organizations on a staged scale but also the configuration and dispersion of capability beneath an aggregate score.

In the relevant literature, PMMMs have been applied to different industries. Bay and Skitmore [59], for example, assessed the Indonesian construction industry and found that more than 85 percent of respondents considered implementing PM methods to be important or critical. Backlund et al. [60], focusing on the Swedish construction industry, argued that insufficient attention to a common way of working and excessive reliance on individual project leaders may hinder organizational development. Guangshe et al. [61] conducted a single-project OPM3 assessment survey of large construction projects in China. The researchers concluded that applying the model to PM in China requires adjustments to guidance culture, model training, and PM planning. In the public sector specifically, Young et al. [62] examined project, programme and portfolio maturity in the Australian federal government, and Mishra et al. [63] analyzed the relationship between process maturity, risk,

and project performance across US federal government technology projects.

In shipbuilding, maturity studies are more limited and have generally focused on technological or operational development rather than traditional PM maturity. Woo et al. [21], for example, developed a smart-shipyards maturity framework based on connectivity, automation, and intelligence and applied it to eight South Korean shipyards. That work demonstrates the value of maturity thinking in shipyard assessment but addresses smart-production capability rather than organization-wide PM. To the best of the authors' knowledge, the official P3M3® Self-Assessment Tool has not previously been applied to the shipbuilding industry. More importantly for the present study, the shipbuilding literature has not examined whether a single aggregate PM maturity score conceals distinct organizational maturity profiles among shipyards operating in the same national context.

### 2.3. P3M3 and Shipyard Capability Assessment

Several considerations support the selection of P3M3 for the present study. First, P3M3 combines a staged maturity structure with a multidimensional perspective encompassing portfolio, programme and project management. This structure is particularly relevant to shipyards, where PM activities extend from individual vessel contracts to the simultaneous coordination of multiple projects and the wider organizational portfolio.

Second, P3M3 assesses maturity across seven process perspectives: organizational governance, management control, benefits management, risk management, stakeholder engagement, financial management, and

resource management. This broad coverage is particularly relevant to shipbuilding, where projects involve contractual commitments, financial exposure, resource allocation, subcontractor coordination, stakeholder interaction, and regulatory compliance alongside technical production activities. The model, therefore, provides an organizational perspective that extends beyond the assessment of individual PM tools or isolated operational processes.

The official P3M3® version 2.1 Self-Assessment Tool provides a structured instrument for organizational self-assessment across project, programme and portfolio lenses [64]. P3M3 does not define a single combined maturity rating across all three lenses; the lenses are intended to be considered separately. This feature is important in the present study because it discourages treating a single composite number as a complete representation of organizational capability. Accordingly, the analysis reports lens- and dimension-level results directly and uses aggregate classifications and cluster profiles only as supplementary descriptive and exploratory devices. The profile analysis is intended to preserve organizational heterogeneity that may be obscured by averages across the organizations assessed.

### 3. Materials and Methods

#### 3.1. P3M3 Instrument and Assessment Structure

The study employed the official P3M3® version 2.1 Self-Assessment Tool [64]. P3M3 assesses organizational

PMM through three organizational lenses: Portfolio Management (PfM3), Programme Management (PgM3), and Project Management (PjM3). Each lens is assessed through seven process perspectives: organizational governance, management control, benefits management, risk management, stakeholder engagement, financial management, and resource management. The model uses a five-level maturity scale, from Level 1 (awareness of the process) to Level 5 (optimized process), as illustrated in Figure 2.

The instrument used in the study comprised 24 assessment items (Q13-Q36), covering eight assessment dimensions across the three P3M3 organizational lenses: seven dimensions corresponding to the official P3M3 process perspectives (management control, benefits management, financial management, risk management, stakeholder engagement, organizational governance, and resource management), together with an eighth, Process/General, dimension derived from the lens-specific Maturity Level descriptions set out in Table 1 of the official P3M3 guide [64]. A separate single item (Q12) captured respondents' global self-assessment of maturity, based on the same generic maturity level descriptions, and was not included in the 24-item scale used for dimension- and lens-based analyses. Items Q1-Q11 collected demographic and professional background information. For this study, a shipyard's composite score is defined as the arithmetic mean of its 24 item scores;

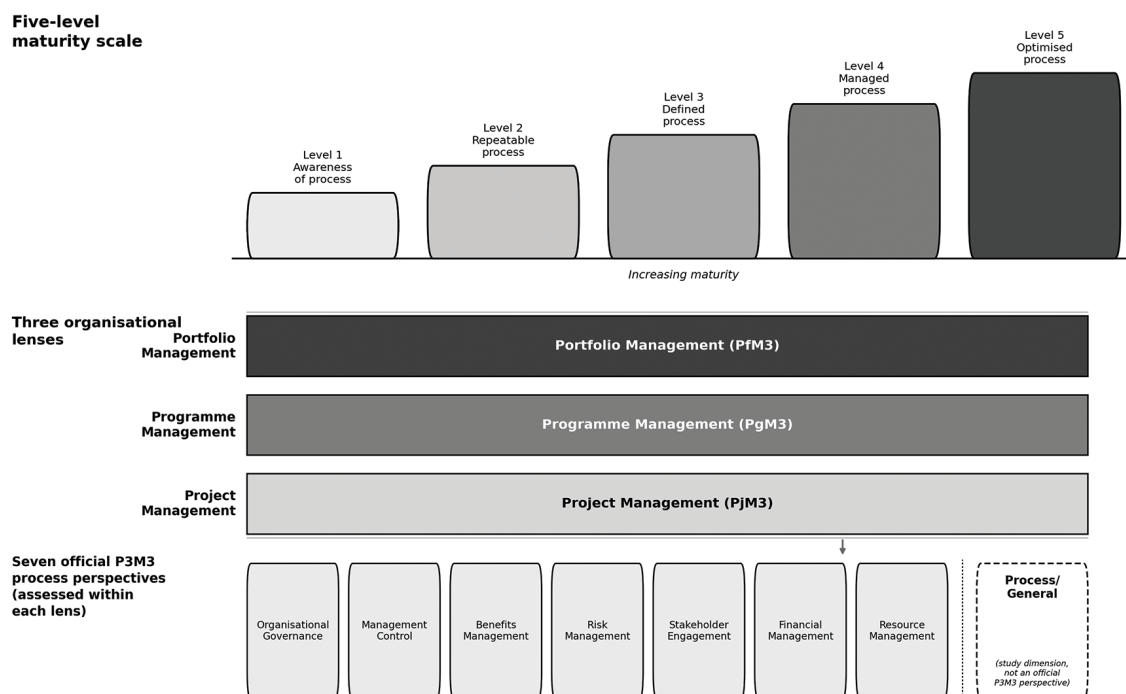


**Figure 2.** P3M3 assessment structure used in the study. Authors' illustration based on Sowden et al. [64].

the sample mean composite score is the average of those shipyard scores. These are descriptive summaries, not official combined P3M3 maturity ratings.

### 3.2. Instrument Translation

Members of the research team translated the official P3M3® version 2.1 Self-Assessment Tool into Turkish, with additional support from an external contributor. The translated items were subsequently cross-checked with machine-assisted translation tools to identify potential wording inconsistencies. A formal back-translation procedure, pilot test, or independent expert-panel review was not conducted; this is acknowledged as a limitation of the study. High Cronbach's alpha values indicate internal consistency within this sample but do not establish translation equivalence or construct validity and cannot substitute for formal validation of the translated questionnaire.

### 3.3. Data Collection and Research Ethics

The translated questionnaire, designed to take no more than 25 minutes to complete, was administered through a dedicated web-based platform developed for the study using PHP. We contacted the Turkish Shipbuilders' Association (GİSBİR), and after receiving approval from its board of directors, they distributed the survey link to their members via email. All items on the web-based questionnaire required a response before submission, so no missing data were recorded.

Thirty-two respondents from GİSBİR member shipyards completed the questionnaire, representing an estimated 47% response rate among the association's 68 members at the time of the study. Participation was voluntary and was prompted by GİSBİR's email invitation, with one complete questionnaire per participating shipyard. Their reported positions were grouped for descriptive reporting as executive/general management (n=12), project/programme management (n=11), or functional/technical management (n=9) roles

(Table 2). The assessment required an organization-level view of PM practices across the three P3M3 lenses, and the responses reflect these managers' assessments of their shipyards.

GİSBİR granted institutional permission to conduct the study, and its board then distributed the survey invitation to its members. Participation was voluntary. Before completing the questionnaire, each participant was individually contacted by telephone and informed about the purpose of the study, the voluntary nature of participation, and the confidentiality of the information provided; verbal informed consent was obtained from all participants who agreed to take part, and only those participants completed the questionnaire.

### 3.4. Analytical procedure

Data was analyzed using Jamovi version 2.7 [65] running on R version 4.5 [66]. The internal consistency of the translated instrument was assessed using Cronbach's alpha with the psych package [67]. Descriptive statistics (means, medians, and standard deviations) were computed for each item, assessment dimension, and organizational lens. Given the ordinal nature of the P3M3 maturity scale, non-parametric Friedman tests were used to examine differences across dimensions and lenses; Kendall's W was reported as an effect-size measure. Spearman's rank correlation was used to examine associations between selected respondent characteristics and maturity scores. Exploratory hierarchical cluster analysis using Euclidean distance and Ward's linkage method was performed with the snowCluster module [68] to identify maturity profiles among participating shipyards. The three-cluster solution was selected by visual inspection of the dendrogram (Figure 3) and the interpretability of the corresponding eight-dimensional profiles. The illustrated cut retains three branches with consistently lower, intermediate, and higher dimension scores (Table 6; Figure 4), providing an interpretable summary of the differences among the

**Table 2.** Demographic and professional characteristics of respondents (n=32).

| Characteristic                                                                                                                | Summary                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| Respondents                                                                                                                   | 32                                                                                                              |
| Location                                                                                                                      | İstanbul (including Tuzla), Yalova, Kocaeli, Muğla, Antalya                                                     |
| Age (years)                                                                                                                   | Mean 42.9, SD 9.5, range 25-68                                                                                  |
| Professional experience (years)                                                                                               | Mean 19.3, SD 9.8, range 2-46                                                                                   |
| Organizational tenure (years)                                                                                                 | Mean 5.1, SD 5.6, range 1-25                                                                                    |
| Position                                                                                                                      | Executive/general management (n=12); project/programme management (n=11); functional/technical management (n=9) |
| Education level                                                                                                               | Bachelor's degree (n=26); master's degree (n=6)                                                                 |
| Education field                                                                                                               | Naval architecture and marine engineering (n=26); other engineering or business fields (n=6)                    |
| Note: The authors grouped position categories for descriptive reporting. İstanbul figures include respondents based in Tuzla. |                                                                                                                 |

participating shipyards. The solution is treated as exploratory; this analysis has not established its optimality and stability.

## 4. Results

### 4.1. Respondent Characteristics

Table 2 summarizes the demographic and professional characteristics of the 32 respondents.

### 4.2. Instrument Reliability

The overall 24-item maturity scale demonstrated excellent internal consistency (Cronbach's  $\alpha=0.973$ ). The eight dimension-based subscales ranged from 0.775 (Risk Management) to 0.922 (Organizational Governance). The three lens-based subscales were 0.941 (Portfolio), 0.928 (Programme), and 0.912 (Project). All coefficients exceeded the 0.70 threshold, and most exceeded 0.80 (Table 3).

The correlations among the three lenses were also strong: Portfolio with Programme,  $\rho=0.94$ ; Programme with Project,  $\rho=0.91$ ; Portfolio with Project,  $\rho=0.84$  (all  $p<0.001$ ).

### 4.3. Assessment Dimensions and Descriptive Composite Scores

The eight assessment dimensions are summarized in Table 4, ordered from Financial Management ( $M=3.25$ ) to Management Control ( $M=2.95$ ). The eight means spanned a range of 0.30 points. A Friedman test found no statistically significant difference among the eight dimensions [ $\chi^2(7)=7.46$ ,  $p=0.383$ ; Kendall's  $W=0.03$ ]; the ordering above should therefore be read as descriptive only.

Standard deviations ranged from 0.92 (Financial Management) to 1.18 (Organizational Governance), and

**Table 3.** Reliability coefficients of the scale and subscales (Cronbach's  $\alpha$ ).

| Scale/subscale            | Items | Cronbach's $\alpha$ | Interpretation |
|---------------------------|-------|---------------------|----------------|
| Overall scale (Q13-Q36)   | 24    | 0.973               | Excellent      |
| Management Control        | 3     | 0.861               | Good           |
| Benefits Management       | 3     | 0.824               | Good           |
| Financial Management      | 3     | 0.789               | Acceptable     |
| Risk Management           | 3     | 0.775               | Acceptable     |
| Stakeholder Engagement    | 3     | 0.918               | Excellent      |
| Organizational Governance | 3     | 0.922               | Excellent      |
| Resource Management       | 3     | 0.919               | Excellent      |
| Process/General           | 3     | 0.877               | Good           |
| Portfolio lens            | 8     | 0.941               | Excellent      |
| Programme lens            | 8     | 0.928               | Excellent      |
| Project lens              | 8     | 0.912               | Excellent      |

The correlations among the three lenses were also strong: Portfolio with Programme,  $\rho=0.94$ ; Programme with Project,  $\rho=0.91$ ; Portfolio with Project,  $\rho=0.84$  (all  $p<0.001$ ).

**Table 4.** Maturity statistics by assessment dimension (n=32).

| Dimension                 | Mean | Median | SD   | Min-Max   | $\alpha$ |
|---------------------------|------|--------|------|-----------|----------|
| Financial Management      | 3.25 | 3.33   | 0.92 | 1.00-5.00 | 0.789    |
| Organizational Governance | 3.18 | 3.00   | 1.18 | 1.00-5.00 | 0.922    |
| Resource Management       | 3.11 | 3.00   | 1.06 | 1.00-5.00 | 0.919    |
| Process/General           | 3.04 | 3.00   | 0.97 | 1.67-5.00 | 0.877    |
| Benefits Management       | 2.99 | 3.17   | 1.02 | 1.00-5.00 | 0.824    |
| Risk Management           | 2.99 | 3.17   | 1.01 | 1.00-5.00 | 0.775    |
| Stakeholder Engagement    | 2.99 | 3.00   | 1.05 | 1.00-5.00 | 0.918    |
| Management Control        | 2.95 | 2.83   | 1.16 | 1.00-5.00 | 0.861    |

Standard deviations ranged from 0.92 (Financial Management) to 1.18 (Organizational Governance), and seven of the eight dimensions spanned the full 1.00-5.00 scale; only Process/General had a floor above 1.00 (1.67). Four dimensions had a median of exactly 3.0. In Financial Management, Benefits Management, Risk Management, and Stakeholder Engagement, the median exceeded the mean; in Organizational Governance, Resource Management, Process/General, and Management Control, the mean exceeded the median. Across the 32 participating shipyards, the sample mean composite score was 3.06 (SD=0.93 across shipyards).

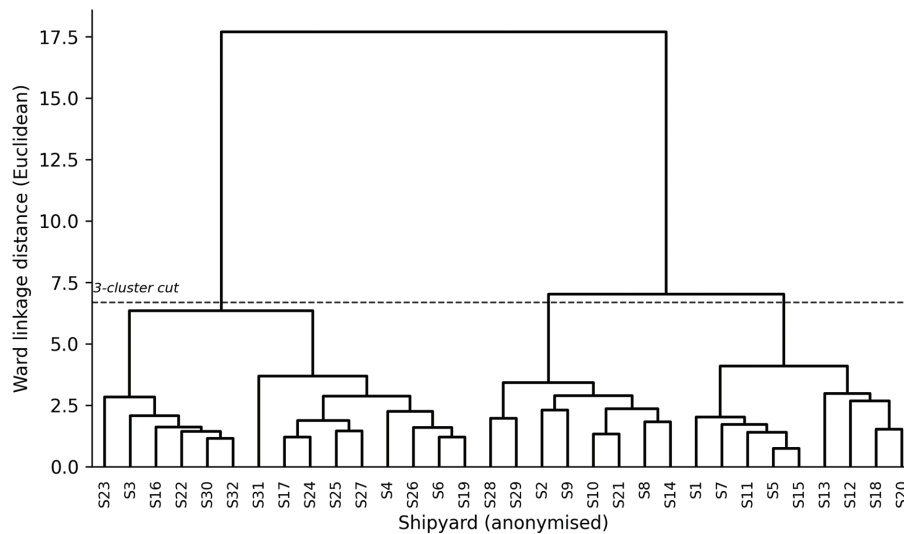


**Figure 3.** Hierarchical clustering dendrogram of participating shipyards (Ward's method, Euclidean distance). Shipyard labels are anonymized (S1-S32) to preserve respondent confidentiality.

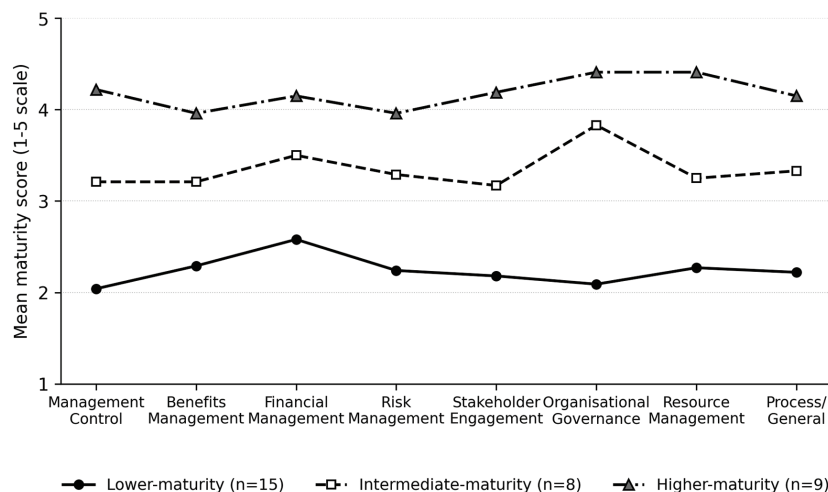


**Figure 4.** Maturity profiles of the three clusters across the eight assessment dimensions.

seven of the eight dimensions spanned the full 1.00-5.00 scale; only Process/General had a floor above 1.00 (1.67). Four dimensions had a median of exactly 3.0. In Financial Management, Benefits Management, Risk Management, and Stakeholder Engagement, the median exceeded the mean; in Organizational Governance, Resource Management, Process/General, and Management Control, the mean exceeded the median. Across the 32 participating shipyards, the sample mean composite score was 3.06 (SD=0.93 across shipyards).

Two supplementary classifications were used to summarize each shipyard's assessment scores for descriptive comparison. A conservative classification set each shipyard's descriptive level equal to the lowest

of its eight assessment dimension scores, rounded to the nearest integer level; a mean-based classification instead used each shipyard's average dimension score, likewise rounded to the nearest integer level. Neither classification is not part of the official P3M3 methodology, which does not define a single combined maturity rating across the three organizational lenses; both are reported here only as descriptive comparisons. Under the conservative classification, the distribution was Level 1, n=6 (19%); Level 2, n=13 (41%); Level 3, n=10 (31%); Level 4, n=3 (9%); and Level 5, n=0 (0%). Under the mean-based classification, the distribution was Level 1, n=1 (3%); Level 2, n=10 (31%); Level 3, n=10 (31%); Level 4, n=9 (28%); and Level 5, n=2 (6%).

#### 4.4. P3M3 Organizational Lenses

The three P3M3 lenses are summarized in Table 5. The means fell within a narrow band: Project 3.14 ( $\pm 0.89$ ), Portfolio 3.06 ( $\pm 1.00$ ), and Programme 2.99 ( $\pm 1.00$ ). A Friedman test found no significant difference among the three lenses [ $\chi^2(2)=4.06$ ,  $p=0.132$ ; Kendall's  $W=0.06$ ].

#### 4.5. Item-Level Patterns

Mean scores for the 24 scale items ranged from 2.81 (Q15, Management Control-Project; and Q17, Benefits Management-Programme) to 3.31 (Q33, Resource Management-Project). The median was 3.0 for all items except Q19 (Financial Management-Portfolio), which had a median of 4.0. Standard deviations across items ranged from 0.95 to 1.38, indicating considerable dispersion among shipyards for individual items. The single global self-assessment item (Q12, General maturity) had a mean of 2.97, a median of 3.0, and an SD of 1.12.

#### 4.6. Associations with Respondent Characteristics

No statistically significant associations were identified between the selected respondent characteristics (age, sector experience, education, and current tenure) and maturity scores at the 5% significance level. Among the correlations tested, the largest was between current tenure and stakeholder engagement maturity (Spearman's  $\rho=-0.338$ ,  $n=32$ ,  $p=0.058$ ), which did not reach the conventional significance threshold.

#### 4.7. Maturity Profiles

Exploratory hierarchical cluster analysis, using Euclidean distance and Ward's linkage method applied to the eight-dimensional score data, suggested a three-cluster solution, selected based on the dendrogram structure (Figure 3) and the interpretability of the resulting groups: a lower-maturity profile ( $n=15$ , mean composite score  $\approx 2.24$ ), an intermediate-maturity profile ( $n=8$ ,  $\approx 3.35$ ), and a higher-

maturity profile ( $n=9$ ,  $\approx 4.18$ ). Table 6 presents the mean scores for each assessment dimension within each profile.

Figure 4 presents these profiles graphically across the eight assessment dimensions. The ordering of the three profiles—lower-, intermediate-, and higher-maturity—is preserved across all dimensions, with the widest separation between profiles occurring in organizational governance and the narrowest in financial management.

### 5. Discussion

#### 5.1. Heterogeneity Beneath the Sample Mean Composite Score

The most important result is not the sample mean composite score of 3.06 by itself, but the heterogeneity beneath it. The eight dimensions occupied a narrow band and did not differ significantly, which could suggest a relatively uniform maturity picture if interpretation stopped at the aggregate level. The organization-level data presents a contrasting narrative: standard deviations typically hovered around 1 point on the 5-point scale, most dimensions covered nearly the entire scale, and cluster analysis revealed lower-, intermediate-, and higher-maturity profiles with mean scores of approximately 2.24, 3.35, and 4.18. The sample mean composite score, therefore, provides a descriptive benchmark for the participating shipyards but does not capture the full variation in their capabilities.

This finding speaks directly to the current debate on the contextual limits of maturity models. Recent reviews argue that project-based organizations require more adaptive and context-sensitive interpretations rather than rigid prescriptions [18,19]. The present evidence adds an empirical perspective on shipbuilding: organizations exposed to the same national industry, regulatory setting, and professional environment can nevertheless occupy markedly different

**Table 5.** Maturity statistics by P3M3 lens ( $n=32$ ).

| Lens      | Mean $\pm$ SD   | Median | Min-Max   | $\alpha$ |
|-----------|-----------------|--------|-----------|----------|
| Portfolio | 3.06 $\pm$ 1.00 | 3.00   | 1.12-5.00 | 0.941    |
| Programme | 2.99 $\pm$ 1.00 | 3.12   | 1.12-4.75 | 0.928    |
| Project   | 3.14 $\pm$ 0.89 | 3.12   | 1.38-4.88 | 0.912    |

**Table 6.** Mean maturity scores by cluster profile.

| Profile               | n  | MC   | BM   | FM   | RM   | SE   | OG   | ResM | PG   |
|-----------------------|----|------|------|------|------|------|------|------|------|
| Lower maturity        | 15 | 2.04 | 2.29 | 2.58 | 2.24 | 2.18 | 2.09 | 2.27 | 2.22 |
| Intermediate maturity | 8  | 3.21 | 3.21 | 3.50 | 3.29 | 3.17 | 3.83 | 3.25 | 3.33 |
| Higher maturity       | 9  | 4.22 | 3.96 | 4.15 | 3.96 | 4.19 | 4.41 | 4.41 | 4.15 |

MC: Management Control, BM: Benefits Management, FM: Financial Management, RM: Risk Management, SE: Stakeholder Engagement, OG: Organizational Governance, ResM: Resource Management, PG: Process/General.

maturity configurations. In this sense, maturity is better interpreted as an organizational profile than as a single aggregate score.

## 5.2. Implications of Distinct Maturity Profiles

For the participating shipyards, the three exploratory profiles may provide a more actionable basis for capability development than a uniform improvement programme. Shipyards with a lower maturity profile may benefit most from foundational process documentation, explicit planning routines, structured risk and change control, and consistent assignment of responsibility. Intermediate-maturity shipyards appear to require consolidation and standardization of practices that are already present but not uniformly embedded. Higher-maturity shipyards are better positioned to emphasize quantitative performance measurement, organizational learning, and continuous improvement. These implications should not be treated as a prescriptive P3M3 typology; the clusters are empirical groupings derived from this sample, not official P3M3 maturity categories.

The ordering of lower-, intermediate-, and higher-maturity profiles was preserved across all assessment dimensions. This consistency suggests that the profile differences are not driven by a single isolated practice area but reflect broader organizational capability patterns. At the same time, the degree of separation varied by dimension, reinforcing the value of examining the maturity configuration rather than assigning each shipyard a single label.

## 5.3. Dimension-Level Patterns: Financial Management and Management Control

Financial management had the highest descriptive mean and the narrowest spread, whereas management control had the lowest descriptive mean. The Friedman test indicated that the differences in dimensions were not statistically significant, so these rankings should not be interpreted as sector-wide strengths and weaknesses. They are nevertheless operationally informative. Financial discipline is structurally important in capital-intensive, contract-based shipbuilding, while management control covers progress tracking and the management of design and scope changes during construction—recurring challenges in ETO production. The pattern, therefore, points to in-flight project governance as a plausible area for targeted capability development, while remaining appropriately cautious about statistical significance.

This interpretation is consistent with the earlier qualitative observation of Doğan and Helvacıoğlu [20] that Turkish shipyards recognize the value of standardized PM practices but do not always implement them consistently. The present study does not establish causality or performance effects,

but it provides a quantitative organizational view that complements those earlier observations.

## 5.4. Interpreting the P3M3 Lens Correlations

No statistically significant difference was detected among the project, programme and portfolio scores, which were very strongly correlated ( $\rho=0.84-0.94$ ). This finding is relevant because the three P3M3 lenses are conceptually distinct. One interpretation is that shipyards develop project, programme and portfolio practices in a coordinated way rather than through a strict sequential hierarchy. An alternative explanation is methodological: a single respondent may form a broad judgment of organizational capability and reproduce that impression across questions framed around different lenses. The present design cannot distinguish these explanations.

The strong correlations, therefore, support a cautious use of aggregate maturity measures. They may reflect genuinely integrated organizational capability, common-method effects, or both. Future assessments using multiple respondents per shipyard and documentary evidence would help determine whether the three lenses are empirically differentiated in shipbuilding practice.

## 5.5. Respondent Characteristics

No statistically significant association was found between maturity scores and respondent age, sector experience, education, or current tenure. This null result does not show that individual manager characteristics are irrelevant; rather, it is consistent with the view that maturity is primarily an organizational property expressed through routines, structures, and resources. Testing that proposition directly will require organization-level variables such as shipyard size, workforce, ownership structure, project mix, and export orientation.

## 6. Limitations and Future Research

Several limitations should be considered. The sample comprised 32 shipyards, each represented by a single respondent, so self-assessment scores cannot be independently verified against documentary evidence or corroborated by other staff within the same organization. Participation was voluntary following distribution through GİSBİR's communication channels, which may introduce self-selection. The sample should not be assumed to represent all Turkish shipyards. The Turkish version was translated by the researchers using the original P3M3 questionnaire and verified with the assistance of artificial intelligence. High internal consistency does not establish linguistic equivalence or construct validity. The strong correlations among the P3M3 lenses may reflect coordinated capability, a common organizational impression, or both. The three-cluster

partition was selected through visual interpretation and substantive interpretability, and its stability and optimality remain unverified. Organization-level explanatory variables such as size, workforce, ownership, and export orientation were not collected. Finally, the data represents a single point in time and does not establish a maturity trajectory.

Future research should use multiple respondents per shipyard, triangulate self-assessments against project schedules, audit records, or other documentary evidence, and collect organization-level variables to explain why shipyards exhibit different maturity profiles. Longitudinal studies could examine movement between profiles, while comparative studies across shipbuilding nations could test whether the heterogeneity observed here is specific to Türkiye or characteristic of shipbuilding more broadly. Qualitative case studies contrasting lower- and higher-maturity shipyards would be particularly useful for identifying the organizational mechanisms behind the profiles.

## 7. Conclusion

This study assessed PMM in 32 Turkish shipyards using the official P3M3® version 2.1 Self-Assessment Tool. The sample mean composite score was 3.06 on the five-point scale, but the main finding is that this average conceals substantial heterogeneity. Exploratory hierarchical cluster analysis identified three maturity profiles with average scores of approximately 2.24, 3.35, and 4.18. Financial Management had the highest descriptive dimension score, and Management Control had the lowest, although differences among dimensions were not statistically significant. Project, programme and portfolio lens scores were also strongly correlated.

The study's principal empirical contribution is therefore not simply the introduction of P3M3® to a new sector. It indicates that the sample mean composite score may not fully capture differences in capability among the participating shipyards. For shipyard managers and sector bodies, differentiated capability-building based on organizational maturity profiles may be more informative than a uniform improvement programme derived from an aggregate mean. For maturity research, the findings support current calls for context-sensitive interpretation and greater attention to multidimensional configuration and within-sector heterogeneity.

## Ethics

**Ethics Committee Approval:** This research was executed as a non-intrusive organizational survey targeting adult professionals, authorized formally by the Board of Directors of the Turkish Shipbuilders' Association, which aided in disseminating the survey to its member shipyards. The

study adhered strictly to ethical standards concerning human subjects: involvement was completely voluntary, verbal informed consent was obtained from every participant, and they were comprehensively briefed on the research's aims, voluntary aspect, and data confidentiality before taking part.

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## Footnotes

### Authorship Contributions

Concept: K. E. Erginer, Design: K. E. Erginer, Data Collection or Processing: K. E. Erginer, A. Y. Kaya, and S. Çapar, Analysis or Interpretation: K. E. Erginer, A. Y. Kaya, and S. Çapar, Literature Review: K. E. Erginer, A. Y. Kaya, and D. A. Akyar, Writing: K. E. Erginer, A. Y. Kaya, D. A. Akyar, S. Çapar.

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**Data Availability:** The corresponding author can provide the data supporting the findings of this study upon reasonable request.

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