IJMRSETM

e-ISSN: 2395 - 7639

INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH

IN SCIENCE, ENGINEERING, TECHNOLOGY AND MANAGEMENT

Volume 9, Issue 7, July 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.580

+91 99405 72462 +9163819 07438 ijmrsetm@gmail.com www.ijmrsetm.com

International Journal of Multidisciplinary Research in Science, Engineering, Technology & Management (IJMRSETM)

| ISSN: 2395-7639 | www.ijmrsetm.com | Impact Factor: 7.580|

| Volume 9, Issue 7, July 2022 |

| DOI: 10.15680/IJMRSETM.2022.0907009 |

Utilizing Performance Metrics and the DEA Method to Evaluate the Efficiency of Decision-Making in Supply Chain Industries using DEA approach

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ABSTRACT: This study was conducted with the intention of shedding light on the issue of making use of performance indicators and the DEA approach in order to analyses the effectiveness of decision-making units within a tyre firm. The findings of the Stochastic Frontier Analysis (SFA), which may be used to assess performance, are somewhat inaccurate and can be interpreted in a number of different ways. DEA was used to classify the sub-categories into groups with the highest levels of performance. The nine sub-criteria for the three major criteria (Economic Performance Measure, Environmental Performance Measure, and Social Performance Measure) used in this research were identified as Supplier Cost, Delivery Cost, Manufacturing Cost, Lead time, Rejection, Landfill Waste, Energy Usage, and Revenue Growth. These sub-criteria were identified using the research. Inefficient DMUs have the potential to gain knowledge from and model their own practises after those of the benchmarking set or reference set, which is comprised of DMUs whose efficiency is equal to 1. In its computations, this method uses VRS, a kind of return to scale that is more precise than CRS.

KEYWORDS: DEA, Stochastic Frontier Analysis, DMU, VRS

I. INTRODUCTION

Much more attention has been paid to sustainable supply chain management by businesses and academics than in any prior time period (Hassini, 2010). One possible definition of sustainable supply chain management is "the set of operations responsible for managing inventory network information, allocated funds, information, and resource utilization with the end goal of profitability while also minimizing adverse impacts on the environment and maximizing societal well-being."

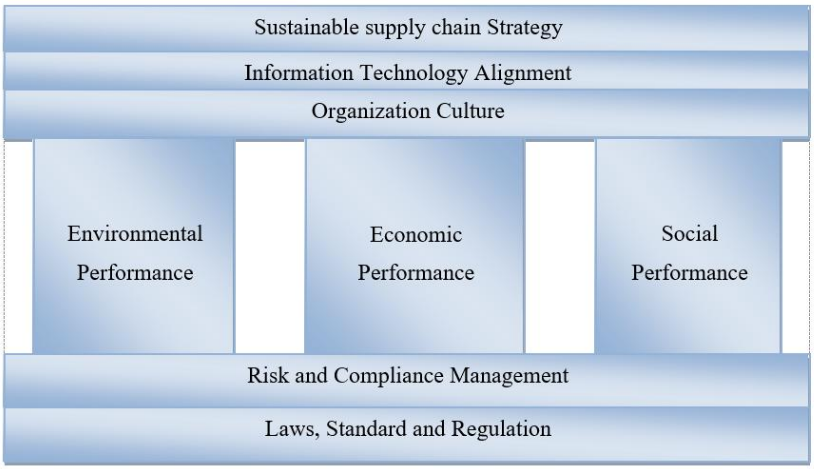

Fig. 1: House of sustainability management (Source: Ashby et al., 2012)

| ISSN: 2395-7639 | www.ijmrsetm.com | Impact Factor: 7.580|

| Volume 9, Issue 7, July 2022 |

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Figure 1 shows that TBL was chosen as the most crucial column in order to maintain an appropriate risk, hazard, and consistency management framework for the building.

A strong and flexible green IT environment, a well-organized business strategy, and a company-wide commitment to a set of core values are all essential components of a sustainable supply chain management approach. Taking these precautions will ensure that the framework is protected from any threats to the environment or society. When evaluating or monitoring a supply chain management strategy, it is important to focus on developing and using execution metrics. This evaluation and the design of performance data get more complicated when considering supply chain sustainability by including climate or public obligation measurements (Ashby et al., 2012).
The whole supply chain, from initial supplier selection through wholesaler partners and finally to the end-user, should be analyzed from an environmental perspective (Su et al., 2014).Stakeholder value creation and risk mitigation are at the heart of sustainability management (Tseng et al., 2008; Wong et al., 2014). It was observed by Diaz- Garrido et al. (2011) that the manufacturing unit's goals are the aggressive requirements in supply chain management since they enable businesses to compete, make use of the capabilities they've developed for the task at hand, and strengthen their position in the market. The economic implications, both good and negative, associated with corporate sustainability initiatives are a major focus of academic inquiry and a well-established area of literature in the field of corporate sustainability (Sarkis et al., 2011). Managers in the supply chain need performance measurement frameworks to ensure their operations are effective and efficient. Few guidelines exist for supply chain managers, making it difficult to implement standards and use appropriate techniques for assessing employee performance.

Performance Measurement

Simply said, performance measurement is a methodical process through which critical processes, systems, and programmes may be isolated, quantified, and evaluated. In order to minimize their negative effects on the environment and society, commercial enterprises are under pressure to maximize their returns on investment.

II. DATA ENVELOPMENT ANALYSIS APPROACH

Dimensional assessment, one of the biggest issues with performance measurement, cannot provide management or shareholders with a credible picture of success. A counting tool with the right design that can accurately track an organization's progress would be essential in such situation. To evaluate sustainable supply chain management, this research employs a Data Envelopment Analysis (DEA) strategy. For DEA to work, it is not essential to attribute a statistical distribution error to the input performance measures or the output performance measures, nor is there any relationship between the two. This study takes the organisations under scrutiny to be DMUs, indicating that profit is not the primary motivation for the research. Organizational DEA ratings range from 0 to 1, with 0 being the least efficient and 1 being the most efficient (Mohammad and Said, 2013). This finding suggests that DEA may be used to create a virtual DMU that ineffective DMUs can then follow. In this dissertation, a sophisticated mathematical programming model is developed.

Strengths of DEA

a) DEA can handle various inputs and outputs with ease.

b) Input and output data are not necessary for determining the approach (b).

c) Comparisons between peers

d) are made between peers.

e) Inputs and outputs may be measured on different scales.

III. APPLICATION OF DEA ON CASE ORGANIZATIONS

Background Information of Case eight Organizations

Specifically, eight companies operating in the Indian subcontinent were chosen for this case study because their respective markets and products are quite similar. Those chosen are either big or medium-sized businesses operating

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in a manufacturing or stock market-related industry (MTS). Although this research does not focus on any one particular Supply Chain, the case organisations that serve as its focus are all components of such chains. All eight of these companies have prominent positions in the Indian tyre manufacturing sector. There is an absolute ban on disclosing the actual values of any of the eight entities involved. All eight organisations' data were acquired for analytical purposes, with the understanding that their confidentiality would be maintained. Organization A, Organization B, Organization C, Organization D, Organization E, Organization F, Organization G, and Organization H.

A Private Limited Company, established in 1958, produces and distributes off-road tyres and tyres for two-wheeled vehicles in India and other countries. It is the first tyre company in the world to be certified to ISO/TS 16949:2002, and it works in a highly competitive market with a wide range of products.

In 1987, group "B" had its start. The American agriculture market accounts for 80% of the company's revenue. There was a recent ranking that put their company at number 41 among tyre companies throughout the globe. Tires for earthmovers, ATVs, and other off-road vehicles are manufactured by the company. In 1984, group "C" came into being. In fact, the majority of its customers are located in that country. Tires for motorcycles and tricycles are among the offerings.

Organization 'D' started making tyres in 1972, making it the 17th-largest producer in the world. Although sales to other regions, such as Europe and the United States, are important, India accounts for the bulk of its revenue. It functions in a market where both quantity and diversity of offerings are commonplace. Two-wheeler tyres and off-road tyres make up the bulk of the inventory.

Company 'E', which has been around since 1890, is the only provider of tyres to numerous multinational corporations based in countries other than India. The company is a major player in the market for tyres for motorcycles and bicycles. Business 'F' has been around since 1946 and has grown to become India's primary tyre producer. Products range from tyres and tubes to conveyor belts and paints. The tyre company has received the TS 16949/ISO9001 certification.

The 'G' Corporation, which has been around since 1968 and is widely considered to be one of the best tyre producers in the nation. Bicycle and vehicle tyres as well as tubes and chains are among the company's output. Standards such as ISI, ASTM, and ETRTO are met, and the company is ISO14001:2004 compliant throughout the board. In 1874, the company that would become known as "H" was established to focus on the manufacture of tyres, tubes, and flaps for automobiles.

IV. DATA ANALYSIS

Each of the eight inputs and the single output are used in the evaluation of this DEA model. Revenue growth is the outcome, while the inputs include things like the price of materials and labour, the time it takes to make a product, the rate at which products are rejected, and the amount of waste produced through things like landfill trash, water use, and energy use. Measures of inputs and outputs, as well as data collected from various organisations, are discussed in terms of performance.

DEA frontier, a solution for assessing issues utilising the DEA method, was used to do the DEA analysis. All eight DMUs were analysed, and the results are shown in a table that includes a reference set and a return to scale . Efficient DMUs are studied in terms of sharing a common reference set in Chapter 3. DMUs that are less efficient than the average tend to mimic the behaviour of the most efficient DMUs.

Table 1: displays the DMU efficiency scores under the premise of a variable return scale. Since DMU B serves as a reference point for the other DMUs (A, C, D, and H), the optimal benchmark identifies DMU B as the leading DMU. On the other hand, there are other DMUs that combine the best features of both efficient DMUs, such as DMU G, which provides greater weight to DMU B and less weight to DMU F. To add insult to injury, DMU E places more emphasis on DMU F and less on DMU B. Intriguingly, no DMU has DMU F as its reference set other than DMU F itself, meaning that no DMU is specifically following DMU F.

In addition, the ideal weights of all DMUs' outputs and inputs are determined. The optimal weights are calculated by applying a multiplier model to the DEA frontier in Excel. As can be seen in table 4.4, all of the inefficient DMUs have an ideal weight of zero since they have a greater number of inputs (supplier cost, delivery cost, production cost, lead time, rejection, landfill waste, water consumption, and energy usage). One-to-one weights within the ideal set indicate extremely small input values. Finally, we see that the ideal weight for Energy Usage (=1) for DMU B is the same as the optimal weight for Landfill Waste (=1) in the case of DMU F, but that the revenue growth for DMU B is larger than DMU F, indicating that Energy Usage has more effect than Landfill Waste.

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Table 1: Projection of data for inefficient DMUs

Projection of data for inefficient DMUs					
DMU No.	**Input-output factors**	**VRS Score**	**Projection**	**Difference**	**Percentage**
	A	0.7667			
	Supplier cost	7224.97	6099.95	-1124.96	-15.57
	Delivery cost	1002.84	894.50	-108.34	-10.80
	Manufacturing cost	1197.99	978.49	-219.50	-18.32
	Lead time	13	11	-2	-15.38
1.	Rejection	222	215	-7	-3.15
	Landfill waste	578.50	498.50	-80	-13.82
	Water Usage	5812	5628.00	-184	-3.16
	Energy use	6815.78	6521.30	-294.48	-4.32
	Revenue growth	138	180	42	30.34
	C	0.733			
	Supplier cost	7241.45	6099.95	-1141.50	-15.76
2.	Delivery cost	1169.50	894.50	-275	-23.51
	Manufacturing cost	1209.35	978.49	-230.86	-19.08
	Lead time	15	11	-4	-26.67
	Rejection	277	215	-62	-22.38
	Landfill waste	545.80	498.50	-47.30	-8.67
	Water Usage	7027	5628	-1399	-19.90
	Energy use	6837.28	6521.40	-315.98	-4.62
	Revenue growth	132	180	48	36.36
	D	0.933			
	Supplier cost	6955.575	6099.95	-855.62	-12.30
	Delivery cost	1194.50	894.50	-300	-25.11
	Manufacturing cost	1056.55	978.49	-78.06	-7.38
3.	Lead time	16	11	-5	-31.25
	Rejection	293	215	-78	-26.62
	Landfill waste	578.90	498.50	-80.40	-13.89

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	Water Usage	7182	5628.00	-1554.4	-21.63
	Energy use	7803.78	6521.30	-1282.48	-16.43
	Revenue growth	168	180	12	7.144
	E	0.799			
	Supplier cost	6709.17	6405.90	-303.51	-4.49
	Delivery cost	1167.5	975.183	-192.37	-16.43
	Manufacturing cost	1245.75	1048.05	-197.30	-15.83
4.	Lead time	14	11.76	-2.24	-16
	Rejection	269	224.99	-44.01	-16.36
	Landfill waste	356.32	356.32	0.00	-0
	Water Usage	6744	6392.22	-351.78	-5.14
	Energy use	7344.29	7322.09	-22.21	-0.32
	Revenue growth	126	161.53	-35.53	28.19
	G	0.746			
5.	Supplier cost	6998.475	6152.2	-846.275	-12.09
	Delivery cost	1143.5	908.28	-235.21	-20.57
	Manufacturing cost	1156.32	990.37	-165.95	-14.35
	Lead time	13	11.13	-1.87	-14.38
	Rejection	257	216.70	-40.30	-15.68
	Landfill waste	474.23	474.23	0.00	0.00
	Water Usage	6922.5	5758.60	-1163.9	-16.81
	Energy use	7569.29	6658.1	-911.19	-12.038
	Revenue growth	132	176.87	44.87	33.99
	H	0.788			
	Supplier cost	7470.825	6100	-1370.87	-18.34
	Delivery cost	1084	894.56	-189.44	-17.481
	Manufacturing cost	1430.12	978.5	-451.63	-31.57
6.	Lead time	17	11	-6	-35.29
	Rejection	352	215	-137	-38.92

	Landfill waste	574.23	498.5	-75.72	-13.27
	Water Usage	7102.5	5628	-1474.5	-20.76
	Energy use	7747.54	6521.33	-1226.15	-15.82
	Revenue growth	142	180	38	26.76

Based on a literature analysis and interviews with industry experts, this study aims to highlight how tyre manufacturing companies might choose DMUs to use as benchmarks for more environmentally friendly supply chain management. A total of three primary criteria and nine secondary criteria for performance measurement were defined, and DEA was used to divide all DMUs that fall inside the efficient frontier into distinct groups. This approach has been utilised to enhance the ranking of the most prominent DMUs, and it expressly deals with confusing and imprecise data. In this way, the top-performing DMU among eight tire-making companies may be identified and used.

V. CONCLUSIONS

The purpose of this research was to shed light on the topic of utilising performance metrics and the DEA method to evaluate the efficiency of decision-making units in a tyre company. Inefficient DMUs may learn from and mimic the practises of the benchmarking set or reference set (DMUs with efficiency=1) made available by this technique. This approach employs VRS, a more accurate kind of return to scale than CRS, in its calculations. Table 4 shows that the organisation has been analysed to have two DMUs (DMU B and DMU F). Three DMUs were found to be operating at the efficient frontier, with efficiencies more than one, while the other six DMUs lagged behind, with efficiencies below one. To the extent that four DMUs now use DMU B as their standard (DMU A, DMU C, DMU D, DMU H). Specifically, DMUs B and F serve as a benchmark for DMUs E and G. Virtual group, also known as a shadow group, is a combination of two effective DMUs that provides a guiding light to a less effective DMU. Therefore, the DEA formulation argues that an organization's efficiency should not be measured by its production levels (Revenue Growth).

Scope of Future Research

The performance metrics are very generic and may not be suitable for use in certain sectors. Managers may find this approach useful in determining key performance indicators for their fields. Taken together, the findings suggest that DEA might be a valuable technique for use in future studies involving decision-making units. This research process may be expanded into additional domains in the future.

REFERENCES

1. Mantel, S. J., Meredith, J. R., Shafer, S. M., & Sutton, M. M. (2008). Project management in practice. Hoboken: John Wiley & Sons Inc.
2. Melton, T. (2005). The benefits of Lean manufacturing: what lean thinking has to offer the process industries? Chemical engineering research and design, 662-673.
3. Middleton, P. (2001). Lean Software Development: Two Case Studies. Software quality journal, 241- 252.
4. Naftanaila, I., &Brudaru, P. (2009). Lean principles applied to software development- avoiding waste. Economia. Seria Management, 162-170.
5. Ohno, T. (1988). Toyota Production System: Beyond large scale production. Productivity press.
6. Oxford English dictionary. (n.d.). Oxford English Dictionary. Retrieved 12 22, 2011, from OED: http://www.oed.com.ludwig.lub.lu.se/view/Entry/59732?redirectedFrom=efficacious#eid
7. Oxford English Dictionary. (n.d.). Oxford English dictionary. Retrieved 12 22, 2011, from OED: http://www.oed.com.ludwig.lub.lu.se/view/Entry/59736?redirectedFrom=efficacy#eid
8. Oxford Enligsh Dictionary. (n.d.). Oxford Dictionary. Retrieved 12 22, 2011, from OED: http://www.oed.com.ludwig.lub.lu.se/view/Entry/59676?rskey=3Ud7Fh&result=3&isAdvanced=false #
9. Parmenter, D. (2007). Key performance indicator: Developing, implementing and using winning KPIs. Hoboken, New Jersey: John Wiley & Sons Inc.

| ISSN: 2395-7639 | www.ijmrsetm.com | Impact Factor: 7.580|

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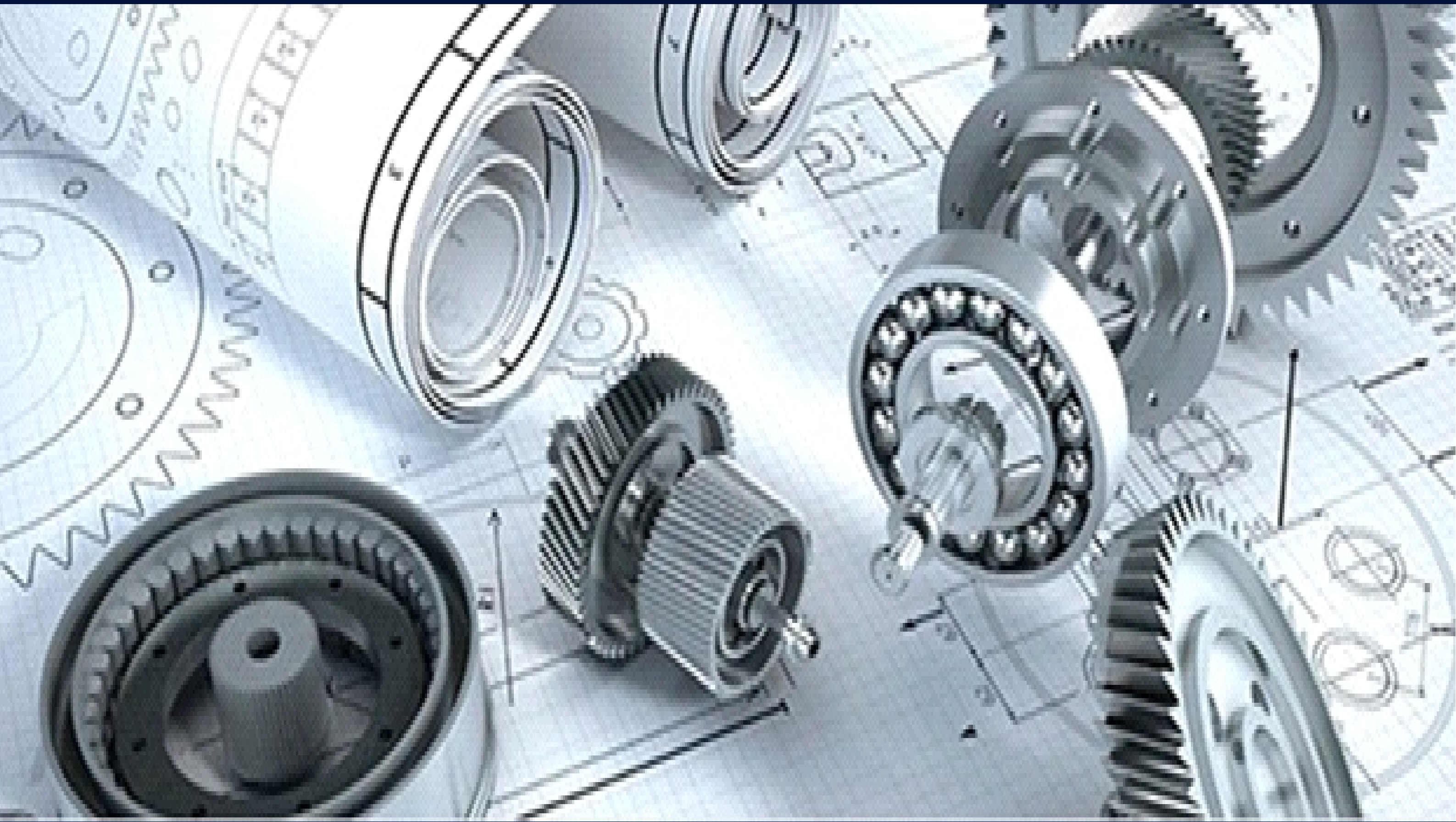
| DOI: 10.15680/IJMRSETM.2022.0907009 |

10. Parnell-Klabo, E. (2006). Introducing Lean principles with agile practices at a fortune 500 company. Proceedings of AGILE 2006 conference (AGILE'06) (pp. 232-242). IEEE.
11. Petersen, K., &Wohlin, C. (2010). Software process improvement through the lean measurement (SPILEAM) method. Journal of system and software, 1275-1287.
12. PMI, Project Management Institute. (2008). A Guide to the project management body of knowledge (PMBOK guide). Newtown square: Project management institute Inc.
13. Poppendick, M., &Poppendick, T. (2007). Implementing LEAN software development: From concept to cash. Boston: Pearsson Education, Inc.
14. Poppendick, M., &Poppendick, T. (2010). Leading LEAN software development: Results are not the point. Boston: Pearson Education Inc.
15. poppendieck, M. (2007). Lean Software Development. 29th conference on software engineering (pp. 165-166). IEEE.
16. Poppendieck, M. (2007). Lean Software Development. 29th conference on software engineering (pp. 165-166). IEEE.
17. Poppendieck, M., &Poppendieck, T. (2003). Lean software development: An agile toolkit. Addison Wesley.
18. Rahman, S.-u. (1998). Theory of constraints- A review of the philosophy and its applications. International journal of operations & production management, 336-355.
19. Raman, S. (1998). LEAN software development: is it feasible? Digital avionics system conference (pp. C13/1-C13/8). IEEE.
20. Sauter, T., Soucek, S., Kastner, W., & Dietrich, D. (2011). The evolution of factory and building automation. IEEE industrial electronics magazine, 35-48.
21. Shtub, A., Bard, J. F., &Globerson, S. (1994). Project Management- Engineering, Technology and Implementation. Engelwoodclifs: Prentice-Hall.
22. Singh, B., Garg, S., Sharma, S., & Grewal, C. (2010). Leans implementation and its benefits to production industry. International Journal of Lean and six sigma , 157-168.
23. Software engineering institute, SEI. (2010). CMMI for development version 1.3. Carnegie-mellon.
24. Sommerville, I. (2005). Integrated requirements engineering: A tutorial. IEEE software, 16-23.
25. SOU 1991:82. (1991). Drivkrafter för ProduktivitetochVälstånd SOU 1991:82. Stockholm: Allmänaförlaget.
26. Staats, B. R., Brunner, D. J., & Upton, D. M. (2011). Lean principles, learning, and knowledge work, evidence from a software service provider. Journal of operations management, 376-390.



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