

The role of integrated project controls in successful project and programme delivery

A systematic literature review and Saudi Arabian construction case analysis

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Abstract—Complex construction programmes rarely fail because a single activity goes wrong. More often, performance deteriorates through a chain of connected events: a design decision affects procurement, procurement affects construction sequencing, sequencing affects the critical path, delay increases cost exposure, and the resulting commercial position creates additional management risk. This paper examines whether Integrated Project Controls (IPC) can provide a practical mechanism for understanding and managing those connections. The study uses a structured systematic literature review, supported by a secondary case analysis of empirical evidence from Saudi Arabian construction projects. The analysis indicates that effective project controls are broader than schedule and cost reporting. They depend on the interaction of organisational capability, competent people, reliable data, technology, governance and operational control processes. Recent Saudi evidence is particularly relevant: a 2025 study of 222 completed construction projects reported that 64% exceeded planned time and 53% experienced cost overruns, while its structural model showed that organisational, human and technological inputs influenced performance largely through operational control mechanisms. The paper proposes an Input-Process-Output conceptual framework and a five-level Project Controls Maturity Model ranging from reactive reporting to strategic, predictive control. Five research questions and associated hypotheses are developed for future empirical testing. The paper concludes that IPC should be positioned as a strategic management capability rather than an administrative reporting function. Its value lies in creating a credible line of sight from baseline to actual performance, from actual performance to forecast, and from forecast to timely management action.

Index Terms—Integrated Project Controls, Project Management, Programme Management, Construction, Project Performance, Earned Value Management, Risk Management, Schedule Management, Cost Control, Saudi Arabia.

I. INTRODUCTION

Large construction and infrastructure programmes operate in environments characterised by uncertainty, multiple interfaces, contractual dependencies and significant capital exposure. In such settings, the project team is continuously balancing scope, time, cost, quality, risk, resources, procurement and stakeholder expectations. The management challenge is therefore not simply to collect information; it is to turn information into a reliable view of current performance and a credible forecast of future outcomes.

Project controls have traditionally been associated with planning, scheduling, cost control and reporting. That description is now too narrow. The contemporary controls function increasingly brings together schedule management, cost forecasting, risk, change, commercial information, progress measurement, performance analysis and decision support.

ISO 21502:2020 provides project-management guidance applicable to projects of different sizes, complexities, delivery approaches and organisational settings [1]. A large multi-contract programme requires a different control architecture from a small, relatively stable project.

The practical need for integration is straightforward. A delayed design deliverable can delay procurement; late procurement can delay construction; construction delay can increase site overheads; the resulting delay may create an extension-of-time issue; and the combined effects can change the forecast final cost.

Integrated Project Controls (IPC) addresses this problem by connecting these disciplines through a common structure, common data and common governance. The central proposition of this paper is that project-control effectiveness is created not by any single software platform or metric, but by the interaction of people, processes, technology and management decisions.

A. Research Problem and Gap

Despite decades of project-control practice, construction projects continue to experience cost and schedule problems. The issue is therefore not the absence of control techniques; it is the difficulty of integrating them into an operating system that consistently changes project behaviour. Recent systematic research on project control systems identified 12 key determinants and 29 sub-determinants across organisational, human, technological and operational categories [2].

Alotaibi et al. [3] analysed 222 completed construction projects in Saudi Arabia and found that 64% exceeded planned time while 53% experienced cost overruns. Their findings indicate that organisational, human and technological inputs influence project performance through operational control stages.

II. RESEARCH AIM, OBJECTIVES AND QUESTIONS

The aim of this research is to examine the role of Integrated Project Controls in improving the predictability, governance and performance of complex construction projects and programmes, with particular attention to the Saudi Arabian context.

A. Research Objectives

- To examine how project controls have evolved from traditional reporting towards integrated management and decision support.
- To identify organisational, human, technological and operational factors associated with effective project-control systems.
- To assess the relationship between integrated project controls and project performance.
- To examine recent empirical evidence from Saudi Arabian construction projects.
- To propose a practical Integrated Project Controls Framework and maturity model suitable for implementation and future empirical testing.

B. Research Questions

TABLE 1. RESEARCH QUESTIONS

RQ	Focus
RQ1	What are the principal components of an effective Integrated Project Controls system?
RQ2	How does integration among schedule, cost, risk, change and commercial controls influence project performance?
RQ3	Which organisational, human and technological factors most strongly influence project-control effectiveness?
RQ4	What does recent empirical evidence from Saudi Arabia reveal about project-control systems and performance?
RQ5	How can organisations implement and measure project-controls maturity to support proactive management decisions?

III. SYSTEMATIC LITERATURE REVIEW

A systematic literature review was undertaken to identify the principal concepts, empirical findings and research gaps relevant to integrated project controls. The review was structured around five themes: (1) project success and performance, (2) project-control systems, (3) schedule and cost integration, (4) risk/change/commercial integration, and (5) organisational and technological capability.

A. Search Strategy

Searches were conducted across accessible academic and professional sources including publisher databases and professional institutions. Search terms combined "project controls", "integrated project control", "project control system effectiveness", "construction project performance", "earned value management", "schedule cost integration", and "Saudi Arabia construction projects". Priority was given to peer-reviewed empirical studies, systematic reviews, recognised standards and established professional sources.

The review was not designed as a statistical meta-analysis because the literature is heterogeneous in terminology, research design, project type and outcome measures. Instead, a structured qualitative synthesis was used, following the logic of recent systematic work on project-control system effectiveness [2].

TABLE 2. LITERATURE REVIEW SUMMARY

Theme	Representative Evidence	Implication for IPC
Project success	Cooke-Davies [4]; Radujkovic & Sjekavica [5]	Success extends beyond time and cost to benefits, stakeholders, learning and organisational outcomes.
Project controls	Hollander [6]; Alotaibi et al. [2]	Controls should be integrated and decision-oriented rather than isolated reporting functions.
Schedule and cost	Del Pico [7]; PMI sources	Schedule and cost need a common WBS, baseline and performance structure.
Earned value	PMI [8]; Elsaid et al. [9]	EVM provides integration, but forecasting method should reflect project stage and data quality.
Risk integration	PMI risk/EVM literature [8]	Risk should influence cost and schedule forecasts rather than remain a separate register.
Saudi construction	Alotaibi et al. [3]; El-Kholy & Akal [10]	Organisational capability, leadership, stakeholder integration and control practices are material to outcomes.
Digitalisation	ISO 21502 [1]; EVM/BIM research	Technology can strengthen controls but cannot compensate for weak processes or poor data.

B. *Project Success*

Cooke-Davies [4] distinguished among project-management success, project success and consistently successful organisations. This distinction is useful for project controls because it prevents a narrow interpretation of performance. A project can meet a baseline and still fail to deliver the intended business benefit; conversely, a project may require an approved change to achieve a more valuable outcome. Radujkovic and Sjekavica [5] argue that project success is influenced by multiple dimensions and should not be reduced to a single measure.

C. *Project Control Systems*

Hollander [6] described integrated project control as a dynamic process for obtaining project information and making project decisions. Del Pico [7] presents construction project control as the integration of cost and schedule, supported by planning, monitoring, forecasting and corrective action. Alotaibi et al. [2] identified four broad determinant categories: organisational, human, technological and operational. Their finding that human dimensions remain comparatively under-researched highlights a continuing opportunity to strengthen the people side of controls.

D. *Earned Value and Integrated Performance*

Earned Value Management (EVM) combines scope, schedule and cost within a baseline and provides a structured basis for measuring variance and forecasting outcomes [8]. The basic EVM measures are Planned Value (PV), Earned Value (EV) and Actual Cost (AC). Cost Performance Index (CPI) is calculated as EV/AC , while Schedule Performance Index (SPI) is calculated as EV/PV . Recent empirical research by Elsaid et al. [9], using 30 construction projects, found that different earned-value techniques perform differently depending on project stage and performance conditions.

E. *Risk, Change and Commercial Integration*

Risk management and EVM have often developed as separate disciplines even though they describe the same underlying project uncertainty from different perspectives. Risk information should influence forecasts, contingency and scenario analysis. Change control is similarly central to integration: a design change is not simply a scope event. It may alter quantities, procurement, construction sequence, resources, risk exposure and contractual entitlement. Commercial and contract management depend heavily on reliable controls evidence.

F. *Organisational and Human Factors*

Project controls are performed by people. Research on large Saudi construction projects by El-Kholy and Akal [10] identified competency of key personnel, labour capability, communication channels and project-manager competence and authority among highly significant success factors. Recent Saudi project-control research further identified leadership and team capacity, estimation accuracy, stakeholder engagement, PMO involvement and knowledge management as priority improvement areas [3].

IV. RESEARCH METHODOLOGY

The study adopts a qualitative, evidence-based research design combining a structured systematic literature review with a secondary case analysis of Saudi Arabian construction evidence. The methodology is appropriate because the research objective is conceptual and explanatory: to understand how project-control components interact and to develop a framework for future empirical testing.

A. *Research Design*

The study follows four stages. First, relevant literature was identified using structured search terms. Second, sources were screened for relevance to project controls, construction performance and integration. Third, evidence was coded thematically across organisational, human, technological and operational dimensions. Fourth, the resulting themes were synthesised into an Input-Process-Output conceptual framework and a practical maturity model.

B. *Inclusion and Exclusion Principles*

- Included peer-reviewed research, recognised professional guidance and international standards directly relevant to project controls or project performance.
- Prioritised construction and infrastructure evidence because these sectors provide the strongest relevance to integrated controls.
- Included Saudi Arabian studies where they directly addressed construction performance, project controls or critical success factors.
- Excluded sources whose principal focus was unrelated to project management, or where project-control concepts were incidental.
- Used recent studies to represent current practice while retaining foundational research where it remains conceptually important.

C. *Analytical Approach*

The analysis used thematic synthesis rather than statistical aggregation. Each source was considered in relation to four analytical questions: What control capability is described? What performance mechanism is proposed? What evidence supports the relationship? What organisational conditions enable the control to work? This produced the proposed model linking inputs, control processes, decision support and project outcomes.

D. Proposed Hypotheses for Future Testing

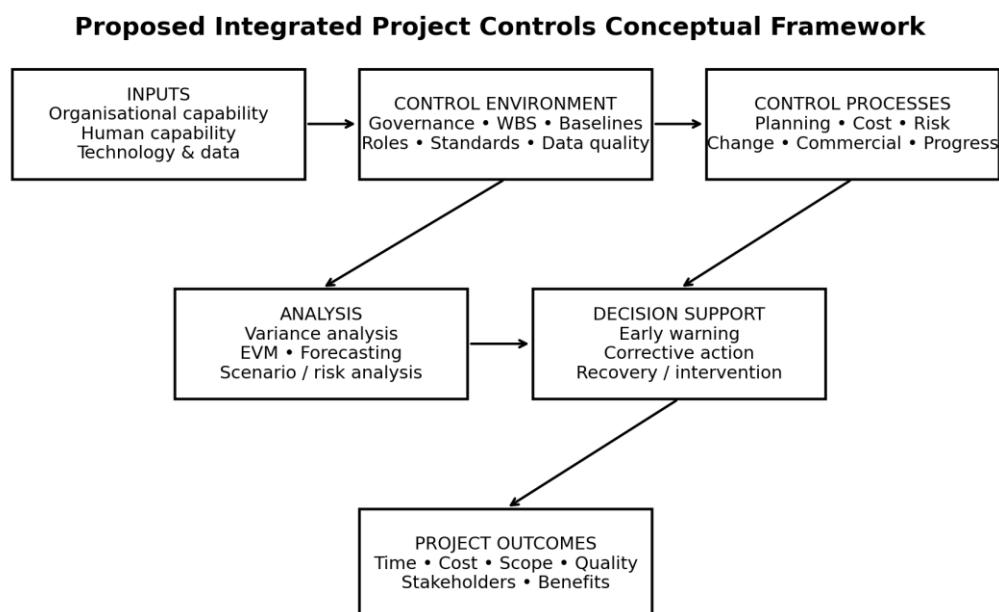
TABLE 3. RESEARCH HYPOTHESES

Hyp.	Proposition	Rationale
H1	Organisational project-control capability positively influences the effectiveness of operational project-control processes.	Governance, PMO capability, leadership and accountability should enable better control execution.
H2	Human capability positively influences the effectiveness of Integrated Project Controls.	Competence, communication and collaboration affect data quality and corrective action.
H3	Technological capability positively influences the integration and timeliness of project-control information.	Integrated systems, dashboards and data environments can improve information flow when processes are mature.
H4	The integration of schedule, cost, risk and change controls positively influences project performance predictability.	Integration reduces fragmented decision-making and improves forecasting.
H5	The effectiveness of operational project controls mediates the relationship between organisational/human/technological capability and project performance.	Capabilities create value through the control processes that translate them into action.

V. CONCEPTUAL FRAMEWORK

The framework proposes that project performance is not directly produced by technology or procedures alone. Organisational capability, human capability and technology provide the enabling conditions. These inputs are translated through governance and operational control processes, including planning, cost management, risk, change, commercial control and progress measurement. Analysis then converts project data into early warnings, forecasts and management decisions. The final outcome is improved predictability and control of time, cost, scope, quality, stakeholder outcomes and benefits.

Figure 1 — Proposed Integrated Project Controls Input-Process-Output Framework



VI. SAUDI ARABIA CASE STUDY

Saudi Arabia provides a strong setting for examining Integrated Project Controls because the construction environment combines major capital programmes, multiple stakeholders, ambitious delivery targets and a wide range of project types. The case evidence is a secondary analysis of published empirical research.

A. Empirical Evidence from 222 Projects

Alotaibi et al. [3] examined 222 completed construction projects in Saudi Arabia through a cross-sectional survey of professionals involved in project delivery. The study developed and tested an Input-Process-Output model linking organisational, human and technological determinants to operational control stages and project outcomes. Seventeen of twenty hypothesised relationships were supported, providing unusually strong evidence for the integrated nature of project-control effectiveness.

TABLE 4. EMPIRICAL EVIDENCE FROM SAUDI ARABIAN PROJECTS

Indicator	Published Finding	Interpretation
Sample	222 completed Saudi construction projects	Substantial empirical base for the national context.
Schedule performance	64% exceeded planned time	Schedule predictability remains a major challenge.
Cost performance	53% experienced cost overruns	Cost control and forecasting remain material issues.
Hypotheses supported	17 of 20	Broad empirical support for the proposed control relationships.
Priority improvement areas	Leadership/team capacity; estimation; stakeholder engagement; PMO; audits; knowledge management; schedule compression	Control maturity depends on organisational and operational capability.

B. Interpretation

The most important lesson is that control effectiveness is sequential. Organisational and human inputs influence operational controls, which in turn influence project outcomes. This means that simply purchasing a new project-management information system will not automatically improve performance. The study gives weight to post-operational control and corrective action: a project can only benefit from a warning if someone has the authority, information and resources to respond.

C. Saudi Construction Success Factors

El-Kholy and Akal [10] surveyed 61 industry experts and identified critical success factors for large building projects in Saudi Arabia. Contractors rated competency and capability of key personnel, labour resources and public impact highly; consultants highlighted personnel competency, communication between owner/project manager and designer, and project-manager competence, authority and involvement. The findings reinforce the human and governance dimensions of the proposed IPC framework.

VII. QUANTITATIVE EVIDENCE AND ANALYTICAL IMPLICATIONS

The quantitative evidence demonstrates the scale of the performance problem and supports the need for integrated controls research. A useful management implication is that a project-control dashboard should distinguish between lagging indicators (actual cost, achieved progress) and leading indicators (emerging procurement risk, float erosion, design deliverable slippage, unresolved changes). A mature control system should combine both.

TABLE 5. EVIDENCE SUMMARY

Measure	Value	Source	Implication
Projects analysed	222	Alotaibi et al. [3]	Meaningful empirical basis.
Exceeded planned time	64%	Alotaibi et al. [3]	Schedule control and forecasting require attention.
Experienced cost overruns	53%	Alotaibi et al. [3]	Budget control alone is insufficient; forecasting matters.
Supported hypotheses	17/20	Alotaibi et al. [3]	Strong support for integrated determinants.
Large-project CSF survey	61 respondents	El-Kholy & Akal [10]	Human and stakeholder capability are significant.
EVM forecasting study	30 projects	Elsaid et al. [9]	Forecasting method should reflect project stage.

VIII. INTEGRATED PROJECT CONTROLS MATURITY MODEL

A maturity model is proposed to help organisations assess their current control capability and define a realistic improvement path. The model is intentionally practical rather than software-specific.

TABLE 6. PROJECT CONTROLS MATURITY MODEL

Level	Characteristics	Priority Action
1 - Reactive	Reports are largely historical; baselines are weak or frequently changed; data is fragmented; issues are escalated late.	Establish governance, WBS, baseline and reporting calendar.
2 – Basic	Planning, cost and risk functions exist but remain largely separate; limited forecasting.	Standardise definitions and integrate schedule/cost structures.
3 Integrated	Common WBS; schedule, cost, risk and change are linked; regular forecasting and variance analysis.	Introduce integrated dashboards, formal change and risk links.
4 Predictive	Scenario analysis, quantitative risk, trend forecasting and early-warning indicators are used consistently.	Strengthen analytics, data quality and management intervention.
5 - Strategic	Controls are embedded in enterprise governance; predictive analytics, lessons learned and benefits tracking inform investment decisions.	Continuously optimise and benchmark controls.

IX. PRACTICAL IMPLEMENTATION FRAMEWORK

Implementation should be progressive. Attempting to introduce advanced analytics before establishing reliable basic controls usually creates complexity without improving decisions.

TABLE 7. TEN-STEP IMPLEMENTATION FRAMEWORK

Step	Implementation Action
1. Governance	Define authority, accountability, escalation thresholds and approval routes.
2. Common WBS	Create a common structure connecting scope, schedule, cost, contracts and reporting.
3. Baselines	Approve scope, schedule and cost baselines with controlled change procedures.
4. Data standards	Define progress rules, cost coding, reporting cut-offs and data ownership.
5. Integrated schedule	Establish an integrated master schedule with clear interfaces and critical-path logic.
6. Cost and forecast	Connect commitments, actuals, accruals, changes, risk and estimate-at-completion.
7. Risk and change	Link material risks and approved changes directly to cost and schedule forecasts.
8. Performance analytics	Use variance analysis, EVM, trend analysis and scenario modelling as appropriate.
9. Management action	Assign owners and deadlines to corrective actions; track closure.
10. Learning	Use post-project reviews, control-data analysis and lessons learned to improve future baselines.

A. Governance Structure

- Project Director / Programme Director: accountable for overall performance and major decisions.
- Project Controls Manager: owns the integrated control architecture, baseline governance and performance reporting.
- Planning Manager: owns schedule integrity, progress and critical-path analysis.
- Cost Manager: owns budget, commitments, actuals and forecast final cost.
- Risk Manager: owns risk methodology and quantitative risk integration.
- Commercial Manager: links contract events, variations, claims and commercial exposure.
- PMO / Data Lead: maintains standards, reporting, systems and data quality.
- Project Manager / Package Managers: own corrective actions and delivery outcomes.

X. DISCUSSION

The literature and case evidence converge on one central finding: project-control effectiveness is a system property. It emerges from the interaction of organisational structures, people, technology and operating processes. This explains why projects can possess sophisticated software but still suffer from unreliable forecasts.

The first implication is that integration should begin with structure rather than technology. A common WBS, clear control accounts, consistent progress rules and agreed reporting calendars provide the foundation for connecting project information. Without these structures, system integration simply moves inconsistent data faster.

The second implication concerns management behaviour. Project controls have limited value if leadership treats adverse information as a reporting problem rather than a management signal. A healthy controls culture encourages early escalation and treats forecast deterioration as an opportunity to intervene rather than as evidence of individual failure.

The third implication is that forecasting should be treated as a core management process. A project can be behind schedule today but recoverable; it can also be on schedule today while developing risks that will cause a future delay. Forecasting therefore provides more decision value than historical variance alone.

Finally, the Saudi evidence suggests that organisational and human capability deserves more attention. The systematic review [2] found relatively limited research attention to human dimensions, while the Saudi empirical study [3] identified leadership, team capacity, stakeholder integration and PMO involvement as priority areas.

XI. ACADEMIC CONTRIBUTION

The paper makes three principal academic contributions. First, it synthesises project-success literature and project-control literature into a single framework rather than treating control techniques independently. Second, it positions organisational, human and technological capabilities as enabling inputs whose value is realised through operational control processes. Third, it translates the literature into five testable hypotheses and a maturity model that can support future empirical research.

XII. MANAGERIAL IMPLICATIONS

- Treat Project Controls as a strategic management function with direct access to project leadership.
- Create one integrated baseline architecture rather than separate schedule, cost and commercial structures.
- Measure physical progress using transparent, auditable rules and avoid subjective percentage-complete reporting.
- Use forecasts and leading indicators to identify problems before they become contractual or financial crises.
- Link risk, change and commercial events to schedule and cost forecasts.
- Assess controls maturity annually and create a targeted improvement roadmap.

- Invest in people and professional development alongside software and systems.
- Make executive reporting decision-oriented: every material variance should state cause, impact, forecast, owner and required decision.
- Use digital systems to reduce data duplication and improve traceability, but do not substitute technology for governance.
- Capture lessons from completed projects and feed them into future estimating, scheduling and risk processes.

XIII. LIMITATIONS AND FUTURE RESEARCH

This paper is a conceptual and evidence-synthesis study rather than an original primary-data investigation. Its hypotheses are proposed for future testing and should not be interpreted as empirically validated by the author.

Future research should test the proposed five-hypothesis model using a larger Saudi or Gulf-region sample. A questionnaire could measure organisational, human, technological and operational control maturity, while project outcomes could be measured using schedule variance, cost variance, scope stability, quality, safety and stakeholder satisfaction.

Longitudinal research would be particularly valuable. Instead of asking teams to describe control maturity retrospectively, researchers could follow projects from mobilisation to close-out and examine whether improvements in control maturity precede improvements in forecast accuracy.

Further research should also examine artificial intelligence, predictive analytics, digital twins and automated progress measurement. These technologies may significantly alter project-control practice, but their value should be evaluated in relation to data quality, governance and human decision-making rather than technology adoption alone.

XIV. CONCLUSION

Integrated Project Controls should be understood as a management system for converting project information into timely decisions. The evidence reviewed in this paper suggests that the strongest control environments do not rely on one technique. They integrate scope, schedule, cost, risk, change, commercial information, progress, governance and stakeholder interfaces.

The Saudi Arabian construction evidence demonstrates the practical importance of this agenda. With 64% of the 222 projects in the published study [3] exceeding planned time and 53% experiencing cost overruns, the issue is not theoretical.

The practical message for project and programme leaders is simple: a baseline is only useful if performance can be measured against it, a forecast is only useful if it is credible, and a warning is only useful if management acts on it. Integrated controls create the connection between those three conditions.

The ultimate value of Integrated Project Controls is therefore not the number of reports produced or the sophistication of the software used. It is the organisation's ability to know where the project stands, understand why it is there, anticipate where it is heading and act early enough to influence the outcome.

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APPENDIX A

Proposed Project Controls Maturity Assessment

The following assessment can be used as a practical diagnostic tool. Score each dimension from 1 (Reactive) to 5 (Strategic). The overall maturity score is calculated as the average of the dimension scores.

TABLE 8. MATURITY ASSESSMENT DIMENSIONS

Dimension	Assessment Criteria	Score
Governance & leadership	Roles, authority, escalation, sponsor/PMT engagement	1-5
WBS & baseline management	Common WBS, schedule/cost alignment, baseline governance	1-5
Planning & scheduling	Integrated schedule, logic, critical path, progress rules	1-5
Cost control & forecasting	Budget, commitments, actuals, EAC, variance analysis	1-5
Risk & opportunity	Risk ownership, quantitative analysis, forecast integration	1-5
Change control	Impact assessment, approval, baseline update, traceability	1-5
Commercial controls	Claims, variations, contract events, payment and final account	1-5
Progress measurement	Objective physical progress and evidence quality	1-5
Data & technology	CDE, ERP, scheduling, dashboards, data quality	1-5
People & capability	Competence, training, collaboration, communication	1-5
Performance reporting	KPI quality, trend analysis, exception reporting, decisions	1-5
Lessons learned	Close-out review, knowledge capture, reuse in future baselines	1-5

TABLE 9. SCORING GUIDE

Score	Maturity	Meaning
1	Reactive	Controls are largely historical and fragmented; problems are identified late.
2	Basic	Core processes exist but operate independently and inconsistently.
3	Integrated	Major control disciplines share structures, data and governance.
4	Predictive	Forecasting, scenario analysis and early-warning indicators drive action.
5	Strategic	Controls are embedded in enterprise decision-making and continuously improved.

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