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AN INITIAL EMPIRICAL EVALUATION OF THE INFLUENCE OF ERP POST-IMPLEMENTATION MODIFICATIONS ON BUSINESS PROCESS OPTIMISATION

Research-in-progress

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Abstract

In this research in progress paper, we present and discuss an initial empirical evaluation of a model on ERP post-implementation modifications. The theoretical foundation and derivation of a set of propositions from the model were reported recently (citation withheld); it categorises post-implementation modifications to ERP systems and relates it to business process optimisation. While ERP systems can improve the efficiency, effectiveness and flexibility of business processes, the relationship between these measures of business process optimisation and post-implementation modifications is not adequately understood. By drawing on the post-implementation experience of a large Australian manufacturing company, we report several post-implementation modifications, and empirically classify them in light of our model. The model and empirical evidence together provide a convincing theoretical foundation for research into the impact of post-implementation modifications on business process optimisation, an important area for achieving competitive advantage. With empirical evidence (though initial), we are able to support the utility of our model as a useful managerial tool for clarifying differences amongst various modifications and guiding modifications and its implications to deliver business process optimisation.

Keywords: Business process optimisation, ERP, post-implementation, modifications

1 Introduction

Enterprise Resource Planning (ERP) systems are packaged suites of application software, capable of fully integrating business processes, and are adopted for enterprise management and business process optimisation (Grabski et al. 2011). Once implemented, organisations invariably make selective post-implementation modifications to maintain, update, and further align the system with the organisation's functions and strategies (Ng 2001). We define post-implementation modifications as all forms of changes carried out on the ERP system from the time it is implemented until it is substituted by another ERP system. Post-implementation modification begins after the implementation phase, and is undertaken during the use and maintenance, and evolution phases, and so includes maintenance, enhancements, and upgrades (Ng et al. 2002). To date, post-implementation modifications have generally received limited research attention (Law et al. 2010), and how organisations manage their

portfolio of modification projects has not been considered. Given the significant importance ERP systems play in supporting business operations, impacts of post-implementation modification initiatives need to be closely examined. In response, we have recently reported the development of a model of how ERP post-implementation modifications influence ERP capability and business process optimisation (Oseni et al. 2012). That model however lacks empirical validity. In this research-in-progress paper, therefore, we discuss an initial empirical evaluation of the model using an in-depth single case study conducted in a large Australian manufacturing company. The data gathered provides a rich description of ERP post-implementation modifications and of how ERP capabilities are enhanced to improve business process optimisation. Our analysis indicates that post-implementation modifications can be classified as maintenance, technical upgrades, enhancements, and functional upgrades, as described in our model, and that each activity fulfils a distinct and valuable role in ensuring the continued viability and fit of an organisational system.

2 Background Literature

ERP post-implementation studies acknowledge how that modifications take different forms (Ng and Gable 2010), and vary in their impact on organisations (Ng et al. 2002). Such changes and additions to an ERP system following implementation are generally labelled maintenance We find that reference has been made to motivations for modifications in the wider IS and ERP literature (Fedorowicz and Gogan 2010; Ng et al. 2002). However in such discussions, the type of motivation has not been used as a theoretical lens to understand the outcome of modifications to ERP systems. In other words, motivation is not a monolithic construct, and very little has been done to understand the relationship between the type of modification and the kinds of outcomes that organisations experience from an organisational motivation perspective. By organisational motivation, we mean high-level objectives of the organisation to initiate a particular project (Smith et al. 2008). This definition is supported by (Rahim et al. 2011), who suggests the existence of two types of motivations for IT projects. There are two types of motivation for ERP systems mentioned in the literature: business and technical. Business motivation refers to an organisational intention to gain benefits related to customer satisfaction and overall productivity. A technical motivation is an organisational intention to attain benefits drawing on the technical capabilities within the system (Themistocleous et al. 2001; Tomblin 2010). It is possible for organisations to conceive motivations for modifications due to the influence of external sources, for instance regulatory bodies and ERP vendors (Ng et al. 2002). However, regardless of external pressures, organisations tend to have internal motivations because they need to have business cases for modification initiatives.

Several studies also suggest that different organisational learning types are involved as organisations use, maintain and improve their ERP systems (Kraemmerand et al. 2003; Yamin and Sinkovics 2007). We thus argue that ERP post-implementation modifications are not only likely to reflect different organisational motivations, but also involve different organisational learning types. Organisational learning concerns the active use of data in guiding organisational behaviour (Edmondson and Moingeon 1998), and describes the efficient application of captured and assimilated knowledge to achieve positive influences on organisations' IT infrastructure and business experience (Kane and Alavi 2007; Tomblin 2010). Thus, an organisational learning lens is useful for understanding past experiences of an organisation with initial implementation and how such experiences may influence modification initiatives. March (1991) suggests two types of organisational learning: exploration - discovery and innovation; and exploitation- refinement and extension of existing competencies.

Based on a review of ERP literature, we observe that outcomes of post-implementation modifications have not been widely investigated. For instance, some studies report the impact of ERP implementations on business process efficiency, effectiveness and flexibility; however, no considerations were given to the possible impact of post-implementation modifications. To address this gap, in our earlier publication, we reported the development of a model which classifies ERP post-implementation modifications, with propositions of how each category influences business process optimisation. Business process optimisation (BPO) is as an approach aimed at improving

business processes by elevating efficiency, effectiveness and flexibility of business processes within organisations (Hammer & Champy, 1993). Each measure of BPO is briefly defined in Table 1.

BPO	Definition	Measures
Business Process Efficiency	The conversion of input to output in the shortest time possible with the lowest utilisation of resources (Trischler 1996)	Reduction in operational cost; Reduction in input/output ratio, Reduction in error correction work (Karimi et al. 2007a; Lee et al. 2011)
Business Process effectiveness	The satisfaction of one or more business objectives while meeting or exceeding the recipient stakeholder's needs (Trischler [illegible])	Better and timely access to corporate data; Higher levels of enterprise-wide data integration (Karimi et al., 2007a)
Business Process Flexibility	The ability to adjust quickly and easily to changes in internal constraints or stakeholder requirements (Trischler 1996)	New ways to customise processes (Karimi et al. 2007a; Lee et al. 2011)

Table 1: Definitions and measures of business process optimisation (Trischler 1996)

We argue that business process optimisation derives from three ERP capabilities: automational (ERP capability to integrate and derive value by substituting capital asset for labour and reducing cost, leading to process efficiency); informational (ERP capability to collect, store, process and disseminate information, leading to process effectiveness); transformational (ERP capability to facilitate and support process innovation and transformation, leading to process flexibility) (Karimi et al. 2007b; Mooney et al. 1996; Uwizeyemungu and Raymond 2012). A brief description of the model, which we refer to as ERP-PIM model is provided in the next section.

3 The ERP-PIM Model

The model presents four distinct categories of ERP modifications linking to three measures of business process optimisation. The model is explanatory and predictive (Gregor 2006) and is founded on the premise that variation in business process optimisation gained from ERP systems can be explained by a corresponding variation in ERP modifications initiatives. This variation is dependent on ERP capabilities accrued as a result of the modification, which is influenced by organisational motivation and organisational learning. The model (Figure 1) is expressed in two parts: a typology of ERP modification initiatives (left hand side); and a set of propositions (shown as an arrow) linking types of ERP modifications to business process optimisation (efficiency, effectiveness and flexibility).

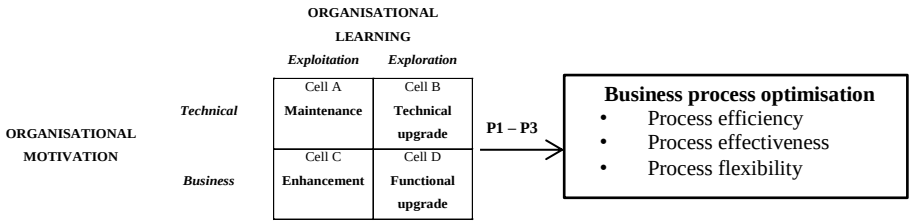

Figure 1 ERP-PIM Model

Typology: The typology identifies four categories of ERP post-implementation modifications as a result of organisational motivation and learning: *Maintenance* represents a category in which organisations undertaking ERP modifications are driven by a technical motivation and a desire to use the 'exploitation' organisational learning approach to support modification initiatives. With *maintenance*, organisations are interested in minor corrections due to technical bugs. *Technical upgrade* represents a category in which organisations undertaking ERP modifications are driven by a technical motivation and a desire to use the 'exploration' organisational learning approach to support modification initiatives. A technical upgrade is undertaken to move an implemented system onto the latest technology platform, without implementing new functionality capable of changing user behaviour or business processes. *Enhancement* represents a category in which organisations

undertaking ERP modifications are driven by a business motivation and a desire to use the 'exploitation' organisational learning approach to support modifications initiatives. We argue that with *enhancement* modifications, organisations will seek the inclusion of new business functionalities within their ERP modification initiatives and will request bolt-on functionalities, new modules, customizations, as well as the creation or modification of user interfaces. *Functional Upgrade* represents a modification category in which organisations are driven by a business motivation and a desire to use the 'exploration' organisational learning approach to support modification initiatives. A functional upgrade is generally undertaken to extend the business process functions of an existing ERP system to develop new business functionality on a new technical platform.

Research propositions: The propositions concern the influence of modification categories on business process efficiency, effectiveness and flexibility. We argue that the outcome achieved from a post-implementation modification will depend on what ERP capability is improved as a result of the modification. As indicated in Section 2.0, these capabilities include automational, informational and transformational ERP capability; respectively facilitating efficiency, effectiveness and flexibility. ERP capability will vary across all four categories of ERP modifications due to varying motivations and organisational learning. For instance, maintenance modifications will increase no ERP capability, while enhancement modifications are able to improve automational and informational ERP capability. The propositions are segregated into P1 (efficiency), P2 (effectiveness) and P3 (flexibility) in Table 2.

ERP-PIM category	**P**	**Business process optimisation: (***Efficiency, Effectiveness, Flexibility)*
Cell A Maintenance	P1a	will have no impact on *Business Process Efficiency*
	P2a	will have no impact on *Business Process Effectiveness*
	P3a	will have no impact on *Business Process Flexibility*
Cell B Technical upgrade	P1a	will have no impact on *Business Process Efficiency*
	P2a	that increases informational ERP capability will improve *Business Process Effectiveness*
	P2b	that does not increase informational ERP capability will not improve *Business Process Effectiveness*
	P3a	will have no impact on *Business Process Flexibility*
Cell C Enhancement	P1b	that increases automational ERP capability will improve *Business Process Efficiency*
	P1c	that does not increase automational ERP capability will not improve *Business Process Efficiency*
	P2b	that increases informational ERP capability will improve *Business Process Effectiveness*
	P2c	that does not increase informational ERP capability will not improve *Business Process Effectiveness*
	P3a	will have no impact on *Business Process Flexibility*
Cell D Functional Upgrade	P1b	that increases automational ERP capability will improve *Business Process Efficiency*
	P1c	that does not increases automational ERP capability will not improve *Business Process Efficiency*
	P2b	that increases informational ERP capability will improve *Business Process Effectiveness*
	P2c	that does not increase informational ERP capability will not improve *Business Process Effectiveness*
	P3b	that increases transformational ERP capability will improve *Business Process Flexibility*
	P3c	that does not increase transformational ERP capability will improve *Business Process Flexibility*

Table 2: Propositions linking ERP-PIM categories to business process outcomes

4 Research Approach

There are no existing frameworks to explain the association between ERP modifications and business process optimisation. Thus, our study is theory-building, and is conducted from a critical realist ontological perspective. As our study attends to how and why ERP post-implementation modifications influence business process optimisation, it can be described as an IS evaluation research (Carlsson 2009), seeking to explain rather than predict.. With this approach, our goal is not simply to verify our

propositions, but to understand what circumstances promote or inhibit business process optimisation. While the critical realist study can be conducted using a mix of quantitative and qualitative data, we adopt a qualitative case study approach because it is ideal for capturing context, including past experience with ERP implementation. Context is particularly important for this study as we argue that post-implementation modifications to ERP systems take different forms and are undertaken within various motivation and learning contexts. A case study approach also suits our goal to explore 'what' ways ERP post-implementation modifications can be classified, and 'how' these modifications influence business process performance; Yin (2009) suggests that such questions are better addressed using qualitative methods. As part of an on-going research, a single case study has been adopted to explore several instances of post-implementation modifications within an organisation. Data were collected via multiple sources; interviews, email conversations, published documents and company website. We conducted four in-depth interviews with the business analyst, IT project manager, SAP super user and reliability engineer, and follow-up questions were answered via emails. Published documents supported the interviews and provided more information on the organisation and the modifications undertaken. Data was coded in Nvivo using a thematic coding scheme that was developed based on major constructs of the model, and evaluated using pattern matching, allowing us to compare capabilities predicted in our model with those identified from the data.

5 Case Study Background

Plasco is an Australian plastic manufacturer and leading supplier of raw materials for the plastics industry, operating several facilities across the country. Plasco implemented SAP Release 2 in 1995, and currently uses SAP ECC6. Plasco was purposefully selected as a suitable case for our research because they were one of very first adopters of ERP in Australia and is a company that makes substantial modifications on an ongoing basis. It is therefore a rich data source to explore motivations and learning across several modifications. The modifications are discussed as separate instances.

6 Case Study Findings and Discussion

6.1 Analysis of typology

Instance 1(Hot-packs): Between 2001 and 2003, Plasco implemented four hot-packs on their SAP Release 4.5B. Comments by the IT manager revealed that hot-packs were a set of support changes and fixes. Hot-packs were seen as proactive way of managing their ERP system, with its main aim being to fix bugs as well as keep current. Hot-packs were characterised by activities that fitted into existing company policy and could be clearly conducted using present knowledge. For instance, it was based on an annual plan and only involved the adept developer and analyst. As bugs are technical errors within software packages, it is arguable that hot-packs, which are essentially a set of bug-fixing notes, were driven by a technical motivation. With no indications of experimentation with new ideas, technologies, strategies and knowledge that characterise exploration organisational learning, the hot-pack can be safely concluded to be an exploitation rather than exploration activity.

Instance 2 (Product costing implementation in SAP Financials): The implementation of product costing within the controlling module of SAP ERP financials was undertaken by Plasco in 2002 on the SAP R/3 Release 4.6. The Business analyst revealed that prior to the implementation "*everything was manual…costing and margin reporting were manually processed. The key motive for this was to have timely reports and better inventory valuation"*. With product costing aimed at better inventory management, and not to fix bugs or gain better architecture, we conclude that it was driven by a business, not a technical need. Features of the implementation reflect exploitation; the activities undertaken seemed clear and were conducted using present knowledge *"…so it was pretty clear what we had to do...it was just a gap we had to fill".* Elaboration of existing ideas was evident *"we only automated already existing processes without incorporating any change"*. With product costing, there were no indications that Plasco challenged procedures/ processes, or undertook activities requiring them to learn new skills or acquire new knowledge.

Instance 3 (Capacity scheduling on SAP R3): Capacity scheduling on SAP was undertaken to simplify the scheduling of plant maintenance; a key category of activities at Plasco. The SAP super user in the plant maintenance department indicated that the goal was "*to try to reconfigure the SAP systems capacity planning system to work in the same line with our full processes"* The configuration took approximately six weeks and involved no risks. With capacity scheduling driven by a need to better schedule plant maintenance activities, it can be concluded that it was driven by a business and not a technical motivation. It was clearly defined and focused, *"we only needed to know to make the capacity planning module work in line with our processes"*. It did not seek new alternatives and presented no risks as such; typically indicating exploitation organisational learning.

Instance 4 (Timesheet system on SAP R3): The business analyst revealed that the timesheet configuration was undertaken at Plasco because there was an identified delay issue; *"when someone worked for us, there was a time delay of about 4 weeks before we actually get the cost in SAP and this impacted the business negatively as timely decisions could not be made"*. Thus, the decision to configure timesheet within SAP was not driven by anything technical, but by a business need. This reflects an emphasis on exploitation; elaborating on existing platforms rather than experimentation with new ideas as the basis of what was sought was already present and they only had to seek ways of getting it to work for them. It seemed more like a short-run improvement of their cost entry system rather than an effort to find new alternatives to improve what was already in existence.

Instance 5 (Enhancement pack 4): Describing Plasco's implementation of enhancement pack 4 (EHP4), the business analyst revealed that the motivation was "*because we had read about what was available in it and felt that some of it might be of use to us and that we would like to explore it in more detail".* From a motivation perspective, it appears EHP4 was not driven by technical issues with the system, but by a business need for new features to facilitate more benefits. Though promising new benefits, the major risk with an enhancement pack is that *"once turned on, it cannot be turned off"*. As such, from an organisational learning perspective, the uncertainty of the outcome of the modification and the risk of being stuck with an un-intended change reflect EHP4 as exploration rather than exploitation.

Instance 6 (Support stack 6 on ECC6): From Plasco's perspective, support stacks are a consolidated set of patches or notes, and are usually implemented for two reasons: to fix bugs and to maintain supportability under maintenance contract. The SAP business analyst revealed that the support stack 6 (ST6) was installed to fix a bug pertaining to the use of the secure socket layer which allows the SAP portal to be run as a secure website. He commented that *"The reason we put in Support stack 6 was to fix bugs. So essentially there was a bug to do with using SSL in the portal. It was low risk…and we didn't put it in because of any functionality considerations".* This reflects a technical rather than business motivation. ST6 implementation did not involve activities requiring new skills or knowledge, or any change in business processes, thus reflecting exploitation organisational learning. Drawing on the discussion above, each instance is classified into one distinct category in Figure 2.

		ORGANISATIONAL LEARNING	
		Exploitation	***Exploration***
ORGANISATIONAL MOTIVATION	***Technical***	Cell A **Maintenance** *Instance 1: Hot-pack* *Instance 6: Support stack*	Cell B **Technical upgrade**
	Business	Cell C **Enhancement** *Instance 2: Product costing* *Instance 3: Capacity scheduling* *Instance 4: Timesheet*	Cell D **Functional upgrade** *Instance 5: Enhancement pack 4*

Figure 2: Instances of post-implementation modifications at Plasco

We make the following observations: First, out of six instances identified, we could not classify any of the instances as a technical upgrade (Cell B). We speculate that the limited access to technically focused staff members at Plasco, rather than an actual absence of such projects, may explain the lack

of data about this type of project. A greater number of interviews would presumably reveal instances of this type of modification. Out of the six instances, three instances are representative of Cell C. This is no surprise, given that organisations are constantly seeking ways to derive better value from their ERP systems by implementing additional modules and adapting their business processes to suit the ERP application. It is however quite surprising that only one instance represented Cell D as organisations are recommended to undertake upgrades in a way that incorporates changes to business processes. Nonetheless, the amount of effort required makes this type of modification less attractive.

6.2 Analyses of propositions

Drawing on the modifications undertaken in Plasco, the ERP capabilities and business process optimisation measures of each modification category predicted in the model are compared with those identified from the case study data. Due to page limitation, it is impossible to provide a detailed explanation of the outcomes of the propositions for each category. However, for the purpose of illustration, we provide an example of how a particular proposition was evaluated for two categories. Taking propositions P2a, P2b, and P2c as an example, we found that both instances of the maintenance category (Cell A) did not increase business process effectiveness as they were undertaken with little business process considerations; thus P2a is supported. Out of three instances representing the Enhancement category (Cell C), only two (instances 3 and 4) were found to improve business process effectiveness as they increased ERP informational capability. The business analyst stated "*Configuring timesheet in SAP allows us to control the cost of our projects a lot more….We make better decisions now…it's made big changes to the way that contractors have been managed across the business, managed, paid and monitored. That in itself has provided better information. There's also been significant time saving in chasing up timesheets because it used to be a very manual paper based system".* This sentiment is equalled by a super user, who commented *"I guess it opened the door for things for the future...we only updated our standard costing once a year prior to configuring product costing within SAP. Being able to update new costs on a monthly basis meant that there was fresher information and that translated into cost savings in terms of maintaining the process of calculating the cost of various products".* Both statements reflect that up-to-date information was made available, and better decisions could be made. Instance 2 on the other hand had no such outcome as revealed by the super user *"Configuring capacity scheduling within SAP probably only saves our planner about 2 working days of working...allowing them to spend time on other things".* With time savings as the key benefit of the capacity scheduling ERP modification, business process effectiveness seemed not to be improved. This is because though it increased automational ERP capability by automating capacity scheduling activities, it did not increase informational capability; thus P2b is supported. Table 3 is a summary of the outcomes of propositions.

ERP-PIM category	**Proposition**	***Instance1***	***Instance2***	***Instance3***	***Instance4***	***Instance5***	***Instance6***	**Remarks**
Cell A Maintenance	P1a	✓	N/A	N/A	N/A	N/A	✓	Supported
	P2a	✓	N/A	N/A	N/A	N/A	✓	Supported
	P3a	✓	N/A	N/A	N/A	N/A	✓	Supported
Cell B Technical upgrade	P1a	No evidence reported for Technical Upgrade						Not investigated for Cell B
	P2b,c							
	P3a							
Cell C Enhancement	P1b,c	N/A	✓	✓	✓	N/A	N/A	Supported
	P2b,c	N/A	✓	✓	✓	N/A	N/A	Supported
	P3a	N/A	✓	✓	✓	N/A	N/A	Supported
Cell D Functional Upgrade	P1b,c	N/A	N/A	N/A	N/A	✓	N/A	Partially Supported
	P2b,c	N/A	N/A	N/A	N/A	✓	N/A	Partially Supported
	P3b,c	N/A	N/A	N/A	N/A	✓	N/A	Partially Supported

Table 3: Instances indicating support for propositions

We discuss the propositions as follows:

First, Propositions P1a, P1b, and P1c, which predict business process efficiency were fully supported for Cells A and C, and only partially supported for Cell D. No business process efficiency was predicted for Cell A; this was observed for both instances of Cell A. For Cell C, only modifications which improved automational ERP capability were predicted to deliver business process efficiency; this was observed for instances 2, 3 and 4. There were no Cell C modifications that did not enhance automational ERP capability. This prompts an assumption that all Cell C modifications always improve automational ERP capability, and will be explored in greater detail with other cases. As only one instance fell into Cell D, only partial support could be confirmed. There was no evidence provided for Cell B, thus it was impossible to assess P1 for Cell B.

Second, Propositions P2a, P2b, and P2c, which predict business process effectiveness were fully supported for Cells A and C, and only partially supported for Cell D. No business process effectiveness was predicted for Cell A; this was observed for both instances of Cell A. For Cell C, only modifications which improved informational ERP capability were predicted to deliver business process effectiveness and this was observed for instances 2 and 4; instance 3 did not improve informational ERP capability and as such did not deliver business process effectiveness. As only one instance fell into Cell D, only partial support could be established.

Third, Propositions P3a, P3b, and P3c, which predict business process flexibility were fully supported for Cells A, and C, and only partially supported for Cell D. No business process flexibility was predicted for Cells A and C; this was observed for both instances of Cell A and all three instances of Cell C. For Cell D, only modifications that improved transformational ERP capability were predicted to deliver business process flexibility. As only one instance fell into Cell D, only partial support could be provided.

7 Conclusion

In this research-in-progress paper, we have reported an initial evaluation of a model that links ERP post-implementation modifications with business process optimisation; efficiency, effectiveness and flexibility. Results from our single case study in a large Australian manufacturing company therefore provide tentative support for the typology proposed in our model. This initial validation of the ERP-PIM model makes contributions to theory and practice alike. Our typology of ERP post-implementation modification enriches the ERP literature and extends the applicability of specific organisation theories (i.e organisational motivation and organisational learning) to ERP post-implementation context. Improved understanding facilitated by the model creates a foundation for theory development in future ERP post-implementation research. The practical contribution of the evaluated model to organisations is a method for classifying ERP post-implementation modifications. In addition to this, we anticipate that the model, when fully evaluated, will provide better knowledge of how business process efficiency, effectiveness and flexibility may be achieved from a post-implementation modification initiative. For instance, knowledge that business process optimisation is dependent on ERP capabilities enhanced by post-implementation modifications. Particularly for senior managers, the model could serve as a tool for guiding post-implementation modification initiatives to enhance ERP capability. As an ERP system embodies an organisation's business processes, increasing ERP capability enhances business process optimisation, an important area for achieving competitive advantage.

Our study is limited as we have only attempted to evaluate the ERP-PIM model and associated propositions using a single case. However though a single case, the selected organisation provided a setting where the relationship between post-implementation modifications and business process optimisation could be explored. Building on this exploratory single-case study, we are currently undertaking a multiple-case study to further reflect post-implementation experiences of several

organisations. With a multiple-case study, comparisons can be made amongst organisations and propositions can be further investigated.

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