JOURNAL OF BASIC SCIENCE AND ENGINEERING

Dynamic Calendar Intelligence and Advanced DAX for Accurate Forecasting in Power BI

Aniket sanjay paithankar[1], Amalraj pillai [2], Aniket Alvekar[3], Rajkumar Prasad[4]
[1,2,3,4]School of Computer Science and Engineering, Sandip University, Nashik 422213, Maharashtra, India

Keywords:
Business Intelligence Framework, Executive Reporting, Calendar Intelligence, Power BI, Multi-Case Study, Maturity Index, Fiscal Calendar, Semantic Modelling, DAX, Decision Support.

DOI:
https://doi.org/10.10399/JBSE.28374 19260

ABSTRACT
Executive reporting is inherently multi-dimensional: a single board-level question typically ranges across a temporal grain, an organisational hierarchy, a comparative basis, a scenario assumption and a data-freshness expectation simultaneously. Business Intelligence platforms model the first four of these as separable concerns, but each of them silently depends on the fifth concern that is rarely modelled at all - the calendar against which every one of the other dimensions is resolved. This paper develops a multi-dimensional BI framework for executive reporting in Microsoft Power BI in which five reporting dimensions are specified explicitly and bound together by a calendar intelligence spine, and in which the maturity of that spine is measured on a six-axis Calendar Intelligence Maturity Index (CIMI). The framework is advanced as a design artefact and evaluated empirically.

A mixed-methods, multi-case design was adopted. The framework was implemented in four organisations of differing sector and calendar convention - a discrete-manufacturing group, a retail bank, a healthcare provider network and a higher-education institution - and evaluated through platform telemetry, documentary analysis of governance records, and a pre- and post-deployment survey of 142 executives and senior managers (72.4 % response). CIMI scores ranged from 2.67 to 4.67 across the four cases and ordered the outcome indicators without exception: executive report cycle time fell to 14.2 hours in the highest-maturity case against 44.1 hours in the lowest, time-to-insight for an ad-hoc executive query to 6.4 against 28.4 minutes, and reported-figure disputes to three against twenty-one per quarter. The overall executive reporting construct index rose from 2.77 to 4.25 on a five-point scale, and a respondent-level regression associated each additional CIMI point with a 0.46-point gain in that index ($p < 0.001$). Five design principles and a four-stage implementation roadmap are formalised.

1. INTRODUCTION

Executive reporting differs from operational reporting less in its content than in its dimensionality. An operational report typically answers a question fixed along most of its axes: yesterday's throughput for this plant against standard. A board-level question is rarely so constrained. "Is the margin recovery in our southern region on track, given the re-forecast, and how does that compare with the same stage of last year?" ranges simultaneously across a temporal grain and horizon, an organisational hierarchy, a comparative basis, a scenario assumption and an implicit expectation about how current the underlying data is. A reporting framework adequate to executive needs must therefore treat these as explicit, independently navigable dimensions rather than as ad-hoc report parameters [1], [2].

Microsoft Power BI supports four of those five dimensions natively and well. Organisational hierarchies are modelled as dimensions, comparative bases as versions or separate fact partitions, scenarios as what-if parameters, and freshness as a refresh schedule. The fifth - the temporal dimension - appears equally well supported, since the platform auto-generates a date table and supplies a family of time-intelligence functions. This paper argues that the appearance is misleading, and that the temporal dimension is not one of the five concerns but the substrate on which the other four are resolved. An organisational consolidation across divisions with divergent fiscal calendars is a calendar problem. A comparison of actual against a budget approved on a different period grid is a calendar problem. A scenario whose horizon is expressed in fiscal periods rather than months is a calendar problem. A freshness contract stated in business days rather than elapsed hours is a calendar problem. Where the calendar is left generic, each of these failures surfaces not as a calendar error but as a discrepancy in a number on an executive report, which is where it does the most damage to institutional trust.

The contribution of this paper is threefold. First, it specifies a multi-dimensional framework in which the five executive reporting dimensions are stated explicitly and bound by a calendar intelligence spine - a marked multi-calendar date dimension with surrogate offset keys, comparability mapping, business-day and event attributes, and calculation-group time intelligence. Second, it operationalises the maturity of that spine as a six-axis Calendar Intelligence Maturity Index, so that the construct becomes measurable and organisations become comparable. Third, it evaluates the framework through a multi-case, mixed-methods design across four organisations of differing sector and calendar convention, combining platform telemetry with a survey of 142 executives. The multi-case design is deliberate: a single-case evaluation cannot establish whether the framework's benefit is contingent on a particular calendar convention, and the four cases were selected precisely because their conventions differ.

The remainder of the paper is organised as follows. Section 2 reviews the literature and states the research gap. Section 3 specifies the framework, the maturity index and the research design. Section 4 presents the results. Section 5 discusses the findings, Section 6 the recommendations, Section 7 the limitations and future scope, and Section 8 concludes.

2. RELATED WORK

Four strands of literature are relevant: executive information systems and reporting requirements; dimensional modelling and the treatment of time; capability maturity models in the information-systems domain; and the measurement of reporting quality and decision support.

2.1 Executive Information Systems and Reporting Requirements

The requirements of executive-level information consumption were established in the executive information systems literature, which identified drill-down, exception reporting and trend comparison as the defining interaction patterns, and identified the brevity of executive attention as the binding design constraint [1]. Watson and Wixom [2] trace the absorption of these requirements into the broader business intelligence stack, and Arnott and Pervan [3] provide the critical review of decision support research, observing that the field has drifted from decision-maker requirements towards technical artefacts. Yeoh and Popovic [4] identify governance and data quality as the critical success factors for implementation. What is common to this literature is that the executive requirement is stated in terms of interaction patterns and information quality, and is not decomposed into the specific model constructs that must exist for those patterns to be supportable - which is the decomposition this paper attempts.

2.2 Dimensional Modelling and the Temporal Dimension

Kimball and Ross [5] supply the canonical treatment: an explicit, pre-populated, contiguous date dimension with descriptive and navigational attributes, the role-playing pattern for multiple date relationships, and the conformed dimension as the mechanism of cross-process comparability. Golfarelli and Rizzi [6] formalise temporal hierarchies within the dimensional fact model and note the difficulties introduced by unbalanced hierarchies such as fiscal-week structures. Within the Power BI literature Ferrari and Russo [7], [8] establish the semantics of the marked date table, the conditions under which native time-intelligence functions behave correctly, and the evaluation model that determines the cost of a temporal expression; the calculation-group construct [9] permits a time-intelligence pattern to be defined once and applied across measures. Microsoft implementation guidance [10] prescribes the certified semantic model as the unit of governance. The multi-calendar case - several divergent fiscal conventions reconciled within one model - is acknowledged in practitioner literature but is not systematically treated.

2.3 Capability Maturity Models

Maturity models have a long history in information systems as instruments for assessing and sequencing capability development, from the capability maturity model for software process onward. Becker, Knackstedt and Poppelbuss [11] provide the design-science procedure model for developing maturity models rigorously, specifying requirements for iterative development, evaluation and transferability. Raber, Winter and Wortmann [12] develop and validate a business intelligence maturity model, and Lahrmann, Marx, Winter and Wortmann [13] apply a Rasch-based approach to BI maturity measurement. These models operate at the level of the overall BI function -

covering strategy, organisation, data and technology - and none isolates the temporal layer. The CIMI instrument proposed here is deliberately narrow and is positioned as a sub-dimension instrument complementary to, rather than competing with, these general models.

2.4 Measuring Reporting Quality and Decision Support

The measurement of information-systems success is anchored by the DeLone and McLean model [14], which specifies information quality, system quality and service quality as antecedents of use and user satisfaction and ultimately of net benefits. Petter, DeLone and McLean [15] review the empirical support for the model and its measurement. Within the BI context, Isik, Jones and Sidorova [16] demonstrate empirically that data quality and interaction flexibility are the capabilities most strongly associated with perceived BI success, and Popovic, Hackney, Coelho and Jaklic [17] connect maturity and analytical culture to decision-making outcomes. The survey instrument used in this study adapts constructs from this tradition, adding two constructs - temporal trust and comparative confidence - that are specific to the argument advanced here and for which no established instrument was found.

2.5 Research Gap

Three gaps follow. First, executive reporting requirements are stated in the literature as interaction patterns and quality attributes but are not decomposed into the semantic-model constructs on which they depend, so no design guidance connects the requirement to the artefact. Second, BI maturity models operate at functional level and contain no instrument for the temporal layer, despite its evident centrality. Third, evaluations of BI framework artefacts are overwhelmingly single-case, which leaves open whether reported benefits are contingent on a particular calendar convention or organisational setting. This study addresses all three.

3. FRAMEWORK, INSTRUMENT AND RESEARCH DESIGN

The study follows the design-science paradigm, in which a designed artefact is constructed to address a class of problems and evaluated against utility criteria, and follows the procedure model of Becker et al. [11] in the development of the accompanying maturity instrument.

3.1 The Multi-Dimensional Framework

The framework specifies five dimensions of executive reporting, each a distinct navigable concern within the semantic model, together with the calendar intelligence spine on which each of them depends. Figure 1 presents the structure.

D1, the temporal dimension, governs the grain at which a metric is reported, the horizon over which it is displayed and the comparability of the periods so displayed. D2, the organisational dimension, governs the entity and hierarchy through which figures are consolidated, including ragged hierarchies where legal and management structures diverge. D3, the comparative dimension, governs the basis of comparison - actual, budget, latest forecast, prior year, or an approved plan version. D4, the scenario dimension, governs what-if levers and the retention of successive re-forecast vintages. D5, the latency dimension, governs refresh cadence and the freshness contract under which a figure is published.

The dependency of each dimension on the spine is specific rather than rhetorical. D2 depends on it because a consolidation across entities reporting on divergent fiscal calendars requires a common comparability key before the figures can be added. D3 depends on it because a budget approved on a monthly grid and an actual recorded on a 4-4-5 grid are not comparable without an explicit mapping. D4 depends on it because a scenario horizon stated as "the next four periods" is meaningless unless the period structure is materialised. D5 depends on it because a freshness contract stated as "by close of the second business day" requires a business-day calendar to be evaluable at all. D1 is the spine's own dimension. The framework's claim is therefore that the spine is not a sixth concern of equal standing but the substrate of the other four.

The listing below illustrates two spine constructs: the multi-calendar comparability mapping on which D2 and D3 depend, and the business-day freshness predicate on which D5 depends.

```
-- Spine: map a local fiscal period to the group comparability key
Revenue Group Basis :=
VAR GroupKeys =
    CALCULATETABLE (
```

```
        VALUES ( 'Calendar Map'[GroupPeriodKey] ),
        ALLSELECTED ( 'Date' )
    )
RETURN
    CALCULATE (
        [Revenue],
        REMOVEFILTERS ( 'Date' ),
        TREATAS ( GroupKeys, 'Calendar Map'[GroupPeriodKey] )
    )

-- Spine: freshness contract expressed in business days
Freshness Status :=
VAR LastLoad   = [Last Successful Load Date]
VAR PeriodEnd  = [Reporting Period End Date]
VAR BusDays    =
    CALCULATE ( COUNTROWS ( 'Date' ),
                'Date'[Date] > PeriodEnd,
                'Date'[Date] <= LastLoad,
                'Date'[IsBusinessDay] = TRUE () )
RETURN
    SWITCH ( TRUE (),
        BusDays <= 2, "Within contract",
        BusDays <= 4, "At risk",
        "Breached" )
```

3.2 The Calendar Intelligence Maturity Index

To render the spine measurable, a six-axis index was developed following the procedure of Becker et al. [11]. The axes are: calendar completeness and attribution, covering the presence of a marked, contiguous, fully attributed date dimension; comparability and offset navigation, covering surrogate keys and analogue mapping for irregular periods; multi-calendar reconciliation, covering the ability to consolidate divergent fiscal conventions on a common spine; temporal governance and certification, covering documented ownership, versioning and regression testing of calendar logic; expression reuse, covering the consolidation of time-intelligence patterns into calculation groups; and latency alignment, covering the alignment of refresh partitioning and freshness contracts with fiscal rather than calendar boundaries.

Each axis is scored from zero to five against behaviourally anchored descriptors, with evidence required for each level: zero denotes absence, three denotes a documented and consistently applied capability, and five denotes a governed, tested and monitored capability applied across the certified estate. Scoring was performed independently by two assessors from documentary evidence and model inspection; the initial inter-rater agreement was 87.5 % across the twenty-four organisation-axis pairs, with the three disagreements resolved by discussion. The overall CIMI score is the unweighted mean of the six axes, which is a deliberate simplification and is addressed in Section 7.

3.3 Case Selection and Data Collection

Four organisations were selected by theoretical rather than statistical sampling, on the criterion of maximum variation in calendar convention: a discrete-manufacturing group on an April-to-March fiscal year of thirteen four-week periods; a retail bank on a calendar fiscal year with month-end and business-day conventions; a healthcare provider network on a July-to-June fiscal year with a 4-4-5 operational calendar; and a higher-education institution on an academic year with term and semester structures that do not nest within its financial year. All four implemented the framework between 2023 and 2026 with the same external implementation partner, which holds the implementation approach approximately constant across cases.

Three data sources were used. Platform telemetry supplied query and refresh metrics, adoption and measure-portfolio counts. Documentary analysis of governance records supplied report cycle times, dispute logs and the evidence base for CIMI scoring. A survey instrument administered before implementation and twelve months after implementation supplied the perceptual outcomes. The instrument comprises nineteen items across five constructs - temporal trust, comparative confidence, timeliness, self-service efficacy and decision usefulness -

Vol. 23, No. 1, (2026)
ISSN: 1005-0930

each measured on a five-point Likert scale. Of 196 executives and senior managers invited, 142 completed both waves, a response rate of 72.4 %. Construct reliability was acceptable throughout, with Cronbach alpha between 0.84 and 0.91.

4. RESULTS AND ANALYSIS

Results are presented in five tables and three figures. Table 1 profiles the four cases. Table 2 maps the five reporting dimensions to their spine requirements and implementing constructs. Table 3 reports CIMI axis scores. Table 4 reports the objective outcome indicators. Table 5 reports the survey results and the regression.

Figure 1. The Multi-Dimensional Executive Reporting Framework

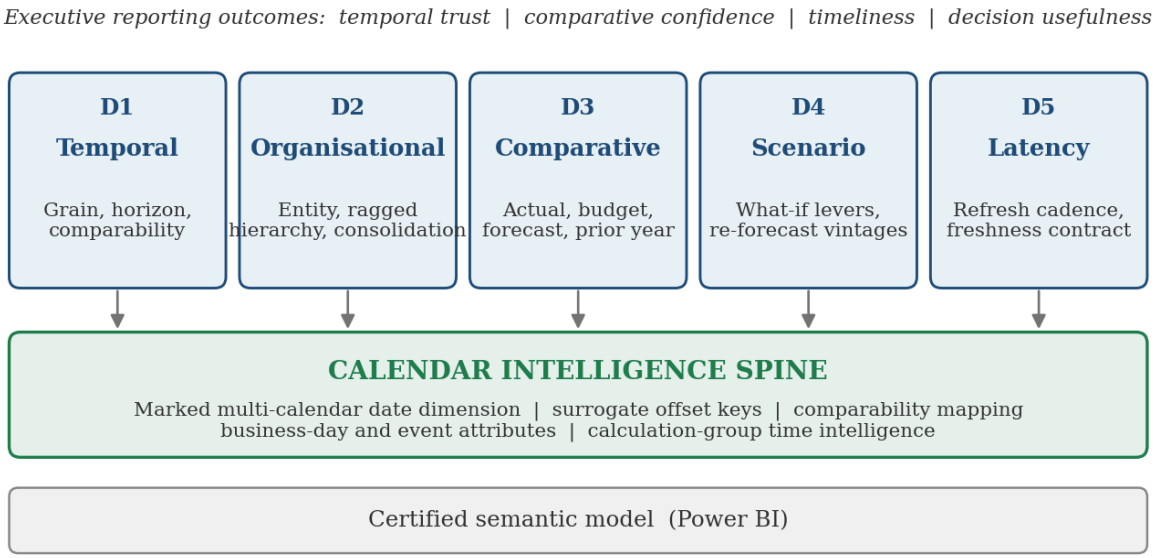


Figure 1: The multi-dimensional executive reporting framework and its calendar intelligence spine

Table 1: Profile of the four case organisations

Case profile attribute	Case A	Case B	Case C	Case D
Sector	Discrete manufacturing	Retail banking	Healthcare network	Higher education
Fiscal convention	Apr-Mar, 13 x 4 weeks	Calendar year, monthly	Jul-Jun, 4-4-5 operational	Academic year, terms
Secondary calendar in use	Retail 4-4-5 (aftermarket)	Business-day settlement	Clinical rota cycle	Semester and exam cycle
Certified model size (million rows)	240	610	380	95
Licensed report consumers	420	1,150	680	260
Executives surveyed (both waves)	38	47	35	22
Overall CIMI score (0 to 5)	4.67	4.17	3.50	2.67

Table 2: Reporting dimensions, their dependence on the calendar spine, and implementing constructs

Vol. 23, No. 1, (2026)
ISSN: 1005-0930

Reporting dimension	Executive requirement	Spine dependency	Implementing construct
D1 Temporal	Grain, horizon and period comparability	Marked, contiguous, attributed date dimension	Surrogate offset keys; comparability mapping
D2 Organisational	Consolidation across entities and ragged hierarchies	Common period key across divergent fiscal conventions	Calendar map table; TREATAS cross-calendar filter
D3 Comparative	Actual against budget, forecast and prior year	Mapping between approval grid and recording grid	Version dimension keyed to comparability key
D4 Scenario	What-if levers and re-forecast vintages	Materialised forward period structure	Vintage snapshot keyed to period; what-if parameter
D5 Latency	Freshness contract and refresh cadence	Business-day calendar and fiscal partition boundaries	Business-day predicate; fiscal-aligned incremental refresh

Table 3: Calendar Intelligence Maturity Index axis scores by case organisation

CIMI axis	Case A	Case B	Case C	Case D	Mean	Range
Calendar completeness and attribution	5	4	4	3	4.00	2
Comparability and offset navigation	5	5	3	3	4.00	2
Multi-calendar reconciliation	4	4	3	2	3.25	2
Temporal governance and certification	5	4	4	3	4.00	2
Expression reuse via calculation groups	5	4	3	2	3.50	3
Latency and refresh alignment	4	4	4	3	3.75	1
Overall CIMI score	4.67	4.17	3.50	2.67	3.75	2.00

Table 4: Executive reporting outcome indicators by case, before and after implementation

Outcome indicator	Case A	Case B	Case C	Case D	Mean before	Mean after
Executive report cycle time (hours)	58.0 to 14.2	66.4 to 19.6	72.5 to 31.8	80.2 to 44.1	69.3	27.4
Time to insight, ad-hoc query (minutes)	41 to 6.4	48 to 9.1	55 to 18.7	62 to 28.4	51.5	15.7
Reported-figure disputes per quarter	24 to 3	29 to 6	33 to 14	38 to 21	31.0	11.0
Executive self-service adoption (%)	36.2 to 88.6	31.8 to 81.2	28.4 to 63.4	24.1 to 48.9	30.1	70.5
Certified measure reuse ratio	1.9 to 8.4	1.6 to 6.9	1.4 to 4.2	1.2 to 2.6	1.5	5.5
P95 report page render time (seconds)	9.8 to 2.2	12.4 to 3.1	11.1 to 5.8	8.6 to 9.4	10.5	5.1

Table 5: Executive survey constructs, reliability and association with calendar intelligence maturity

Survey construct	Items	Alpha	Mean before	Mean after	Change	Beta on CIMI
Temporal trust	4	0.88	2.84	4.31	+1.47	0.58
Comparative confidence	4	0.91	2.61	4.22	+1.61	0.61
Timeliness	3	0.84	3.02	4.38	+1.36	0.34
Self-service efficacy	4	0.86	2.47	4.06	+1.59	0.42

Vol. 23, No. 1, (2026)
ISSN: 1005-0930

Survey construct	Items	Alpha	Mean before	Mean after	Change	Beta on CIMI
Decision usefulness	4	0.89	2.93	4.29	+1.36	0.39
Overall reporting index	19	0.93	2.77	4.25	+1.48	0.46

4.1 Maturity Distribution across the Cases

CIMI scores ranged from 2.67 in the higher-education case to 4.67 in the manufacturing case, with an overall mean of 3.75. The axis-level pattern, shown in Figure 2, is more informative than the aggregate. Latency alignment has the narrowest range across the four cases, at a single point, indicating that refresh scheduling is a well-understood platform discipline that organisations tend to get approximately right regardless of their broader temporal maturity. Expression reuse has the widest range at three points, and multi-calendar reconciliation the lowest mean at 3.25, the two axes on which the cases differ most. This pattern is consistent across the four organisations and suggests a natural development sequence: the operational disciplines are acquired early, while reconciliation across divergent calendars and consolidation of temporal logic into reusable expressions are late-stage capabilities requiring both architectural intent and governance authority.

It is notable that the higher-education case scores lowest despite having by some margin the smallest and technically simplest model. Its difficulty is not scale but structural: an academic calendar of terms and semesters that does not nest within the financial year produces two legitimate and non-reconcilable period hierarchies over the same facts, so that student-load reporting and financial reporting cannot be placed on a common spine without an explicit mapping the institution had not built. This is a useful counterexample to the assumption that temporal complexity scales with data volume.

Figure 2. Calendar Intelligence Maturity by Axis and Case Organisation

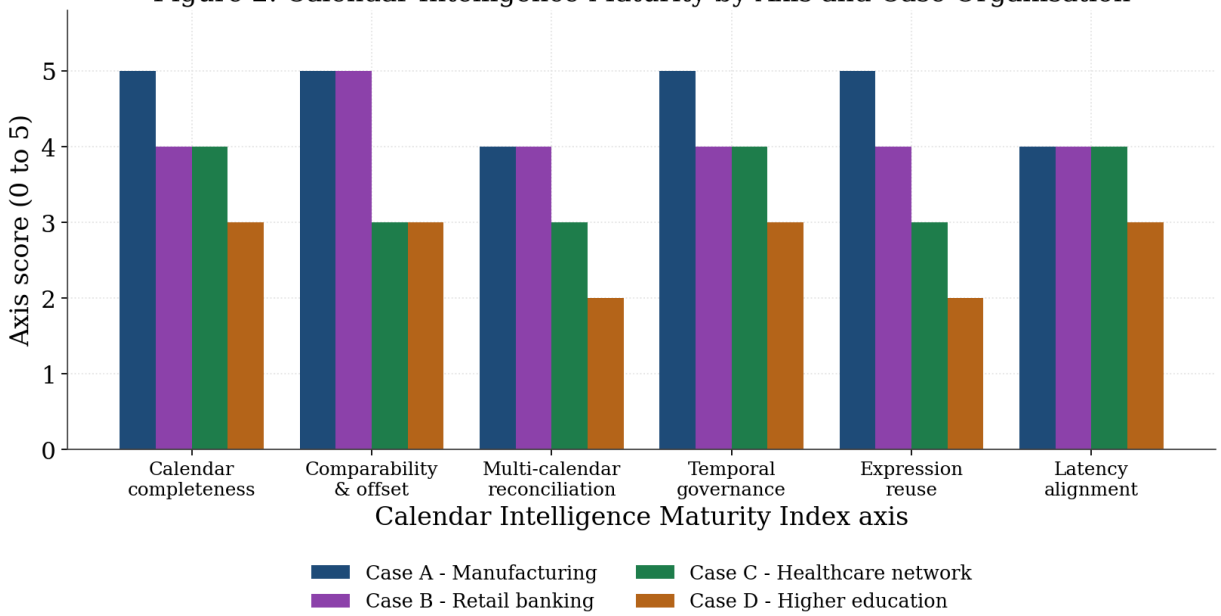


Figure 2: Calendar Intelligence Maturity Index axis scores by case organisation

4.2 Outcome Indicators and their Association with Maturity

The objective outcome indicators in Table 4 order themselves by CIMI score without exception across the six indicators and four cases. Executive report cycle time after implementation is 14.2 hours in Case A against 44.1 in Case D; time to insight for an ad-hoc executive query is 6.4 minutes against 28.4; reported-figure disputes are three per quarter against twenty-one; and executive self-service adoption is 88.6 % against 48.9 %. With four cases this ordering cannot support an inferential claim, and it is reported as a rank consistency rather than as a correlation.

Two indicators deserve separate comment. The certified measure reuse ratio - the mean number of reports consuming each certified measure - rises from a mean of 1.5 to 5.5, and its spread across cases tracks the

expression-reuse axis closely, which is expected since the two are near-neighbour constructs. More interesting is the P95 render time, which is the one indicator that does not improve monotonically: Case D deteriorated from 8.6 to 9.4 seconds. Investigation established that this case had added considerable reporting content on a largely unchanged temporal foundation, so that the additional load was not offset by the efficiency gains the other cases obtained from offset-key navigation and aggregation alignment. This is the clearest evidence in the study that content growth on an immature spine is actively harmful rather than merely unproductive.

4.3 Survey Results

All five constructs improved substantially between the two waves, as Figure 3 shows. The overall reporting index rose from 2.77 to 4.25 on the five-point scale, an increase of 1.48 points. The largest gain was in comparative confidence, from 2.61 to 4.22, and the lowest post-implementation mean was in self-service efficacy at 4.06, which remains the weakest construct despite the largest proportional gain. Construct reliability was acceptable throughout, with Cronbach alpha between 0.84 and 0.91 and 0.93 for the full nineteen-item index.

A respondent-level ordinary least squares regression of the overall reporting index on the respondent's organisational CIMI score, controlling for role level, tenure and weekly platform usage, yields a coefficient of 0.46 index points per CIMI point (standard error 0.07, $t = 6.57$, $p < 0.001$) with an adjusted R-squared of 0.41. Construct-level coefficients are reported in the final column of Table 5 and are highest for comparative confidence at 0.61 and temporal trust at 0.58, and lowest for timeliness at 0.34. This ordering is theoretically coherent: comparative confidence and temporal trust are the constructs most directly dependent on calendar semantics, whereas timeliness depends substantially on refresh infrastructure that is only partly a calendar concern.

The regression must be interpreted with care. Respondents are nested within four organisations and the predictor varies only between organisations, so the effective number of independent observations on the predictor is four rather than 142, and the reported standard error is consequently optimistic. The result is presented as a description of the association within this sample and not as an estimate of a population parameter; a design with more organisational clusters would be required for the latter.

Figure 3. Executive Reporting Construct Means Before and After, n = 142

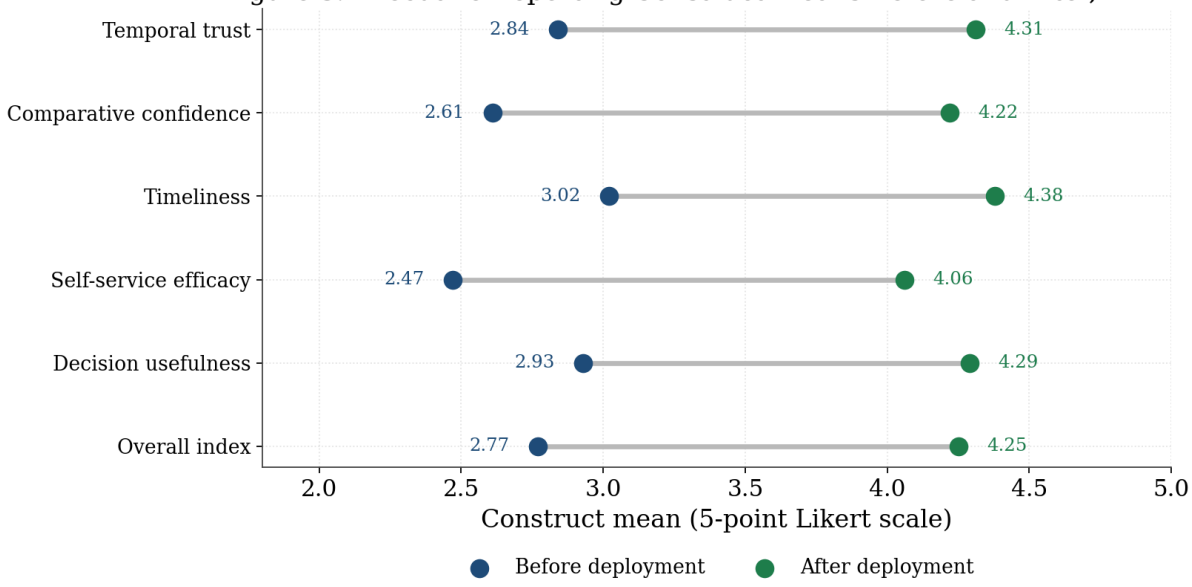


Figure 3: Executive reporting construct means before and after implementation, n = 142

5. DISCUSSION

Five issues arise from these findings.

First, on the central structural claim: the framework asserts that the calendar is the substrate of the other four reporting dimensions rather than a fifth concern of equal standing. The case evidence supports this in a specific way. In every case the observed failures of the organisational, comparative and scenario dimensions reduced on

investigation to calendar failures - a consolidation that could not be trusted because two divisions closed on different grids, a budget variance that was not comparable because the budget was approved monthly and recorded in fiscal periods, a scenario whose horizon shifted when the fifty-third week arrived. Executives did not experience these as calendar problems; they experienced them as unreliable numbers. This gap between where a defect originates and where it is perceived is, on this evidence, the reason the temporal layer is chronically under-invested.

Second, on the maturity instrument: the axis-level pattern - narrow range on latency alignment, wide range on expression reuse, lowest mean on multi-calendar reconciliation - suggests that CIMI is capturing a genuine developmental sequence rather than simply restating overall BI maturity. The two low-mean axes are precisely those requiring architectural authority over multiple business units, which is consistent with the governance findings of Yeoh and Popovic [4]. The instrument is at an early stage of validation, with content validity established through the procedure of Becker et al. [11] and inter-rater agreement of 87.5 %, but no construct validation across a larger sample.

Third, on the higher-education counterexample: Case D shows that temporal complexity is not a function of data volume. Its ninety-five-million-row model is the smallest in the study, yet its two non-nesting period hierarchies - an academic calendar of terms and a financial year - constitute a harder reconciliation problem than anything in the manufacturing case. The practical implication is that the common heuristic of sizing temporal investment to data volume is wrong; it should be sized to the number of legitimate, mutually non-nesting period hierarchies the organisation must report on simultaneously.

Fourth, on the deterioration in Case D's render time: this is the study's only negative result and it is instructive. Adding reporting content on an immature spine produced a measurable deterioration in performance where the other three cases improved. The generalisable inference is that the relationship between content growth and reporting quality is conditional on spine maturity - a claim that would be worth testing directly, since it implies that the common practice of expanding an executive reporting estate before consolidating its temporal foundation is not merely inefficient but counterproductive.

Fifth, on what the evidence cannot bear: the outcome ordering across four cases is a rank consistency, not a correlation, and the respondent-level regression is clustered in a way that inflates apparent precision. Furthermore, all four cases used the same implementation partner, which strengthens internal comparability while introducing a common-method concern: an implementation-partner effect cannot be distinguished from a framework effect in this design. The findings are best read as a well-instrumented demonstration of a mechanism across varied calendar conventions, rather than as an estimate of effect size.

6. RECOMMENDATIONS

The findings support four clusters of recommendation, sequenced as a four-stage implementation roadmap.

6.1 Stage One: Establish the Spine

Before any dimension-level work, the organisation should establish a single marked, contiguous and fully attributed date dimension generated within the model, carrying surrogate integer keys at every reporting grain, business-day and event attributes, and a comparability key mapping each period to its true historical analogue. Role-playing requirements should be met through inactive relationships in the measure layer, never through duplicate date tables. The calendar specification should be a governed, versioned document with a named owner.

6.2 Stage Two: Reconcile the Calendars

Where the organisation reports on more than one legitimate period hierarchy, an explicit calendar map table should be built that relates each local period key to the group comparability key, and all cross-entity consolidation should traverse that map rather than assuming alignment. The number of mutually non-nesting hierarchies, rather than the data volume, should determine the investment in this stage. Organisations should resist the temptation to declare one hierarchy authoritative and force the others onto it, since in cases such as the academic calendar both hierarchies are genuinely required.

6.3 Stage Three: Consolidate the Expression Layer

Time-intelligence patterns applied to more than two base measures should be migrated into a calculation group so that each pattern exists exactly once, with format strings defined at calculation-item level. A regression suite should

evaluate each calculation item against fixed reference periods, including irregular periods and both fiscal-year boundaries, and should run on every model deployment. Expression reuse was the widest-ranging axis in this study and is the one on which organisations most commonly stall.

6.4 Stage Four: Align Latency and Govern the Estate

Incremental refresh should be partitioned on fiscal rather than calendar boundaries, and freshness contracts should be stated and evaluated in business days using the spine's own business-day attribute, so that the contract is machine-evaluable and can be published alongside the figure it qualifies. Thereafter the estate should be governed by measuring the spine: CIMI or an equivalent instrument should be re-scored annually, and content expansion should be gated on spine maturity, given the evidence from Case D that growth on an immature foundation degrades rather than improves the reporting experience.

7. LIMITATIONS AND FUTURE SCOPE

Six limitations should be recorded. First, four cases cannot support inferential generalisation, and the consistent ordering of outcomes by CIMI score is reported as rank consistency rather than as a correlation. Second, all four implementations used the same external partner, so an implementation-partner effect is confounded with the framework effect. Third, the survey regression is clustered, with a predictor varying only across four organisations, so its reported standard error is optimistic and the coefficient should not be read as a population estimate. Fourth, the CIMI instrument has content validity and acceptable inter-rater agreement but no construct or predictive validation on an independent sample, and its equal weighting of six axes is an unexamined simplification. Fifth, the pre- and post-implementation survey design cannot separate the framework effect from general improvement or from respondent expectation. Sixth, outcomes were measured at reporting-process level rather than at the level of decision quality or financial result.

Five directions for further work follow. A larger multi-organisation study with sufficient clusters would permit a properly specified multilevel model of the maturity-outcome association. Validation of the CIMI instrument on an independent sample, including examination of axis weighting and of whether the six axes form one factor or several, would establish its measurement properties. A longitudinal design tracking a single organisation across maturity levels would address the confound between maturity and other organisational differences. Direct testing of the Case D inference - that content growth on an immature spine degrades reporting quality - would be valuable, since it carries a clear practical prescription. Finally, extension of the framework to organisations reporting under multiple regulatory calendars simultaneously, such as multinational groups with divergent statutory year-ends, would test the multi-calendar reconciliation axis at its limit.

8. CONCLUSION

This paper developed a multi-dimensional business intelligence framework for executive reporting in Power BI, specifying five reporting dimensions - temporal, organisational, comparative, scenario and latency - bound together by a calendar intelligence spine, and operationalising the maturity of that spine on a six-axis Calendar Intelligence Maturity Index. The framework was evaluated through a mixed-methods, multi-case design across four organisations selected for maximum variation in calendar convention, combining platform telemetry and documentary analysis with a two-wave survey of 142 executives.

CIMI scores ranged from 2.67 to 4.67 and ordered every objective outcome indicator across the four cases: executive report cycle time after implementation of 14.2 hours in the highest-maturity case against 44.1 in the lowest, time to insight of 6.4 against 28.4 minutes, disputes of three against twenty-one per quarter, and self-service adoption of 88.6 % against 48.9 %. The overall executive reporting construct index rose from 2.77 to 4.25 on a five-point scale, with the largest gains in comparative confidence and temporal trust - the two constructs most directly dependent on calendar semantics. A single negative result, the deterioration of render time in the lowest-maturity case, indicates that content growth on an immature spine degrades rather than improves the reporting experience.

Five design principles are formalised. The calendar is substrate, not sibling: the organisational, comparative, scenario and latency dimensions each resolve through it, and a defect in it surfaces elsewhere as an untrustworthy number. Reconciliation should be explicit, since organisations with legitimately non-nesting period hierarchies must map them rather than force one onto the other. Complexity follows hierarchies, not volume, so temporal

investment should be sized to the number of mutually non-nesting calendars rather than to model size. Temporal logic belongs in the dimension and the calculation group, not in the measure portfolio. And maturity should be measured, since a capability that is not scored is not sequenced, and content expansion should be gated on it. Together these principles reposition the calendar from an incidental modelling detail to the organising structure of executive reporting.

References:

[1] H. J. Watson, R. K. Rainer, and C. E. Koh, "Executive information systems: a framework for development and a survey of current practices," MIS Quarterly, vol. 15, no. 1, pp. 13–30, 1991.
[2] H. J. Watson and B. H. Wixom, "The current state of business intelligence," Computer, vol. 40, no. 9, pp. 96–99, 2007, doi: 10.1109/MC.2007.331.
[3] D. Arnott and G. Pervan, "A critical analysis of decision support systems research revisited: the rise of design science," Journal of Information Technology, vol. 29, no. 4, pp. 269–293, 2014.
[4] W. Yeoh and A. Popovic, "Extending the understanding of critical success factors for implementing business intelligence systems," Journal of the Association for Information Science and Technology, vol. 67, no. 1, pp. 134–147, 2016.
[5] R. Kimball and M. Ross, The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modeling, 3rd ed. Indianapolis, IN: John Wiley and Sons, 2013.
[6] M. Golfarelli and S. Rizzi, Data Warehouse Design: Modern Principles and Methodologies. New York, NY: McGraw-Hill, 2009.
[7] A. Ferrari and M. Russo, The Definitive Guide to DAX: Business Intelligence for Microsoft Power BI, SQL Server Analysis Services and Excel, 2nd ed. Redmond, WA: Microsoft Press, 2019.
[8] M. Russo and A. Ferrari, DAX Patterns, 2nd ed. Milan, Italy: SQLBI Corporation, 2020.
[9] M. Russo and A. Ferrari, "Calculation groups in DAX and Power BI: patterns and pitfalls," SQLBI Technical Article Series, vol. 9, no. 2, pp. 1–24, 2021.
[10] Microsoft Corporation, "Power BI implementation planning: data architecture and semantic model guidance," Microsoft Learn Documentation, Redmond, WA, 2024.
[11] J. Becker, R. Knackstedt, and J. Poppelbuss, "Developing maturity models for IT management: a procedure model and its application," Business and Information Systems Engineering, vol. 1, no. 3, pp. 213–222, 2009.
[12] D. Raber, R. Winter, and F. Wortmann, "Using quantitative analyses to construct a capability maturity model for business intelligence," in Proceedings of the 45th Hawaii International Conference on System Sciences (HICSS), Maui, HI, 2012, pp. 4219–4228.
[13] G. Lahrmann, F. Marx, R. Winter, and F. Wortmann, "Business intelligence maturity: development and evaluation of a theoretical model," in Proceedings of the 44th Hawaii International Conference on System Sciences (HICSS), Kauai, HI, 2011, pp. 1–10.
[14] W. H. DeLone and E. R. McLean, "The DeLone and McLean model of information systems success: a ten-year update," Journal of Management Information Systems, vol. 19, no. 4, pp. 9–30, 2003.
[15] S. Petter, W. DeLone, and E. R. McLean, "Measuring information systems success: models, dimensions, measures, and interrelationships," European Journal of Information Systems, vol. 17, no. 3, pp. 236–263, 2008.
[16] O. Isik, M. C. Jones, and A. Sidorova, "Business intelligence success: the roles of BI capabilities and decision environments," Information and Management, vol. 50, no. 1, pp. 13–23, 2013.
[17] A. Popovic, R. Hackney, P. S. Coelho, and J. Jaklic, "Towards business intelligence systems success: effects of maturity and culture on analytical decision making," Decision Support Systems, vol. 54, no. 1, pp. 729–739, 2012.