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The MinK Framework: Developing Metrics for the Measurement of Individual Knowledge

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Abstract

Knowledge is the currency of the current economy and a vital resource for the sustainability of performance quality in today's knowledge intensive business environment. To avoid the detrimental consequences of knowledge loss, managers are urged to identify where knowledge stocks exist and how knowledge flows within their organisations by keying out wellsprings of knowledge among their employees. Although some studies have attempted to measure knowledge on an organisational level using different methods, very few studies have addressed the individual knowledge carrier. Moving from a critical literature review of the existing approaches to knowledge measurement, this paper proposes a novel framework that enables organisations to measure individual knowledge in a business context using a set of metrics. The metrics are subsequently validated through a series of in-depth interviews with senior managers.A summary of the managers' views on individual knowledge measurement is presented. Reflections regarding the industry application and recommendations for the proposed framework are also discussed.

Introduction

Knowledge is recognised as a foundation of sustainable quality and competitive advantage in the current complex and dynamic business era (Tullawat and Vichita Vathanophas, 2012). The ability of organisations to create value is no longer solely dependent on their financial and physical capital, but rather on their capacity to acquire, create and utilise knowledge (Carmeli and Tishler, 2004). Asserting that knowledge is the main value driver in today's businesses, the management of knowledge as a strategic resource gave rise to the rapidly growing field of Knowledge Management (KM), which has been growing exponentially in the last decade (Serenko et al., 2010). However, based on the saying "*if you can't measure it, you can't manage it*," the need to measure knowledge resources within an organisation emerged as a key area of interest for both researchers and practitioners within the KM domain (Skyrme, 2003).

Despite being one of the most challenging activities in KM (Chen et al., 2009), the need to measure knowledge arises to achieve two organisational objectives: internal monitoring and external presentation. From an internal perspective, managers may be obliviousof the knowledge that exists within their own organisations, as once stated by the CEO of Hewlett-Packard in his famous quote "if only HP knew what HP knew, we would be three times as profitable" (Davenport and Prusak, 2000). In such cases, knowledge measurement is essential to expose "hidden" knowledge resources leading to more effective KM (Edvinsson and Malone, 1997). Furthermore, knowledge measurement remains crucial during the implementation of KM initiatives to evaluate the effect of KM on organisational

knowledgeand to provide managers with convincing justifications for the substantial costs associated with KM implementation (Liebowitz and Suen, 2000, Khalifa et al., 2008). From an external perspective, the mounting gap between book values and market values of companies has led to the widespread view that a company's "true" value could only be expressed if intangible assets are also evaluated (Boda and Szlavik, 2007). In this regard, the value of a company is viewed as the summation of its financial capital and its intellectual capital (IC). IC (Galbraith, 1969)is a term that refers to "packaged useful knowledge" (Stewart, 1998). In the traditional conceptualisation where organisational knowledge is envisaged as a series of "stocks and flows", IC refers to the stock of knowledge within an organisation at a certain time, while KM is concerned with the flows, namely knowledge acquisition and sharing (Bontis et al., 1999, Al-Laham et al., 2011).

The need to measure knowledge to enhance its management and evaluate companies has impelled researchers to propose a number ofknowledge measurement frameworks. However, it is observed that the majority of models attempted to measure knowledge at a company level, with very few efforts directed towards measuring the knowledge of individual employees, although they are the actual source of all knowledge within any organisation (Kannan and Aulbur, 2004). In their classic work two decades ago, Nonaka and Takeuchi (1995) stated, "*knowledge is created only by individuals. An organisation cannot create knowledge on its own," "organisational knowledge creation should be understood as a process that organisationally amplifies the knowledge created by individuals*." Viewing knowledge in isolation from *theknowerswho own it*is among Fahey and Prusak's (1998) list of gravest mistakes in KM where they state "*there is no knowledge without someone knowing it*."Since knowledge identification is a core activity of the KM process (Heisig, 2009), the success of KM would be largely dependent upon an organisation's ability to identify individual knowledge carriers and creators before striving to implement other KM activities including knowledge sharing and knowledge utilisation. This identification should contribute to the reduction of knowledge loss, since managers would take measures to ensure knowledge holders remain within the organisation through proper compensation, longer contracts and loyalty programmes. Despite its cardinal importance, the measurement of individual knowledge remains a fundamental, yet comparatively unexplored, subdomain of knowledge measurement and KM.

This study presents an attempt to fill this gap by proposing a new framework referred to as *MinK*, an acronym for *Measuring Individual Knowledge*.The ultimate objective of *MinK* is to provide managers with a comprehensive tool which allows them to assess individual knowledge given the complexities surrounding the process. In attempt to achieve the stated objective, a succinct critical review of the different existing methods used to measure knowledge in the KM literature was conducted along with a discussion of the main frameworks used by each method. The development of *MinK* is then described and the model's structure is presented. A pilot study aimed at the preliminary validation of *MinK* is introduced followed by the findings and future work recommendations.

Literature Review

The literature offers a diverse array of knowledge measurement methods in which researchers have applied different methods to assess organisational knowledge (Skyrme, 2005). Three main approaches are identified: Financial Methods, IC Components Methods, and Performance Methods.

Financial Methods

In the first approach, IC is computed in financial terms by using data from a company's financial results and records. Few of the most widely cited models and their respective knowledge valuation methodologies are listed in Table 1.

Table 1: Financial knowledge measurement methods

Model	Methodology
Tobin's Q (Tobin, 1969)	Measures knowledge as the ratio between a company's market value and its book value.A Q higher than one is an indicator of the ability to create value by utilising knowledge.
Economic Value Added (Stewart, 1994)	Applying 164 adjustments to traditional balance sheets to account for intangibles after which EVA is calculated by deducting the cost of capital from operating profit (Weaver, 2001).
Human Resource Accounting (HRA) (Hermanson, 1964)	Uses three types of models: • *Cost models*- Value human capital comprising knowledge as the cost of acquiring human assets. • *Market models* - Equate knowledge with cost of buying an individual's services from the market. • *Income models*- Use the present value of the revenues an employee is expected to generate while working for a company as a measure of knowledge (Flamholtz et al., 1993).
Value Creation Intellectual Coefficient (Pulic, 2000)	Calculates how efficiently financial and intellectual capital are utilised to generate value for the company using financial data.

IC Components Methods

Within the second approach, IC is divided into different components, and each component is measured individually (Luthy, 1998). Most IC methods tend to apply a minimum of the first two of the following four steps:

1. *Classification*: IC is broken down into components, usually Human Capital (HC) and Structural Capital (SC), where HC refers to the combined knowledge of employees, while SC refers to "*knowledge that doesn't go home at night*" including the company's supportive infrastructure, business processes, IT systems and customer relations (Ranjit, 2004). SC may be divided further into Organisational Capital and Customer Capital (Edvinsson, 1997).
2. *Metric Development*: Metrics are selected to measure each IC component.

3. *Aggregation*: IC measures are aggregated into one numerical figure using such methods as averages, weighted averages or other methods. The outcome of this step should be one number that reflects a company's IC.
4. *Financial Valuation*: A financial value of IC may be computed and presented in monetary terms, or a correlation may be established between the IC value and a financial indicator. Widely cited IC frameworks in the KM literature are summarised in Table 2.

Table 2: IC Component measurement models

Framework	IC Classification	Metric Development	Aggregation	Financial Valuation

Skandia Navigator
 	
(Edvinsson and Malone, 1997)
	• Human Capital
	• Structural Capital
	  ○ Customer Capital
	  ○ Organisational Capital
	  ▪ Process Capital
	  ▪ Innovation Capital
		• Developed 112 metrics that cover five components of IC.	• Combines all financial indicators into a single monetary value *C*.
			• Converts all the remaining metrics into ratios then aggregates them into an efficiency indicator *I*.
				• The overall financial value of IC is equal to *I* multiplied by *C*.

IC Index
 	
(Roos et al., 1998)
	• Human Capital (*thinking part*)
	  ○ Competence
	  ○ Attitude
	  ○ Intellectual Agility
	• Structural Capital (*non-thinking part*)
	  ○ Relationships
	  ○ Organisation
	  ○ Renewal and Development
		• Does not propose specific metrics.
		• Provides a framework by which every organisation would set its own metrics in light of its strategy, characteristics and the surrounding environment.
			• Metricsmust be expressed as a dimensionless numbers.
			• Metricsare assigned weights to reflect their relative importance, and are aggregated into a single index using a weighted average.
				• Indicates the behaviour of a correctly designed IC Index should be correlated to financial value of the company.

Intangible Assets Monitor
 	
(Sveiby, 1997, Sveiby, 1993)
	• Internal Structure
	• External Structure
	• Human Competence
		• Proposes indices to measure each IC component from three perspectives:
		  ○ Growth and renewal
		  ○ Efficiency
		  ○ Stability
			• Visually presents IC components' strengths and weaknesses in an aggregated tabular form, but provides no numerical aggregation.	• No financial valuation.

IC Rating
 	
(Jacobsen et al., 2005)
	• Human Capital
	  ○ Management
	  ○ Employees
	• Organisational Capital
	  ○ Process
	  ○ Intellectual Properties
	• Relational Capital
	  ○ Network
	  ○ Brand
	  ○ Customers
	• Business Recipe
		• Evaluates 200 parameters through in-depth interviews with internal and external stakeholders.
		• Assesses IC components from the perspectives of:
		  ○ Effectiveness
		  ○ Risk
		  ○ Renewal
			• Results are presented using a letter grading system ranging from 'AAA' to 'D' in one diagram, but no numerical aggregation is conducted.	• No financial valuation.

Knowledge Assets Map
 	
(Marr et al., 2004)
	• Stakeholder Resources
	  ○ Stakeholder Relationships
	  ○ Human Resources
	• Structural Resources
	  ○ Human Resources
	  ○ Physical Infrastructure
	  ○ Virtual Infrastructure (Culture, routines, and IP)
		• Does not propose specific metrics and states that metrics should be identified by top management according to their organisation's unique competencies and strategy.	• No numerical aggregation is suggested, however, managers have the flexibility to present their selected indicators in the manner they find most appropriate to evaluate their company's knowledge assets.	• No financial valuation.

Technology Broker (IC Audit) (Brooking, 1996)	• Market assets • Human-centred assets • Intellectual property assets • Infrastructure assets	• IC components are audited using: - Surveys - Interviews - Quantitative analysis - Market research - Documents auditing - Evaluation of return on investment • Based on the audit, each aspect is compared with the optimal state and is rated with an index score from 1 to 5.	• Results are visually represented on a target diagram/bull's-eye chart (Wickham, 2008) to depict the score, importance and trend of each aspect. • No numerical aggregation.	• Uses cost, market or income valuation methods (as described in HRA).

Performance Methods

While a number of researchers designed ample models to measure knowledge, others adopted the view that knowledge could not be measured due to its fluid and complex nature, and that only the *effects*or *outcomes*of utilising knowledge are measureable (Liebowitz and Wright, 1999). Therefore, research within the third knowledge measurement approach directs its efforts towards the measurement of the impact of applying knowledge with the objective of establishing a link between KM and improvement in organisational performance, a link that according to the literature remain nebulous (Petra and Annelies, 2012). This is achieved by the comparison of an organisation's performance before a KM process is instated and after its implementation to identify the effect KM has had on performance. To this end, studies vary in their methodology of evaluating organisational performance mostly adopting either a quantitative or qualitative approach (Huang et al., 2007). To measure performance, quantitative methods use financial indicators such as profitability or return investment, or non-financial indicators such as cycle time or number of complaints On the other hand, qualitative methods rely on surveys, questionnaires, or interviews to obtain feedback on the effect of KM on performance Finally, some KM researchers assess performance using *The Balanced Scorecard*; one of the most popular and comprehensive performance measurement tools that comprises quantitative, qualitative, financial and non-financial measures (Kaplan and Norton, 1996).

In summary, review of the literature reveals three main approaches to knowledge measurement. Financial models provide a concise unbiased overview of a company's IC and may be beneficial in investment decisions and benchmarking, however, they do not elucidate where KM problems exist nor do they suggest what decisions should be taken to improve knowledge creation, sharing and utilisation (Kannan and Aulbur, 2004). IC Components models offer more vivid insights about each element of IC and where corrective action is required, however, are criticised because they provide a "snap shot" evaluation of knowledgeby only reflecting static knowledge stocks without considering the dynamism of organisational knowledge present in knowledge flows (Lerro et al., 2012, Bontis, 2001). Finally, performance methods provide some correlation between KM and performance, however, are built on the inaccurate assumption that changes in organisational performance are solely due to KM disregarding a number of other endogenous and exogenous performance factors (Yu et al., 2007).

The *MinK* Framework

The authors endeavoured to benefit from the existing mass of knowledge measurement literature when developing a new individual measurement model. First, the authors adopted the view that the absolute "*quantity"* of knowledge an individual holds could never be measured with a direct formula because knowledge is both intangible and contextual. However, the assessment of certain attributes and actions of individuals could provide a good indication of the knowledge they hold, acquire and share.Thus, instead of attempting to measure knowledge *itself*, characteristics that indicate knowledge is present within an individual would be identified and assessed. Accordingly, ten *individual knowledge*

indicators (IKI) are suggested in *MinK*, where each indicator implies that an individual possesses certain knowledge that is of value to his/her organisation or is actively acquiring and sharing knowledge.In light of the literature review, the authors preferred not to rely on a single approach when developing IKIs but rather amalgamated a number of perspectives to propose IKIs that reflect individual knowledge components, knowledge stocks and flows, knowledge utilisation outcomes (i.e. effects on performance), in addition to financial IKIs.The ten IKIs are:

1. *Education* - The formal education an individual has received from academic institutions (e.g. BSc, MBA, PhD...etc.)
2. *Training* - Training courses and internships the individual has attended during their career.
3. *Experience* - The individual's years of professional experience.
4. *IT Literacy* - An individual's ability to use IT tools (software and hardware) in business to acquire, create and share knowledge.
5. *Business Communications* - The nature, rate and patterns of an individual's internal business communications (with managers, colleagues, subordinates) and external communications (with customers, suppliers, regulators) using different means (meeting, phone calls, emails).
6. *Business Process Interactions* - The interaction of the individual with business processes internal and external to the organisation.
7. *Personal Network* - The size and quality of the network of business contacts the individual interacts with.
8. *Performance* - The individual's performance at work and contribution to their organisation.
9. *Creativity/Innovation* - The ability of the individual to generate new ideas and solutions to existing problems.
10. *Financial Indicators* - The financial value of the individual on the job market (e.g. recruitment cost, training cost, salary) and their monetary contribution to the organisation (e.g. sales, cost-savings, funds acquired).

The first four IKIs (education, training, experience, IT literacy) are *knowledge stock indicators*.These are background measures that reflect an individual's knowledge based on their history and background and provide static measures of a person's knowledge stock (Bolisani and Oltramari, 2012). The next three IKIs (business communications, business process interactions, personal network) are *knowledge flow indicators,* whichareprocess indicatorsthat reflect the exposure of individuals to knowledge flows and their corresponding roles in knowledge acquisition and sharing (Malhotra, 2003). The following two IKIs (performance and creativity) are *knowledge utilisation indicators,* which, as output indicators, reflect the effect an individual's knowledge has had on the outcomes of their work and their performance.The inclusion of this perspective is essential because an employee's knowledge would be of value to his/her organisation only if it is used to sustain quality, improve performance, and gain competitive advantage (Baron, 2011). Finally, analogous to financial methods in the literature, the last indicator uses financial figures associated with the individual as measures of their knowledge.

The subsequent step is the development of metrics to assess each IKI. Metrics are measurement units which describe the properties of each indicator (Lerro et al., 2012). They may be direct counts, monetary values or ratios/percentages when used to measure quantitative attributes, or numerical scale-based ratings when used to quantify qualitative attributes. Proposed metrics for each indicator are shown in Table 3 along with their corresponding units of measurement, where "#" is a number, "*%*" is a percentage,"*$*" is a monetary value and "*r*" is a rating

Table 3: Metrics for each individual knowledge indicator

<table>
<tr><th colspan="4">Knowledge Stock Indicators</th></tr>
<tr><td>Education</td><td>Experience</td><td>Training</td><td>IT Literacy</td></tr>
<tr><td>• Level of education (r)
• Grades (%)
• Relevance of education to job (r)</td><td>• Professional years (#)
• Years in industry (#)
• Years in function (#) (e.g. finance)
• Years in the company (#)</td><td>• Professional Qualifications (r)
• Training hours (#)
• Training expense ($)
• Internships (n)</td><td>• General IT Literacy (r) (Windows, Office, Internet)

• Specific IT literacy (r) (Function specific software)</td></tr>
<tr><th colspan="4">Knowledge Flow Indicators</th></tr>
<tr><td colspan="2">Business Communication</td><td>Business Process Interactions</td><td>Personal Network</td></tr>
<tr><td colspan="2">• Meetings attended per week (#)
• Meetings with managers per week (#)
• Meetings with subordinates per week (#)
• Meetings with per week with external stakeholders (#)
• Communications sent per week (#) (phone/email/memo/report)
• Communications received per week (#)</td><td>• Processes utilised (#)
• Processes supervised (#)
• Processes reviewed/audited (#)
• Process improvement Suggestions (#)
•Process improvement suggestions implemented (#)
• Business process quality systems involvement (e.g. ISO) (r)
• Contribution to information systems (r)</td><td>• Contacts (#)
• Relevance of contacts to business (r)
•No. of social media connections (#)
• Percentage of external contacts (%)
• Percentage of international contacts (%)
• Percentage of "VIP" contacts (%)
• New contacts acquired/month (#)
• Business contacts retention (r)</td></tr>
<tr><th colspan="4">Knowledge Utilisation Indicators</th></tr>
<tr><td colspan="2">Performance</td><td colspan="2">Creativity/ Innovation</td></tr>
<tr><td colspan="2">• Performance Appraisal (r)
• Cost Savings ($)</i>
• Income generated/Sales <i>($)
• Productivity (r)
• Percentage of Target(s) Achieved (%)</td><td colspan="2">• New ideas suggested (#)
• New ideas implemented (#)
• Patents (#)</td></tr>
<tr><th colspan="4">Financial Indicators</th></tr>
<tr><td colspan="4">• Compensation ($)</i>
• Recruitment / Replacement costs <i>($)
• Market cost of equivalent services ($)</i>
• Investment in Training <i>($)</td></tr>
</table>

Preliminary Validation Study

Before proceeding to the second phase of this research, preliminary validation was required to examine the validity of the proposed indicators and metrics as measures of individual knowledge. A study was conducted through semi-structured interviews of a sample of elevensenior managers and directors representing small, medium and large corporations from eight different industries and located in six countries (Table 4). Respondents were selected from diverse backgrounds to examine the generalisability of *MinK* across different disciplines, company sizes and countries.

Table 4: Pilot study respondents' profiles

Respondent No.	***Position***	***Company Description***	***Number of Employees***	***Country***
1	Managing Director	Marketing consulting company	6	Egypt
2	HR Consultant	Training and HR consulting company	9	South Africa
3	Chief Scientist	Software research company	9	USA
4	Business Development Manager	Healthcare development contractor	25	Lebanon
5	Sales Lead	Multinational Pharmaceutical Company	150	Dubai
6	Associate Professor	Private college	174	USA
7	Business Development Advisor	Medical equipment supplier	300	Egypt
8	Managing Director	Private equity and investment advisory	400	Egypt
9	Vice-President for Quality Assurance	Private university	1000	Egypt
10	Channel Marketing Manager	Multinational consumer goods manufacturer	1800	Egypt
11	Supply Planning Manager	Multinational food manufacturer	70000	Saudi Arabia

Interviews started with background information about knowledge measurement and a brief explanation of *MinK*. The first few questions examined the awareness of knowledge management and measurement in respondents' organisations and the KM challenges they arecurrently confronted with. Participants were then asked to complete an evaluation questionnaire to assess the relevance of the proposed indicators and metrics to individual knowledge measurement using a five-point Likert scale (Likert, 1932) ranging from 1 (highly irrelevant) to 5 (highly relevant). The questionnaire was then discussed and the managers provided insights related to their answers in addition to their reflections and opinions regarding the *MinK* framework.

Findings and Feedback

During initial discussionsparticipants seemed familiar with KM, and most of their organisations implemented some sort of KM activity, of which the most interesting was a

virtual interactive knowledge marketplace, mentioned by respondent number 10, which employees were encouraged to use by "selling" knowledge to their colleagues from their "kiosks" in return for virtual "stars". However, most respondents indicated that their organisations were still suffering from knowledge loss primarily due to staff turnover.When introduced to *MinK*, all respondents emphasised the value of individual knowledge and expressed interest in the idea of individual knowledge measurement. Six out of the eleven participants stated their organisations attempt to measure individual knowledge mostly by performance appraisals or subjective assessments by managers.

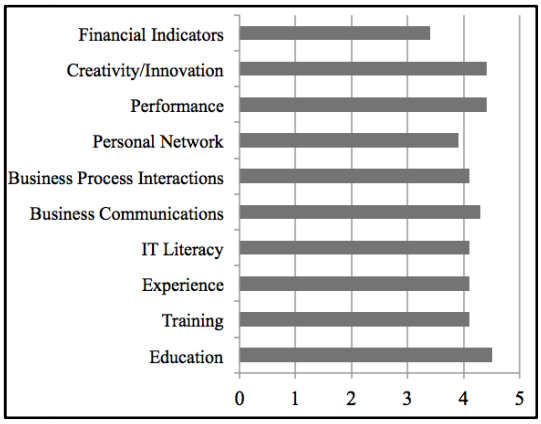

Figure 1: Indicators evaluation questionnaire results

Analysis of the questionnaire results regarding the evaluation of IKIs revealed that the *MinK* framework was highly regarded, where nine out of ten indicators had an average rating higher than 4. Having the lowest average rating of 3.4, financial indicators were viewed as the least relevant IKI. Five respondents questioned the relationship between compensation and knowledge since it is common for knowledgeable employees to be underpaid and, in some cases, less knowledgeable ones could be overpaid. On the other hand, two participants offered an interesting suggestion by recommending a new IKI to represent "*interpersonal skills*" or "*the ability to convey knowledge*" as an additional measure of knowledge flow. Nevertheless, the overall outcome of IKI evaluation was highly positive as interviewees unanimously agreed that *MinK*'s indicators collectively provide "a good indication of individual knowledge."

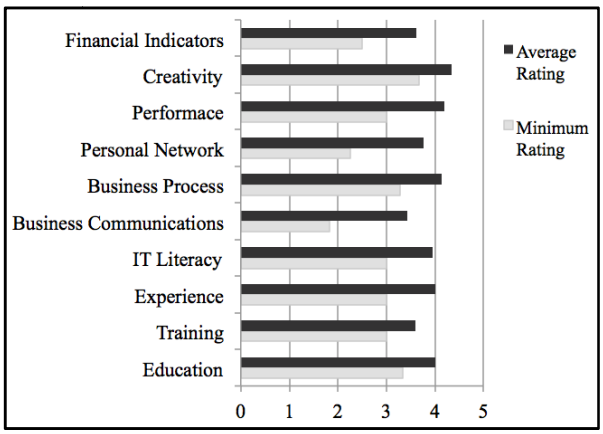

Figure 2: Metrics evaluation questionnaire results

When evaluating metrics, the metrics for six indicators received an average rating of 4 or higher (Figure 2). It was observed that participants who found financial indicators to be irrelevant also gave low ratings to financial metrics. Some respondents found that metrics under the *Business Communications* and *Personal Network* IKIs that were based on direct counts (e.g. number of contacts, number of emails per day) were not very relevant to their corresponding IKIs because they measured the "quantity" and not the "quality." As one manager stated, "*an employee can attend tens of meetings and receive hundreds of emails per day, only for bureaucratic tasks that would have limited effect on her or his individual knowledge*." Likewise, interestingly a large number of participants found that training expenses were highly irrelevant to the value of the knowledge acquired during training. Such comments by managers were found to offer valuable feedback that would be used to improve *MinK*.

Conclusion and Future Work

This study presented the first phase in the development of *MinK*, a framework designed to measure individual knowledge in a business context to fill an existing gap in the literature and, more importantly, help organisations manage knowledge more effectively by identifying knowledge holders. Ten indicators that denote individual knowledge were selected, and metrics were developed to assess each metric individually. As a mean of preliminary validation, a study was conducted though semi-structured interviews with managers from different industries. The framework was rated high and managers who contributed in the study provided useful insights and recommendations that will be considered in the final version of *MinK*.

The main limitation of the preliminary validation stage is the sample size. The subsequent phase is therefore planning to include more companies and a larger scale of contribution from top management in the targeted organisations. The framework will then be modified to incorporatethe valid suggestions that emerged from the preliminary validation and the subsequent validation phase.

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