

**IMPACT OF INDUSTRY 4.0 REVOLUTION
AND LEADERSHIP SUPPORT
ON THE OPERATIONAL EFFICIENCY MANAGEMENT
OF THE MANUFACTURING INDUSTRY IN ASEAN COUNTRIES**

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Abstract: Operational efficiency of an organization is considered to be a crucial element of any firm. The production of goods and services, their quality, marketing and profitability depend on the efficiency of business operations. Moreover, the reliance on operational efficiency is mostly associated with the industry 4.0 revolution and leadership support. Thus, the current research investigates the impact of the industry 4.0 revolution and leadership support on the operational efficiency management of the textile industry in the Association of Southeast Asian Nations (ASEAN) countries. The liquidity and capital structure have been used as the control variables. In the current article, researchers extracted the secondary data from the financial statements of the textile industry from 1991 to 2020. The researchers also applied the panel Autoregressive Distributed Lag (ARDL) to test the relationships among the constructs. The results revealed that the industry 4.0 revolution, leadership support, liquidity, and capital structure were positively associated with operational efficiency management of the textile industry in ASEAN countries. This study guides the regulators in establishing the policies related to operation efficiency management by focusing on the industry 4.0 revolution and leadership support.

Key words: Industry 4.0 revolution, leaderships support, liquidity, capital structure, operational efficiency management

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Introduction

All the activities of a company undertaken to produce desired products and services and market them are considered business operations. The production of goods and services, their quality, marketing, and profitability depend on the efficiency of business operations. If the business operations are carried on efficiently, money, resources and time are less waste. Similarly, the optimal use of building, inventory and equipment enhances their productive capacity, reduces the cost per unit, and

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expands production and marketing. So, the operational efficiency regarding building, inventory and equipment enhances sales, and it adds to the firms' financial performance. One feature of operational efficiency is to encourage the employees to put their best effort to challenge the problems, overcome risks, pick the opportunities, meet the given tasks, and work for business innovation. For this, they are appropriately trained, and their performance is analyzed. Such employees provide maximum productivity with limited resources within the given time. So, the business organizations whose efficiently managed operations are agile, quick responsive, leaner and highly profitable (Nicholson & Stevens, 2021).

The operational management efficiency depends on the nature and work performance of the resources, such as physical, technological and human resources. The industry 4.0 revolution and leadership support are the two significant factors influencing operational management efficiency. The industry 4.0 revolution minimizes the gap between the physical, digital, and biological worlds. It is a mixture of advancements in robotics, artificial intelligence (AI), the Internet of Things (IoT), 3D printing, quantum computing, genetic engineering, and other technologies. It's the driving force behind a slew of products and services that are quickly becoming vital in today's world. The application of industry 4.0 inventions, discoveries and technologies in different business organizations improved the productivity of different physical and human resources. So, organizational operations can more efficiently be managed and operated, bringing improvement in company goodwill and profitability. Supportive leadership is the leadership style where the leaders build trust, arouse inspiration, and assist team members in overcoming problems. Leaders who want to express their support for their teams should foster teamwork, pay extra attention to relationships among team members, and demonstrate commitment. This develops a commitment among team leaders and team members. Thus, it inspires the team members to comply with the instructions given, work efficiently for the assigned tasks, and develop particular skills and abilities essential to the job positions they hold. Hence, with improvement in human resources, efficiency can be enhanced in business operational management (Li, Lam, Ho, & Yeung, 2022).

This study examines the influences of the industry 4.0 revolution and leadership support, liquidity, and capital structure on operational efficiency management in the Association of Southeast Asian Nations (ASEAN) economy. Indonesia, Malaysia, the Philippines, Thailand, and Singapore started the ASEAN in 1967. With the passage of time association continues to grow, and it has become a ten-member association having five more states, Brunei Darussalam, Cambodia, Myanmar, Vietnam, and Laos, with Papua New Guinea a supervisor. The purpose of the ASEAN formation is to increase the economic growth rate of the region. The total GDP of US\$2.9 billion determines that it has expanded to become the world's fifth-largest economy. As the region's population grows and the wage rate falls, some member countries, particularly Vietnam, Cambodia, Laos, and Myanmar, are expected to gradually develop new locations in industrial supply chains. All member states of the ASEAN association have large manufacturing industries.

Leading manufacturing sectors of ASEAN are: automotive, plastics, fabricated metal products, and rubber (Indonesia), beverage, food, and tobacco (Singapore), chemicals and petroleum refining, electronics and telecommunications (Vietnam), electrical machinery and transport equipment (Malaysia), rubber, automotive, and plastic industries (Thailand), chemicals; engineered products; copper wire rods; paper pulp, and tool and die (the Philippines), and so on. ASEAN countries include ten economies like Thailand, Malaysia, Philippines, Indonesia, Singapore, Brunei Darussalam, Cambodia, Laos, Vietnam, and Myanmar. Most of these countries are developing economies. But, the pace of development for these economies is not as fast as it must be. The reason behind these countries' lack of progress is due to the inefficient operational management in many of the commercial enterprises' operatives in the ASEAN region (Lee, Hamid, & Hardy, 2022). It is required that research must focus on this point. So, the present study focuses on operational management efficiency. It investigates the impact of the industry 4.0 revolution, leadership support, liquidity, and capital structure on operational efficiency management (Adeyemi & Aigbavboa, 2021).

The present study is distinctive in the existing literature for its contribution. First, industry 4.0 revolution and leadership support are the two complete and separate business concepts linked to technology, and the other is related to human resources management. These two business concepts have yet to be discussed separately regarding operational efficiency management. Therefore, the study explores the simultaneous influences of the industry 4.0 revolution and leadership support operational efficiency management. Secondly, the studies on operational efficiency management have taken into account the management of internal operational efficiency. The present study examines the efficiency of internal operations and pays attention to external operations as it measures operational efficiency management by inventory turnover. So, the current study is an excellent contribution to the literature. Third, the past study has dealt with the impacts of the industry 4.0 revolution and leadership support operational efficiency management. However, limited studies address the need for operational efficiency management in ASEAN economies. The current study that chooses the context of ASEAN economies to analyze the industry 4.0 revolution and leadership support role in operational efficiency management adds to the literature.

Literature Review

Operational efficiency refers to the optimal use of resources, time and money, and it is needed for the firms for many reasons like reducing the total costs by reducing the wastage of time, resources, and human labor, preserving the resources for future use, improves the quality of the resources and products, and expand the marketing. But, the operational efficiency is influenced by leadership style, techniques, and technologies applied for operating business processes and financial management. The present study examines the impacts of the industry 4.0 revolution, leadership support, liquidity, and capital structure on operational efficiency management. Many

researchers and scholars have written about the impacts of the industry 4.0 revolution, leadership support, liquidity, and capital structure on operational efficiency management.

In a literary article on Industry 4.0 consequences in business and Economics, Maresova et al. (2018) examine the impacts of the industry 4.0 revolution on operational efficiency management. For the empirical investigation of the nexus between the industry 4.0 revolution on operational efficiency management, the information was collected from publications on the topics of Industry 4.0, economics, production economics, economic development, and the financial sector from the Web of Science, Scopus, and Science Direct for the period 2014-2018. After getting 67 full papers screened, the results showed a positive relationship between the industry 4.0 revolution and operational efficiency management. The study implies that industry 4.0 has been provided with digital information and communication technologies that assist in attaining quality information and process, store, and communicate the information at the time of need. This assures efficient operational management with quality resources and effective production processes, which can raise marketing and profitability (Aljazzazen & Schmuck, 2021).

A study was conducted by Huang et al. (2021) to identify the impacts of industry 4.0 on workforce efficiency and operational efficiency management in the Indian automotive industry. The findings regarding the impacts of industry 4.0 on workforce efficiency and operational efficiency management were acquired from a review of the literature on industry 4.0, the efficiency of the workforce, and operational efficiency in the automotive industry globally. The study shows the positive impacts of industry 4.0 on workforce efficiency and operational efficiency management. The study posits that industry 4.0 focuses on innovative technologies and processes in business organizations. The use of innovative digital, artificially intelligent and automatic technologies attracts an efficient workforce and retains and develops them through upskilling and re-skilling practices. When the organization's active, talented, and skilled workforce is maintained, the business operations, including production and marketing, can be managed efficiently (Fabbro & Tonchia, 2021).

Likewise, the theoretical research of Ghobakhloo and Fathi (2019) throws light on the impacts of industry 4.0 on operational efficiency management. The study reveals that information technologies, as confirmed, enhance awareness, communication, and relationship building, provide a stair to success in improving lean digitized manufacturing and operational efficiency management. But, the study also throws light on the fact that only when the firms have better leverage of information technology if they have peculiar core competencies and capability and the optimal utilization of information technology leads the firm towards improvement lean digitized manufacturing and operational efficiency management (Khoma & Vdovychyn, 2021).

The study presented by Tortorella, de Castro Fettermann, Frank, and Marodin (2018), examines the relationship between leadership styles and operational

management efficiency. Lean manufacturing (LM) implementation has been analyzed for leadership style, supportive leadership, and operational management efficiency. The study implies that when the leaders apply a supportive style to deal with their subordinates while implementing the policies and strategies formed in consultation with the top management, they can influence the team members' thinking. Such abilities and skills can be indulged in them that are helpful to operate different technologies and operational activities efficiently without wasting time. So, the supportive leadership style helps implement lean manufacturing with increased operational efficiency management (Al-Shammari, 2021).

With an empirical investigation, Burawat (2019) identifies the relationship between transformational leadership that is supportive leadership, lean manufacturing practices, and operational management efficiency. The empirical information for transformational leadership, supportive leadership, lean manufacturing practices and operational management efficiency was acquired from the middle and senior managers working in small and medium firms operating in the Thai manufacturing industry. The study implies that transformational or supportive leaders provide emotional, cognitive, and economic support by giving importance to their needs and helping them remove their problems. Thus, supportive leadership gives team members peace of mind and emotional satisfaction and motivates them to work on the given task effectively and efficiently. The accuracy of the work and completion of tasks within the reduced time drives lean manufacturing and operational management efficiency (Alzahrani & Alfares, 2021).

In an article, Akkaya and Tabak (2020) examine the influences of two kinds of supportive leadership on organizational agility and operational efficiency management. The study implies that when the leaders adopt a supportive leadership style for leading the team members, they successfully have their hearts, trust, and commitment, making it easy for the leaders to meet the goals of a project by implementing strategies. So, the inspired team members carry out the business operations efficiently.

The study by Alberca and Parte (2018) integrates the impacts of both financial and non-financial factors on operational efficiency in restaurants. The study suggests that liquidity defines the firms' access to cash at the time of need. The easy access to cash under a high rate of liquidity in assets enhances the firms' ability to make business transactions at any time or make contingent contracts that may require a certain sum of money immediately in the future. So, with consistency, agility, and responsiveness, the firms can improve operational efficiency and enhance profitability (Lipińska, 2021).

Dang, Vu, Ngo, and Hoang (2019) analyze the impacts of firm size, capital structure, growth, and profitability on operational efficiency management and enterprise value with pieces of evidence from the Vietnam economy. The study implies that an effective capital structure always assures the availability of financial resources at any time. The effective capital structure enhances the firms' ability to benefit from opportunities and overcome the risks, exposures, and damages on account of the

acquisition of different effective technologies and resources. So, effective capital structure improves firms' operational efficiency management; thus, there is a positive relationship between these factors.

Research Methodology

The research investigates the impact of the industry 4.0 revolution and leadership support, liquidity, and capital structure on the operational efficiency management of the textile industry in ASEAN countries. In the current article, researchers extracted the secondary data from the financial statements of the textile industry from 1991 to 2020. The researchers also applied the panel ARDL to test the relationships among the constructs. The study equation is given below:

$$OEM_{it} = \alpha_0 + \beta_1 IR_{it} + \beta_2 LS_{it} + \beta_3 LQ_{it} + \beta_4 CS_{it} + e_{it} \quad (1)$$

Where;

OEM = Operational Efficiency Management

t = Time Period

i = Country

IR = Industry 4.0 Revolution

LS = Leadership Support

LQ = Liquidity

CS = Capital Structure

Table 1 shows these measurements of variables in detail.

Table 1. Measurements of variables.

S#	Variables	Measurement	Sources
01	Operational Efficiency Management	Inventory turnover ratio	(Amanda, 2019)
02	Industry 4.0 Revolution	The ratio of technology expenditures to total expenditures	(Kamble, Gunasekaran, Ghadge, & Raut, 2020)
03	Leadership Support	The ratio of incentives expenditures and total expenditures	(Kryscynski, Coff, & Campbell, 2021)
04	Liquidity	The ratio of current assets to current liabilities	(Purnomo, 2018)
05	Capital Structure	Debt to equity ratio	(Solihin, 2019)

The current article has run the correlation matrix to examine the directional linkage between the constructs but ignores the significance of the association. Moreover, the article also applied the ARDL bound test to check the co-integration. Finally, the

present research has also applied the Augmented Dickey-Fuller (ADF) test to check the unit root. The equation is given as under:

$$d(Y_t) = \alpha_0 + \beta t + \gamma Y_{t-1} + d(Y_t(-1)) + \varepsilon_t \quad (2)$$

The current article has used the ADF test, and the ADF test has checked the unit root individually. Hence, the individual equations are given as under:

Operational Efficiency Management

$$d(OEM_t) = \alpha_0 + \beta t + \gamma OEM_{t-1} + d(OEM_t(-1)) + \varepsilon_t \quad (3)$$

Industrial 4.0 Resolution

$$d(IR_t) = \alpha_0 + \beta t + \gamma IR_{t-1} + d(IR_t(-1)) + \varepsilon_t \quad (4)$$

Leadership Support

$$d(LS_t) = \alpha_0 + \beta t + \gamma LS_{t-1} + d(LS_t(-1)) + \varepsilon_t \quad (5)$$

Liquidity

$$d(LQ_t) = \alpha_0 + \beta t + \gamma LQ_{t-1} + d(LQ_t(-1)) + \varepsilon_t \quad (6)$$

Capital Structure

$$d(CS_t) = \alpha_0 + \beta t + \gamma CS_{t-1} + d(CS_t(-1)) + \varepsilon_t \quad (7)$$

The researchers also applied the panel ARDL to test the relationships among the constructs. In addition, ARDL techniques are especially for time-series data, and when the panel data is more than thirty years, then the researchers can use the panel ARDL, and the current study has taken the thirty years data as mentioned above. In addition, when some variables are stationary at the level and others are stationary at the first difference, the researchers can also apply panel ARDL. Finally, the panel ARDL can provide both long and short-run associations. The panel ARDL equation is given as under:

$$\Delta OEM_{it} = \alpha_0 + \sum \delta_1 \Delta OEM_{it-1} + \sum \delta_2 \Delta IR_{it-1} + \sum \delta_3 \Delta LS_{it-1} + \sum \delta_4 \Delta LQ_{it-1} + \sum \delta_5 \Delta CS_{it-1} + \varphi_1 OEM_{it-1} + \varphi_2 IR_{it-1} + \varphi_3 LS_{it-1} + \varphi_4 LQ_{it-1} + \varphi_5 CS_{it-1} + \varepsilon_{it} \quad (8)$$

Research Results

The current article has run the correlation matrix to examine the directional linkage between the constructs but ignores the significance of the association. The results revealed that the industry 4.0 revolution, leadership support, liquidity and capital structure were positively associated with operational efficiency management of the textile industry in ASEAN countries. Table 2 shows these associations.

Table 2. Correlation.

Variables	OEM	IR	LS	LQ	CS
OEM	1.000				
IR	0.730	1.000			
LS	0.382	-0.388	1.000		
LQ	0.197	0.281	0.443	1.000	
CS	0.281	0.339	-0.102	0.392	1.000

The present research has also applied the ADF test to check the unit root. The results indicated that the OEM and CS are stationary at a level while IR, LS, and LQ are stationary at first difference. Table 3 shows the unit root test results.

Table 3. Unit root test.

Augmented (ADF)	Dickey-Fuller Test	Level	t-statistics	p-values
OEM		I(0)	-3.982	0.012
IR		I(1)	-6.252	0.000
LS		I(1)	-4.920	0.000
LQ		I(1)	-6.762	0.000
CS		I(0)	-3.827	0.014

Moreover, the article also applied the ARDL bound test to check the co-integration. The results exposed that the calculated f-statistics value (5.873) is higher than the critical values. These results exposed co-integration exists. Table 4 shows the bound test.

Table 4. ARDL bound test.

Model	F-statistics	Lag	Level of Significance	Bound test critical values	
				I(0)	I(1)
OEM/(IR,LS,LQ,CS)	5.873	4	1%	6.120	6.342
			5%	5.092	5.763
			10%	4.277	4.762

The results of panel ARDL revealed that the industry 4.0 revolution, leadership support, liquidity and capital structure positively affect operational efficiency management of the textile industry in ASEAN countries in the short-run. R square value (0.567) also indicated that 56.7 per cent of changes in OEM are due to all the predictors. Table 5 shows the short-run associations.

Table 5. Short-run coefficients.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(IR)	3.763	1.382	2.723	0.033
D(LS)	4.292	1.437	2.987	0.025
D(LQ)	2.878	1.320	2.180	0.046
D(CS)	3.495	1.092	3.201	0.012
CointEq(-1)*	-1.739	0.431	-4.035	0.000
R-squared	0.567	Mean dependent var		-0.063
Adjusted R-squared	0.545	S.D. dependent var		2.101

The results also revealed that the industry 4.0 revolution, leadership support, liquidity and capital structure were positively associated with operational efficiency management of the textile industry in ASEAN countries in the long run. Table 6 shows the long-run associations.

Table 6. Long term coefficients.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IR	4.192	1.763	2.378	0.023
LS	2.985	1.321	2.260	0.027
LQ	3.805	1.096	3.472	0.003
CS	2.209	1.011	2.185	0.035
C	1.903	0.439	4.335	0.000

Discussion

The study results indicated that the industry 4.0 revolution positively impacts operational efficiency management. These results are supported by Shahin, Chen, Bouzary, and Krishnaiyer (2020), which posits that the industry 4.0 revolution introduces artificial intelligent technologies, automatic machinery, the internet of things, and digital information and communication technologies. The use of such things, technologies and machines enhances the work continuity, accuracy of the practices, and speed of the operations. Hence, the industry 4.0 revolution helps management improve operational efficiency. These results are also in line with the

study of Fettermann, Cavalcante, Almeida, and Tortorella (2018), which shows that the adoption of industry 4.0 technology communication, information acquisition, and big data analysis assists the administration in making better decisions, accountants for processing and storing the data accurately, and auditors for accuracy, easy track of changes, and recalling the stored data.

The study results showed that leadership support positively impacts operational efficiency management. These results are supported by Lan et al. (2022), which show that the policies and strategies formed by the team leader, the way of passing instruction to team members, the structure through which the leader can communicate with the subordinates, and the way to assess the performance of team member all influence performance of the team. If the leader is supportive and adopts a cooperative and influencing conduct towards the team members, they try their best to perform their functions efficiently. So, the leadership support positively contributes to the operational efficiency management. These results also agree with the study of Suifan, Abdallah, and Al Janini (2018), which states that the team leader adopts a supportive leadership style to deal with the team members, they can influence their thinking, abilities, and performance within the organization. In the presence of a supportive leader, management can improve operational efficiency.

The study results revealed that liquidity positively impacts operational efficiency management. These results are supported by Schoemaker, Heaton, and Teece (2018). These results also agree with Adam, Safitri, and Wahyudi (2018), which claim that the high liquidity of the assets allows the business firm to facilitate their operational functions and improve their effectiveness by applying efficient technologies, quality resources, proficient labor, and productive building, on account or by borrowing money in the present. The reason is that the high liquidity provides quick access to cash at the time of need. Hence, high liquidity assists management in achieving high operational efficiency.

The study results revealed that the debt-to-equity ratio positively impacts operational efficiency management. These results are supported by Lu et al. (2022), which capital is the crucial factor of a business. Capital structure, the combination of debt and equity, determines operational management efficiency. If the business firms form the capital structure in such a manner, they can arrange the financial resources for acquiring resources and hiring the services to operate the business practices.

Conclusion

The study carries both theoretical and empirical implications. The present article, which combines analysis of industry 4.0 revolution, leadership support, liquidity, and capital structure role in operational efficiency management, contributes to existing literature. The study contributes to the literature by analyzing the relationship between the industry 4.0 revolution, leadership support, liquidity, and capital structure on operational efficiency management in the context of ASEAN economies. Besides the theoretical contribution of the study, it has much empirical importance in the emerging economies across the world as it talks about operational

management efficiency. The study is a guideline to economists and businesses on how they can improve operational management. To enhance operational efficiency management, they must form the policies to benefit from industry 4.0 revolution, leadership support, liquidity, and effective capital structure.

The results revealed that operational management efficiency could be improved with the adoption of industry 4.0 like artificial intelligent technologies, automatic machinery, internet of things, and digital information and communication technologies. When the team leader assumes a supportive behavior toward the team members, they can influence them and motivate them to perform firm operations efficiently. The results stated that the increase in the firm's liquidity enhances the firms' financial power, which is crucial to increasing operational management efficiency. The results showed that when the firms adopt a favorable capital structure with enough funds for business without having any large burden of debts, the operational management works efficiently.

The study has some limitations, and the scholars are recommended that they must focus on removing these limitations. The authors' focus is on the role of the 4.0 revolution, leadership support, liquidity, and capital structure in improving operational efficiency management. There are many factors that have a crucial role in operational efficiency management, but the current study pays no attention to these factors while analyzing operational efficiency management. So, future authors must also pay attention to factors in future studies. In addition, ASEAN countries have been fast-developing countries and are good examples of operational efficiency management. Still, they do not provide enough information for reliable findings. Future research must analyze the impacts of the 4.0 revolution, leadership support, liquidity, and capital structure on improving operational efficiency management across the world.

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WPLYW REWOLUCJI PRZEMYSŁU 4.0 I WSPARCIA PRZYWÓDZTWA NA ZARZĄDZANIE EFEKTYWNOŚCIĄ DZIAŁANIA PRZEMYSŁU WYTWÓRCZEGO W KRAJACH ASEAN

Streszczenie: Sprawność operacyjną organizacji uważa się za kluczowy element każdej firmy. Produkcja towarów i usług, ich jakość, marketing i rentowność zależą od efektywności prowadzonej działalności gospodarczej. Co więcej, poleganie na efektywności operacyjnej kojarzy się przede wszystkim z rewolucją przemysłu 4.0 i wsparciem przywództwa. W związku z tym obecne badanie dotyczy wpływu rewolucji przemysłu 4.0 i wsparcia przywództwa na zarządzanie efektywnością operacyjną przemysłu tekstylnego w krajach Stowarzyszenia Narodów Azji Południowo-Wschodniej (ASEAN). Jako zmienne kontrolne zastosowano płynność i strukturę kapitału. W niniejszym artykule badacze wyodrębnili dane wtórne ze sprawozdań finansowych przemysłu tekstylnego od 1991 do 2020 roku. Badacze zastosowali również panel Autoregressive Distributed Lag (ARDL), aby przetestować relacje między konstruktami. Wyniki pokazały, że rewolucja przemysłu 4.0, wsparcie przywództwa,

płynność i struktura kapitału były pozytywnie powiązane z zarządzaniem efektywnością operacyjną przemysłu tekstylnego w krajach ASEAN. Niniejsze opracowanie prowadzi regulatorów w ustalaniu polityk związanych z zarządzaniem efektywnością działania, koncentrując się na rewolucji przemysłu 4.0 i wspieraniu przywództwa.

Słowa kluczowe: rewolucja Przemysłu 4.0, wsparcie przywództwa, płynność, struktura kapitału, zarządzanie efektywnością operacyjną

工业 4.0 革命和领导支持对东盟国家制造业运营效率管理的影响

摘要：组织的运营效率被认为是任何公司的关键要素。商品和服务的生产、质量、营销和盈利能力取决于企业运营的效率。此外，对运营效率的依赖主要与工业 4.0 革命和领导力支持有关。因此，目前的研究调查了工业 4.0 革命和领导支持对东南亚国家联盟 (ASEAN) 国家纺织业运营效率管理的影响。流动性和资本结构已被用作控制变量。在当前的文章中，研究人员从 1991 年至 2020 年的纺织行业财务报表中提取了二手数据。研究人员还应用面板自回归分布滞后 (ARDL) 来测试构造之间的关系。结果表明，工业 4.0 革命、领导力支持、流动性和资本结构与东盟国家纺织业的运营效率管理呈正相关。本研究通过关注工业 4.0 革命和领导力支持，指导监管机构制定与运营效率管理相关的政策

关键词：工业4.0革命，领导层支持，流动性，资本结构，运营效率管理