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Modelling Technical Capacity of Industrial Machines Suppliers' Selection Post Engineering and Economic Considerations

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ABSTRACT

After considering engineering, economics, and supply due-date strategic decisions as the death knell for the selection of industrial machinery suppliers, the technical capability of the suppliers is one of the strategic decisions for consideration. To achieve this, necessary attributes of this strategic decision were identified in this study. These attributes include the quality of mechanics used, quality of staff used, level of research work done, level of quality control, and quality of companies patronizing the vendor. They were modelled and integrated (logic) for decision-making and then evaluated using a case study of procuring a Cocoa Liquor Press for extracting butter from the cocoa liquor using three vendors V1, V2, and V3 that passed the three strategic decision death knells. The overall performance indices of all three vendors as per their strength on the considered strategic decision (technical quality of the supplier) are 1.71, 1.66, and 1.63 which are 43.2%, 33.25%, and 32.6% respectively by percentage. While their weaknesses are 3.28, 3.34, and 3.37 which are 65.6%, 66.8%, and 67.2%. Vendor one (V1) having a performance index of 1.71 strength and 3.28 weakness (43.2% strength and 65.8% weakness) post engineering and economic consideration death-knell was found to be best suitable and was selected.

Keywords: Technical capacity, Mathematical models, Industrial machines, Logic development, Supplier selection.

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نمذجة القدرات الفنية لموردي الآلات الصناعية اختيار ما بعد الهندسة والاعتبارات الاقتصادية

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الخلاصة

بعد النظر في القرارات الاستراتيجية في تاريخ الاستحقاق الهندسي و الاقتصادي والعرض كقوة لاختيار موردي الآلات الصناعية فإن القدرة التقنية للموردين هي أحد القرارات الاستراتيجية للنظر فيها لتحقيقذلك. تم تحديد السمات الضرورية لهذا القرار الاستراتيجي في هذه الدراسة. تتضمن هذه السمات :جودة الميكانيكا المستخدمة, جودة الموظفين المستخدمين, مستوى العمل البحثي المنجز, مستوى مراقبة الجودة و جودة الشركات الراعية للبائع. تم نمذجة تلك السمات ودمجها (منطق) لاتخاذ القرار ثم تم تقييمها باستخدام دراسة حالة لشراء مكبس كاكاو لاستخراج الزبدة من مشروب الكاكاو باستخدام ثلاثة بائعين التي اجتازت قرارات الاعداد الاستراتيجية الثلاثة. مؤشرات الأداء الإجمالية لجميع البائعين الثلاثة حسب قوتهم على القرار الاستراتيجي (الجودة الفنية للمورد) هي 1.71و 1.66 و 1.63 وهي43.2 و %33.25 و32.6 ٪ على التوالي بالنسبة المئوية. في حين ان مؤشرات ضعف الاداء هي 3.28, 3.34, و 3.37 والتي هي 65.6%, 66.8%و 67.2%. البائع الاول (V_1) له مؤشر قوة اداء 1.71 و3.28 ضعف (43.2% قوة و 65.8% ضعف) ما بعد الهندسة والاعتبارات الاقتصادية Death–knell لتكون افضل مناسبة وتم اختيارها.

الكلمات المفتاحية: القدرةالتقنية, النماذج الرياضية, الآلات الصناعية, التطويرالمنطقي, اختيارالمورد

1. INTRODUCTION

Technical capacity is the knowledge and skill required for an individual and organization to elaborate on their task. This requires staff knowledge, training, and experience along with the systems in place required to operationalize a policy **(Akinnuli, 2018; UN, 2023)**. The goals of procurement managers in every industry usually are acquiring the right materials at the right time, at the right prices and quantities. And to achieve these goals, the best suppliers should be selected using a well-defined strategic decision (**Mohammad et al., 2021**). Equipment/Machinery suppliers are not left out on this strategic decision when the decision for their selection for equipment procurement arises. The means of quantifying this strategic decision is still a gap in the literature and this research proffers solutions.
Supplier capacity management helps businesses prepare for inevitable disruptions by analyzing and proactively mitigating supplier capacity risks **(GEP, 2022; Kaur and Singh, 2020; Wong, 2020)**. It involved gathering supplier intelligence at the company, product, part, and process level to detect capacity disruptions before they happen **(ND, 2023; Guidi, 2003),** the ability of suppliers to meet the requirement of a lead firm or buying firm including specifications about quality, timely delivery and environmental and safety standards **(Intuitix, 2020; OECD, 2015).** The benefits of supplier capacity management include: increased visibility into supplier performance, improved understanding of supplier constraints and capabilities, reduced lead times, improved on-time delivery, increased production flexibility, and agility, as well as reduced inventory levels and associated costs

(NS, 2021; Richard, 2019). Generally, there are six types of suppliers which are: services, sub-contractors, manufacturers/producers, distributors, importers, and trade directories **(Indeed, 2023; Oluwapelumi, 2020).** In the work of **(Feng and Gong, 2020; Hasan et al., 2020; Hosseini and Nezha, 2019; Esmaeili-Najafabadi et al., 2021)** the supplier selection and order allocation decisions under quantity discount, fast service options, a bi-objective sustainable supplier selection and order allocation considering quantity discounts under disruption risks as well as extended alternative queuing method with linguistic Z-numbers. Its applications for green supplier selection and order allocation respectively were also reported. Integrated linguistic entropy weight method, multi-objective programming model for supplier selection, order allocation in a circular economy, resilient supplier selection in logistics 4.0 with heterogeneous information, developing an optimal policy for green supplier selection, order allocation using dynamic programming, resilient supplier selection and optimal order allocation under disruption risks, were studied and reported.

In **(Hosseini et al., 2019; Noori-Daryan et al., 2019; Tirkolaee et al., 2020; Wang et al., 2020)** the researchers focused on sustainable supplier selection and order allocation; a multi-stage hybrid model for supplier selection and order allocation considering disruption risks and disruptive technologies. The authors also worked on analyzing pricing, promised delivery lead time, supplier selection, ordering decisions of a multi-national supply chain under an uncertain environment, and a novel hybrid method using fuzzy decision-making and multi-objective programming for sustainable-reliable supplier selection in two-echelon supply chain design. Additional works done by these authors include; supplier selection and order allocation under a carbon emission trading scheme (a case study from China), dynamic procurement risk management with supplier portfolio selection, and order allocation under green market segmentation. The researchers **(Meena et al., 2022; Singh et al., 2023; Erzaij and Bidan, 2016)** worked on supplier performance and selection from a sustainable supply chain performance perspective and sustainable supplier selection in a construction company respectively. Moreover, **(Changalima et al., 2022; Prior et al., 2022; Shafiq et al., 2022; and Cho et al., 2021)** worked on supplier performance and selection from a sustainable supply chain performance perspective, sustainable supplier selection in a construction company. The work presented the MCDM method based on dominance-based rough set analysis, supplier development, and public procurement performance, incorporating supplier trustworthiness into supplier selection criteria, building synergies between operations culture, operational routines, and supplier monitoring, implications for buyer performance, supplier selection, and partnerships, effects upon restaurant operational strategic benefits were implemented.

There were other important supplier challenges areas well researched and solutions proffered. In the work of **(Kumar and Ganguly, 2021)** the non-financial e-procurement performance measures, their interdependence and impact on production cost, a dynamic decision support system for sustainable supplier selection in the circular economy, sustainable production and consumption were studied. In **(Alavi et al., 2021; Alipour et al., 2021; Bektur, 2020; Chen et al., 2020)** the researchers considered Pythagorean fuzzy-based decision-making method through entropy measure for fuel cell and hydrogen components supplier selection, an integrated methodology for the selection of sustainable suppliers and order allocation problem with quantity discounts, lost sales and varying supplier availabilities, sustainable supplier selection for smart supply chain considering internal and external uncertainty: Similarly, related works by **(Hendiani et al., 2020a; Hendiani et al., 2020b; Firouzi and Jadidi, 2021; Hasani et al., 2021; Razzauki and Al-Jumailly, 2024)** include but not limited to**:** risk-averse supplier selection and order

allocation in the centralized supply chains under disruption risks; multi-objective model for supplier selection and order allocation problem with fuzzy parameters; resilient supplier selection in logistics 4.0 with heterogeneous information; a multi-objective optimization approach for green and resilient supply chain network design; a likelihood-based multi-criteria sustainable supplier selection approach with complex preference information; and a multi-stage multi-criteria hierarchical decision-making approach for sustainable supplier selection; Management Model for Evaluation and Selection of Engineering Equipment Suppliers for Construction Projects in Iraq. Some other current work relevant to this research are the work of **(Alegoz and Yapicioglu, 2019; Duan et al., 2019; Cheraghalipour and Farsad, 2018; Jia et al., 2020).**
In this present research, manufacturers/producers' suppliers were the focus. Consideration is given to the supplier's technical capacity after meeting the engineering, economics, and due-date delivery. Objectives were to: identify the attributes for quantifying the technical capacity of the supplier as it affects machinery and equipment of manufacturing industries; develop models for computing the identified attributes of the strategic decision; formulate the logic table for integrating the models developed; and apply the logic developed for decision making in selecting optimal machinery supplier post engineering, economic and due-date delivery considerations.

2. MATERIALS AND METHOD

To achieve the aim and objectives of this work, some strategic decisions were identified in this study. They are presented in sub-sections 2.1 to 2.7 respectively and they include; mechanic required ability, technician productivity model, quality of staff used, supplier research ability, level of quality control, quality of companies patronizing the vendors, and the decision models for selecting the vendors.

2.1 Mechanic Required Ability

This depends on the productivity of the mechanic. Machine smechanics must develop skills in areas like problem-solving, communication, and attention to detail. Mechanics don't need a postsecondary degree, but many complete non-degree training programs at a technical school. Machine mechanics need dexterity to complete their jobs. The ability to use, repair, and maintain machines and tools; to be thorough and pay attention to detail; have the problem-solving skills; the ability to work well with their hands; have the required customer service skills; the ability to work well with others; knowledge of engineering science and technology matters as good attributes.

2.2 Technician Productivity Model

The general formula for productivity as presented in Eq. (1) is the ratio of output to input.

$$Productivity(P) = \frac{Output}{Input} = \frac{Hours\ worked\ (O_t)}{Hours\ available\ (I_t)} \quad (1)$$

For technician productivity, we look specifically at the ratio of hours worked to the hours employed. Hours worked (O_t) is Time spent actively completing work orders and Hours available (I_t) is Total time engaged as an employee or contractor.

Eq. (2) below shows the formula for calculating a technician's productivity.

$$(T_p)_{vj}=\left(\frac{Pe}{Pw}\right)_{vj} \quad (2)$$

where T_p is technician productivity, *Pe* period employed, and *Pw is* period worked. The goal with technician productivity is to get it as close to 100% as possible. This means that they're spending as much of their time as possible engaged in revenue-generating work for clients and customers. The higher their productivity, the more value they're creating for the cost of engaging them, which is generally a fixed amount.

2.3 Quality of Staff Used

Supply chain professionals use time management strategies to enhance operational efficiency. Time management skills help in the ordering of products at the right time and communicating with suppliers to ensure timely deliveries. Because supply chain managers handle various work tasks, time management is important to set schedules and establish processes to remain organized at work. These skills can also be applied to ensure the company delivers to customers on time and improve customer satisfaction and loyalty. Hence this attribute is very necessary in assessing the staff quality of Machine Suppliers (Vendors).

In this study, the percentage of deviation of the supplier's proposed time of supply from the buyer's determined expected time was used to determine the quality of staff used. As presented in Eq. (3) below, the Quality of staff used (Q_s), is the ratio of the Supplier's Proposed Time (S_{pt}) to the Buyer's Determined Time (B_{dt})

$$(Q_s)_{vj}=\left(\frac{S_{pt}}{B_{dt}}\right)_{vj} \quad (3)$$

2.4 Supplier Research Ability

The ability of a machine manufacturer/supplier to engage in productive research to improve and enhance the manufacturing process will ultimately rub off on its technical capacity as this will ensure adequate exposure to new technologies and inventions.

The consideration made on each vendor as it affects their research and development capability was based on the published research by the supplier's company.

The model for computation is presented in Eq. (4). Level of Research and Development (L_{rd}) is the Number of research work (N_{rw}) done and published by the supplier according to the age of the supplier (A_s).

$$(L_{rd})_{vj}=\left(\frac{N_{rw}}{A_s}\right)_{vj} \quad (4)$$

2.5 Level of Quality Control

When a client requires a statement of conformance to predetermined specifications, there are several cases where the uncertainty in measurement influences the statement of conformance. Reduction in specification proves less quality of the system to be purchased. Therefore, in this study, conformance to specification was used as a means to compute the level of quality control put in place. The mathematical model is presented in Eq. (5) as the conformity to specification (C_{sp}) is the ratio of supplied specification fulfilled (S_{sp}) to the buyer specification (B_{sp})made available before procurement.

$$(C_{sp})_{vj} = (\frac{S_{sp}}{B_{sp}})_{vj} \quad (5)$$

2.6 Quality of Companies Patronizing the Vendor

It is good to realize that people patronize every business for a particular reason as many vendors can be patronized. Good patronage attracts: knowing the purchaser, the purchaser patronizing the vendor, the vendor having what the buyer needs, and because of the vendor's attitude. These will earn a vendor a good reputation and patronage at the International, National, State and Local level. The quality of the companies patronizing a vendor was assessed based on International, National, State and Local patronage experienced by each vendor. With assigned weighing scores for each level. The number of patronages at each level should not be greater than 2 and each level was assigned a weight score as follows International (I) = 4; National (N) = 3; State (S) = 2 and Local (L) = 1. This makes the maximum score any of the vendors can have to be 2(4+3+2+1) = 20. The computation of each vendor's performance under this attribute is presented in Eq. (6) below.
Vendo Score $(V_s)_{vj}$= (International + National+ State +Local) of i_s scores.

$$(V_s)_{vj} = I_n(4) + N_n(3) + S_n(2) + L_n(1) < \text{or} = 20. \quad (6)$$

where; I_n or N_n or S_n or $L_n < \text{or} = 2. \{ 0, 1 \text{ or } 2 \}$

The performance index for each vendor on this attribute was determined using the ratio method as presented in Eq. (7). Whereby, the performance of each vendor is the ratio of their scores to the maximum available score which is 20.

$$(V_p)_i = \frac{(V_s)_{vj}}{20} \quad (7)$$

2.7 The Decision Model for Selecting the Best Vendor

Eqs. (8) and (9) represent the technical capacity of any vendor $(V_{tc})i$ as a function of all the attributes determined above. Therefore:

$$(V_{tc})i = f\,(T_{p;}\,; Q_s\,; L_{rd}\,; C_{sp}\,; (V_p)_i) \quad (8)$$

$$(V_{tc})i = \sum(T_{p;}\,; Q_s; L_{rd}\,; C_{sp}\,; (V_p)_i)_{Vi} \quad (9)$$

3. RESULTS AND DISCUSSION

3.1 Application of the Developed Models.

Various attributes of the data collected for vendors are presented in **Table 1.**

Table 1. Attributes of Data Collection for Vendors

S/N	Attributes / Symbols	Buyer's	V_1	V_2	V_3
1	Period worked (P_w). (mins/hours/days/weeks/months/years).	-	27	29	33
2	Period employed (P_e). (mins/hours/days/weeks/months/years).	30	-	-	-
3	Supplier's Proposed Time (S_{pt}), (mins/hours/days/weeks/months/years).	-	90	120	85
4	Buyer's Determined Time (B_{dt}). (mins/hours/days/weeks/months/years).	100 Days	-	-	-
5	Number of research work (N_{rw})	-	4	6	3
6	Age of the supplier (A_s). (Years).	-	15	9	7
7	Number of Supplied specifications fulfilled (S_{sp})	-	5	4	4
8	Number of Specification made available by buyer (B_{sp})	7	-	-	-
9	International (I_n) (0 = or < I_n < or = 2).	-	2	0	2
10	National (N_n) (0 = or <N_n< or = 2).	-	0	2	1
11	State (S_n) (0 = or S_n < or = 2).	-	1	2	1
12	Local (L_n), (0 = or L_n < or = 2).	-	2	1	1

3.1.1 Determination of Quality of Mechanic Used (T_p) for Vendor j = 1,2 and 3.

$(T_p)_{V1} = ((P_e /P_w)) v_1 = (30/21) = 1.4286. = (42\%).$
$(T_p)_{V2} = ((P_e /P_w)) v_2 = (30/29) = 1.0345 = (31\%).$
$(T_p)_{V3} = ((P_e /P_w)) v_3 = (30/33) = 0.9090. = (27\%).$
$\sum_{j=1}^{j=3} [Tp]vj = (T_p)_{V1} + (T_p)_{V2} + (T_p)_{V3}) = 3.3721$

From the above computations, the quality assessment indices for quality of mechanics used (T_p) by vendors V_1, V_2, and V_3 are 1.428 (42%), 1.0345 (31%), and 0.9090 (27%) respectively. The results show that vendor V_1 performed better in terms of quality of mechanics used followed by vendor V_2, with vendor V_3 coming last.

3.1.2 Determination of Quality of Staff Used (Qs) for Vendor j = 1,2 and 3.

$(Q_s)vj = (B_{dt}/S_{pt})vj$

$(Q_s)v_1 = (B_{dt}/S_{pt})v_1 = (100/90) = 1.1111= (36\%)$

$(Q_s)v_2 = (B_{dt}/S_{pt})v_2 = (100 /120) = 0.8333= (27\%)$

$(Q_s)v_3 = (B_{dt}/S_{pt})v_3 = (100/85) = 1.1765= (37\%)$

$\sum_{j=1}^{j=3} [Qs]vj =(Q_s)v_1 +(Qs)_{V2} + (Qs)_{V3}) = 3.1209$

The above computations show that the quality of staff used (Q_s) by vendors V_1, V_2, and V_3 are 1.1111 (36%), 0.8333 (27%) and 1.1765 (37%) respectively. The results show that vendor V_1 performed better in terms of quality of staff used followed by vendor V_3, with vendor V_2 coming last.

3.1.3 Level of Research and Development Done

$(L_{rd})_{vj} = (N_{rw} / A_s)_{vj}$

$(Lrd)_{v1} = (N_{rw} / A_s)_{v1} = (4/15)_{v1} = 0.2666 = (19\%)$

$(L_{rd})_{v2} = (N_{rw} / A_s)_{v2} = (6/9)_{v2} = 0.6666 = (49\%)$

$(L_{rd})_{v3} = (N_{rw} / A_s)_{v3} = (3/7)_{v3} = 0.4286 = (32\%)$

$\sum_{j=1}^{j=3} (Lrd)vj = (Lrd)_{v1} + (L_{rd})_{v2} + (L_{rd})_{v3}) = 1.3618$

The level of research and development result shows that vendor V_2 came first with 0.6666 (49%), Vendor V_3 came second with 0.4286 (32%) and vendor V_1 came third with 0.2666 (19%)

3.1.4 Level of Quality Control

$(C_{sp})_{vj} = (S_{sp} / B_{sp})_{vj}$

$(C_{sp})_{v1} = (S_{sp} / B_{sp})_{v1} = (5/7)_{v1} = 0.7143 = (40\%)$

$(C_{sp})_{v2} = (S_{sp} / B_{sp})_{v2} = (4/7)_{v2} = 0.5714 = (30\%)$

$(C_{sp})_{v3} = (S_{sp} / B_{sp})_{v3} = (4/7)_{v3} = 0.\ 5714 = (30\%)$

$\sum_{j=1}^{j=3} (Csp)\ vj = (C_{sp})_{v1} + (C_{sp})_{v2} + (C_{sp})_{v3} = 1.8571$

From the above computation, vendor V_1 with a score of 0.7143 (40%) has the best level of quality control while vendors V_2 and V_2 have a score of 0.5714 (30%) each.

3.1.5 Quality of Companies Patronizing the Vendor

$(V_{sn})_{vj} = I_n(4) + N_n(3) + S_n(2) + L_n(1) <$ or $= 20.$

$(V_{s\,n})_1 = (I_n(4) + N_n(3) + S_n(2) + L_n(1))_{v1}/20 = (2(4) + 0(3) + 2(2) + 1(1))/20 = (0.65) = (34\%).$

$(V_{s\,n})_2 = (I_n(4) + N_n(3) + S_n(2) + L_n(1))_{v2} = (0(4) + 2(3) + 2(2) + 1(1))_{v2}/20 = (0.55) = (29\%)$

$(V_{s\,n})_3 = (I_n(4) + N_n(3) + S_n(2) + L_n(1))_{v3} = (2(4) + 1(3) + 1(2) + 1(1))_{v3} / 20 = (0.70) = (37\%).$

$\sum_{j=1}^{j=3} (Vsn)vj = (V_{s\,n})_1 + (V_{s\,n})_2 + (V_{s\,n})_3 = 1.90$

The analysis of the quality of Companies patronizing the vendor indicates that vendor V_3 has the best score of 0.70 representing 37% followed by vendor V_1 with a score of 0.65 representing 34% and vendor V_2 with a score of 0.55 representing 29%.

3.1.6 Overall Performance of Vendors for Selection Determination

The performance of each vendor $(V_p)_j$ as per each attribute was summed up for decision-making.

$(V_p)_j = \sum_{j=1}^{j=3} [Tp]vj + \sum_{j=1}^{j=3} [Qs]vj + \sum_{j=1}^{j=3} (Lrd)vj + \sum_{j=1}^{j=3} (Csp)\, vj + \sum_{j=1}^{j=3} (Vsn)vj$.

$(V_p)_j = \sum_{j=1}^{j=3} ([Tp]vj + [Qs]vj + [Lrd]vj + [Csp]vj + (Vsn)vj)$.

The performance of the selected vendors in this study is stated in **Table 2.**
The vendors' performance as per each attribute is shown in **Fig. 1**.

Table 2. Performance indices of the Selected Vendors $(\mathbf{V_p})_{ij}$.

S/N	Attributes	Vendor 1 (V_1)	Vendor 2 (V_2)	Vendor 3 (V_3)
1	$[Tp]vj$	0.42	0.31	0.27
2	$[Qs]vj$	0.36	0.27	0.37
3	$[Lrd]vj$	0.19	0.49	0.32
4	$[Csp]vj$	0.40	0.30	0.30
5	$(Vsn)vj$	0.34	0-29	0-37
6	$(V_p)_{ij}$	1.71	1.66	1.63

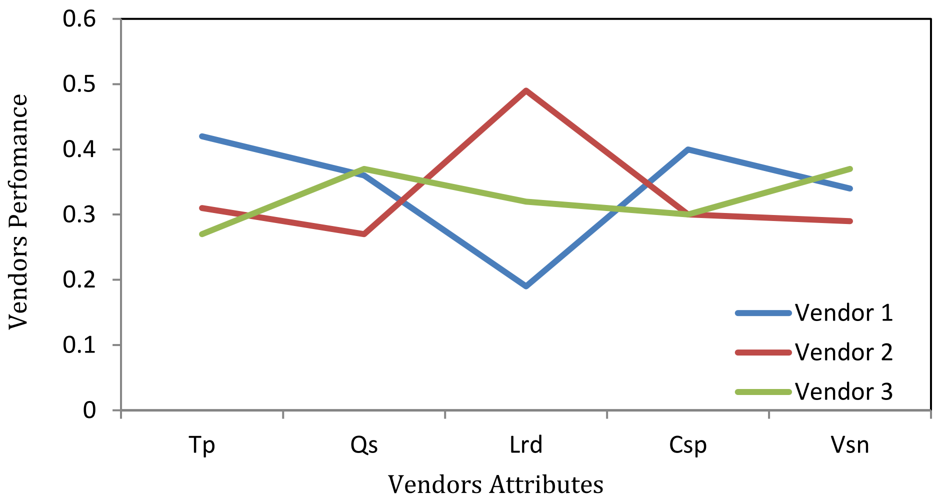

Figure 1. Vendors Attributes Performance

Comparing the results in **Table 1**, and the graph shown in **Fig. 1**. concerning the Quality of mechanics used V_1 lead with 0.42 followed by V_2 (0.310) and V_3 came third with (0.27), as per the quality of staff used V_3 lead with (0.49) followed by V_1(0.36) and V_2 came in third with (0.27).On the level of research work done V_2 lead with (0.49), V_3 came in second with (0.32) and V_1 was third with (0.19); level of quality control, V_1 lead by (0.40) while V_2 and V_3 tally with a score of (0.30) and in quality of companies patronizing the vendors V_3 lead with (0.39), V_1 came in came second with (0.34) and V_3 was third scoring (0-29).

3.1.7 Determination of Performance Strength and Weakness of each Supplier Technical Capacity

A performance index is a measurement tool business owners and managers use to evaluate business operations. These indices can usually be applied to the entire company, specific divisions or departments and individual managers or employees. The purpose of this is to measure the strengths as well as the weaknesses of business operations. Performance Strengths and Weaknesses of each vendor $(P_{sw})_{vj}$ is presented in **Fig. 2**

$(P_{sw})_{vj} = 1 - (V_p)_j$

$(P_{sw})_{v1} = 1 - 0.342$(Strength) (34,2%) = 0.658 (Weakness) = (65.8%)

$(P_{sw})_{v2} = 1 - 0.332$(Strength) (33,2%) = 0.668(Weakness) = (66.8%).

$(P_{sw})_{v3} = 1 - 0.328$(Strength) (32,8%) = 0.672(Weakness) = (67.2%).

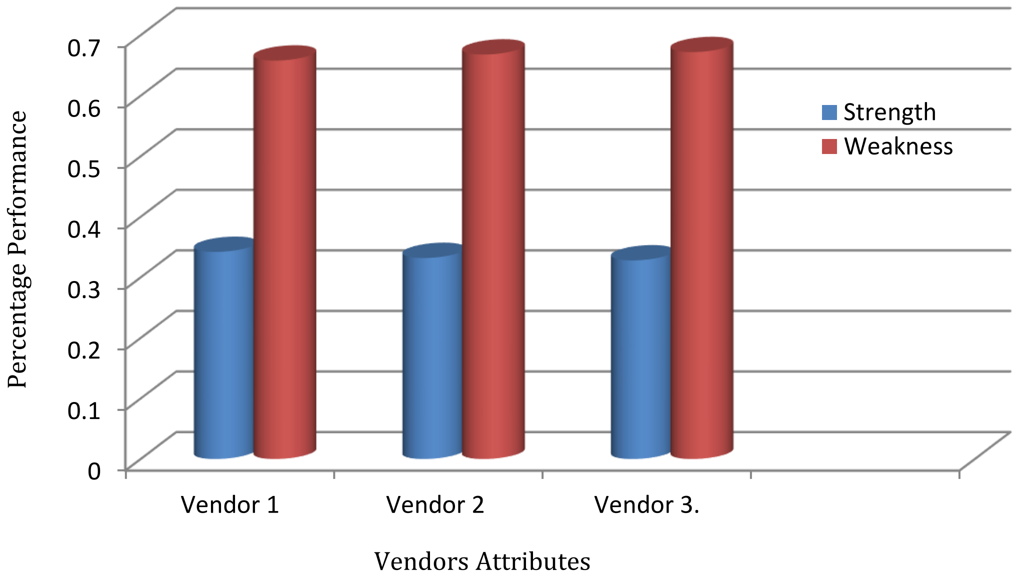

Figure 2. Performance Strength and Weakness of each vendor $(Psw)_{vj}$

The overall performance indices of all three vendors as per their strength on the considered strategic decision (technical quality of the supplier) are 1.71, 1.66 and 1.63 which are 43.2%, 33.25% and 32.6%. respectively by percentage. While their weaknesses are 3.28, 3.34 and 3.37 which are 65.6%, 66.8% and 67.2%. Though the technical quality of the three vendors was not encouraging as per this study, the vendor that had a performance index of 1.71 strength and 3.28 weakness (i.e. 43.2% strength and 65.8% weakness) post engineering and economic consideration death-knell which is Vendor one (V_1) is the best. For this reason, Vendor One (V_1) won the supply award and was selected, while vendors V_2 and V_3 came in second and third position.

4. CONCLUSIONS

In this research, modeling the technical capacity of industrial machine suppliers' selection post-engineering and economic considerations has been done. Required attributes for the technical capacity of suppliers were identified. The model for each of the attributes was developed and the necessary methods required were used, data was collected to run the developed model for its performance evaluation. The model responds positively to the aim of this study. The best supplier under this strategic condition (supplier technical quality) post engineering and economic considerations were selected using a case study of three vendors that were able to meet up with the set death knell of John Venture Cocoa Processing

Industry Akure, Nigeria, with a proposal to buy Cocoa Liquor Press. This model is applicable in industries where machine/equipment procurement affects their production in underdeveloped, developing, and developed countries.

NOMENCLATURE

Symbol	Description	Symbol	Description
A_s	Age of the supplier, years	P	Productivity, dimensionless
B_{dt}	Buyer's Determined Time, days	P_e	Period Employed, mins/hours/days/weeks/months/years
B_{sp}	Number of Specification made available by buyer, dimensionless	P_{sw}	Performance Strengths and Weaknesses of each vendor, dimensionless
C_{sp}	Level of quality control, dimensionless	P_w	Period Worked, mins/hours/days/weeks/months/years
I_n	International, dimensionless	Q_s	Quality of staff used, dimensionless
I_t	Hours available, hr	S_n	State, dimensionless
L_n	Local, dimensionless	S_{pt}	Supplier's Proposed Time, days
L_{rd}	Level of research and development, dimensionless	S_{sp}	Number of Supplied specifications fulfilled, dimensionless
N_n	National, dimensionless	T_p	Technician productivity
N_{rw}	Number of research work, dimensionless	vj	Vendor j, dimensionless
O_t	Hours worked, hr	V_p	Vendors performance, dimensionless

Credit Authorship Contribution Statement

Ayodeji S. Aninkan: Writing – original draft, review & editing, Validation, Methodology. Basil O. Akinnuli: Writing – review & editing. Micheal K. Adeyeri: Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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