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Title:

LONGITUDINAL-GROUNDED CASE STUDY OF A PROJECT MANAGEMENT INFORMATION SYSTEM: A REALITY CHECK.

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Abstract: *This paper presents the methodology and findings of a longitudinal-grounded case study of the ambitious implementation of a PMIS within the public works organization of the HKG SAR. It has provided an opportunity for practical experimentation through the quantitative measurement of 'before' and 'after' effects arising from a change in management techniques. These were substantially dependent upon the introduction of a novel PMIS that conformed to the Cleland and King model for a portfolio-management-system that is added-value gained from a project-management data pipeline. The timing of the implementation and its attributes makes it an appropriate vehicle for experimentation to substantiate the Cleland and King proposition for project and portfolio management in multi-projects scenarios. A triangulated-search of the case files covering all aspects of the implementation of the PMIS provides a reality check of the construction business issues that drive systems implementation. It leads to the observation that empirical research into the day-to-day reality of IT innovation within the industry is essential if the gap between research and practice is to be narrowed. Pre and post implementation measurements of performance are used to assess the results achieved from this example of in-practice innovation. At least a three-fold improvement in spending performance was achieved when five years post implementation performance was compared to the five-year pre-implementation period.*

INTRODUCTION

This paper presents the methodology and findings of a longitudinal-grounded case study of the ambitious implementation of a PMIS within the public works organization of the Government of the Hong Kong Special Administrative Region (HKG SAR). A triangulated-search of the case files covering all aspects of the implementation of the PMIS provides a reality check of the construction business issues that drive systems implementation. Pre and post implementation measurements of performance are used to assess the results achieved from this example of in-practice innovation.

The fast track implementation of the Public Works Management System (PW_MS) was part of a revitalised approach to the management of their large programme of public works¹. This change included emphasis on a 'project management approach' to the delivery of the projects within the Public Works Programme of the HKG SAR. The PWP managed with the assistance of the PW_MS is a rolling-programme of projects that includes up to seventy-two types of public infrastructure. The projects within the PWP vary according to the policies of the HKG SAR and the consequent demand for infrastructure but the scale of the portfolio is sufficiently large to ensure that it has great diversity. Table 1 lists some of the attributes of the PWP at March 31, 1999 to illustrate the diversity and scale of this portfolio of projects. The PW_MS is complicated but largely complies with the model proposed by Cleland and King² for an MIS that serves concurrently as a project management tool and for the management to portfolios-of-projects as a whole. Its purpose is twofold: to support project management of the projects and to provide corporate control for the PWP portfolio of projects as a whole. These two objectives comply with the fourteen requirements for a project-management MIS as stated by Cleland and King in their seminal work in 1983. Table 2 lists them and comments on corresponding intentions for the PMIS deployed for the management of the PWP. This case study thus provides insight into the application of a MIS to manage projects and the portfolio of projects. Research within the population samples of Hong Kong contractors and Hong Kong consultant firms showed that this approach is not generally adopted³. In this sense, the PWP MIS provides a unique opportunity to record an uncommon practical experiment that follows the precepts stated in Table 2.



PWP at 31 March, 1998	Values
No projects	<ul style="list-style-type: none"> 886 No. Expenditure per annum per project, <ul style="list-style-type: none"> High = HKD 510 million Low = HKD <0.1 million Median = HKD 3.4 million Mode = HKD <0.1 million Mean = HKD 19.9 million SD = HKD 48 million
Diversity of projects	<ul style="list-style-type: none"> 48 out of 72 categories of infrastructure
Diversity of Clients	<ul style="list-style-type: none"> 16 Clients. e.g., Nos projects for 3 most active Clients; <ul style="list-style-type: none"> 233 No Planning, Env't, Lands Bureau 147 No Works Bureau 139 No Transport Bureau
Diversity of Controlling Officers	<ul style="list-style-type: none"> 10 No. e.g., Nos projects for 3 most active are; <ul style="list-style-type: none"> 307 No Director Architectural Services 199 No Director Territory Development 105 No Director of Highways

Table 1 Statistical indicators of the diversity of the PWP at March 1998 for the financial year 1998-1999.

#	Cleland and King ³ Criteria	PW_MIS
1	Provide essential information on the cost-time-performance parameters of a project and on the interrelationships of these parameters.	Yes
2	Provide information in standardised form to enhance its usefulness to top management for multi-project control and long range planning.	Yes
3	Be decision-orientated, in that information reported should be focused toward the decisions required of the project manager and top management.	Yes
4	Provide for customer-reporting requirements.	Yes
5	Be exception-orientated, in that it will focus the manager's attention on those critical areas requiring attention rather than simply reporting on all areas and requiring the manager to devote attention to each	Yes
6	Fit into the organisation information system and strategic planning system.	Yes
7	Be prospective in nature rather than retrospective, in that it should give special attention to potential problem areas within the project; it should, in effect be an 'early warning' system for the project manager.	Yes
8	Incorporate both external and internal data to provide a capability for keeping track of evolving projects in the customer's organisation. In his fashion, the PMIS can interface with an organisational strategic management system.	No
9	Be consistent with existing project management guides and procedures.	Yes
10	Be consistent with policy documentation developed by the organisation.	Yes
11	Provide a capability for routine reporting, exception reporting, and special analyses (such as statistical analyses) which may be desired by the project manager or top management.	Yes
12	Provide for measurement of the critical project-functional interface, so that the project manager and functional manager will have data on which to base those decisions for which authority and responsibility are shared.	Yes
13	Provide a basic data requirement for functional managers to furnish to the project office and to facilitate in-house functional visibility.	No
14	Provide for project visibility during phases of a project life cycle.	Yes

Table 2 Applicability of the Cleland and King requirements for a PIMS in the case study.

It is a suitable case study of an in-practice experiment for several reasons. One, the requirement for change and the subsequent implementation is documented in correspondence files that allow the triangulation of supporting statements. Two, the system has been in operation for five years, long enough to become an established operational practice so that the user response to a questionnaire survey are based on norms of performance. Three, there are quantitative records of PWP performance before and after the change that provide a measurement of the impact of the change. Four, there is a population sample of five hundred and ninety three registered users of the MIS. This sample size is large enough to provide statistically robust measures of user satisfaction. Five, the PWP is made of individual projects whose impact on the portfolio overall is mutually

exclusive. The lack of interrelationship between projects means that the performance of one project has no impact on others. Finally, six, the change of management approach was rapid: in the form of a 'big-bang' change to replace the predecessor process. This reduces confusion due to the overlap of processes that would occur in a gradual introduction of change. The new approach was universally introduced within a large organisation delivering more than fifteen hundred varied projects within an overall portfolio-of-projects of singular known objective. The results are consequently broad-based, thus providing robust measurement of effect.

In the absence of a final statement of functional requirement for the PW_MS and because the management debate during implementation reflects subjective attitudes toward the implemented system, the emerging functional requirement has been traced in chronological order and audited against the physical system. The inception and early development of the PW_MS is observed in terms of the decisions and objectives of the day to explain them in the context the evolution of the PW_MS. It also illustrates changes of intent dictated by the prevailing environmental circumstances, especially the drivers for change.

DRIVERS FOR CHANGE

The leadership for a change in approach in the management of the PWP was from the senior-levels of the HKG SAR. The need for change was driven by unacceptably high levels of under-spending of the funds allocated to public works. In his 1993-94 Budget speech, the Financial Secretary reported that he was no longer tolerant of the trend of continuing under-spending. He went on to announce the initiative for an improvement to the delivery of the PWP that included the implementation of the PW_MS. Whilst the vision for the PW_MS was clear, the detail was unspecified. The functional requirements for the MIS developed over time. A triangulated-search of the case files held by the Works Bureau of the HKG SAR has been used to identify the evolving functional requirements for the PW_MS and their delivery. An audit of the implemented PW_MS against the specified functionality is used to measure the extent that it meets the stated needs of the project/portfolio management system. The pre-change, and the post-change performance in terms of project-delivery, is assessed using qualitative statements and quantitative measurement derived from published data on the public-works-programme of projects of the HKG SAR.

FAST-TRACKED IMPLEMENTATION OF THE PW_MS.

Due to time constraints a rapid prototyping implementation was used instead of more definitive SSADM methodologies. As a result, the PW_MS was implemented in an ad hoc pragmatic manner without a clear statement of the functional requirement. Proprietary software was selected that was the closest fit to the problem. Gaps in the functionality of the software were bridged with customised-coding of the product commissioned from the manufacturer.

Using a systems approach of diagnostic analysis⁴, the implementation of the PW_MS is seen to follow three fundamental stages of development: 'conception', 'inception', and 'construction'. Key decisions were made between these stages. These determined the nature of the system and how it was introduced into the public works organisation of the HKG SAR. Whereas, the fundamental management influences to the implementation are identified as: 'corporate leadership and commitment'; 'business drivers for change'; and 'concern for detail'.

The key-decision that defined the end of the PW_MS conceptual work, was the public announcement by the Financial Secretary of the initiative for a 'project management approach to delivery of the PWP'²⁰. The characteristics of the conceptual work on the PW_MS are identified in Table 3. The decisions made within the inception stage of the implementation were founded on the objectives and the constraints announced earlier by the Financial Secretary. McKinsey Inc was appointed as consultants to the Secretary for Works and became the prime-movers for the fast-track implementation. They imposed strategies that would fulfill the requirements of the conception. The characteristics of the inception stage of the PW_MS implementation are identified in Table 4. The award of a contract to develop the pilot system using a uniquely-customised version of Panorama[®] software without agreeing a detailed final specification of Functional Requirement was the second key decision. It delineated the end of inception and the start of the construction stage of the PW_MS implementation. It permitted a high-degree of flexibility in defining the 'minimum-core-requirements' of the initial PW_MS. The characteristics of the construction stage of the PW_MS implementation are identified in Table 5.

CONCEPTION STAGE OF IMPLEMENTATION

High Degree Of Corporate Leadership And Commitment Due To:

- Leadership and commitment to achieve an early implementation of a project/portfolio management information system (PW_MS), was driven from the highest levels of authority within the HKG SAR;
- The PW_MS was publicly announced within the context of the 1993/94 budget as a major component of Government policy for effective management of the public works programme;
- Implementation was steered in a transparent fashion by high-ranking government officials at ministerial level, respected leaders of the construction industry, and by politicians with appropriate cognate experience;
- A powerful consensus of the Directors of the Works Departments supported the initiative; and,
- McKinsey Inc., were hired to assist in this undertaking.

Business Drivers For Change Were Paramount Due To:

- The cost of the MIS was not an issue but the urgent need for a useable system was a predominant concern as the Financial Secretary had already stated that it would be in operation within nine months;
- Within this timeframe, the development of a customised MIS using SSADM and PRINCE methodologies was agreed as not practicable;
- The PW_MS was conceived as a critical-success-factor in the business of project/portfolio procurement. The information technology involved was a secondary consideration; and as a consequence,
- The project was lead as a business initiative by the business leaders with most to win from its success.

Low Apparent Concern For Detail Due To:

- The functionality of the MIS was not clearly stated, other than it would serve as an aid to the project management of the public works projects and would thus enable the Secretary for works to manage the whole of the PWP so as to match actual expenditure to budgeted funding.
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Table 3 Fundamental management influences at the 'Conception' stage of implementation.

INCEPTION STAGE OF IMPLEMENTATION

Moderate Degree Of Corporate Leadership And Commitment Due To:

- The leadership and commitment from the highest levels of authority, evident at the conception stage to achieve an early implementation of the PW_MS, was now content to subordinate their authority to McKinsey Inc who had been appointed with responsibility for recommendation and implementation; and
- The tendency to delegate-down decisions on detail but retain a 'steering' authority on the 'big-picture' become irrelevant as the importance of the detail outweighed other considerations.

Business Drivers For Change Were Paramount Due To:

- Definition using SSADM methods of a minimum set of functionality for the PW_MS was not achieved due to the Client's fixation on preserving the existing core-process of PWP procurement, some of which was enshrined in Hong Kong legislation;
- Selection of a UK-based proprietary software as the 'best-fit' solution that none-the-less required customisation to suit the Client's needs was a courageous decision that imposed managerial challenges in coordinating communications, understanding, and the production of software deliverables in the UK for issues arising in Hong Kong.

Low Apparent Concern For Detail Due To:

- Implementation of the PW_MS using a rapid-prototyping approach was determined as essential to bring the MIS into operational service within a nine-month project period;
 - Selection of a best-fit proprietary software solution was expedient and in keeping with the rapid prototyping, but it resulted in conforming the problem to fit the solution; and,
 - Lack of consultation with the Users on the adoption of software and by default, the Functionality, caused a lack of 'ownership' from the User community with regard to the change in the PWP delivery process. Resistance to change at the middle-management level became an issue from this moment forward.
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Table 4 Fundamental management influences at the 'Inception' stage of Implementation

CONSTRUCTION STAGE OF IMPLEMENTATION

Low Degree Of Corporate Leadership And Commitment Due To:

- The leadership and commitment from the highest levels of authority evident at the conception stage to achieve an early implementation of the PW_MS was further reduced to the extent that decision-making on 'technical' issues was substantially delegated to the consultants.

Business Drivers For Change Were Paramount Due To:

- The functional specification for the PW_MS was dictated by what was possible within existing constraints rather than desirable, excepting for a 'core' minimum set of requirements.

Low Apparent Concern For Detail Due To:

- Retrospective user-consultation showed dissatisfaction with the PW_MS functionality and performance; and,
 - Retrospective SSADM analysis showed lack-of-fit between desired and delivered functionality.
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Table 5 Fundamental management influences at the 'Construction' stage of Implementation

Table 6 shows the variation in the Owner's participation in the implementation.

Aspect ▼	Conception	Inception	Implementation
High level leadership and commitment	H	M	L
Business drivers are paramount	H	H	M
No apparent concern for detail	L	H	L

Table 6 Owner's involvement in the PW_MS implementation.

McKinsey Inc., completed their assignment on January 31, 1994 having managed the customisation of the core PW_MS software and the installation of a 50 terminal wide area network in a short period of time from November 1993 to the end of January 1994. The core-prototype PW_MS became operational in May 1994. However, the fifty-six terminals in the core-prototype PW_MS network did not provide enough access points for the regular update of project data. The system response was very slow, making it frustrating to use the software, and few people were trained in the operation of the PW_MS or the concepts of project management. To overcome some of these problems the core-prototype was rapidly expanded so that it would be equipped with a sufficient number of terminals distributed to system users so that data updates and report generation can take place quickly enough to produce timely progress reports and monitoring of projects. The pilot system implemented was a sub-set of the total ambition described in the Preliminary Technical Specification for the PW_MS. It comprised the core PW_MS functionality: 'baseline management and reduced scope change; exception generation and corrective action planning; generic templates for work-scheduling; work progress tracing using timesheets; annual resource planning process using aggregates of resource demand and availability.' Other desirable functions were to be delivered in subsequent stages of development. This did not take place. Adjustments to the software to remove the weaknesses recognised during prototyping were not fully implemented. This second stage of PW_MS implementation was carried out according to I.T. professional standards. ITSD appointed James Martin Ltd., information technology consultants, to this role. They were instructed to apply SSADM techniques as far as possible and work to PRINCE methodologies to provide an unbiased professional opinion on the 'weaknesses recognised during prototyping' and the status of the prototype PW_MS overall. The Final Report of 'Selected Business System Options'²⁵ identified the 'lack-of-fit' between the things the PW_MS could do, when compared to the things that needed to be done. These were the failings in the existing system that most threatened its viability in use. The IT contractor advised that, in the short term, these lack-of-fit' issues must be fixed to maintain an on-going service from the PW_MS. In the long term, the contractor recommended an early start to a fundamental re-development of the PW_MS. Irrespective of these detractions the PW_MS has remained in operational service since May 1994.

The implementation of the PW_MS successfully achieved its stated objectives. It was understood from an early stage that further, post-implementation development would be needed to fully establish the innovative system within the established public works organisation. The ambition for operational service within nine-months although challenging, was accomplished.

THE FUNCTIONAL STATUS OF THE PW_MS AT 5-YEARS POST-IMPLEMENTATION

Table 7 shows operational objectives defined for the PW_MS. The PW_MS was assessed at 5-years operational service against these benchmarks. The table is thus a critique of the functionality found within the PW_MS compared to the owner's objectives.

Attribute	Benchmark	Outcome
<u>Ease of access</u>	256 terminals to interconnect stakeholders	168 terminals, 42:1 to 4:1 projects/terminal.
<u>Ease of use</u>	MS.Windows®' type operation Pull-down menus Mouse driven	Without on-line 'Help'. Inappropriate terminology No 'hourglass' indicators Deemed 'hard and slow to use'
<u>Proficient use</u>	Hands-on training Training manuals	the PWSAU noted ²⁶ that, '[it] is more difficult to use on a routine basis, compared to most PC-based word-processing or spreadsheet software. Its response is much slower than PC's and it uses a high degree of project management jargon.'
<u>Good fit to purpose</u>	Easy to operate Speedy response	

Table 7 Comparison of desired utility and outcome

To alleviate these failings, the system administrators proposed: increasing user skills within the software and in project management expertise by training. Modifying the software to remove the lack-of-fit between the software and the functional needs; and modifying current practices so that the PW_MS is used as the single source of PWP data for RAE and Estimates purposes. Some of these initiatives have been carried through.

Production of information from the PW_MS

A fundamental requirement of the PW_MS is that it must feed information to managers so that the PWP projects and the portfolio of projects is executed with efficiency and effectiveness. The Preliminary Functional Specification²⁹ accepted by the Steering Committee, states that 'customised reports should be [created] without programming [expertise]'. In practice, the PW_MS can provide information on the PWP and it's projects in three ways. From an inter-active use of the PW_MS when information is presented on the PW_MS screens; from the PW_MS reports; and from data taken from the PW_MS database and imported via a pre-programmed data download into other software for re-use. There is a limited flexibility to improve the production of information from the PW_MS. Writing the PW_MS paper reports requires a high degree of knowledge of the PW_MS, expertise in computer programming, and detailed knowledge of the Oracle database, whereas writing screen reports requires access to computer coding that is only possible technically and legally by PSCL. In some areas, particularly baseline date information, the data required for meaningful reports is not recorded within the PW_MS²⁵. It is worth noting that the SSADM consultants recommended that an improvement in the flexibility of producing information was possible by a data-download into other report writing software. In 1998 the PWSAU implemented this solution with a limited data-download into a FoxPro™ database. The consultants also recommended the introduction of data-warehouse techniques so that flexibility in report writing is also achieved. The Works Bureau has not agreed to implement a data-warehouse on the PW_MS network.

Use of information from the PW_MS

The PWSAU⁵ intend that the PW_MS should provide useful information to the key participants in the PWP delivery process; namely: the works departments; the enabling departments; the client bureaux; and the managers of the PWP – primarily the Secretary for Works and the Secretary for the Treasury. The Works Group of Directors⁶ agreed in 1995 that the PW_MS should be used so as to be the single source of PWP data by project and by programme. It is difficult to measure the degree of use of PW_MS information by the works departments and the enabling departments. PW_MS statistics measure the number of times a report is printed at user request. They show a high degree of use of project-level reports. User representatives state their acceptance of the data download facility but have asked for improvement and a greater range of data to be made available to them.

Results of the change in the PWP process

Post-change performance measurement

On the 17th March, 1999, the Secretary for Works stated in his annual report to the Special Finance Committee Meeting of Legco⁷;

‘Last year, we successfully reduced under-expenditure from 36% in 1991/92 to about 6% in 1996/97. In this financial year [1998-97], we have further reduced the under-spending on PWP to around 5%. These figures exclude the purchase of properties and land. In the next financial year, we estimate that the expenditure on public works will be maintained at a level comparable to that of last year. We budget to spend about \$22.8 billion and start 93 new PWP projects.’

This was queried further in a written/supplementary question to the Secretary for Works⁸ when he was specifically asked,

‘For project A002XZ [the PW_MS], comparing the actual expenditure with the original estimate, what were the percentages of underspending of the Public Works Programme in the past few years since the implementation of this system? Has the Government carried out any review to ascertain whether the system is cost-effective or not?’

The written reply by the Secretary for Works provided the annual percent underspending excluding land acquisition and purchase of premises as shown in Table 8. By the end of April 1999, provisional figures indicated an underspending on the PWP of 1.4%. This was the best performance achieved in ten years⁹. The record of the speaking notes of the Secretary for Works for the Special Meeting of the Finance Committee included a statement regarding the PW_MS, under the heading ‘... regular reviews of the on cost-effectiveness of the Public Works Management System’:

‘The system is an effective tool for project management. There has been a sustained trend of improvement in PWP spending (i.e. to a level below 5%) since implementation of the system. The output and benefits produced by the system are being monitored.’

Financial Year	Underspending %
1994-95	6.3
1995-96	9.1
1996-97	6.1
1997-98	3.4
1998-99	4.5 (estimated)

Table 8 Percent underspending on the PWP for the period 1994-95 to 1998-99.

Table 9 gives more detail to this official message of satisfaction with the effectiveness of the PW_MS. The figures are taken from the annual reports on public expenditure following the implementation of the PW_MS in 1992-93.

Financial Year 1993-94	Underspending (+ve)	
	Cf Estimate	Cf Am'd Estimate
Estimates		
Total outturn for 1993-94 ⇒	-3%	24%
Financial Year 1994-95	Underspending (+ve)	
Estimates	Cf Estimate	Cf Am'd Estimate
Total outturn for 1994-95 ⇒	6%	23%
Financial Year 1995-96	Underspending (+ve)	
Estimates	Cf Estimate	Cf Am'd Estimate
Total for 1995-96 ⇒	3%	27%
Financial Year 1996-97	Underspending (+ve)	
Estimates	Cf Estimate	Cf Am'd Estimate
Total for 1996-97 ⇒	12%	25%
Financial Year 1997-98	Underspending (+ve)	
Estimates	Cf Estimate	Cf Am'd Estimate
Total for 1997-98 ⇒	6%	21%

Table 9 PWP underspend in percent for 1993-94 to 1997-98

Comparison of pre and post change measurement

The measure of improvement achieved over a five-year pre-implementation period and also the post-implementation period is shown in Table 10. These figures provide quantitative measurements of an improved outturn performance after 1992/93 when the management of PWP spending was improved: to the extent that the outturn, twelve months after the publication of the target Estimates of spending, was approximately 6% on target. At least a three-fold improvement in spending performance compared to the five-year period before 1992/93.

Year	Cf. Estimates	Annual Difference	Cf. Rev Estimates	Annual Difference
87-88	18%	-	18%	-
88-89	22%	4%	-18%	0%
89-90	15%	-7%	-21%	-3%
90-91	-10%	-25%	-29%	-8%
91-92	-33%	-23%	-40%	-11%
92-93	-25%	+8%	-34%	6%
93-94	3%	+28%	-24%	10%
94-95	-6%	-9%	-23%	1%
95-96	-3%	3%	-27%	4%
96-97	-12%	-9%	-25%	-2%
97-98	-6%	6%	-21%	4%

Table 10 Comparison of spending performance pre and post PW_MS implementation in 92-93.

A similar improvement was not achieved for spending performance measured against the Revised Estimates. Revision to the published Estimates takes place throughout the financial year. The outturn comparison for the financial year against the Revised Estimates is not a good indicator of satisfactory project management. The PWP management process takes the latest approval of the Finance Committee as an approved change to the baseline programme of the project even though they are too late in the year to be managed successfully.

Conclusions

The figures in Table 10 indicate that the management of the PWP improved in the five year period after 1992/93, from the year that the Hong Kong Government imposed new practices and processes for the management of the PWP. There is no proof that this improvement is due to the PW_MS: although it is recognized that the PW_MS is an intrinsic and essential part of the new management approach. This leads to the observation that empirical research into the day-to-day reality of IT innovation within the industry is essential if the gap between research and practice is to be narrowed. With regard to the management results obtained from PW_MS, the figures in Table 10 indicate that the management of the PWP has improved in the five-year post implementation period. In 1999, at the Special Meeting of the Finance Committee, the Secretary for Works said that there had been a sustained trend of improvement in PWP spending i.e., to a level below 5% since implementation of the system. After 1992/93, the management of PWP spending over a five-year period improved to the extent that the annual outturn was approximately 6% on target. At least a three-fold improvement in spending performance compared to the five-year period before 1992/93. There is no proof that this improvement is due to the PW_MS: although the PW_MS is an intrinsic and essential part of the new management approach.

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