CONSTRUCTION PROJECTS' CLASSIFIED PERFORMANCE INDICATORS (CPIs)

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ABSTRACT

Given the ongoing need for projects to achieve profitability, it is critical that they are completed on time and to the agreed-upon contractual specifications and quality. The need to identify the most important classified performance indicators (CPIs) for assessing construction projects' progress toward these objectives, as well as the satisfaction of the various stakeholders involved in the projects. As a result, the goal is to identify and prioritize CPIs that reflect Egyptian construction project performance. CPIs are identified in two stages and are divided into eight major perspectives (financial, operation, supporting, stakeholders, human capital, health, safety, and environmental, social, and innovation, learning, and growth). The first stage involved identifying (110) factors from the literature, which were then filtered and developed. The second stage involved creating a questionnaire based on the significant factors that had been identified. As a result, the (40) most important CPIs affecting the performance of the development project were identified.

KEYWORDS: Classified Performance Indicators (CPIs) - Perspectives - Performance – Egyptian Construction Projects**.**

1. INTRODUCTION

Success has undergone a wonderful deal of research and a spotlight over the past twenty years. The insufficiency of traditional financial performance measurement and the introduction of non-financial metrics are the catalysts for much of this research and interest. Moreover, reports by Egan (1995) necessitated improvement in performance within the industry with performance measurement as a key component.

Understanding performance measurement can help organizations realize its importance for achieving business profitability and maintaining a long-term competitive advantage. Since the event industry is project-based, successful projects in achieving their objectives have the simplest influence on a company's profits. Therefore, the target is to identify and prioritize Classified Performance Indicators (CPIs) that reflect the performance of Egyptian construction projects.

2. LITERATURE REVIEW

"Performance" has been employed in an awfully large number of choices and has been the focus of numerous researchers as a helpful tool in making strategic decisions and specializing in shareholder value (Deng & Smyth, 2013). One of the comments on the meaning of performance was stated by Lebas (1995) that "there are some agreements between people on the meaning of performance: the meaning may be everything relative to efficiency, to being powerful and having enough resistance to investment, or the opposite definition, which is able to not be fully satisfied with the term".

The process of performance measurement "PM" is defined as an impact system acting as a closed-loop, which organizes strategy and policy and attains feedback from numerous levels for managing the performance of the business. Performance measurement is defined thanks to the system of operating PM effectively and efficiently. Additionally, performance measurement was correspondingly considered thanks to the guts of PM, which is of crucial importance (Bititci et al., 1997).

Hronec (1993) defined performance measures as the critical and vital signs of the organization which "quantify or evaluate how well the activities

within a process do or how a process output achieves the desired goal" (Kagioglou et al., 2001).

Performance indicators are also illustrated as measurable characteristics of outcomes, services, procedures, and operations or actions that a corporation employs to trace performance (Bititci et al., 1997).

These are measures that are indicative of the performance of associated processes. If this measure is used as a variety of indicators (Constructing Excellence, 2010), then it gives an early warning, identifies a possible problem and highlights the need for further investigation. Previous Summarized Classified Performance Indicators (CPIs) are identified as shown in Table 1.

3. METHODOLOGY

To achieve the objective of this study, the research development, consists of five stages. According to Fig. 1. Previous Studies, Grouping, Filtering, and Minimizing Classified Performance Indicators (CPIs), Data Collection and Analysis, Selected CPIs, and Conclusion.
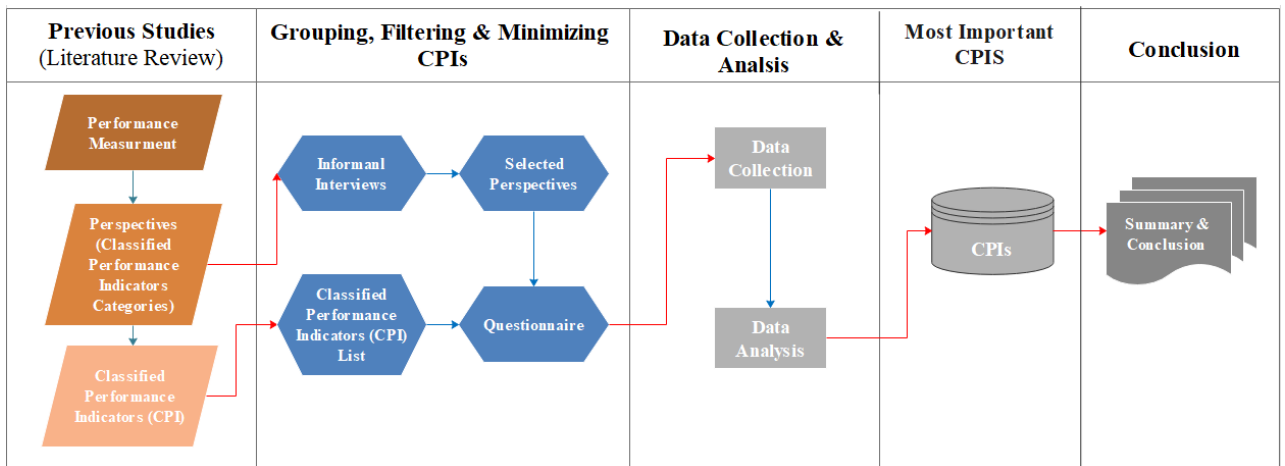

Fig. 1. Research Methodology

Table 1. Previous Summarized Classified Performance Indicators (CPIs)

Classified Performance Indicators (CPIs)

Authors and Years	Business performance	Changes Performance	Client / Customer satisfaction performance	Contractor performance	Cost performance	Efficiency	Effectiveness	Financial performance	Health, Safety, and Environment Performance	Innovation and Improvement R & D	Personnel and work team performance	Productivity	Project management performance	Quality performance	Social Performance	Sustainability	Time performance
Latham (1994)			√					√		√				√			
Jastaniah (1997)		√	√		√			√	√		√		√				√
Eagan (1998)			√		√			√	√			√					√
DETR (2000)	√	√	√		√			√	√					√			√
Kagioglou et al. (2001)			√		√			√	√				√	√	√		
Wegelius (2001)		√			√			√									√
Pillai et al. (2002)			√		√			√			√		√				
Takim and Akintoye (2002)			√		√			√	√		√	√		√			√
Cox et al. (2003)			√		√			√						√			√
Bassioni et al. (2004)			√		√			√	√			√		√			√
Beatham et al. (2004)			√		√			√		√			√				√
Chan & Chan (2004)			√		√			√	√		√			√			√
Cheung et al. (2004)			√		√			√			√			√			√
Wong (2004)				√	√			√									√
Constructing Excellence (2005, 2006, 2009)			√	√	√			√				√		√		√	√
Bassioni et al. (2005)			√		√			√						√			√
Dawood et al. (2006)			√		√			√			√	√	√	√			√
El-Mashaleh & O'Brien (2007)			√		√			√						√			√
Nudurupati & Turner (2007)	√		√		√			√	√			√		√			√
Luu & Park (2008)		√	√		√			√	√			√		√			√
Rankin et al. (2008) and Canadian Construction Innovation Council (CCIC) (2007)			√		√			√	√				√	√		√	√
Dawood & Sikka (2009)			√		√			√				√	√	√			√
Latorre & Riley (2010); Roberts & Latorre (2009)	√		√		√			√			√			√			√
Skibniewski & Ghosh (2009)			√		√									√			√
Butcher & Sheehan (2010)			√		√			√	√		√			√			√
Dawood (2010)	√		√		√	√		√			√		√				√
Horta, Camanho & Da Costa (2010)	√			√				√	√				√				
Latorre et al. (2010)			√		√			√	√			√		√			√
Toor & Ogunlana (2010)		√	√		√	√	√							√			√
Wadugodapitiya et al. (2010)			√		√			√	√	√	√	√	√	√	√	√	√
Construction Industry Institute (CII) (2011)		√			√			√				√		√			√
Constructing Excellence (2011)	√		√		√			√			√			√			√
Halman & Voordijk (2012)			√		√			√	√			√	√	√			√
Nasir et al. (2012)					√			√						√		√	√
Ali, Al-Sulaihi & Al-Gahtani (2013)	√		√		√	√		√	√					√			√
Daniel & Joseph (2013)		√	√	√	√			√	√		√	√	√				√
Ren & Yang (2013)			√			√		√	√			√	√				
Vyas and Kulkarni (2013)		√	√		√			√	√		√	√	√	√			√
Yeung et al. (2013)	√		√	√	√	√	√	√	√			√					√
Kundi & Unab (2014)			√		√			√	√			√		√			√
Mandisa et al. (2015)			√		√			√	√			√		√			√
Rana (2016)			√					√			√	√					√
Shaikh & Darade (2016)					√									√			√
Luong & Tsunemi (2017)			√		√			√	√			√	√	√	√		√
Pablo et al. (2017)			√		√			√							√		
Felipe et al. (2019)	√	√	√	√	√	√		√	√	√	√	√	√	√	√	√	√
Mohammed et al. (2019)			√					√		√	√				√		
A Barros et al. (2020)			√					√		√	√	√		√			√
Husam et al. (2020)			√		√			√					√	√			√
Olugboyega & Windapo (2020)			√	√	√			√						√			√

4. CONSTRUCTION PROJECTS' CLASSIFIED PERFORMANCE INDICATORS (CPIs) DEVELOPMENT:

4.1. Grouping, Filtering, and Minimizing CPIs stage:

4.1.1. Perspectives (Classified Performance Indicators Categories):

Ten experts with experience greater than or equal to 20 years in construction project management were interviewed from the top five Egyptian construction companies (according to the number of projects and their work volume). After interviewing the experts, the Construction Projects' Classified Performance Indicators Categories, which incorporate eight categories, were developed. It includes financial, operational, supporting, stakeholders' satisfaction, human capital, health, safety, and environmental, social, and innovation, learning, and growth perspectives as shown in Fig. 2.
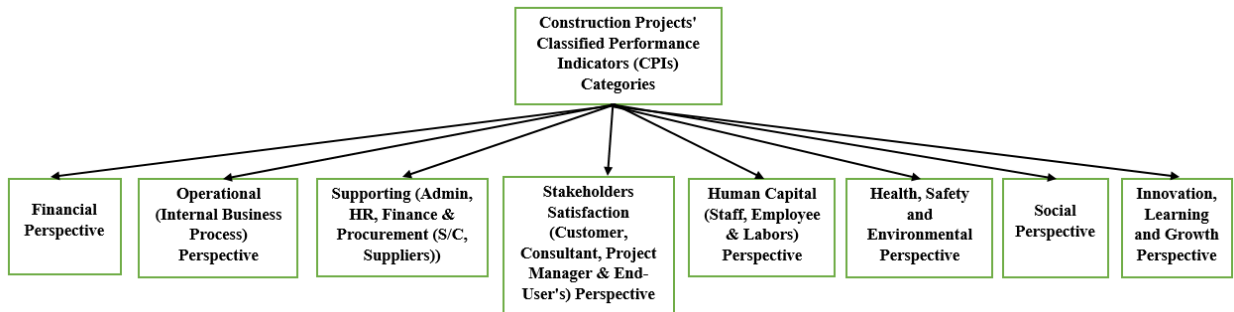
Fig. 2. Hierarchy of Construction Projects' Classified Performance Indicators Categories

4.1.2. Classified Performance Indicators:

Detailed Classified Performance Indicators (CPIs) are summarized and assigned to predetermined eight perspectives, as shown in Table 2, based on Table 1 and after the literature review. These (110) variables will be the most important CPIs for determining the performance of construction projects.

4.1.3. The questionnaire:

Based on Table 2, each respondent was required to produce numerical scores before every CPI expressing his/her opinions supported by his/her experience in construction projects in Egypt. The questionnaire was designed to take into account the importance of every CPI on the project's performance. All scores were divided into five divisions: Score (1-Very Low Impact), Score (2-Low Impact), Score (3-Moderate Impact), Score (4-High Impact), and Score (5-Very High Impact).

Table 2. Summarized and Allocated Detailed Classified Performance Indicators (CPIs)

	Perspective (Classified Performance Indicators Categories)	Detailed Classified Performance Indicators (CPIs)
A	**Financial Perspective**	- Capital cost - Cash Flow - Costs -- (Estimated, Actual and Predictability) --- (Project, Design, Construction), Cost performance, Cost effectiveness, Cost Variance, Cost of project changes, Cost of Reworking & Cost of customer complaints - Equity/ Debt ratio - Profit/Profitability --- (Cumulative, Gross), (before interest and tax), Predictability (project) - Payments & Revenue - Return on Assets - Return on Investments - Time Value of Money --- (Net Present Value, Internal Rate of Return) - Work Volume --- (Estimated, Actual and Predictability)
B	**Operational Perspective (Internal Business Process)**	- Aggravation, disputes, and conflicts --- (Occurrence and magnitude) - Benefit - Budget --- Clear objectives - Change management - Changes - Claims - Conformance - Contact & Communication (Channels & Efficiency) - Contract management - Deliberating the alternatives --- V.E - Drawings --- (S.D & As-Built Drawings) - Durability - Duration to complete the report - Earned Man-Hours - Efficiency (Doing things right) - Effectiveness (Doing the right things) - Facility management - Features - Flexibility --- of internal processes and nature of project - Free from Defects (high quality of workmanship) - Functionality - Index of good practices in construction sites; Defects detected in the delivery of the property; Evaluation of suppliers' materials; Term deviation; Number of non-conformities in audits. - Integration of design to supply, client satisfaction, time, cost, risk, reuse of design, understanding client's needs, design process, innovation

- Interaction among participants in each phase
- Interferences
- Joint site visits
- Meetings
- Planning --- (effectiveness, Efficiency, period)
- Problem definition
- Processes
- Production
- Productivity
- Products (Result Indicators)
- Quality Performance --- Control & Assurance (Punch List)
- Relationship
- Record maintenance
- Reducing the difficulty of construction, i.e., rework times
- Reliability
- Rework
- Resource --- (Management & Utilization)
- Risk
- Schedule performance
- Scope
- Service
- Setup / Dismantle Time
- Site management
- Specifications
- Speed of Construction
- Stress/conflict management
- Sustainability
- Technicality
- Time -- (Estimated, Actual and Predictability) --- (Project, Design, Construction), Time performance, Time effectiveness, Time of project changes, Lost Time Accounting, Variation, Time Variance, Time to rectify defects , to Resolve Customer Complaints
- Top management Commitment

C	**Supporting Perspective**	- Procurement: - Material (Suppliers) --- (Ordering, Delivery, Handling and Management) - S/C - Self-Execution - Labor --- (Dependency, Relationship, Utilization) - Equipment --- (Ordering, Utilization and Management) - Health - Safety - HR - Administrational - Security - Finance

- Customer Satisfaction (CSI) --- (Customer Satisfaction Index)

D	**Stakeholders' Satisfaction Perspective**	• Consultants Satisfaction • Project Manager Satisfaction • End-User Satisfaction
E	**Human Capital Perspective**	• Employees' satisfaction Index (Internal Customer Satisfaction Index) --- (ICSI) • Employees' Performance Index (Internal Customer Performance Index) --- (ICPI) • Absenteeism • Turnover • Motivation • Experience • Diversity • Appraisal levels • Education and Recruitment • Trust and Respect • Communication • Qualifications • efficiency • Productivity • Professionalism • Stress/conflict management • Labor relationship • Labor dependency • Teamwork • Coordination
F	**Health, Safety and Environmental Perspective**	• Health Index (H.I) • Safety Index (S.I) • Environmental Index (E.I)
G	**Social Perspective**	• Social Impact • Social satisfaction
H	**Innovation, Learning and Growth Perspective**	• Research & Development (R&D) • learned organization (Lessons learned) --- for Continues Improvement • Innovation, Learning, and improvement • Information Management • Knowledge of participants • New Technology, New Method of Construction , New Method Statement • Training • Knowledge • Document Management • Value Engineering

4.2 Data Collection Stage:

4.2.1 Determination of Required Sample Size:

By using Bartlett et al. (2001) equation (1) to compute the required sample size for an infinite population:

$$n = \frac{K^2 * P(1-P)}{E^2} --- (1)$$

Where:

-**n** is the specified sample size for an infinite population. **K** value equals 1.645 when confidence level equals 90%. **P** is the proportion of the population, i.e., the degree of variance between the weather of the population (the critical value of **P** is 0.5). **E** is an appropriate margin of error= 10% for confidence level of 90%.

-By substituting these parameters in equation (1), the desired study sample size for the infinite population is (68) samples because that is the minimum value.

4.2.2 Response to the questionnaire:

-Data was collected from some professionals and experts in construction projects in Egypt. A total of 100 questionnaires were administered to professionals and experts in construction projects in Egypt through face-to-face interviews, email, and Google forms over 10 weeks. A complete of (70) questionnaires representing 70% of the overall questionnaires administered were returned. The main points of the questionnaires administered and also the return rate are shown in Table 3.

Table 3: Details of questionnaires administered and the rate of return

CONSTRUCTION PROJECTS PROFESIONALS AND EXPERTS	NO. OF QUESTIONNAIRES DISTRIBUTED	NO. OF QUESTIONNAIRES RETURNED	% RATE OF RETURNED
Contractors	73	53	72.6%
Clients	10	4	40%
Consultants	5	4	80%
Project Managers	6	5	83.3%
Project Management Experts	6	4	66.7%
TOTAL	**100**	**70**	**70%**

4.2.3 Classification of the surveyed experts based on their job title category:

It should be mentioned that the respondents' job titles were classified into five categories in the Egyptian construction projects, as shown in Table 3.

4.2.4 Classification of the surveyed experts based on their experience:

A questionnaire survey was conducted among construction experts to identify the most important construction projects' CPIs. The respondents to the questionnaire were classified according to their experience, as shown in Table 4.

Table 4. Classification of the surveyed experts based on their experience

YEARS OF PRACTISING IN THE COUNSTRUCTION INDUSTRY	Contractors	Clients	Consultants	Project Managers	Project Management Experts	TOTAL	%
(Less than 10 years)	5	1	1	1	1	9	**12.9%**
(Greater than or equals to 10 years and less than 20)	22	1	1	1	1	26	**37.1%**
(Greater than or equals to 20 years)	26	2	2	3	2	35	**50%**
TOTAL	**53**	**4**	**4**	**5**	**4**	**70**	**100%**

4.3 Data Analysis (Ranking of CPIs based on their importance index):

The questionnaire respondents have provided numerical scores expressing their opinions based on their experience of the construction projects in Egypt. Such analysis includes a lot of important steps that can be summarized into the following steps:

First, calculate the total score.

Second, calculate important indexes for the previously identified (110) CPIs.

$$\textbf{Total score} = \sum \textbf{score of each factor} = \sum_{i=1}^{n} (\textbf{S}) \dots (2)$$

$$\textbf{Important Index (II)} = \sum_{i=1}^{n} (\textbf{S})/ (\textbf{N*5}) * \textbf{100} \dots (3)$$

Where:

N = total number of respondents to each factor, (**N**=70).

5 represented the upper scale of the measurement.

4.4 Most Important CPIs:

Table 5 represents the perspectives and CPIs developed in this study. Finally, (40) CPIs (with an Important Index of over 80%) were suggested as top-ranked Classified Performance Indicators for Egyptian construction projects.

Table 5. Top-Ranked Construction Projects' Classified Performance Indicators (CPIs)

	Perspectives (Categories)	Classified Performance Indicators (CPIs)	Avg.	Important Index
A	**Financial Perspective**	• Profit/Profitability	5.00	100.0%
		• Cost Performance	4.98	99.7%
		• Payments & Revenue	4.85	97.0%
		• Cash Flow	4.72	94.3%
		• Work Volume	4.61	92.2%
B	**Operational Perspective (Internal Business Process)**	• Time Performance	4.95	99.0%
		• Productivity	4.93	98.7%
		• Technicality	4.80	96.0%
		• Quality Performance Index	4.70	94.0%
		• Risk	4.72	94.3%
		• Efficiency	4.60	92.0%
		• Effectiveness	4.55	91.0%
		• Aggravation, disputes, and conflicts	4.43	88.7%
		• Changes	4.27	85.3%
		• Drawings	4.20	84.0%
C	**Supporting Perspective**	• Financial Support	4.90	98.0%
		• Procurement Support	4.83	96.7%
		• Equipment Support	4.75	95.0%
		• Human Resources Support	4.68	93.7%
		• Administrational Support	4.65	93.0%
		• Security Support	4.45	89.0%
		• Health Support	4.43	88.7%
		• Safety Support	4.37	87.3%
D	**Stakeholders' Satisfaction Perspective**	• Customer Satisfaction (CSI) --- (Customer Satisfaction Index)	4.80	96.0%
		• Project Manager Satisfaction	4.75	95.0%
		• Consultants Satisfaction	4.50	90.0%
		• End-User Satisfaction	4.35	87.0%
E	**Human Capital Perspective**	• Employees' satisfaction Index (Internal Customer Satisfaction Index) --- (ICSI)	4.85	97.0%
		• Employees' Performance Index (Internal Customer Performance Index) --- (ICPI)	4.70	94.0%
		• Employees' Motivation Index --- (MI)	4.63	92.7%
		• Absenteeism	4.55	91.0%
		• Turnover	4.48	89.7%
F	**Health, Safety and Environmental Perspective**	• Health Index (H.I)	4.67	93.3%
		• Safety Index (S.I)	4.63	92.7%
		• Environmental Index (E.I)	4.18	83.7%
G	**Social Perspective**	• Social Impact	4.10	82.0%
		• Social Satisfaction	4.03	80.7%
H	**Innovation, Learning and Growth Perspective**	• Document Management	4.60	92.0%
		• learned organization (Lessons learned)	4.55	91.0%
		• Training	4.15	83.0%

Table 6 shows a summary list of categories before and after questionnaire results, weight, and also how you look after selected CPIs relative to any or all CPIs. It clearly illustrates that rather than (10) CPIs, (5) CPIs were only considered under the financial perspective, (10) CPIs rather than (53) under the operation perspective, (5) rather than (20) under the human capital perspective, (3) rather than (10) under the innovation, learning, and growth perspective, and every one of the CPIs under supporting, stakeholders, social, health, safety, and environmental perspectives were selected.

Table 6: CPIs' categories affecting project performance before and after questionnaire

No.	Perspective (Category)	CPIs before questionnaire results and ranking (All CPIs)		CPIs after questionnaire results and ranking (Selected CPIs)		% of Selected CPIs relative to All CPIs
		Sum	Weight	Sum	weight	
1	**Financial Perspective**	10	9.10%	5	12.5%	50.0%
2	**Operational Perspective**	53	48.20%	10	25.0%	18.9%
3	**Supporting Perspective**	8	7.30%	8	20.0%	100.0%
4	**Stakeholders' Satisfaction Perspective**	4	3.60%	4	10.0%	100.0%
5	**Human Capital Perspective**	20	18.20%	5	12.5%	25.0%
6	**Health, Safety and Environmental Perspective**	3	2.70%	3	7.5%	100.0%
7	**Social Perspective**	2	1.80%	2	5.0%	100.0%
8	**Innovation, Learning and Growth Perspective**	10	9.10%	3	7.5%	30.0%
	Total	**110**	**100%**	**40**	**100%**	**36.4%**

5. RESULTS DISCUSSION, AND LIMITATIONS

According to the number of CPIs, the results show that the Egyptian construction projects' performance depends mainly on operational perspectives, then supporting perspectives, then financial and human capital perspectives, then stakeholders' satisfaction perspectives, and finally the other remaining perspectives (HSE perspectives, social perspectives, and innovation, learning, and growth perspectives).

The study's results were validated by the findings of specific group meetings through 5 separate individual sessions over 2 weeks. Basically, the perceptions of the specific group were in line with the study's results. The group agreed that profitability, cost performance, time performance, and productivity are the most important CPIs for construction projects. Furthermore, it is necessary for the project's scope and documents to be well defined to identify clients' predetermined needs and requirements.

Based on the results of this study, the findings were considered in an integrated manner, taking into account the experience of all stakeholders only in the Egyptian construction industry and their participation in the projects' CPIs. And they did take into account types of construction projects.

6. SUMMARY AND CONCLUSIONS

This paper is aimed at identifying and prioritizing Classified Performance Indicators (CPIs) that influence the performance of Egyptian construction projects in an integrated and sustainable manner. The CPIs were identified and grouped into eight perspectives: Financial, Operational, Supporting, Stakeholders Satisfaction, Human Capital, Health, Safety and Environmental, Social, Innovation, Learning and Growth Perspectives through two stages. In the first stage, (110) CPIs were collected from the literature review. In the second stage, a questionnaire was designed using the identified significant factors. Accordingly, the (40) most CPIs affecting the project's performance were identified, which are integrated between all perspectives and take into consideration the three pillars of sustainability (Economic, Social, and Environment) as a decision-making tool to measure, evaluate, and improve project performance. This study did not consider the relative weights between perspectives and CPIs. This can be investigated in future studies.

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