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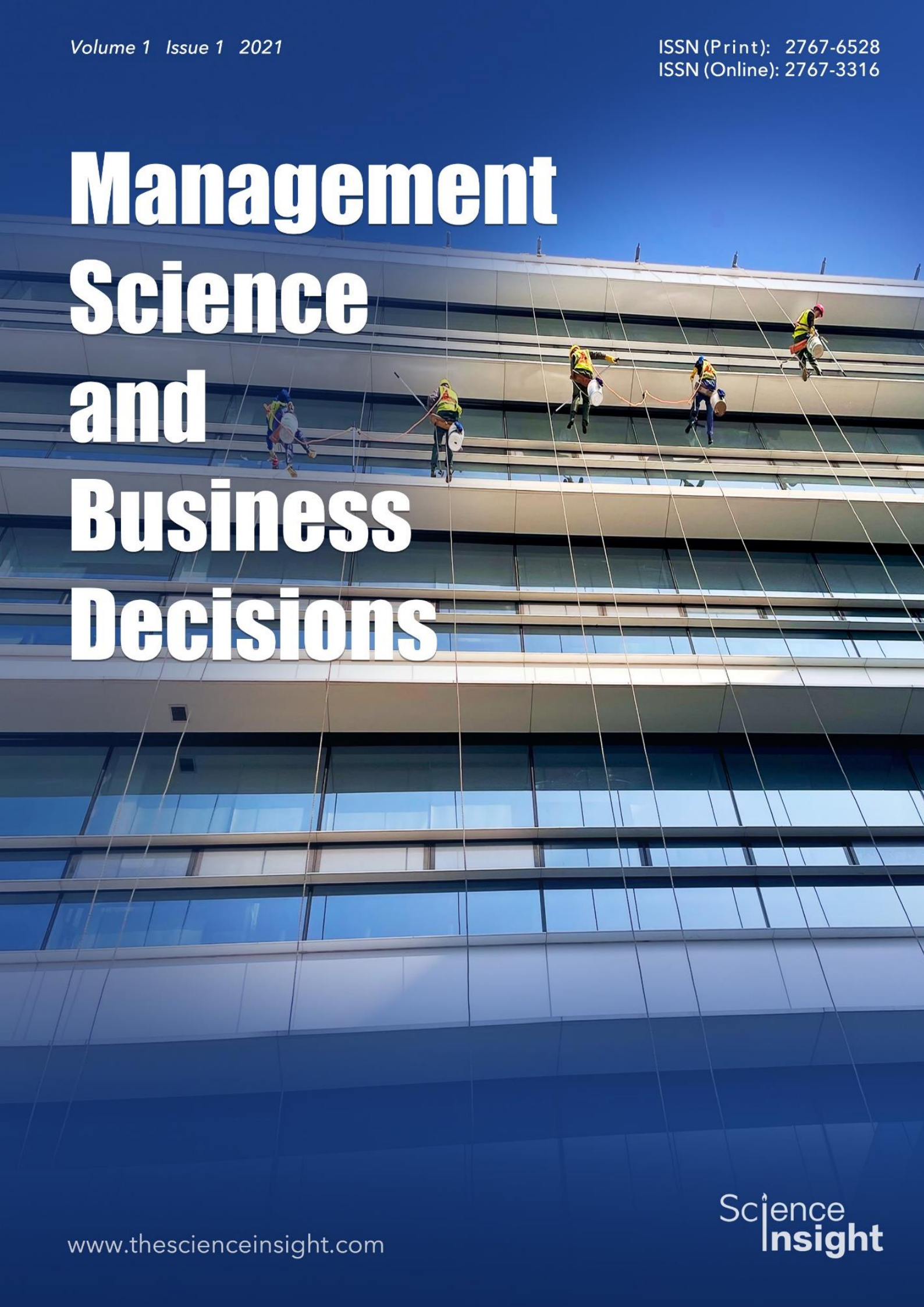

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Editorial

Management Science and Business Decisions is an international journal primarily dedicated to dissemination of new and tested ideas and their applications in the management sciences and its sub-disciplines to aid the business decision-makers of today and the future in making better decisions and policies. It intends to be more than an academic journal publishing *positive* results. We believe development comes from contradictions. Thus the *negative* results may also be published as long as the methodology is sound and rigorous, no matter how much it offends the fans of the *p*-value. In the end, the ultimate objective is to nurture exciting debates and shape new ways to see old things (and, sometimes, old ways to see new things).

Today, *Management Science and Business Decisions* is born. However, with every passing year, it is hoped that it would gain strength, support, and influence, and a day would come when we would talk about this day once again! As the saying goes, "The journey of a thousand miles begins with a single step," I hope our one step today enables us to take our field to new heights in the future. The journey ahead is no easy, but we have nothing to lose!

Finally, I wish to thank everyone who played some role in the journal's launch. The people who developed our website and the online system. The people who provided us legal existence. The people who helped us edit, review, and publish the manuscripts. The people who submitted their manuscripts to us. And, the people who are going to read, share and cite these manuscripts. We thank them.

At *Management Science and Business Decisions,* communication is two-way. Feel free to communicate with us if you have any proposal that can benefit the journal and the scientific community it intends to serve. I hope *Management Science and Business Decisions* provides us all not only another outlet for our future submissions but also a shoulder to stand on, and to see further.

Saad A. Javed
Editor-in-chief

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Evaluating Suppliers for Healthcare Centre using Ordinal Priority Approach

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Abstract: Supplier selection is one of the most critical problems in the industry. In the healthcare sector, where the tolerance level for mistakes and errors is low, the need to improve the supplier evaluation system is ever increasing. Earlier, the cardinal data-based mathematical models played an important role in supplier selection however since last few decades, the emphasis on the decision-making methods that can handle ordinal relations is gaining exceeding attention. The development of the Ordinal Priority Approach (OPA) is an essential milestone in this regard that is being used in the current study to evaluate the suppliers of a Chinese healthcare facility. The study confirms that the OPA is convenient and powerful approach that can single-handedly estimate the weights of suppliers, criteria and experts. The results demonstrated the feasibility and validity of the approach for healthcare supplier selection problems.

Keywords: Ordinal Priority Approach OPA; multi-criteria decision-making MCDM; healthcare; supplier selection

1. Introduction

The healthcare industry is an important sector to our day-to-day wellbeing. The functionality and sustainability of the industry always remained a primary societal need. Therefore, a well-equipped healthcare system is required to enable the nation provide necessary medical and health care services (Fan *et al.*, 2020; Javed *et al.*, 2018). Nonetheless, medical commodities and equipment supplies turn to be a significant shortcoming in recent health discussions. A sustainable supply chain by suppliers can play an important role in addressing this situation to achieve economic, social, and environmental gains (Suraraksa & Shin, 2019). While focusing on the supply chain's best management practices, the healthcare supply chain improved drastically (Saetta & Caldarelli, 2020). Suppliers of healthcare products are key players in the sector. Therefore, the need to strengthen the supply chain management to ensure sustainability is vital to study.

Because of the increasing importance in real-life, supply chain management and supplier selection remain scholars' focus. Given that, supplier selection has been a sensitive aspect of the supply chain since it has the potential to promote an efficient and sustainable supply chain. Fashoto *et al.* (2016) argued that to enhance supplier evaluation system, it is advisable to consider several criteria such as delivery, service, quality, price, and risk other than the traditional approach that only relied on cost and/or references in making a decision. The challenges in the supplier section in the healthcare sector

become barriers for patients' satisfaction and administering a good quality service. The trade-off between cost and other criteria is an important discussion in literature (Reuter *et al.*, 2012); however, supplier evaluation with a focus on price is no more a popular choice, and supplier selection is analysed through multi-criteria decision-making (MCDM) approach is gaining exceeding attention. MCDM method recognizes two or more criteria that are relevant to the subject matter in making analyses. Typical examples of MCDM methods are Analytical Hierarchy Process (AHP) and Technique of Order Preference to Similarity to Ideal Solution (TOPSIS), Grey Relational Analysis (GRA), fuzzy methods, and artificial neural networks. These model techniques have been used in many industries for supplier selection and have yielded satisfactory results. However, each method has its own limitations, and when the problem contains preferential relations and experts are also weighted, these methods may become impractical. The Ordinal Priority Approach is a new development in this regard that has resolved many problems haunting the existing MCDM methodologies, and will be the focus of the current study.

The rest of the study is organized into the following sections. The second section introduces the Ordinal Priority Approach and its computational step. The third section presents research methodology where data collection methodology and data collected is shown, along with the framework of the supplier selection. The fourth section presents the results and discussion. The last section concludes the study with some recommendations.

Table 1. A review of supplier selection in the healthcare sector

Year	Description	Methodology	Literature
1997	Review of supplier selection criteria in healthcare setting	Qualitative study	Lambert *et al.* (1997)
2014	Sustainable supplier selection for the medical device industry	Fuzzy Inference System (FIS)	Ghadimi and Heavey (2014)
2015	Supplier selection in blood bags manufacturing industry	Fuzzy TOPSIS	Venkatesh *et al.* (2015)
2015	Project selection for the healthcare industry	DEMATEL-ANP	Ortíz *et al.* (2015)
2016	Supplier selection in healthcare sector	AHP and ANN	Fashoto *et al.* (2016)
2018	Supplier selection for hospital waste management	AHP	Ishtiaq *et al.* (2018)
2019	Evaluation and selection of supplier for hospital	(i) AHP-TOPSIS (ii) AHP-ELECTRE (iii) AHP-GRA (iv) AHP-SAW	Akcan and Güldeş (2019)
2019	Site selection for new hospital	AHP	Şahin *et al.* (2019)
2019	Supplier selection for hospital pharmacy	Fuzzy AHP and Fuzzy TOPSIS	Manivel and Ranganathan (2019)
2020	Sustainable supplier selection for the healthcare industry	Measurement of Alternatives and Ranking according to COmpromise Solution (MARCOS)	Stevic *et al.* (2020)
2021	Evaluation of urban public health care quality	Fuzzy TOPSIS	Khambhati *et al.* (2021)
2020	Supplier selection for Vendor Managed Inventory (VMI) in healthcare industry	(i) Fuzzy Delphi approach (ii) Fuzzy Step-wise Weight Assessment Ration Analysis (SWARA) (iii) Fuzzy Complex Proportional Assessment of Alternatives (COPRAS)	Sumrit (2020)
2020	Supplier evaluation in the public healthcare system	(i) Making Trial and Evaluation Laboratory (DEMATEL) (ii) Best Worst Method (BWM) (iii) Evaluation based on distance from average solution (EDAS)	Yazdani *et al.* (2020)
2020	Supplier selection for hospitals	Artificial neural network and fuzzy VIKOR	Bahadori *et al.* (2020)
2021	Evaluation of a Chinese healthcare facility's suppliers	The Ordinal Priority Approach	The current study

Table 2. Sets, indexes, and variables for the OPA

Sets	
I	Set of experts $\forall i \in$ I
J	Set of criteria $\forall j \in$ J
K	Set of alternatives $\forall k \in$ K
Indexes	
i	Index of the experts $(1, \dots, p)$
j	Index of preference of the criteria $(1, \dots, n)$
k	Index of the alternatives $(1, \dots, m)$
Variables	
Z	The objective function
${W_{ijk}}^r$	Weight (importance) of k^{th} alternative based on j^{th} criterion by i^{th} expert at r^{th} rank
Parameters	
i	The rank of expert i
j	The rank of criterion j
r	The rank of alternative k

2. Ordinal Priority Approach

Attributes, alternatives, and experts (respondents) are key components of any decision-making problem. The Ordinary Priority Approach (OPA) is a linear programming-based approach proposed by Ataei *et al.* (2020) to help decision-makers solve complex problems using preferential relations. It is an emerging technique of multi-criteria decision-making, and within a short period, it has seen several successful applications in various fields. The OPA has several advantages over other MCDM models as it does not require pairwise comparisons, normalization of data, completeness of data (Mahmoudi *et al.*, 2020). Also, the extended versions of the OPA can further assist the decision-makers in solving problems containing uncertainty (Shajedul, 2021; Mahmoudi *et al.*, 2021a).

In the current study, the OPA was used to estimate the weights of criteria, experts and suppliers. In the current section, the computation steps of the OPA are concisely explained. In Table 2 essential parameters of the OPA are defined. Guided by the literature (Mahmoudi *et al.*, 2021b; Ataei *et al.*, 2020), the relevant steps of the OPA are shown below.

Step 1: Identification of criteria and sub-criteria for supplier selection.

Step 2: The ordinal preference of criteria and sub-criteria should be defined.

Step 3: The linear model (1) should be formed, which is based on collected data from the steps 1 to 2, and later the model can be solved by using an appropriate software (e.g., LINGO, MATLAB, Python, etc.).

$$Max\ Z \tag{1}$$

s.t.

$$Z \leq i\left(j\left(r\left({W_{ijk}}^r - {W_{ijk}}^{r+1}\right)\right)\right) \qquad \forall\ i, j, k \text{ and } r$$

$$Z \leq \ ijm{W_{ijk}}^m \qquad \forall\ i, j \text{ and } k$$

$$\sum_{i=1}^{p}\sum_{j=1}^{n}\sum_{k=1}^{m} W_{ijk} = 1$$

$$W_{ijk} \geq 0 \qquad \forall\ i, j \text{ and } k$$

where Z: Unrestricted in sign

After solving the model, Eq. (2) should be employed to determine the weights of suppliers.

$$W_k = \sum_{i=1}^{p} \sum_{j=1}^{n} W_{ijk} \qquad \forall\, k \tag{2}$$

In order to determine the weights of criteria, Eq. (3) should be employed.

$$W_j = \sum_{i=1}^{p} \sum_{k=1}^{m} W_{ijk} \qquad \forall\, j \tag{3}$$

In order to calculate the weights of experts, Eq. (4) should be utilized.

$$W_i = \sum_{j=1}^{n} \sum_{k=1}^{m} W_{ijk} \qquad \forall\, i \tag{4}$$

Later, these weights can be used for decision-making and ranking of criteria, experts and the suppliers.

3. Research Methodology

Based on the problem (Figure 1), data was gathered from three respondents working in the procurement department of a private healthcare facility in Nanjing, China. To maintain privacy, suppliers were classified as follows: first supplier (A1), second supplier (A2), third supplier (A3), and fourth supplier (A4). Those suppliers were evaluated with which all respondents were familiar. Each respondent was at least a college graduate. Judgments by the experts were primarily based on four criteria, namely delivery performance (C1), cost (C2), quality of the product (C3), and service level (C4), where criteria C1, C3, and C4 are positive criteria and C2 being a negative criterion. The data collected is shown in Tables 3 and 4. In these tables, 1, 2, 3 and 4 imply 1st Priority, 2nd Priority, 3rd Priority, and 4th Priority. The Ordinal Priority Approach will be used for the evaluation of the suppliers. The benefit of using the OPA model is that one can avoid the normalization of data, e.g., one can ignore which criteria were higher-the-better and which were lower the better as the objects are evaluated based on their relative priority (Mahmoudi *et al.*, 2020b).

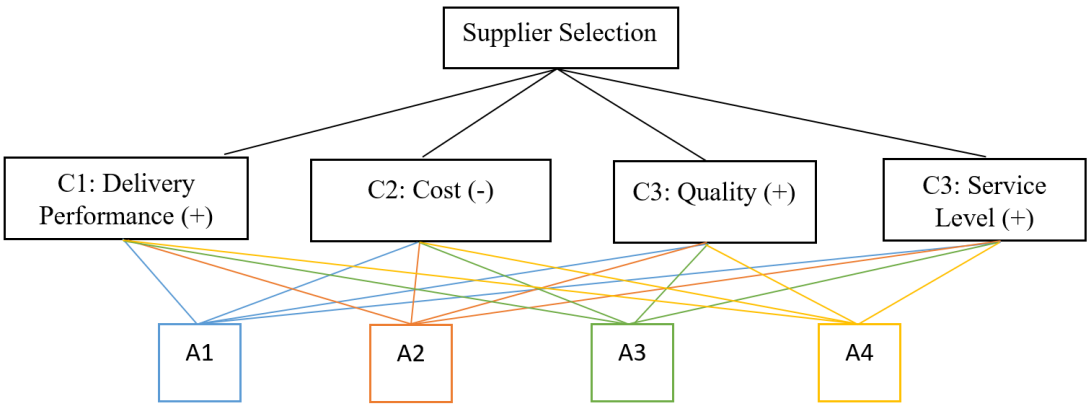

Figure 1. The evaluation of four suppliers of a healthcare facility against four criteria

4. Results

The Ordinal Priority Approach was executed as per the steps mentioned before. After solving the OPA model, the weights of experts, criteria, and suppliers were obtained using Eqs. (2) – (4). Later, they were ranked in ascending order, where higher weight means higher rank. Table 4 shows the weights and the ranking of experts. Tables 5 shows the weights and ranking of the experts, criteria and suppliers.

Table 3. The relative importance of criteria

	C1	*C2*	*C3*	*C4*
E_1	1	2	1	1
E_2	4	3	1	2
E_3	2	1	1	1

Table 4. The relative importance of suppliers against each criterion

	E1				*E2*				*E3*			
	C1	*C2*	*C3*	*C4*	*C1*	*C2*	*C3*	*C4*	*C1*	*C2*	*C3*	*C4*
A1	3	1	2	3	3	1	2	3	1	1	2	2
A2	1	2	1	2	1	2	1	1	1	2	1	1
A3	1	3	2	2	2	1	1	4	2	1	1	3
A4	2	3	1	1	1	3	1	2	1	2	1	1

Table 5. The weights and ranking of the experts, criteria and suppliers using the OPA

		Weight	**Rank**
Experts	*E1*	0.354031	2
	E2	0.242539	3
	E3	0.403431	1
Criteria	*C1*	0.210978	3
	C2	0.179760	4
	C3	0.345798	1
	C4	0.263465	2
Suppliers	*A1*	0.176672	4
	A2	0.307376	1
	A3	0.231218	3
	A4	0.284734	2

Overall, A2 stands out as the best supplier, followed by A4, A3, and then A1, as shown in Figure 2. Therefore, a long-term relationship with the second supplier is more likely to payoff to the healthcare facility than other suppliers. The first supplier should be avoided, and its services should only be obtained when no better supplier is available.

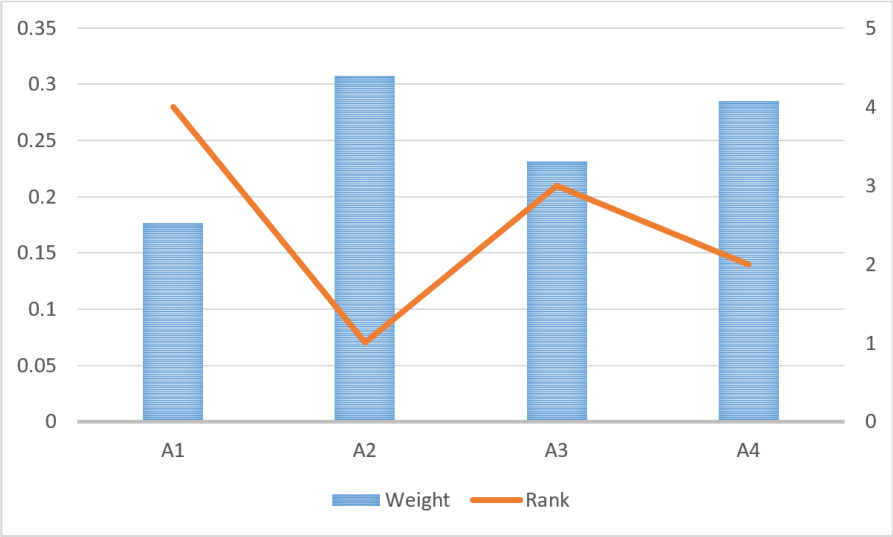

Figure 2. Ranking of the suppliers through the OPA

5. Conclusion and recommendations

The reliability of a supply chain is dependent on reliable suppliers. In the healthcare sector, high-performing supplier selection is very crucial for decision-makers. The Ordinal Priority Approach (OPA) is a breakthrough technique for multi-criteria decision-making (MCDM) with a promising future. The current study made pioneering attempts to evaluate and select suppliers for the healthcare industry using

the OPA method. The OPA method that has many advantages as compared to other existing MCDM technique. The OPA method enjoys a high level of flexibility in dealing with uncertainty in decision-making problems and does not need any standardization of incommensurable criteria, which is the major concern for almost every MCDM technique. After evaluating all criteria and extracting the local and global ranking, the result suggests that the fourth supplier should be selected to minimize the overall negative effect and maximize the supply chain surplus.

Every methodology has its shortcomings. In the future, the role of subjective and linguistic variables can be considered to improve the results further. Also, while benefiting from other emerging operations research techniques, the OPA method should be applied in other decision-making problems to find its further strengths and limitations. For instance, the integration of the OPA into other methods can be carried out to evaluate the relative performance of suppliers to the healthcare sector. Since there are various factors related to the healthcare sector, such as patient care, delivery, quality, price, risk management, etc. These factors can affect the healthcare delivery system and its relation to suppliers and, in the long run, more importantly, can influence overall healthcare supply chain surplus. In the future, more criteria can be included in the problem.

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Effect of Manpower and Resource Factors on Labor Productivity at House Building Projects in DHA Lahore

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Abstract: Construction industry suffers numerous issues and complicated factors like price, period, quality and safety. It is said that Construction projects are versatile because they associate with contractors, architects, advisers, designers, the project owners, etc. Keeping in view of above factors, objective of this research is to highlight those factors which have impact on labor productivity in house building project. Through literature review as well as discussion with different consultants, several factors of productivity were identified. Out of which 20 factors were selected, which were later categorized into two sets, for analyzing in the current study. A comprehensive questionnaire was prepared and sent to project manager, engineers, designers, and builders. It was found, that total expense of construction comes to much higher as it was originally calculated. It is suggested that human resource should be developed through an effective and well planned training program, so that construction project do not suffer due to low performance. The mentioned factors are supposed to help in completed the construction projects effectively.

Keywords: Productivity; Construction; Manpower factor; Resources factor

1. Introduction

In the past, number of studies were conducted for labor productivity in construction sector. Numerous of them were to analyze the effect of factors of productivity. This analysis and quantifiable calculation of these factors of productivity are essential for many purposes. It can be used for the calculation of project duration, its planning and forecasting. Previous studies reflect that it is very difficult to evaluate such impact. Also there is no globally recognized standard to evaluate the factors which result in the loss of labor productivity for construction sector. This deficiency of process of evaluating the effects of labor productivity emphasize the requirement to generate the quantifiable valuation for the factors which affect the productivity in construction sector. Hence this is the research topic.

These days the major issue for the organizations is to enhance their productivity, by converting the human resource into such a valuable commodity which can sell at a high rate and can earn high profit for the organization (Wilcox, 2000). Researchers have done significant effort to comprehend the

concepts of productivity. This effort resulted in numerous definition of productivity (Karayalcin & Pintea, 2015; Oglesby *et al.*, 2002; Paulson, 1975).

1.1 Productivity Defined

The ratio of output volume to input is normally defined as Productivity. It can also be defined as the efficiency of labor used as input to produce certain level of output. Researchers say that perfect productivity, which is equal to one (1.0) can be attained if labor work for forty hours a week. They should avail all the due holidays. Work should not be delayed. There should not be any rework. Work safety has been the prime consideration. Weather condition should be optimum and no court case at the end of the project (Rowlinson & Procter, 1999).

The link among output and input coined the term productivity (Liou & Borcherding, 1986). This input and output varies from industry to industry. The definition of productivity will change with the change in location of the industry. The productivity of labor is normally determined by the expense incurred on labor to the work they performed (Liou & Borcherding, 1986). The labor productivity as per Drewin, is defined as quantity of goods and services generated by the labor in a unit time (Drewin, 1982).

Littre defined productivity, in the year 1883, as a desire to produce (Jarkas, 2005). There is an Organization for European Economic Cooperation (OEEC), this organization has defined productivity in nineteen hundred and fifty, as a quotient gained as output divided by one of a production factors (Sumanth, 1984). Subject to dimension of purposes and accessibility of the data, numerous definitions of the productivity come across. The United States Department of Commerce has also defined productivity, as "numbers of dollars generated by one labor hour input" (Adrian, 1987).

1.2 Productivity Importance

Construction industry is labor and capital intensive. Hence in this industry it is very essential to emphasize on productivity. For the construction projects labor productivity establishes an important share of production input. There are numerous internal and external factors in construction sector which are not constant therefore it is not possible to identify them beforehand. Therefore due to this factor labor productivity varies continuously. Here it is important to ensure that plan, schedule, and work should not effect by decline in productivity, which result in delays. These delays result in losses of revenue. Therefore expenses can be reduced by enhancing the labor productivity. In this way lass number of workers can do the same job by enhanced productivity, resulting save cost and enhance revenue (Thomas, 1991).

1.3 Problem Statement

It has been observed that productivity has Decline in house building sector which is a biggest issues. Because of these field factors, the contracts of construction are deficient in classifying the productivity loss (CII, 2000; Hanna & Haddad, 2009). Among different cost factors like men, material and equipment, the labor factor is generally the most risk bearing factor. The other two factors which are material and equipment do not impact much as their prices are market driven and not under the control of project manager. The estimated labor cost in any construction project is roughly 35 to 50 percent (Hanna *et al.*, 2005). Since human resource is most unpredictable as compare to other cost factors, so it is essential to find out an effect of these factors on productivity of workers. This is also a well-known fact the labor expenses can be reduced by increasing the labor productivity. Hence it plays a very effective part in reducing the cost and increasing the profit in a construction sector (Hanna *et al.*, 2005).

1.4 Research Contribution

This research contributes in investigating a very important and essential factor which directly affects the labor productivity. It is helpful to comprehend these factors for those persons who are responsible to complete the construction projects in time. The study will benefit the stakeholders associated with the house building in the housing societies like the Defense Housing Authorities (DHA), an affluent housing society with presence in multiple cities of Pakistan. The objective of this study is to make

available those factors to project managers which are essential to complete the project successfully and cost effectively.

2. Literature Review

2.1 Labor Productivity

Before 1960 the productivity enhancement was evaluated for construction sector (Stall, 1983). After that it remains a global distress of decline in productivity in construction sector. To cater for this issue a Construction Forum was created in 1968. This forum was created because of issues due to enhanced construction cost, rise in rate of inflation, and considerably decrease of productivity in construction sector (Thomas & Kramer, 1988). In 1965, the United Nations Committee on Housing, Building and Planning circulated an important handbook related to processes and operations of building construction (UNCHBP, 1965). It revealed that enhancement in productivity in construction sector is a dire need in comparison to other sectors. It was also required to adopt the knowledge of manufacturing sector to construction sector (Alarcon, 1991).

There are numerous factors which affect the productivity as revealed previous research. Even in advanced countries it is required to analyze for these unknown factors (Makulsawatudom & Margaret, 2002). Polat and Arditi (2005) revealed that each country has different policies about enhancement of productivity. Different factors were recognized due to this research which has impact on labor productivity. These factors were grouped together as per their characteristics. Adrian (1987) categorized the factors of productivity which are responsible for the decline in productivity. Literature suggests that overtime schedule generally result in decline of efficiency since failure of in time delivery (Ginther, 1993).

The normal methods used in most of the studies related to productivity are interview and survey. In Singapore a survey was conducted for major construction companies to find out factors (Lim & Alum, 1995). These factors have considerable effect on productivity. Following three issues were pointed out, trouble in hiring supervisor, trouble in hiring labor, and high attrition rate of labor. Portas and AbouRizk (1997) circulated questionnaire to project managers and supervisors to find out the factors which impact the productivity. The contractors and suppliers were interviewed, which revealed that delivery of material affect the productivity. The bad weather is also another feature affecting the productivity (Hassanein & Melin, 1997).

Productivity is the resultant of numerous interrelated factors. From previous studies numerous factors were identified which affect the productivity of labor. These factors are discussed in the succeeding section.

2.2 Identification of Factors Affecting Productivity

This study revealed numerous factors from past studies that impact productivity of labor. The factors which were related are grouped. The factors which do not contain any significant value were dropped. Twenty sub-factors were identified and classified into the following two groups of factors:

2.2.1 Manpower Factor. This factor includes eight sub-factors; Absenteeism, Age, Alcoholism, Disloyalty, Lack of competition among workers, Lack of experience, Misunderstanding among laborers, and Personal problems.

2.2.2 Resource Factor. This factor includes twelve sub-factors; Differing site conditions from the plan, Insufficient construction method, Insufficient transport facilities for labors, Increase in the price of materials, Insufficient lighting, Non availability of required construction materials, Shortage of required equipment & tools, Location of Material storage, Access to construction job site is not adequate, Poor site conditions, Quality of required work, and Violations of safety laws.

3. Research Methodology

Survey research method was adopted in the current study. It is defined as collecting data by sending a questionnaire to relevant persons (Enshassi *et al.*, 2006). Questionnaires and personal interviews were

the two methods applied for data collection. The most effective method used was the questionnaire which was preferred more due to the fact that it was designed according to the web and was self-administered. It needs less time and money to create and the answer fills the questionnaire however they prefer. Unfortunately, this results in the estimate of answers given much lower in contrast to personal interviews.

3.1 Survey Planning

The questionnaires for the survey were sent through emails and the goal of the survey was to acquire general information about labor productivity in building construction at the Defense Housing Authority (DHA) Lahore and its multiple factors. To minimize inaccuracy in the survey, the respondents were informed beforehand of the purpose and the instructions to fill out the questionnaires. To make the procedure go smoothly, some supervision was provided throughout and to preserve confidentiality, the data collected through emails was reserved in raw data sheets.

3.2 Considerations for the Survey

Making the survey uncomplicated and easy to understand for the respondents was the principal aim due to the fact that dropout rate can be quite high if the questions are too challenging. The survey was extremely carefully curated in a way that the opening questions do not affect the result of the following questions negatively. In order to explain the project to the answerers, introductory content was supplied and questions that were logic based and could cause exasperation in the respondents were not included. The study was conducted to find any flaws and inadequacy in the questions and to make sure they were liable.

3.3 Organization of the Questionnaire

It was a largest concern to get back the completely and accurately filled questionnaires. The desire was to get back maximum number of filled forms. Previous studies were taken into consideration while inspecting the accuracy of this study. The fact that the respondents received the required time needed to precisely attempt and turn in the survey to the researcher online was given the utmost importance and the simplicity and understandability of the questions was assured. In total, the amount of the questionnaires distributed was 250.

4. Results and discussion

4.1 Data collection through surveying

Collecting accurate and appropriate data is the main concern of any scientific study. From a defined population, the important data obtaining is an essential procedure (Bohrnstedt, 1994). The number of questionnaires sent to construction professionals via email was 250 and in return around 64 were filled out which resulted in 25.6 percent rate of replies (Table 1). Most often data missed as questionnaire filling person do not respond the questions properly (Kim, 1993). The amount of invalid data deleted altogether from the research was about 14 (i.e., 5.6%), for the reason being that most of the data was either incomplete or inaccurate.

4.2 Dimensions of collected data

At different stages of house building there are number of troubles and risks affecting construction activities. To counter these threats, four situational grades were defined; (i) Not applicable, (ii) Not

Table 1. The questionnaire distribution

	Number	**Percentage**
Total questionnaires sent	250	
The questionnaires returned	64	25.6
Invalid data	14	5.6
Valid data for the study	50	20.0

affective, (iii) Little bit affective, and (iv) Significantly affective. Such grading is not uncommon in literature. This grading helped the respondents to easily understand the different grades of risk levels and threats to house building projects. The elaborative questionnaire was constructed to be used as an instrument to compute the factors which are responsible to increase or decrease the labor productivity in a house building project.

To adopt the appropriate method for this study, the grades are to be evaluated. There is appropriate method for each grade. This study has adopted ordinal scale. Normally digits like 1-2-3-4 are used to define these grades. Here one can be lowest or highest grade, depending on the needs of the researcher. Normally these grades do not have equal weightage, and are generally are used for labeling purpose (Ugwu & Haupt, 2007; Iyer & Jha, 2005; Cheung *et al.*, 2004).

4.3 Analysis technique

A procedure was formulated to analyse the collected data. The easy communication was established to make the process simple. Generally two methods are adopted to compute the data. Relative Importance Index (RII) was used to analyse data. It involves, (i) Grading the factors in ascending or descending order as per their degree of risk followed by computation of RII against each factor, and (ii) Later categorizing the grades as significant or not. Different researchers has successfully used RII for analyzing productivity factors in house building projects (see, e.g., Ugwu & Haupt, 2007; Iyer & Jha, 2005; Cheung *et al.*, 2004). Also, it has seen application on Pakistani construction projects as well (Sheikh *et al.*, 2019). RII can be calculated as:

$$\text{RII} = \frac{\sum W}{A \times N}$$

where, W = number 1 - 4 marked by persons on questionnaire, A = the maximum value on the scale, which is 4 in our case, and N = total number of responses.

4.4 Manpower factors affecting worker productivity

For the manpower group, various factors for their ranking are shown in Table 2. With an RII value of 475, the manpower factor of lack of experience topped the list.

Productivity is greatly influenced by lack of experience of labor. Paulson has evaluated the consequences faced by the workers and its effect on labor productivity (Paulson, 1975). This deduction is also reinforced by Heizer and Render (1990) who confirmed that the work site productivity is influenced by the skills and awareness of the workers. Thus, one may argue that as a result of the skills, productivity of labor is likely to increase.

4.5 Resource factors affecting worker productivity

Group of resource factors is shown in Table 3. With an RII value of 557, the construction material shortage is at 1st position.

Table 2. The group of manpower factors

Manpower Factors	RII	Rank
Inadequate experience	475	1
Absenteeism	467	2
Misunderstanding among laborers	436	3
Age	422	4
Lack of competition among the laborers	412	5
Alcoholism/drugs	359	6
Disloyalty	348	7
Personal problems	338	8

As per Kini (1999), the material resource make out about 40 to 60 percent of total value of house building project. It is evaluated from old studies that impact of material management on labor productivity was not given due consideration. Without the necessary materials needed for a particular task, it is impossible to complete it. In different past studies this factor was places at first position in different countries (Lim & Alum, 1995; Guhathakurta, 1993; Olomolaiye, 1987). Materials that are beyond reach or need a long time to acquire is known as a lack of material. Thomas *et al.* (1999) evaluated that lack of material management about 18 percent of work-hour are to be done extra. Material unattainability resulted in 35.6 hours of unproductive time; hence, 9.5% of wasted time in total.

With an RII of 539, non-availability of construction equipment is placed at 2nd place. For construction procedure the accessibility of tools is necessary. Factors that affect labor productivity is the lack of tools in most cases, also shown in previous studies (see, Guhathakurta, 1993; Olomolaiye, 1987).

With an RII of 503, the location of material storage is placed at number 6th position among resource group. Sanders and Thomas (1991) argued that construction material storage size and location has a considerable effect on the productivity of the workers.

With an RII of 509, inadequate lighting is placed at third position.

A not proper approach to the construction site is placed at 7th position having RII 489. Sanders and Thomas (1991) also reported similar fact.

With an RII of 489, inadequate access in a construction site has got 7th place among resource group. Sanders and Thomas (1991) verifies that inadequate access to constriction site is a cause of low workers' productivity.

With an RII of 485, not following the safety laws was placed at eighth position. House building construction is considered to be among extreme unsafe industrial sectors (Suazo & Jaselskis, 1993). Some of the main reasons that cause accidents is human behaviour, the distinctive nature in housing project, construction location situation etc. These situations are difficult and result in poor safety management. It often jeopardizes the working process, work equipment and work process. Among employees and employers, the main objective should be to minimize occupational injuries and illnesses. Working environment tends to change regularly which increases risks in the construction industry. When a hazard id identified in any construction site and it is managed properly, then it is very likely that a new hazard may emerge within no time (Davies & Tomasin, 1990).

In the resource group 9th rank was given to the quality of work with an RII value of 479. Often rework is required since the quality of the product is not up to mark. Cheung *et al.* (2004) argued that job quality will always have an impact on the quality of work. Iyer and Jha (2005) has analysed that quality of douing s job has always an impact on the cost management of the house building. The three main constrictions are quality, cost, time.

The lack of transportation facility for labors is placed at 10th with RII of 437. Past studies (Karayalcin & Pintea, 2015; Harriet *et al.*, 2013) confirm that lack of transport facility has impacted on the labor

Table 3. The group of resource factors

Resource Factors	RII	Rank
Deficiency of required construction material	557	1
Deficiency of required construction equipment /tools	539	2
Inadequate lighting	509	3
Site condition not appropriate	509	4
Site condition not as per plan	503	5
Location of Material storage	503	6
Access to construction job site is not adequate	489	7
Safety laws Violation	485	8
Required work quality	479	9
Insufficient transport facilities for labors	437	10
Insufficient construction material	436	11
Rise in the price of material	395	12

productivity. It is difficult for the workers to reach the construction site if it is located outside the city or no transport goes to that place.

5. Conclusion and recommendations

5.1 Conclusions

Construction sector is known as number one sector which play a pivotal role to boost the economic conditions of a nation. It is very essential to have a thorough understanding about construction work and labor productivity, as it will save cost and reduce rework. Since construction projects at time are complicated and require huge investment. Hence there are numerous factors which have impact on the projects construction process also the labor productivity may get affected. This leads to late completion pf project, result in incur more finances as it were planned.

This particular research work emphasizes to identify the factors involved to reduce the productivity of labor. The data collected was analyzed, as the goal of this research was to evaluate those factors which have impact on labor Productivity in labor intensive house building sector. Relative Important Index (RII) was used to calculate the factors ranking.

5.2 Recommendations and future directions

Collecting The progress of building projects hampered because of litigation and conflicts, more over they are costly projects. To successfully complete the project construction companies should keep the atmosphere conducive. It is also very important to identify the risks and flaws of the project so that they could be managed well in time. To improve labor productivity few points are listed below.

i. Material supply schedule be prepared for timely availability of building material from the market.
ii. Light should be adequate to avoid work injuries and accidents.
iii. Safety training should be periodically given to workers.
iv. Material should be placed near to construction site so that provision of material to workers should be in minimum time.
v. Plan should be there to select best worker of the month.
vi. Monitory benefit can be given to best worker.
vii. An atmosphere of competition can be created at the construction site.
viii. There should be periodical drug test of the workers and penalize those who found positive.
ix. The workers may be provided transport facility if construction site at remote area.
x. Workers presence can be enhanced by providing them paid off time and holidays.

This research is confined to the construction of house buildings in the DHA Lahore. Further study can be conducted in other regions and housing societies. It can also be done for different type of buildings like, educational buildings, commercial plaza, high-rise buildings etc. It can also be done for other sectors like transportation, which include roads and bridges.

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Relationship between Real Effective Exchange Rate and Labor Productivity: Empirical Evidence

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Abstract: Labor productivity is one of the indicators that reveal a country's economic development, human resource quality, availability of infrastructure and technology, among others. Improvement in organizational productivity is also dependent on labor productivity. The current study attempts to study the relationship between labor productivity and the Real Effective Exchange Rate in the selected countries. The sample included Australia, Brazil, Bulgaria, Canada, China, Iceland, Japan, Malaysia, South Africa, and the USA. With the aid of statistical techniques, the study found that productivity and exchange rate are correlated with varying degrees of strength and the nature of the relationship varies from country to country. The study concludes with important directions for future investigations.

Keywords: Real Effective Exchange Rate; Labor Productivity; Correlation; Regression

1. Introduction

Economic growth has several indicators that can be used to determine the economic condition inside a country's economy. For instance, growth in real Gross Domestic Product, increase in Human Development index, etc. Unfortunately, there is one indicator that is often overlooked – Labor productivity – despite its ability to show how well the labor performs inside the economy. Furthermore, it can show the availability of the facility, technology, etc. Labor productivity is affected by several factors, such as technical, organizational, geographic, social, and structural (Fedulova *et al.*, 2019; Choudhry, 2009). These factors will show an overall economic condition that the country experience, which will help us consider the development of the people inside the country.

Labor productivity has several influencing factors that could contribute to its growth (Choudhry, 2009). For instance, location, cultural beliefs, international influence, and incentives. Also, the currency exchange rate is another factor connected with labor productivity (Jeanneney & Hua, 2011). Moreover, it is believed that international currency exchange influence may have both positive and negative impacts on the growth of labor productivity depending on the country and its policies. For instance, foreign direct investment is considered to be an important determinant that could affect a country's economic system (IMF, 2006). Do countries with similar income levels exhibit similarities when it comes to the relationship between labor productivity and exchange rate? The current study attempts to look for its answer by revisiting the relationship between real effective exchange rate and labor productivity for different countries using a statistical approach.

The rest of the study is organized as follows: the second section is the review of relevant literature, followed by research methodology section. The fourth will be on data, results, and discussion, and the fifth section will conclude the study with recommendations and limitations.

2. Literature Review

2.1 Real Effective Exchange Rate

The currency exchange rate is the rate at which one national currency will be exchanged for another. It is also regarded as the value of one country's currency against another country's currency (O'Sullivan & Sheffrin, 2003). Unfortunately, it is unstable and sensitive to market conditions. Therefore, to reduce its instability, a measurement was taken into consideration of the domestic and external inflation rates; these measures vary depending on the regime preferred in a given country. The relationship between the domestic goods and services and the prices of these goods and services in external markets is called the Real Effective Exchange Rate (REER) (Campbell, 2012).

Since then, REER has become an important indicator that can be used to measure the competitiveness of one country's economy. REER takes the relative price of the same goods in the domestic market then compare it with product in a different region (Özkan, 2003). In other words, REER is estimated by calculating the basket of goods in one economy followed by its comparison with a similar basket of goods in another economy. Therefore, while representing the actual value of the currency, it is obtained through the weighted average of the nominal effective exchange rate (Sebastian *et al.*, 2014),

$$REER = \prod_{i=1}^{n} \left[\left(\frac{e}{e_i} \right) \left(\frac{P}{P_i} \right) \right] w_i$$

Where,

e : the exchange rate of home currency
e_i : the exchange rate of foreign currency in indexed form
w_i : weight attached to foreign currency/country. Total sum equals 1.
P : wholesale price index
P_i : Consumer price index
n : number of countries/currencies in the index other than the home country

2.2 Labor Productivity

Labor productivity is an economic indicator that shows economic growth, domestic competitiveness, living standards in one economy (ILO, n.d.). Meanwhile, labor productivity can also imply the number of goods or services produced per hour of labor in a period of time. Labor productivity (L) can by counted as the GDP (G) per total hours worked (H) such as (Ohanian, 2012).

$$L = \frac{G}{H}$$

Whereas the total hours worked can be obtained from the product of hours worked per worker (h) and employment (E) divided by the size of productive age (16-64 years) population P,

$$H = h * \frac{E}{P}$$

Labor productivity indicates the growth of the country's economic condition and living standards. It could be observed on high variability and dynamism, Factors of changes in labor productivity are the reasons for the change in its level. They are classified into several factors; Material and technical, Organizational, Regional economic, Social, Structural factors (Fedulova *et al.*, 2019). Furthermore, when labor productivity in one country increases, it shows the development of labor quality in that country. As the labor productivity formula shows, it is highly affected by the diversity in goods and services, technology, education, among others.

2.3 Relation Between REER and Labor Productivity

Labor productivity calculation comes from GDP that is divided by total hours worked. From this formula, we can conclude; higher GDP and lower working hours will increase the labor productivity

inside a country. By increasing the amount of transactional value inside the country, the development of infrastructure will follow. However, in poorer countries, some of them have neither enough capital nor qualified human resource to grow their economy (Fedulova *et al.*, 2019). Therefore, they can rely on foreign investors rather than borrowing money from an economic entity. However, to attract investment, a country must improve its macroeconomic situation (Boghean & State, 2015). Moreover, by setting an optimum currency exchange rate and removing trade barriers, investors can also be attracted. The changes in exchange rate impact investors' confidence in the profitability prospects in the country and economic growth. Later, by investing in productivity-enhancing technologies and infrastructures, the labor productivity level can be improved.

3. Research Methodology

3.1 Sample and data collection

Our sample contained ten countries, some of which were high-income economies while others were middle-income economies. High-income economies are the economies whose income range is above $12,536 and include Australia, Canada, Iceland, Japan, and the USA. Middle-income economies are the economies whose income range is $4,046 ~ $12,535 and include Brazil, Bulgaria, China, Malaysia, and South Africa. This classification is being done by Worldbank (2020).

The data for "Labor Productivity" was collected from OWID (2021), and data for "Real Effective Exchange Rate" was collected from Worldbank (2021). The time scale of the data was from 2004 to 2017.

3.2 Data Analysis Techniques

Pearson's correlational analysis will be used to find the correlation between Real Effective Exchange Rate and labor productivity. In Pearson's correlational analysis, there are several degrees of correlation. There is a perfect correlation if the test value is equal to ± 1, High degree of correlation with range ± 0.5 - ± 0.99, Moderate degree ± 0.3 - ± 0.49, Low degree if the value was lower than ± 0.29, No correlation if the value is equal 0 (SS, 2021). The formula for Pearson's correlation coefficient is (Glen, 2021a)

$$r = \frac{n(\sum xy) - (\sum x) - (\sum y)}{\sqrt{[n(\sum x^2) - (\sum x)^2][n(\sum y^2) - (\sum y)^2]}}$$

Also, linear regression analysis will be performed to estimate the relationship between the two variables. It is given by (Glen, 2021b),

$$y = a + bx$$

$$a = \frac{(\sum y)(\sum x^2) - (\sum x)(\sum xy)}{n(\sum x^2) - (\sum x)^2}$$

$$b = \frac{n(\sum xy) - (\sum x)(\sum y)}{n(\sum x^2) - (\sum x)^2}$$

R^2, also called r^2, will be estimated as

$$r^2 = \left(\frac{n(\sum xy) - (\sum x) - (\sum y)}{\sqrt{[n(\sum x^2) - (\sum x)^2][n(\sum y^2) - (\sum y)^2]}}\right)^2$$

4. Results and discussion

In this section, the changes that the currency exchange rate brings to the labor productivity ratio with constant GDP from 2011 will be observed. Thus, we will notice the change in labor productivity without the growth in GPD and could focus on the smaller impact of the currency exchange rate on the shift in labor productivity. Firstly, high-income economies will be discussed and then the middle-high-income economies.

Table 1. Statistical analysis of high-income economies

Countries	Regression Equation	R^2	Pearson's Correlation coefficient
Australia	y = 21.45 + 0.3025x	0.3996	0.6321
Chile	y = 18.254 + 0.036x	0.0015	0.0385
Iceland	y = 60.801 - 0.1136x	0.4468	-0.6684
Japan	y = 50.216 - 0.1124x	0.6234	-0.7895
USA	y = 70.673 - 0.0872x	0.0359	-0.1895
y = labor productivity, x = Real Effective Exchange Rate			

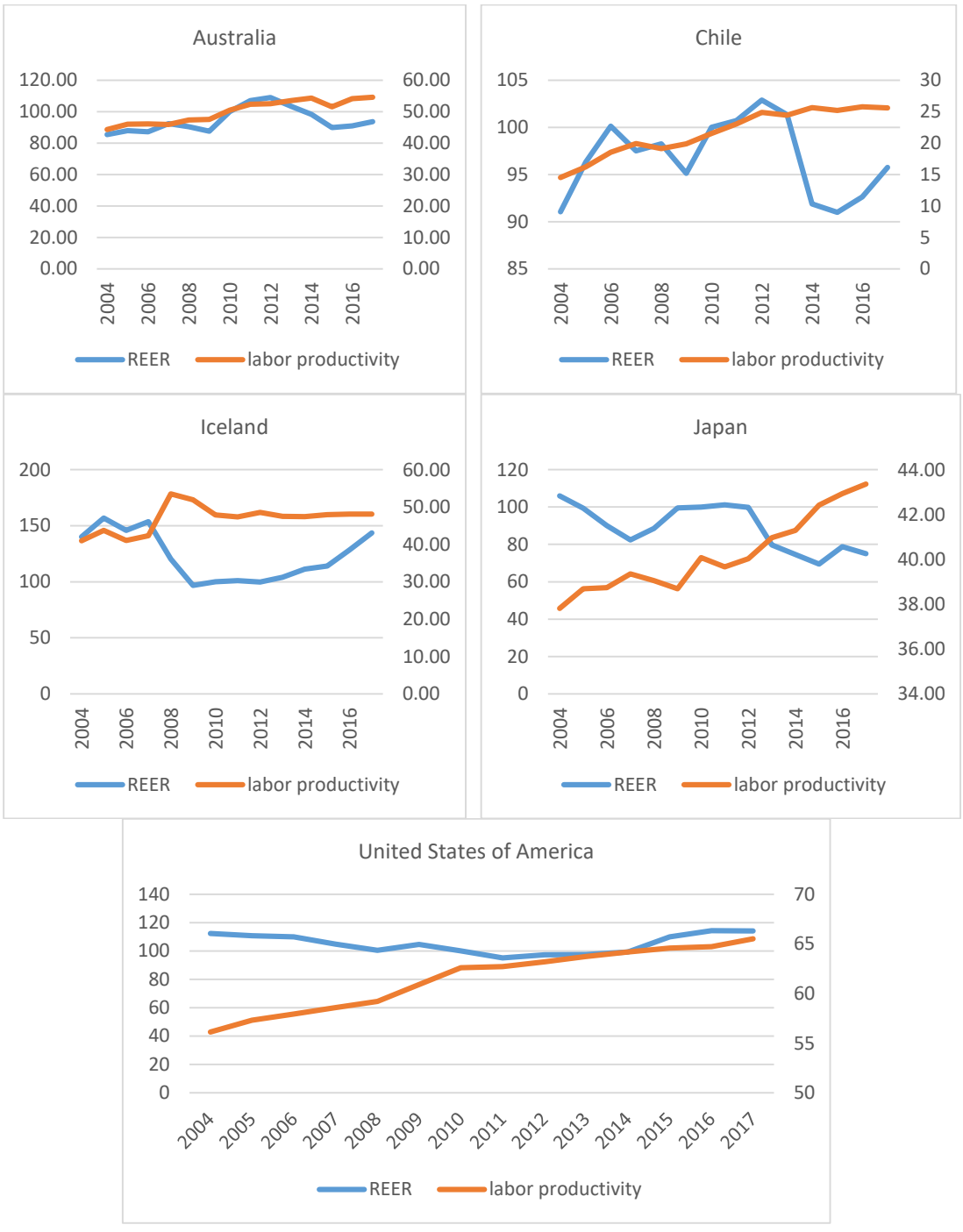

Figure 1. Labor productivity and REER of high-income economies

4.1 High Income Economies

The data analysis revealed different degrees of correlation among different countries' REER and labor productivity. Moreover, these differences in correlation between each country occurred due to differences in each country's economic policies and practices.

The results revealed that REER could have both negative and positive relationships with labor productivity. The effect may vary from country to country. Australia and Chile are having a positive correlation between REER and labor productivity, while Iceland, Japan, and the USA reported a negative correlation, as shown in Table 1. Australian labor productivity is classified as a high degree of correlation, as can be seen from the first panel in Figure 1. The possible cause of this phenomenon occurs because Australia's economic sector is different from Chile's. The Australian economy is transforming from a mining exports-intensive industry to a non-mining economy such as manufacturing, services, and tourism (Firstcapital, 2013). Thus, it is heading to high-quality economic development. Also, as Australia's relationship with its trade partners varies, REER is likely to get affected. Meanwhile, Chile's economy is still relying on natural resources' export (CIA, 2021). Furthermore, the lower value of the currency could contribute to an increase in the price of tradable goods, thus increasing profit and enhancing economic growth (Morvillier, 2020). Therefore, although REER value change in Chile will only slightly affect its labor productivity because their infrastructure and facility required to increase it have already been created. Thus, causing their labor productivity and REER to have little correlation.

In the given period, Iceland experienced a negative correlation between REER and Labor productivity. In the calculation to obtain labor productivity, we are required to use GDP divided by the total hour worked (Ohanian, 2012). Because we used constant GDP, it will create a phenomenon where their labor productivity will remain relatively stable at around $50 since 2010. On the other hand, REER is increasing from year to year as their economy becomes stronger due to increased purchasing power, as shown in the third panel of Figure 1.

Japan also experienced a negative correlation between REER and Labor productivity. According to the Pearson's correlation test, Japan has a -0.78 value this was due to Japan's economic structure. By 2017, 30.1% of their GDP is attributed to their industrial sector (CIA, 2021). Thus, as the REER value decreases, it is shown to improve their labor productivity by a large margin. This occurs because the decrease in REER created a condition where its currency becomes more valuable and competitive. Because higher REER implies more expensive exports (IMF, 2021), it is not a good indicator for a country that heavily relies on industrial exports.

Meanwhile, in the USA, whose 80.2% of economy relying on services, around 70% of its GDP comes from internal consumption (UNCTAD, 2021). Thus, resulting in an economy that is highly independent and resilient. Therefore, resulting in a very low correlation between REER and labor productivity.

4.2 Middle-High-Income Economies

In this section, the first group that will be discussed is the one that revealed a positive correlation between REER and labor productivity, and the second group comprises the countries revealing negative correlation.

All three countries that have experienced a positive correlation between labor productivity and REER are mainly the industrial countries from the developing world. What sets apart the industrialized developing countries from their much-developed counterparts is the drastic changes in economic policies and productive structures, which are potentially affected by REER (Jeanneney & Hua, 2011). Furthermore, the optimization of REER in these countries was intended to control industrial production and capital intensity which also affects foreign direct investment that is crucial to the country's growth and development. Thus, Pearson's correlation test has only revealed the historical truth. Moreover, it is important to note that the effect that occurs in each country will also act differently based on the size of the economy. For instance, the Chinese economy showed the most extreme scenario where REER was highly correlated with the economy labor productivity. One may attribute this extraordinary behavior to the role of state planning in economic development. Also, we know that China's economy highly relies on processing trade and exports (Javed *et al.*, 2021). Neverthless, as discussed earlier in the case of Japan, higher REER may result in more expensive export.

Table 2. Statistical analysis of middle-high-income economies

Countries	Regression Equation	R^2	Pearson's Correlation coefficient
Brazil	y = 6.4853 + 0.0947x	0.1675	0.4093
Bulgaria	y = - 6.0799 + 0.2576x	0.4132	0.6428
China	y = - 6.3256 + 0.1333x	0.9145	0.9562
Malaysia	y = 26.037 - 0.0744x	0.0276	-0.1662
South Africa	y = 20.409 - 0.042x	0.2107	-0.4590
y = labor productivity, x = Real Effective Exchange Rate			

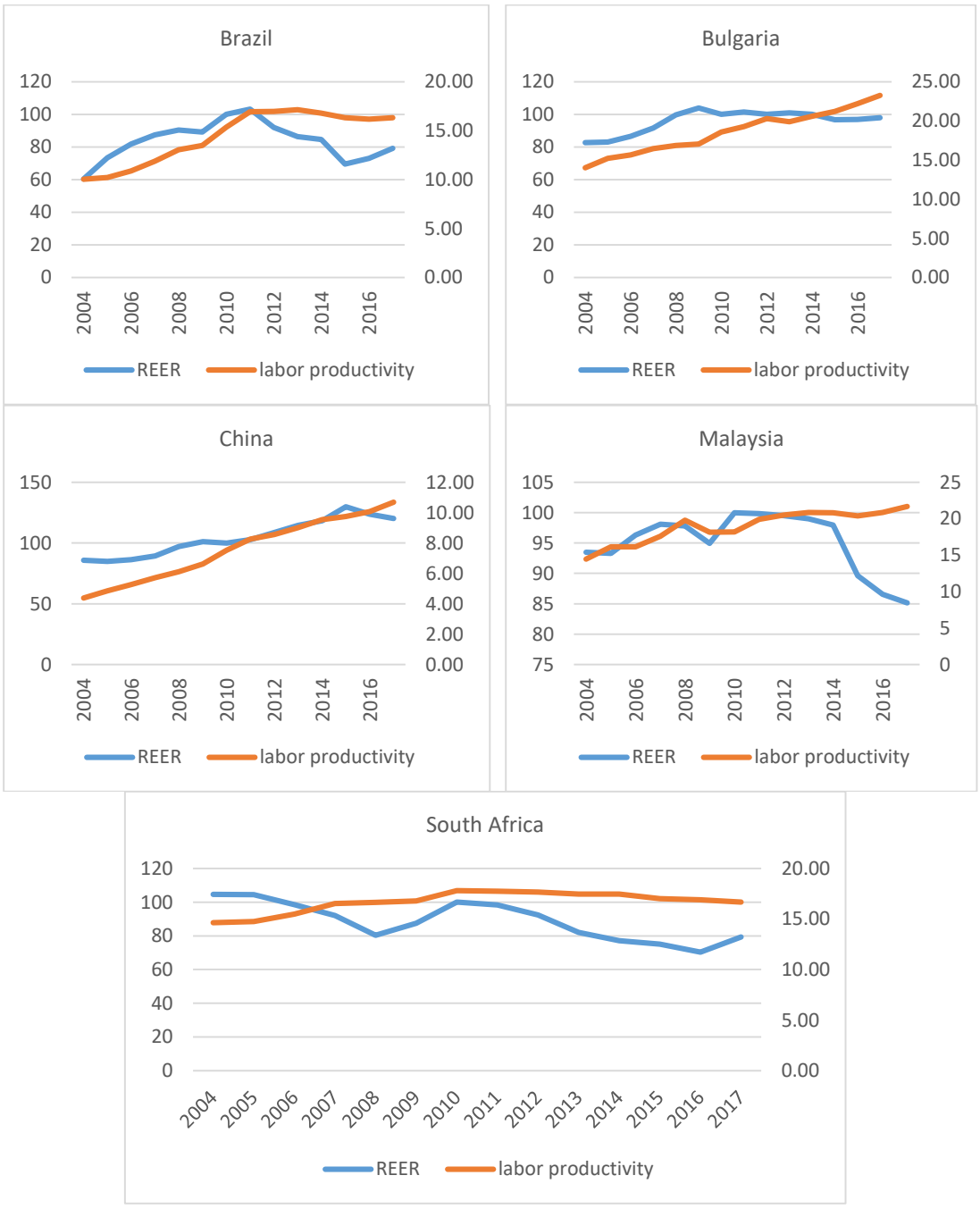

Figure 2. Labor productivity and REER of middle-high-income economies

However, the positive developments that these developing countries experienced outweigh the loss that higher REER may have bought to their economies. Because higher REER can also indicate that the country might be experiencing stable policymaking, their economic outlook healthier and attractive for the investors (Yousaf *et al.*, 2011) thus, the behavior exhibited by China is not strange but interesting.

Although considered a developing country, the Malaysian economy is highly diversified and advanced compared to the other developing country in the region and is one of the most competitive economies in the world, with the rank of 27th (Schwab, 2018). Moreover, the economic growth that Malaysia experiences are less likely to slow down anytime soon. Morvillier (2020) showed that undervaluation of one's currency could cause an increase in the overall price, and in turn, increases profit margins, thus encouraging investments, and as a result, positively influence economic growth. It is a good sign for the overall economy in the long run. The Malaysian situation, as shown in the fourth panel of Figure 2, can be a manifestation of this cycle of positive effects in Malaysia.

Different from the other countries on our list, the South African economy is still highly relying on mineral exports. Thus, the South African economy needs to have a low value of REER to increase the volume of an exported resource. Since the increase in REER may also contribute to higher prices and more expensive products (IMF, 2021), South Africa's economy can perform better by keeping its REER low. However, from the above findings, a question comes to mind that why even within one group of countries, the relations between REER and labor productivity are inconsistent? We know that the socio-economical needs vary from one country to another, and so do the priorities of the policy-makers in these countries therefore, it is very reasonable to believe that a framework comprising only two factors is insufficient to report consistent relationships among different countries. A multivariate framework, guided by large historic data, is needed in the future to better answer this question.

5. Conclusion and recommendations

Labor productivity can help us determine the economic and technological conditions within an economy. Higher labor productivity value can show the quality of labor, availability of infrastructure, competitiveness inside the country. Furthermore, according to the current study's findings, we can conclude that labor productivity correlates with the Real Effective Exchange Rate (REER). Moreover, each country may have a different degree and type of correlation because each country has a unique source of income, economic drivers, technologies and quality of labor. At this stage it is difficult to propose a conclusive generalized hypothesis.

It is important for policymakers to optimize the REER based on the needs and capabilities. As it can both positively and negatively affect the growth of labor productivity, hence monitoring and controlling REER can be difficult and if not handled correctly, it can adversely affect labor productivity. Therefore, managing REER is extremely important for overall economic growth.

In the current study, we could not obtain the labor productivity data with dynamic GDP thus, we resorted to constant GDP-based labor productivity. In future studies, the actual GDP value for each year can be considered. Also, why different countries showed different degrees of correlation and different types of relationships (direct/inverse) are some questions needed to be answered in the future. Also, because of the limited data, low-income economies were not studied, thus leaving behind a space for future investigators. The study involved only two variables, in the future, more variables can be considered before making any generalized assumption.

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Forecasting the Demand of Oil in Ghana: A Statistical Approach

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Abstract: Oil plays a vital role in the economic growth and sustainability of industries and their corporations. The current study sought to forecast oil demand in Ghana for the next decade. The variables analyzed in this study were Petroleum and other liquids, motor gasoline, distillate fuel, and liquefied petroleum gases (LPG). The study utilized three univariate models; thus, linear regression, exponential regression, and exponential smoothing for forecasting various oil components. The linear regression model was deemed a better fit for the analysis of most of the variables. Furthermore, the findings revealed that the LPG growth rate is faster and requires less time to double in numbers than the other energy sources. Also, the exponential smoothing model was ineffective and inefficient. Overall, the demand for oil components analyzed will follow an increasing pattern from 2017 to 2027.

Keywords: Forecasting; Oil demand; Oil consumption; Energy; Ghana Africa

1. Introduction

Merchants and dealers involved in the oil markets view global oil demand and its output forecasts as essential instruments. Speculative and non-quantifiable variables have essential roles in evaluating short-run price fluctuations on the spot and in future markets. Oil prices escalating will lead to oil-consuming nations' economic contraction and inflation, adversely affecting the world economy. Otherwise, a sharp drop in oil price might preclude the economic growth of the countries producing oil and thus create political turmoil and civil upheaval (Chen *et al.*, 2018).

Developing countries like Ghana, Nigeria, Ivory Coast, among others, sometimes struggle to meet the demands of their citizens, and oil is a clear example of it. Bourgeois and technical components that affected each end energy category over the past decade have increased Ghana's demand for crude oil and refined petroleum products. Ghana's oil consumption has increased substantially, and this has shaken many energy experts. The function of energy resources in satisfying, among others, the needs of households, factories, transportation, and agriculture in any economy cannot be overplayed.

Multiple forms of energy sources are needed to meet the demand for lighting, cooking, generating electricity, among many other uses. Ghana's energy demand exceeds energy supply (Mensah *et al.*, 2016). In Ghana's energy sector, light crude oil is the main energy source that powers the electricity output of thermal plants, apart from natural gas. As a multifunctional energy source heavily consumed in most countries, the oil helps multiple sectors of an economy. Due to it being a very significant form of energy for all economies, oil production and consumption are inextricably related to industrialization, sustainable development and economic growth.

In 2016, the government of Ghana decided to launch a new policy which stated one district, one factory. With such expansion and development, the country will be aiming at growing its economy. Still, the demand for oil will increase due to the industrialization tactics being adopted to implement such a policy. With the amount of oil consumed significantly increasing and thus affecting the economic growth of Ghana in the process, the data from the US EIA International Energy Statistics database shows that there have been some variations in oil consumption values in Ghana since 2003 (see Figure 1).

From Figure 1, Petroleum and Other Liquid consumption reached its highest peak in 2017 with an amount of 88TBPD (Total Barrels Per Day) and its lowest peak of 39TBPD in 2003. Motor Gasoline consumption can also be seen experiencing variations in its values, reaching its highest peaks of 27TBPD in 2013, 2015 and 2017. Jet Fuel consumption, Residual Fuel Oil consumption and Liquefied Petroleum Gases consumption (LPG) also reached their highest peak in 2017 with values of 4TBPD, 2TBPD, and 9TBPD, respectively. Kerosene consumption, Distillate Fuel Oil consumption, and Other Refined Products consumption also had recorded values of 3.6TBPD, 39TBPD and 14TBPD, respectively, as their highest peak in the years 2008, 2015 and 2016, respectively.

This study aims to forecast oil demand in Ghana for the next ten years, taking into account the intensifying nature of oil demand in Ghana. To examine the amount of oil consumed in Ghana annually and estimate the dynamics of the various types of oil that influence the aggregate oil demand in Ghana are the key objectives operationalized from the main aim of this study. The subsequent sections of this study are arranged as follows: Section 2 delves into the literature review highlighting underlying concepts used to perform this study. Section 3 outlines the research methodology and approach, whilst sections 4 and 5 deals with results and discussions and, finally, the study concludes with recommendations.

2. Literature Review

Underlying works of literature that form the basis for conducting this research are discussed in this section. The section describes the strengths and shortcomings of current literature based on the role of oil in the energy sector in Ghana and oil forecasting, with key influencing factors affecting oil and its demand in general.

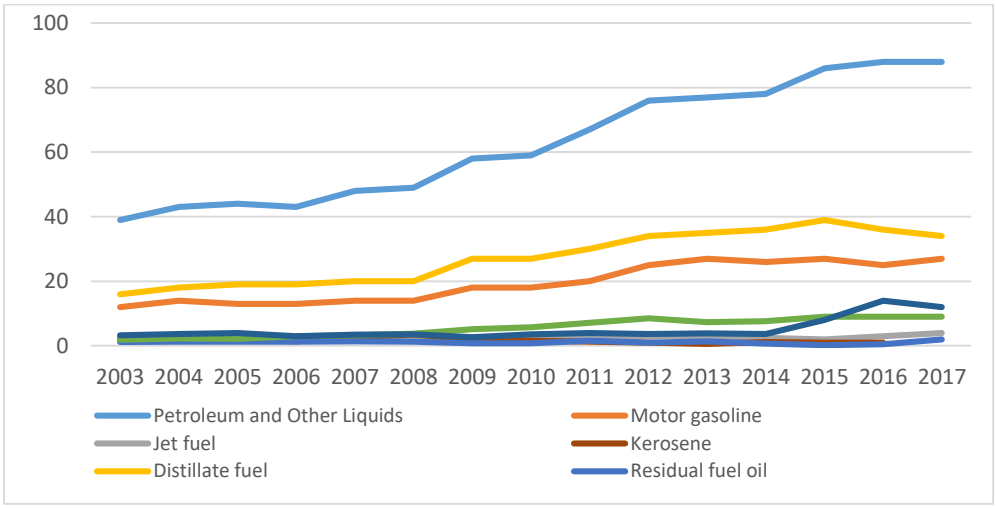
2.1 The role of oil in Ghana's energy sector

"Supply chains are the veins of an economy" (Mahmoudi *et al.*, 2021), and the energy sector enables the smooth flow of supply in these veins. According to the world's economic and human development indicators (HDI), the energy sector is a crucial component that drives economic growth and development. The production and usage of oil can accelerate or impede economic growth as an essential economic element. Over the last decade, oil demand has risen all over the world, leading to high prices.

Between 1980 and 2008, the price of crude oil fluctuated dramatically, with an average price of $32.31 (bbl), a minimum price of $12.72 (bbl) and a maximum price of $140 (bbl) respectively (Abledu *et al.*, 2013). A host of academic studies like that of Richardson *et al.* (2010), and Zhang *et al.* (2013) delved into the increasing rate of energy demands or consumption for both developed and least developed countries. The studies, as mentioned above, highlighted key determinants or indicators that culminate into total consumption or extrapolated elements of various energy forms.

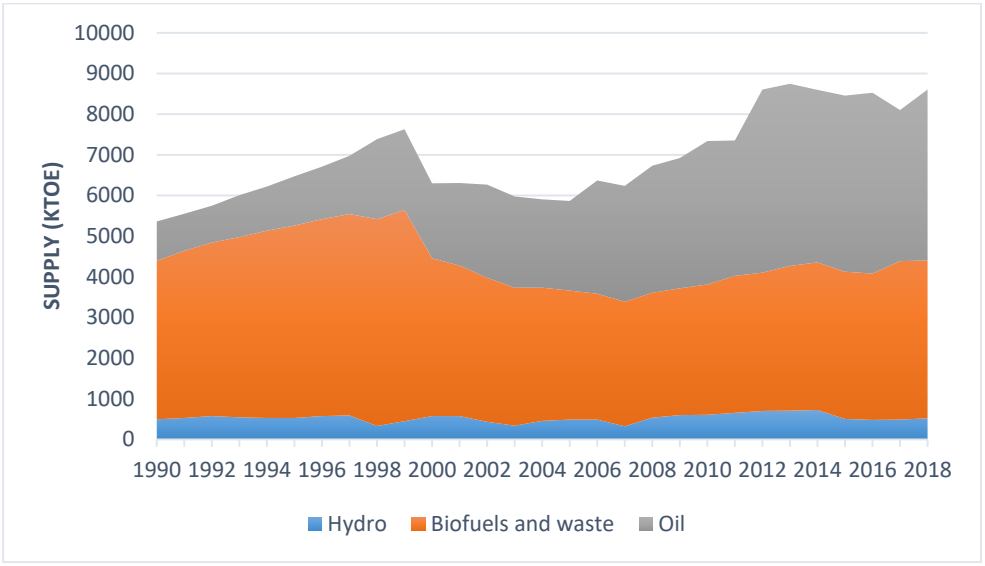
Ghana discovered oil in the year 2007. In 2010, the country began exploiting this resource, and the country has realized its long-standing dream of improving its socio-economic growth with oil revenues through subsequent discoveries. Ghana's energy sector has been prominent in numerous government policies, such as initiatives to attain sustainable energy use to minimize the environmental impact, increase access to new energy sources, and make energy products accessible and inexpensive for Ghanaians (Mensah *et al.*, 2016). A study by Ackah (2014) found that demand for natural gas is primarily driven by income, population, prices, and industrial production share when it modelled Ghana's aggregate residential and industrial demand for natural gas. But the the oil demand was not studied.

High growth rates of economic production and personal income are closely linked to the changing oil requirements in Ghana. Increased demand for petrochemical feedstock, including naphtha-based petrochemicals, which are close in composition to motor gasoline, drives the growth in production in the industrial sector (Abledu *et al.*, 2013). Duku *et al.* (2011) noted that Ghana's energy consumption had increased significantly due to population growth and rapid urban growth. A continuing



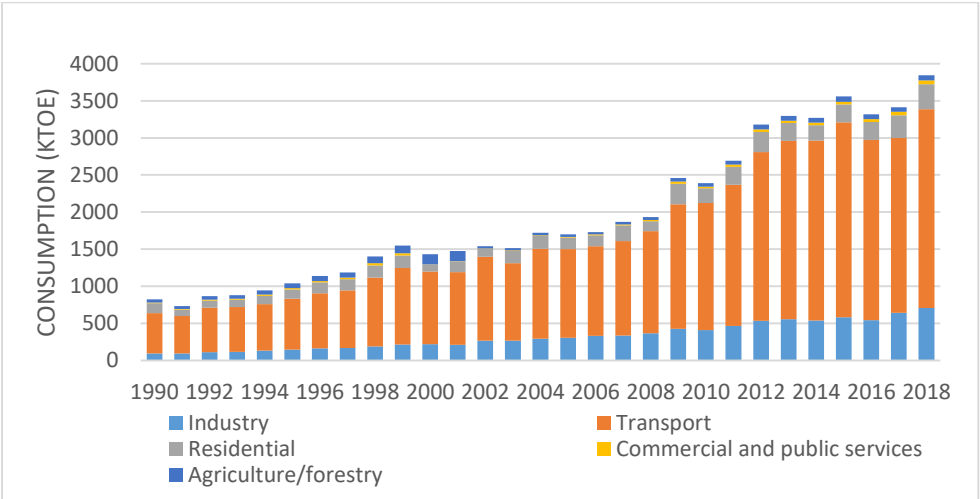
Data source: International Energy Statistics, US EIA database
Graph source: Author's Construct

Figure 1. Ghana's annual oil consumption between 2003 and 2017



Data source: International Energy Agency (IEA), 2020
Graph source: Author's Construct

Figure 2. Ghana's energy supply between 1990 and 2018



Data source: International Energy Agency (IEA), 2020
Graph source: Author's Construct

Figure 3. Ghana's oil consumption by sectors between 1990 and 2018

demographic shift from rural to urban areas drives the increase in incomes and the resulting changes in oil demand. The rising urban population demands new vehicles and highways, thus increasing the demand for oil in the transport sector.

2.2 Oil Forecasting

The significance of the energy sector and energy forecasts has not been sufficiently addressed for the countries like Ghana. A vast amount of literature has been written about oil, determining the key variables that affect it. Some of this literature takes a toll on forecasting the aggregate demand, whereas some adopt the disaggregate demand for exploration. In empirical research, approaches based on the ex-ante best individual forecasting model are effective, but on average, forecast combinations have been found to generate effective forecasts (Timmermann, 2006).

Forecasting of oil demand and supply plays an essential role in a country's development agenda. Several models have been used in the existing literature by several scholars, researchers and organizations to make short, medium, and long-term projections. Notwithstanding these, there is no specific forecasting model assigned to forecasters. However, some researchers commonly use some existing standard forecasting models to make projections that have yielded the needed results. Hence, standard forecasting models could be selected based on a researcher's objectives and the results the researcher seeks to achieve. Such instances include Li *et al.* (2018) who developed 26 combination models using the traditional combination method to avoid overfitting and increase prediction accuracy. Furthermore, Wang *et al.* (2011) used the Hubbert and Generalized Weng models to provide them with the basis for the empirical analysis of the variable they analyzed in their study. Also, Carlevaro *et al.* (1989) modelled and forecasted the world demand for oil on a regional basis in the short – run using a dynamic demand model. They concluded that their model deserved more changes to generate valuable forecasts for the oil industry. As such, several existing forecasting models require further revision.

Owing to the fact that some unaccounted factors interfere with the actual values of oil, during forecasting based on historical data, the actual value sometimes varies from the forecasted value. Comparing the forecasted value with the actual value produces the measured error if there's any. Therefore, some studies proposed that the mean absolute scaled error should be the standard accuracy measure for comparing forecast accuracy over collective time series. To confirm the effectiveness of their approach, Wang *et al.* (2018) evaluated their models using mean absolute error (MAE), mean absolute percentage error (MAPE), and root mean square error (RMSE).

Table 1. Summary of oil forecast related literature

Year	Country of focus	Variable of forecast	Methodology	Literature
2009	United States, Canada, Japan, Australia	Oil consumption	flexible fuzzy regression algorithm	Azadeh *et al.* (2009)
2009	Global	Oil production	Probabilistic estimate	Kontorovich (2009)
2009	China	Transport energy demand	PLSR	Zhang *et al.* (2009)
2012	China	Petroleum product consumption	Bayesian linear regression theory and MCMC	Chai *et al.* (2012)
2012	Iran	Transport energy demand	MLGP	Forouzanfar *et al.* (2012)
2013	Global	Oil demand	STSM	Suleiman (2013)
2015	Nigeria	Oil production	M.A., SES, AF, Box-Jenkings, Classical Decomposition	Aideyan & Nima (2015)
2015	OPEC	Oil production	Multi–cyclic Hubbert Model	Ebrahimi & Ghasabani (2015)
2015	U.K., Norway	Oil production	Monte – Carlo method	Fiévet *et al.* (2015)
2019	China	Oil demand	STSM	Fatima *et al.* (2019)
2019	India	Foreign oil	NMGM-ARIMA and NMGM-BP	Li & Wang (2019)
2021	Ghana	Oil demand	LR, ER and ETS	The current study

PLSR partial least square regression, M.A. moving average, SES seasonal exponential smoothing, A.F. adaptive filtering, MCMC Markov Chain Monte Carlo method, MLGP multi-level genetic programming, STSM structural time series model, NMGM-ARIMA nonlinear metabolic grey model – linear autoregressive integrated moving average and NMGM-BP nonlinear metabolic grey model - nonlinear backpropagation, LR Linear regression, ER exponential regression, ETS exponential smoothing

Cheze *et al.* (2011) forecasted jet fuel consumption at the worldwide level and eight geographical zones by 2025 using dynamic panel–data econometrics. Their findings revealed that between 2008 and 2025, the world's air traffic would increase by 100%, with a growth rate of 4.7% annually. Moreover, the estimated demand of the world for jet fuel will increase by approximately 38%, with an average growth rate of 1.9% annually. Al-Yousef (2004), in his study, proposed a model to predict crude oil consumption for some Asian countries over the period 1982 – 2002. He concluded that GDP and price are important factors in oil demand. He also added that growth in GDP is an important element in the growth or fall in Asian countries' demand for crude oil. Due to briefness, table 1 contains other studies conducted by researchers about the forecasting of oil.

3. Research Methodology

This section focuses on the methodology and approach adopted in the current study for forecasting the demand for oil in Ghana for the next decade based on time series data. The study adopted three univariate models; linear regression model, exponential regression model, and exponential smoothing model. Microsoft Excel (2016 version) was used to run the models.

3.1 Data collection

The bp Statistical Review of World Energy (BP, 2020) ranked oil as the largest share of the energy mix, accounting for 33.1% and perhaps being a dominant economic growth tool in Africa. It also recorded 4096 thousand barrels per day as the consumption of oil in the whole of Africa. The current study sampled 15 years (2003 to 2017) time-series data of Ghana's annual oil consumption. Data from 2003 to 2015 was used for forecasting, and the 2016-2017 data was used for out-of-sample testing. The four energy sources were considered for forecasting; petroleum and other liquids, motor gasoline, distillate fuel oil, and liquefied petroleum gas (LPG). The oil consumption data set was gathered from the U.S. Energy Information Administration (www.eia.gov).

For the study to gain an insight into the vast reach of oil in Ghana, data pertaining to Ghana's energy sector for the period 1990 to 2018 were also gathered. Ghana's energy supply and Ghana's oil consumption by sectors data were obtained from the International Energy Agency (www.iea.org) for this exploration. Data availability was the justification for choosing the period (1990 to 2018).

3.2 Forecasting Techniques

Descriptively, forecasting is carried out by testing time series data with a developed model or applying technical approaches. Over specific periods, distinct models have been tried to predict data, and accurate calculations are needed to determine the accuracy of such models. Time series models used for forecasting can be classified into univariate and multivariate models (Tularam & Saeed 2016). In order to predict the values of a variable that acts as a response variable, univariate data analysis involves the use of past data and involves a distinct evaluation of the findings for each variable in the given data. Thus, the univariate analysis does not find the causation or correlation relationship between independent variables. This study adopted the univariate models, namely; linear regression models, exponential models and exponential smoothing models, for forecasting oil demand in Ghana for a decade. These models were selected due to (1) they are a widely used form of forecasting and (2) the characteristics the data used in this study possess.

3.2.1 Linear regression model. A linear regression (LR) model is a simple yet widely used form of forecasting. The model forms a linear relationship between the forecast variable F and the single explanatory variable Y. In order to analyze the relationship between the variables, the model is defined as:

$$F_t = \beta_0 + \beta_1 Y_t + \varepsilon$$

where,

β_0 = the intercept

β_1 = the slope of the line

F_t = forecasted value for year t

Y_t = Year t

ε = the error term

The intercept β_0 represents the forecasted value of F_t when the explanatory variable (Y_t)= 0. And the slope of the line β_1 represents the average predicted change in the forecasted value F_t resulting from a one-unit increase or decrease in the explanatory variable Y_t. For further details, Sarstedt and Mooi (2014) can be consulted. In the current study, Microsoft Excel's built-in function was used for linear regression.

3.2.2 Exponential regression model. An exponential regression (ER) model is a nonlinear form of a regression model. It is used to model data that does not follow a linear pattern. Exponential regression is used to predict conditions in which development starts slowly and then elevates quickly without bounds or where decay begins speedily and then slows down to get closer and closer to zero. The model is developed as follows:

$$F_t = \beta_0 e^{\beta_1 Y_t} + \varepsilon$$

where,

F_t = forecasted value for year t

Y_t = Year t.

The coefficients β_0 and β_1 are obtained from the graph (data). For further details, Davidov and Zelen (2000) can be consulted. In the current study, Microsoft Excel's built-in function was used for exponential regression.

3.2.3 Exponential Smoothing technique. The exponential smoothing model was first suggested in the late 1950s. This approach is acceptable for forecasting data without a specific trend or seasonal pattern. The exponential smoothing model developed to examine the data is specified as:

$$L_0 = \frac{1}{n}\sum_{t=1}^{n} D_t$$

$$F_{t+1} = L_t$$

$$L_{t+1} = \alpha D_{t+1} + (1-\alpha)L_t$$

where,

n = number of years

D_t = actual demand at year t

D_{t+1} = current year's actual demand

L_0 = forecast demand for year 1

L_t = previous year's forecast demand

L_{t+1}= current year's forecast demand

α = smoothing constant; $0 < \alpha < 1$.

For further details, Chopra and Meindl (2015: Chapter 7) can be consulted. Microsoft Excel's built-in function for exponential triple smoothing (ETS) was used in the current study.

Table 2. Forecasting the consumption of petroleum and other liquids

Year	*Actual data*	*LR*	*ER*	*ETS*	*Cumulative*	*RGR*	*RGR (mean)*	*Dt*	*Dt (mean)*
2003	39	34.83	35.28	47.09	39	-			
2004	43	38.88	37.79	50.24	82	0.74	0.25	0.99	2.25
2005	44	42.92	40.48	53.38	126	0.43		1.54	
2006	43	46.96	43.37	56.52	169	0.29		1.92	
2007	48	51.01	46.46	59.66	217	0.25		2.08	
2008	49	55.05	49.77	62.81	266	0.20		2.28	
2009	58	59.10	53.31	65.95	324	0.20		2.32	
2010	59	63.14	57.11	69.09	383	0.17		2.48	
2011	67	67.18	61.17	72.23	450	0.16		2.52	
2012	76	71.23	65.53	75.38	526	0.16		2.55	
2013	77	75.27	70.20	78.52	603	0.14		2.68	
2014	78	79.32	75.20	81.66	681	0.12		2.80	
2015	86	83.36	80.55	84.80	767	0.12		2.82	
2016	88	87.40	86.29	87.95	87.40	-		-	
2017	88	91.45	92.44	91.09	178.85	0.72	0.25	1.03	2.28
2018		95.49	99.02	94.23	274.34	0.43		1.54	
2019		99.54	106.07	97.37	373.88	0.31		1.87	
2020		103.58	113.63	100.52	477.46	0.24		2.10	
2021		107.62	121.72	103.66	585.08	0.20		2.29	
2022		111.67	130.39	106.80	696.75	0.17		2.44	
2023		115.71	139.67	109.94	812.46	0.15		2.57	
2024		119.76	149.62	113.09	932.22	0.14		2.68	
2025		123.80	160.28	116.23	1056.02	0.12		2.78	
2026		127.84	171.69	119.37	1183.86	0.11		2.86	
2027		131.89	183.92	122.51	1315.75	0.11		2.94	
MAPE (%) in- sample		5.62	6.75	14.64					
MAPE (%) out-of-sample		2.30	3.49	1.79					

NOTE: Actual data (2003 – 2015) and LR-based data (2016 – 2027) were used for the cumulative estimations.

3.3 Forecast Error Measurement

It has been widely recognized that forecasts are always inaccurate. Therefore, they should be accompanied by both the expected value of the forecast and a measure of forecast error (Javed *et al.*, 2020b; Ofosu-Adarkwa *et al.*, 2020). Following Javed *et al.* (2020a), the Mean Absolute Percentage Error (MAPE) was used to test the performance of the forecasting techniques. The MAPE formula is denoted by:

$$MAPE(\%) = \frac{1}{n}\sum_{k=1}^{n}\left|\frac{x(k) - \hat{x}(k)}{x(k)}\right| \times 100\%$$

where,
$x(k)$ = actual values
$\hat{x}(k)$ = simulated values
n = number of years.

Table 3. Forecasting the consumption of motor gasoline

Year	*Actual data*	*LR*	*ER*	*ETS*	*Cumulative*	*RGR*	*RGR (mean)*	*Dt*	*Dt (mean)*
2003	12	10.05	10.59	28.25	12	-			
2004	14	11.47	11.42	28.25	26	0.77	0.25	0.95	2.24
2005	13	12.89	12.32	28.25	39	0.41		1.60	
2006	13	14.31	13.29	28.25	52	0.29		1.94	
2007	14	15.72	14.34	28.25	66	0.24		2.13	
2008	14	17.14	15.47	28.24	80	0.19		2.34	
2009	18	18.56	16.69	28.24	98	0.20		2.29	
2010	18	19.98	18.01	28.24	116	0.17		2.47	
2011	20	21.39	19.43	28.24	136	0.16		2.53	
2012	25	22.81	20.96	28.24	161	0.17		2.47	
2013	27	24.23	22.62	28.24	188	0.16		2.56	
2014	26	25.65	24.40	28.24	214	0.13		2.74	
2015	27	27.06	26.32	28.24	241	0.12		2.82	
2016	25	28.48	28.40	28.24	28.40	-		-	
2017	27	29.90	30.64	28.23	59.04	0.73	0.27	1.01	2.17
2018		31.32	33.05	28.23	92.09	0.44		1.50	
2019		32.73	35.66	28.23	127.75	0.33		1.81	
2020		34.15	38.47	28.23	166.23	0.26		2.03	
2021		35.57	41.51	28.23	207.74	0.22		2.19	
2022		36.99	44.78	28.23	252.52	0.20		2.33	
2023		38.40	48.31	28.23	300.83	0.18		2.44	
2024		39.82	52.12	28.23	352.95	0.16		2.53	
2025		41.24	56.23	28.23	409.18	0.15		2.60	
2026		42.66	60.67	28.22	469.84	0.14		2.67	
2027		44.08	65.45	28.22	535.29	0.13		2.73	
MAPE (%) in- sample		9.35	7.83	66.23					
MAPE (%) out-of-sample		12.33	13.54	8.76					

NOTE: Actual data (2003 – 2015) and ER-based data (2016 – 2027) were used for the cumulative estimations.

The Lewis scale (Javed *et al.*, 2020a) was used for interpreting the MAPE values:

$$MAPE(\%) = \begin{cases} < 10 & Highly\ accurate\ forecast \\ 10{\sim}20 & Good\ forecast \\ 20{\sim}50 & Reasonable\ forecast \\ > 50 & Inaccurate\ forecast \end{cases}$$

3.4 Growth Rate and Doubling Time Analyses

Growth rate and doubling time analyses make forecasts more useful for decision-makers. The expression for the relative growth rate (RGR) and doubling time (D_t) are given by (Javed & Liu, 2018; Quartey-Papafio *et al.*, 2020):

$$RGR = (lnN_2 - lnN_1)/(t_2 - t_1)$$

Since in our study $t_2 - t_1$ is one, the equation is further deduced to:

$$RGR = ln(N_2/N_1)$$

Table 4. Forecasting the consumption of distillate fuel

Year	*Actual data*	*LR*	*ER*	*ETS*	*Cumulative*	*RGR*	*RGR (mean)*	*Dt*	*Dt (mean)*
2003	16	14.20	15.66	14.84	16.00	-			
2004	18	16.20	16.92	16.84	34.00	0.75	0.25	0.98	2.22
2005	19	18.20	18.28	18.83	53.00	0.44		1.51	
2006	19	20.20	19.76	20.83	72.00	0.31		1.88	
2007	20	22.20	21.35	22.83	92.00	0.25		2.10	
2008	20	24.20	23.07	24.83	112.00	0.20		2.32	
2009	27	26.20	24.93	26.83	139.00	0.22		2.23	
2010	27	28.20	26.94	28.83	166.00	0.18		2.42	
2011	30	30.20	29.11	30.83	196.00	0.17		2.49	
2012	34	32.20	31.46	32.82	230.00	0.16		2.53	
2013	35	34.20	33.99	34.82	265.00	0.14		2.65	
2014	36	36.20	36.73	36.82	301.00	0.13		2.75	
2015	39	38.20	39.69	38.82	340.00	0.12		2.80	
2016	36	40.20	42.89	40.82	40.20	-		-	
2017	34	42.20	46.34	42.82	82.40	0.72	0.25	1.02	2.27
2018		44.20	50.08	44.81	126.60	0.43		1.54	
2019		46.20	54.11	46.81	172.80	0.31		1.86	
2020		48.20	58.47	48.81	221.00	0.25		2.10	
2021		50.20	63.18	50.81	271.20	0.20		2.28	
2022		52.20	68.28	52.81	323.40	0.18		2.43	
2023		54.20	73.78	54.81	377.60	0.15		2.56	
2024		56.20	79.72	56.81	433.80	0.14		2.67	
2025		58.20	86.15	58.80	492.00	0.13		2.77	
2026		60.20	93.09	60.80	552.20	0.12		2.85	
2027		62.20	100.59	62.80	614.40	0.11		2.93	
MAPE (%) in- sample		6.31	4.85	6.11					
MAPE (%) out-of-sample		17.89	27.72	19.66					

NOTE: Actual data (2003 – 2015) and LR-based data (2016 – 2027) were used for the cumulative estimations. LR seemed better than ER due to the big difference in their out-of-sample error.

The time needed for the variables analyzed to double in numbers for a given RGR is measured by the D_t and this is denoted as:

$$D_t = (t_2 - t_1)\ln\left[\frac{2}{lnN_2 - lnN_1}\right]$$

or,

$$D_t = ln(2/RGR)$$

where,

N_2 = analyzed variable's cumulative number in the year t_2

N_1 = analyzed variable's cumulative number in the year t_1

A general assessment of the variations of the different variables between the actual trend and the expected trend is useful but challenging. The traditional RGR and D_t cannot solve the problem, especially when the forecasted trend is different from the historical trend. Javed and Liu (2018) solved this problem by introducing a system for estimating the Synthetic Relative Growth Rate ($RGR_{synthetic}$)

Table 5. Forecasting the consumption of liquefied petroleum gases (LPG)

Year	*Actual data*	*LR*	*ER*	*ETS*	*Cumulative*	*RGR*	*RGR (mean)*	*Dt*	*Dt (mean)*
2003	1.9	1.30	2.02	1.32	1.90	-			
2004	2.3	1.94	2.32	1.95	4.20	0.79	0.30	0.92	2.03
2005	2.2	2.57	2.67	2.59	6.40	0.42		1.56	
2006	3	3.21	3.06	3.22	9.40	0.38		1.65	
2007	3.3	3.84	3.52	3.86	12.70	0.30		1.89	
2008	3.8	4.48	4.04	4.49	16.50	0.26		2.03	
2009	5.2	5.11	4.64	5.12	21.70	0.27		1.99	
2010	5.7	5.75	5.33	5.76	27.40	0.23		2.15	
2011	7.1	6.38	6.12	6.39	34.50	0.23		2.16	
2012	8.5	7.02	7.02	7.03	43.00	0.22		2.21	
2013	7.3	7.65	8.07	7.66	50.30	0.16		2.55	
2014	7.6	8.28	9.26	8.29	57.90	0.14		2.65	
2015	9	8.92	10.64	8.93	66.90	0.14		2.63	
2016	9	9.55	12.21	9.56	9.55	-		-	
2017	9	10.19	14.03	10.20	19.74	0.73	0.25	1.01	2.24
2018		10.82	16.11	10.83	30.56	0.44		1.52	
2019		11.46	18.49	11.46	42.02	0.32		1.84	
2020		12.09	21.24	12.10	54.11	0.25		2.07	
2021		12.73	24.39	12.73	66.84	0.21		2.25	
2022		13.36	28.01	13.37	80.20	0.18		2.40	
2023		14.00	32.16	14.00	94.20	0.16		2.52	
2024		14.63	36.93	14.63	108.83	0.14		2.63	
2025		15.27	42.41	15.27	124.09	0.13		2.72	
2026		15.90	48.70	15.90	139.99	0.12		2.81	
2027		16.53	55.92	16.54	156.53	0.11		2.89	
MAPE (%) in- sample		11.54	10.99	11.56					
MAPE (%) out-of-sample		9.68	45.78	9.77					

NOTE: Actual data (2003 – 2015) and LR-based data (2016 – 2027) were used for the cumulative estimations. LR seemed better than ER due to the big difference in their out-of-sample error.

and Synthetic Doubling Time ($D_{synthetic}$). This approach effectively gives the overall picture of the RGR and D_t. The formulas are given by;

$$RGR_{synthetic} = \theta.(RGR_{actual}) + (1-\theta).RGR_{forecast}$$

$$D_{synthetic} = \theta.(D_{actual}) + (1-\theta).D_{forecast}$$

where,

RGR_{actual} = relative growth rate derived through actual data

$RGR_{forecast}$ = relative growth rate derived through forecasted data

D_{actual} = doubling time derived through actual data

$D_{forecast}$ = relative growth rate derived through forecasted data

θ = the weighing coefficient, valued at 0.5 in the current study

For further details on relative growth rate and doubling time analyses and their synthetic versions, Javed and Liu (2018) is recommended.

4. Results

Results obtained from analyzing the data used for this study are discussed in this chapter. The data (2003-2017) were analyzed using Microsoft Excel 2016 version software. The periods 2016 and 2017 were used for out-of-sample testing. The linear regression models (LR), exponential regression models (ER) and exponential smoothing models (ETS) were used to forecast for oil demand in Ghana over the next ten years. The results of the analysis are summarized in Tables 2 to 5. The MAPE was estimated to test the accuracy of the models. Relative growth rate (RGR) and doubling time (D_t) were also used to analyze the growth of the variables explored in this study. Furthermore, the Synthetic Relative Growth Rate ($RGR_{synthetic}$) and Synthetic Doubling Time ($D_{synthetic}$) were applied to assess the variations of the different variables between the actual trend and the expected trend.

Table 2 provides the results obtained for the variable Petroleum and other liquids. Both the Linear Regression and Exponential Regression provided highly accurate forecasts based on the MAPE scale adopted for this study. The Linear Regression instead had a higher forecasting accuracy as compared to the other models. The Linear Regression and Exponential Regression models developed for the Petroleum and other liquids variable are $F_t = 4.044Y_t - 8065.3$ and $F_t = 5E - 59e^{0.0688Y_t}$, respectively.

Table 3 provides the results obtained for the variable Motor gasoline. After analyzing the data, the results provided Linear Regression and Exponential Regression models $F_t = 1.4176Y_t - 2829.4$ and $F_t = 1E - 65e^{0.0759Y_t}$, respectively. The application of the ETS model for forecasting was ineffective for this variable. The Exponential Regression instead provided good forecasting results as compared to the other models.

Table 4 provides the results obtained for the variable Distillate fuel. After analyzing the data, the results provided Linear Regression and Exponential Regression models $F_t = 2Y_t - 3991.8$ and $F_t = 6E - 67e^{0.0775Y_t}$, respectively. Although the application of all three of the forecasting models was effective for this variable, Linear Regression seemed better than Exponential Regression in this case because their out-of-sample errors had a big difference.

Table 5 provides the results obtained for the variable Liquefied Petroleum Gasses (LPG). After analyzing the data, the results provided Linear Regression and Exponential Regression models $F_t = 0.6346Y_t - 1269.8$ and $F_t = 1E - 120e^{0.1383Y_t}$, respectively. Based on the comparison made between the three models' MAPE values, Linear Regression seemed better than Exponential Regression in this case because of the vast difference in their out-of-sample errors.

Moreover, the sequence obtained according to the RGR based on the actual data are;

$$\text{Liquified petroleum gases (LPG)}_{0.297} > Distillate\ fuel_{0.255} > Motor\ gasoline_{0.25} > Petroleum\ and\ other\ liquids_{0.248}$$

Moreover, the sequence obtained according to the D_t based on the actual data are;

$$\text{Liquified petroleum gases (LPG)}_{2.033} < Distillate\ fuel_{2.220} < Motor\ Gasoline_{2.236} < Petroleum\ and\ other\ liquids_{2.249}$$

The above RGR and D_t provides insight into the relative growth rate for LPG and Distillate, which is increasing compared to Motor gasoline and Petroleum and other liquids. Furthermore, for a given RGR, LPG and Distillate fuel need less time to double in numbers than Motor gasoline and Petroleum and other liquids.

Also, the sequence obtained for the $RGR_{synthetic}$ are;

$$\text{Liquified petroleum gases (LPG)}_{0.275} > Motor\ Gasoline_{0.258} > Distillate\ fuel_{0.251} > Petroleum\ and\ other\ liquids_{0.247}$$

And the sequence obtained for the $D_{synthetic}$ are;

$$\text{Liquified petroleum gases (LPG)}_{2.2136} < Motor\ Gasoline_{2.201} < Distillate\ fuel_{2.246} < Petroleum\ and\ other\ liquids_{2.264}$$

According to the $RGR_{synthetic}$ LPG's growth rate is increasing faster than Motor Gasoline, Distillate fuel and Petroleum and Other liquids. Furthermore, LPG requires less time to double in numbers according to the $D_{synthetic}$ then the other variables.

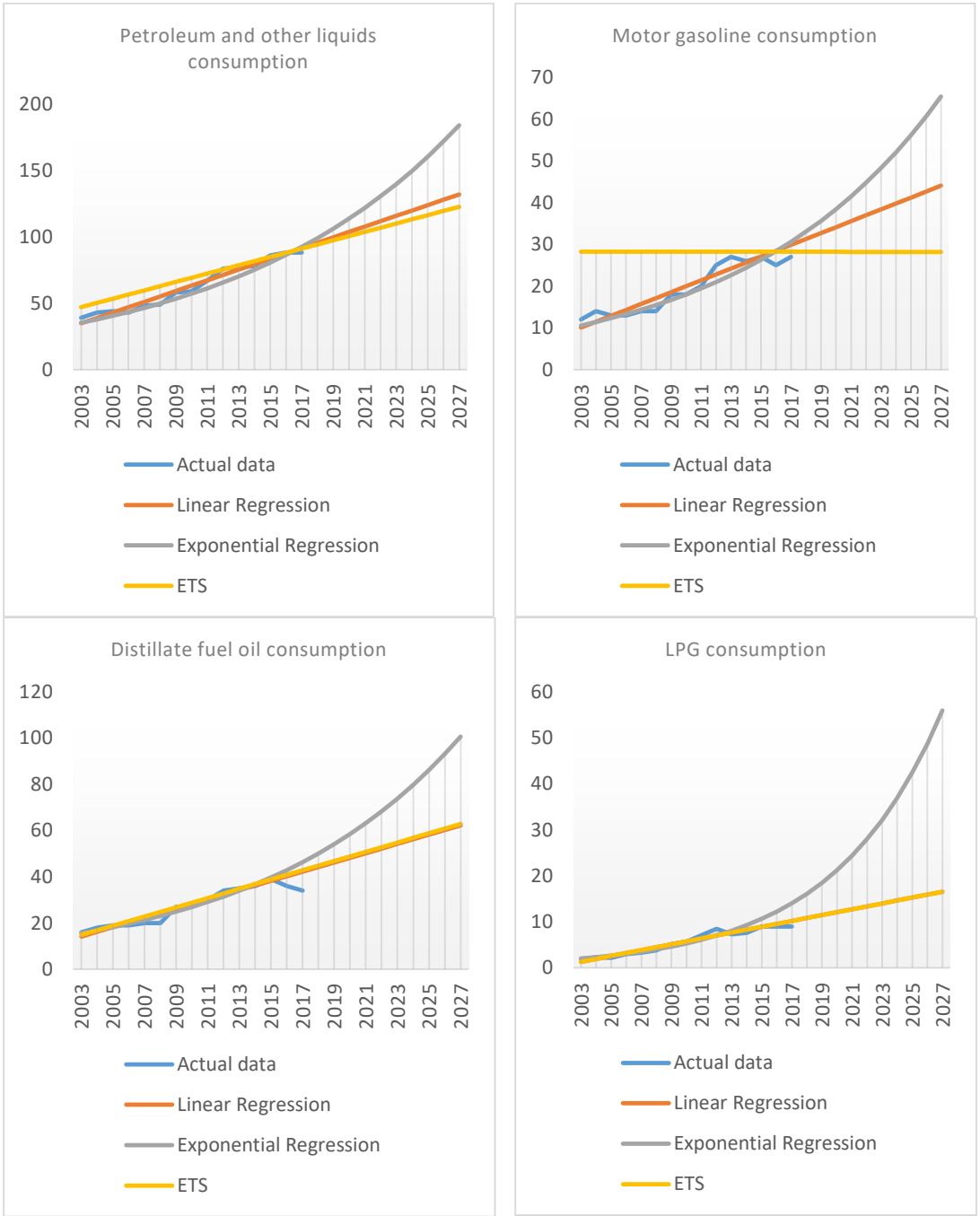


Figure 4. The forecasted values against the actual values (Annual, TBPD)

5. Discussion

Ghana's energy demand surpasses the supply and, as confirmed by BP (2020), oil accounts for a large share of the energy mix and is a dominant economic growth tool in Africa. Considering the intensifying nature of oil demand in Ghana, the current study's objectives were to examine the amount of oil consumed in Ghana and estimate the dynamics of the various types of oil that influence the aggregate oil demand in Ghana. Unlike Ackah (2014), this study focused on forecasting Ghana's oil demand for the next decade. Wang *et al.* (2011) used two typical multicyclic models in forecasting oil, but, by a glance, almost all the analyzed variables' data in this study seem to depict traits of linear trends. In order to test this assumption, the Linear Regression, Exponential Regression, and ETS models were applied.

Oil demand is determined by a variety of factors, including changes in population and income. Findings agree with the results of Duku *et al.* (2011), who in their study revealed that as population or income increases, rapid growth in urbanization occurs. They highlighted how people's behaviour or lifestyle changes when their income levels change. They tend to settle or opt for superior goods instead of inferior goods. For instance, when a person's income increases, they will opt to purchase cars or other automobiles, use flights and other crude oil-related products. Bearing the current economic status per the World Bank or the IMF's economic stratification of countries based on average income levels, considering the country's rapid population growth, Ghana is classified as a lower-middle-income country. The country is expected to depend heavily on oil in various sectors of its economy. Hence, this could affect the country's demand for oil over the next decade. Also, the introduction of Ghana's Single Spine Policy Structure (SSPS) in 2008/2009 as an economic tool and a state policy to enhance salaries of civil servants and other public workers was aimed to improve public workers' income levels. This policy could trickle down economic growth and development, which, in turn, would reduce poverty. Such policies, for instance, go a long way to affect income levels and people's purchasing power, and family sizes (population growth). This change drives the increase in incomes and results in an increase in oil demand.

The oil demand for the variables analyzed and forecasted all followed an increasing trend. By 2027, the oil demand for Petroleum and other liquids will be 131.89TBPD (see Table 2), motor gasoline will be 65.45TBPD (see Table 3), distillate fuel will be 62.20TBPD (see Table 4), and liquefied petroleum gases (LPG) will be 16.53TBPD (see Table 5). This continuous rise in the demand for oil may be attributed to the intent to improve the agricultural and industrial sector through the use of machinery, one district-one factory (industrialization) policy which is now in place, in the transformation of the economy of Ghana from a raw economy into an industrialized economy. An industrialized economy depends mainly on oil. USA and China are clear examples of such economies based on their emission rates and oil demand. If Ghana grows on such tangents, dependence on oil in the next decade and years to come will be high and thus, lead to an increase in the demand for oil.

Residual fuel oil and distillate fuel oil are used in furnaces such as power plants. Currently, residual fuel oil is not as highly utilized in Ghana as other oil components in this study. This assertion might be based on the assumption that; distillate fuel oil is rather used in place of residual oil in the energy sector of Ghana. Ghana's energy sector is highly dependent on thermal and hydroelectric power. In Ghana, T1 and T2 thermal plants in Takoradi, Akosombo hydroelectric, Bui, Karpower badges all depend on crude oil and gas as it stands. Dependence on crude oil and gas would continue in the near future, considering the country's inability to explore other energy options. Solar and nuclear energy are not common due to the cost involved in obtaining solar panels, maintenance, the duration they last for, and technical know-how to manage them.

Applying the Linear Regression, Exponential Regression, and ETS models to the data used in this study provided results, which are ploted in Figure 4. The ETS was highly ineffective and inefficient for most of the variables. Although the ETS on some variables like distillate fuel was deemed a good fit with MAPE (%) of 6.11 (highly accurate forecast based on the MAPE scale), it was somewhat not effective as compared to the other two models (LR and ER). The Linear Regression and Exponential Regression model deemed good fits for some variables, but the Linear Regression fit better in this study. For the distillate fuel and liquefied petroleum gases (LPG), the Linear Regression was chosen over the Exponential Regression due to a big difference in their out-of-sample errors. Thus, regarding distillate fuel, the in-sample error for Linear Regression was 6.31 while that of the Exponential Regression was

4.85. But, their out-of-sample errors were 17.89% and 27.72%, respectively. This study, therefore, confirmed the assumption that almost all the data used in this study depict a linear trend.

6. Conclusion and recommendations

This study focused on forecasting oil demand for the next decade while analyzing the components of oil that influence its aggregate demand in Ghana. The period 2003 to 2017 was chosen due to the availability of data. The univariate models, namely linear regression, exponential regression, and exponential smoothing, were employed to achieve the overall objectives of this study. Among the models employed for the present study, the linear regression model proved to be the most suitable model for forecasting oil demand in Ghana, considering the variables set out for this study. The exponential smoothing model was highly ineffective and inefficient in this study. Furthermore, the production and consumption of oil play a significant role in Ghana's economic growth and development.

The one-district-one factory (industrialization) policy, among other economic policies, when effectively implemented, would validate increasing demand for oil over the next decade, as highlighted in this study. Poor implementation of these policies would somewhat affect the oil demand, as purported in this study. Additionally, variables like kerosene, jet fuel, residual fuel, and other refined products can be included in future studies for analysis. The preliminary investigation found that the accurate forecast of these variables is a big challenge for the three statistical models because of the vast variation in their demand. Thus, better forecasting models such as multivariate grey forecasting models can be used for them in the future. Also, the post-COVID uncertainties can be incorporated in future studies. As the industries, organizations and consumers are heading towards alternative energy and electric vehicles are likely to dominate the automobile industry of the future, how the oil demand would respond to such drastic changes in the market and consumer behaviour is an area that needs further exploration.

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Conceptualizing Supplier Work Passion in light of the Zigarmi's Framework

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Abstract: Similar to other systems, the supply chains are also evolving, and old problems are seeking a new outlook. Work passion is an important concept in human resource management literature, but it rarely sought attention in supply chain management literature in the context of suppliers. By building upon some works by Drea Zigarmi on the employee work passion, the current study makes a pioneering attempt in defining supplier work passion and then conceptualizing it through an eight-dimensional construct. Therefore, a novel framework has been constructed. It is argued that a supplier can be an organization, but it behaves like a passionate individual in its dealing with the buyers. The study is of theoretical and practical significance and is likely to create a new debate in supply chain management on the significance of supplier work passion.

Keywords: Supplier work passion; Business relationship management; Organizational behavior; Supply chain management

1. Introduction

Organizations attempt to recruit the best-fit employees along with enhancing the performance of existing employees (Nawaz et al., 2020). Inline, it would be plausible if organizations recruit passionate employees, which might be imperative to bring the organizational performance upward. Not only organizations but supply chain integration also requires passionate people (McCarter, Fawcett, & Magnan, 2005). Supply chain management (SCM) is a transformative field growing while absorbing ideas from different fields (Mahmoudi *et al.*, 2021; Wieland, 2021). Given that, the classic work of Dauch and Troyanovich (1993) discussed the significance of building teams, Just-In-Time material management, flexible production system, product quality, and work effectively with unions and suppliers. In social psychology, passion is a motivational construct that is domain-specific (Chen *et al.*, 2009). Johri *et al.* (2016) found that the concept of passion has been studied in three different contexts 1) in the context of work, 2) in the context of activities, and 3) in the context of entrepreneurship. Although work passion is relevant for people, it is not irrelevant for organizations.

Perttula (2004) has defined passion for work in the context of work as a psychological state described by a sense of imperative connection towards an individual's work, the experience of strong positive emotions, and an internal drive to work. According to this conceptualization, work passion is a state

consisting of both cognitive and emotional components (meaningful connection and internal drive, joy, and subjective vitality, respectively). Here, a meaningful connection refers to intertwined an individual identity with his/her work. The emotional aspects here deal with a feeling of love towards work, happiness and enjoyment, joy, and other dimensions of work passion. While talking about passion, if an individual does it through the mental process, then that individual becomes passionate about work (Zigarmi *et al.*, 2009). Further, Zigarmi defined work passion as an individual's state of emotionally positivity, persistent state of well-being, affective and cognitive appraisals of various jobs.

Vallerand *et al.* (2003) proposed the most prominent definition of passion in the context of activities as passion is a strong inclination in which individuals invest energy and time, consider it important, and like it as is self-defining activity. Further, they also proposed "obsessive passion (OP) and harmonious passion (HP)" as the two types of passion in the context of activities. These types of passion differ on the basis of personal identity, e.g., self-determination theory (Deci & Ryan, 2000). Obsessive passion typically involves creating an internal pressure, a controlled internalization of activities in individuals' identity to engage in the activities that please them (Vallerand *et al.*, 2003). Whereas, to engage individuals in the activity they like, the autonomous internalization is called harmonious passion (Vallerand *et al.*, 2003).

To define work passion, the emotional component of passion in the context of entrepreneurship has been the focus of academicians, for instance, passion is elaborated as selfish love of work (Shane, Locke & Collins, 2003; Baum & Locke, 2004). Further, Smilor (1997) defined passion as zeal, joy, and enthusiasm that emanate from the vital pursuit of a worthy, challenging, and uplifting purpose. Later making passion a single construct, Cardon *et al.* (2009) provided the concept of entrepreneurial passion by integrating motivational and emotional component. Consequently, entrepreneurial passion is feeling that is defined as "consciously accessible intense positive feelings experienced by engagement in entrepreneurial activities associated with roles that are meaningful and salient to the self-identity of the entrepreneur" (Cardon *et al.*, 2009).

In the disciplines dominated by technologies, techniques, and technical people, it is no wonder "soft" issues are usually overlooked as "hard" issues get most of the attention (Javed *et al.*, 2018). Supply chain management is no exception. Literature is abundant on supplier selection problems and other hard issues related to SCM; however, the soft issues received less attention from scholars and practitioners alike. For instance, Murphy and Smith (2009) recognized the insignificant amount of research dedicated to understanding the suppliers' perspectives. Inline, Jia *et al.* (2014) also recognized the importance of developing theory in this context. Passion has been studied extensively in different industries, from the entertainment industry (Klein, 2007) to the healthcare sector (Luo *et al.*, 2014), to the education sector (Gilal *et al.*, 2019), and the general work environment (Murnieks & Cardon, 2019). However, to the best of our knowledge, the suppliers' work passion has rarely been studied, if ever. The current study attempts to fill this gap by making a pioneering attempt in conceptualizing and defining the supplier work passion.

2. What is work passion, and what isn't?

Based on preceding notions (e.g., Zigarmi *et al.*, 2010), work passion is defined as a person's persistent and emotional state of desire based on cognitive and affective work appraisals that lead to consistent work behaviors and intentions. These consistent behaviors and intentions contain everything from being determined to organizational citizenship behaviors. From the literature (Zigarmi *et al.*, 2009), it is likely that work passion overlaps and also could be interchangeable with different constructs. Nonetheless, we argued about the work passion as it owns distinctive abilities that support its distinctiveness. As a result, we describe the association of work passion with empowerment, intrinsic motivation, job engagement, and other possible consequences. Given that, Conger and Kanungo (1988) defined empowerment as a form of and to improve self-efficacy. Thus, empowerment is deliberated as a cognitive state (related to work passion) that focused on self-perceptions of control and ability.

While talking about emotionality and work passion, emotionality having the elements of liking and well-being, not included in empowerment but has been involved in many thoughts of work passion (Zigarmi *et al.*, 2009). On the other hand, talking about work engagement, Harter *et al.* (2002) made enthusiasm a part of work engagement. Besides, work passion provides encouragement in the form of incentives, which is more proactive and extensive. Extending this argument, we observed that

engagement is too closely associated with the literature of organizational commitment, job involvement, and burnout.

More importantly, from the above discussion, it is easy to say that engagement does not cover the degree of work passion and impact of work passion on individuals. Employees are emotionally focused on activities which they like (Nawaz et al., 2018) and intend to produce favorable responses. However, rather than simply affect, the construct of work passion is more wide-ranging. Affect is not necessarily be associated with organizational activities for which employees are passionate. Thus, affect, compared to passion, has more global feelings of negative or positive emotions. Feelings related to work passion are directed to definite activities such as constructing sales reports and networking. Further, employees may also direct their passion towards certain individuals. Finally, intrinsic motivation refers to pleasure and fulfillment derived from short-term inter-personal task interactions (Ryan & Deci, 2000). Taking the concept of intrinsic motivation, affect, and engagement, the work passion is habitually a self-enhancing state, and hence flattering a stable feature of individuals' identity (Vallerand *et al.*, 2003).

Work passion is highly interrelated to work engagement. In this regard, a number of parameters have been discussed in the literature in which 1) a clear framework is still missing explaining the antecedents and consequences, 2) few common conceptual components have been used by both academicians and practitioners, and 3) convincing evidence were available showing that engagement is a multidimensional construct. Three research implications based on the social cognitive theory of appraisal (SCTA) have been drowned (Zigarmi *et al.*, 2011): 1) to better understand the work passion, the affective aspect of appraisal should be assessed, 2) valuation cognition and intention cognition should be differentiated, and 3) intention and behavior should be differentiated. Besides these parameters, work passion has mainly been neglected to be discussed with the new context of specific employee' category. Furthermore, to the best of our knowledge, the literature also neglected the exploration of organizational work passion, as in certain situations, an "individual" can have characteristics of both an individual and an organization. For instance, a supplier can be an individual or organization. Can we say when a supplier is an individual, it can be passionate about work, but when it is an organization, it cannot be? The literature is silent on such questions.

2.1 Dark side of work passion and its associated outcomes

The bright side of work passion has been linked with positive moods and emotions, including potency and optimism (Zigarmi *et al.*, 2010). However, the dark sides of work passion can be observed when work passion reaches an obsessive or excessively high level (Ho *et al.*, 2011). For instance, uncontrolled rumination is associated with extreme passion and inflexibility (Ratelle *et al.*, 2004; Vallerand *et al.*, 2003). Moreover, passion at its extreme level is associated with aggressive behaviors, including the following aspects: the accumulation of job-related materials, eradicating barriers, and supporting the active detection of goals (Cardon *et al.*, 2009). Thus, when there is high passion in employees, behaviors, and intentions may be considered threatening. Finally, obsessive passion levels may lead to persistence that hinders interpersonal relationships with peers and task completion (Vallerand *et al.*, 2010).

In sum, employees who are just way too into work can easily be identified, they often are shunned by others, and their performance can vary passionately. Thereby, we argue that passion affects the behaviors at large so that how behaviors are internally scripted and externally presented. Research has acknowledged that self-regulation is essential while predicting the failure and success of passion-driven behavior (Lafrenière *et al.*, 2011). Research opportunities associating passion with directories of self-control are challenging yet abundant (Baumeister *et al.*, 2005). In the supply chain context, the dark dimension of work passion is equally important. We can recall many cases (Lewis, 2021, Nix, 2019) where a potential supplier tried to improperly influence a deal or even sued the buyers for not seeking their services. Can we attribute the misconducts in the supplier-buyer relationships to the dark side of supplier work passion?

3. The Proposed Framework of Supplier Work Passion

Drea Zigarmi and colleagues pioneered one of the most refined and well-established frameworks of work passion (Zigarmi *et al.*, 2009), referred to as the Zigarmi's Framework in the current study. By summarizing their point of view, we conclude that the three components such as affect, intentions, and

Table 1. The nine-dimensional construct of the supplier work passion

Dimension	Perceived Meaning
Autonomy	A supplier perceives a business environment where both parties have the tools, training, support, and authority to make selling and buying decisions.
Collaboration	A supplier perceives the environment and culture of the business partnership that improves its collaboration and cooperation with its buyers.
Fairness	A supplier perceives the business environment where revenue, resources, and opportunities are fair and balanced and equitable, and both partners treat each other with respect and as per the commitment.
Growth	A supplier perceives a business environment where it has the opportunity to learn, grow, and develop capabilities that lead to profitability and business growth.
Innovativeness	A supplier perceives a business environment where its work passion could be highly compatible with technological changes and its innovativeness seek out new sources of useful information.
Meaningful work	A supplier perceives the buyers' larger purpose through products and services they buy, considers its services to be worthwhile, and are proud of its contributions and actions that help the buyers serve their customers.
Recognition	A supplier perceives a business environment where it is recognized and appreciated by the buyers for its extraordinary contributions, where it receives future orders for these contributions, and where it is contributing to positive relationship with the buyers.
Connectedness with the buyers	A supplier perceives a business environment where it is trusted by the buyers and where they make an effort to form long-term business relationships with it.
Connectedness with the industry	A supplier perceives a business environment where it is trusted by the industry (and market) and is furnished with the support it required for long-term sustainability.

cognition, must be assimilated into any useful definition of passion, satisfaction, or commitment. By using the appraisal construct affect, intention, and cognition, we understand the operational definition of work passion as follows (Zigarmi *et al.*, 2009: 310).

> "Employee work passion is an individual's persistent, emotionally positive, meaning-based, and state of well-being stemming from reoccurring cognitive and affective appraisals of various job and organizational situations that results in consistent, constructive work intentions and behaviors."

As can be observed, work passion is a higher-order construct that can be explained and examined by incorporating several conceptual relationships. Since intentions and behaviors are meaning-based elements, so the element of persistence and values motivation exist which intentionally and conceptually are the basis for discretionary efforts, organizational citizenship behavior, and excellent performance over time.

An appraisal is an ongoing occurrence that is a latent aspect of the operational definition, the outcome from an ongoing appraisal process. It also implies that, depending upon the characteristics of the nature of work and organization, different variables may come into play in different time durations. Thus, the term situation is a significant point of discussion here that relies on an ongoing historical association, thus creating various meanings and experiences. The proposed context, i.e., the supplier work passion with innovation as one of its core constructs, is also highly important here as passionate suppliers may possess cognitive elements that encourage them for creative thinking and ultimately result in innovation.

The literature categorizes the employee work passion into eight elements (Zigarmi *et al.*, 2011): 1) meaningful work, 2) collaboration, 3) fairness, 4) autonomy, 5) recognition, 6) growth, 7) connectedness with the leader, and 8) connectedness with colleagues. Based on the above discussion and considering its importance in supply chain management (Bai & Sarkis, 2010), innovativeness can also be added to it. It is believed that if suppliers would pay attention to the elements of work passion, then high work passion in suppliers can probably be observed, and when they are passionate, then the thrust of innovation may be produced in the cognition of suppliers. In light of the work of Zigarmi *et al.* (2009), and considering the importance of innovation in the supplier-buyer relationship, the construct of supplier work passion has been developed and presented in Table 1, while the complete supplier work passion model has been shown in Figure 1. Meanwhile, by building upon the work of Zigarmi *et al.* (2009) and the nine-dimensional construct of supplier work passion discussed in Table 1, the current study pioneers the operational definition of supplier work passion, which is defined as:

> A supplier work passion is a supplier's persistent, compatible with technological changes, ideologically positive, meaning-based state of well-being stemming from reoccurring cognitive and affective appraisals of various work situations that results in consistent, constructive work intentions and behaviors towards the buyer and the industry.

4. Discussion

Zigarmi's framework explained certain fundamentals about the occurrence of work passion. Appraisal concept clearer the picture of antecedents and development of work passion. From the research methodology point of view, a separate measure is needed to confirm, delineate, and explain various aspects if a construct is to be validated (Breckler, 1984). The three components (intention, cognition, and affect) are unobservable, hypothetical constructs, and thereby no single measure was assumed in terms of work passion. Similarly, this study suggests that by considering the importance of suppliers' work passion, there is a dire need to develop the measure of supplier work passion. By taking this measure, the modifiers, antecedents, and consequences of supplier work passion would be more fully understood.

In todays' world, technology is considered the engine of growth, and organizations need to keep change with rapid advancements in technology. For contemporary organizations, perhaps, the greatest challenge is the integration and acquisition of technology in their structure, strategy, and process. In this context, the compatibility of work passion could be high with these technological changes. Endless creative thinking and innovation need to espouse organizations in such a competitive environment to gain a competitive advantage.

It was observed that employees having a passionate state can easily adapt the challenging situations (Gubman, 2004). Similarly, the supplier work passion would be compatible with technological changes. Thereby, the buyers' need to buy from passionate suppliers is augmented. In addition, two outcomes might be succeeded by supplier work passion (a) creative thinking and innovation to seek out new sources of knowledge, and (b) tap out insight for building relationships (Hagel III *et al.*, 2010). Thus, buyers and industry (market) need to recruit innovative and passionate suppliers to move forward with continuous improvements. To date, there has been only one study (i.e., Zigarmi *et al.*, 2011) which, instead of personal characteristics, investigated the association of work environment characteristics with work passion. Thus, it has important implications for developing a construct for supplier work passion. Considering the significance of supplier work passion, the current study recommends developing a measure on supplier work passion to which basic accompaniment and support is provided in the current study. Inline, the supplier work passion can empirically be investigated with dispositional antecedents.

One may argue that passion is an individual characteristic or a behaviour exhibited by individuals, is it logical to extend it to an organizational entity like a supplier? Here, the study argues that the supplier may or may not be an organization. For example, in many cases, small businesses usually buy from suppliers who happen to be individuals. These individuals may or may not be acting on behalf of an organization. Generally, it is more likely that a supplier may be an organization. If an organization can

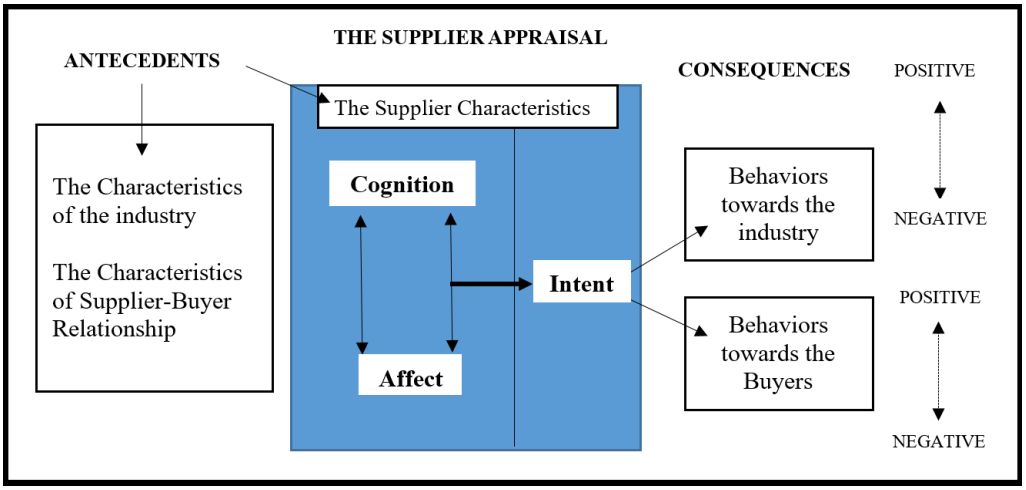

Figure 1. The supplier work passion model (adapted from Zigarmi *et al.*, 2009: 310)

have a 'vision,' 'mission,' and 'power,' what's wrong with having a 'passion'? Isn't an organization merely a group of individuals? It is true that passion is mainly associated with corporate founders, business leaders, entrepreneurs, employees, workers, and other individuals (Makino *et al.*, 2020; Balon & Rimé, 2013). Interestingly, some writers did indeed mention "passionate organization" (Lucas, 1999), a research organization's "passion" [for science] (Nature, 2020), a newspaper's "passion" [for criticism] (Stalin, 1954), and a country's "passion" [for education] (Regan, 2018). However, it should be noted that in the end, the passion of an organizational entity (e.g., a supplier firm's passion for the work for a buyer firm) is supposed to be the sum of the passion of the people who make the organization. The current study argues that an organization can also exhibit passion, but the form of this passion can be different from employee's passion and is a subject of future studies. Also, for those who recognize passion as "the first source of all our enquiries" (Martin, 2021), and know business and market enquiries are an integral part of any organization, it is not difficult to appreciate the proposed concept of supplier work passion irrespective of the fact we view supplier as an individual, group or an organization.

5. Conclusion

Work passion remains a popular topic in the literature concerning human resources and organizational behavior (Hagel III *et al.*, 2010; Perttula, 2004; Carpentier, Mageau & Vallerand, 2012). Johri *et al.* (2016) defined passion in the context of 'work', 'activities', and 'entrepreneurship'. The current study adds to it 'business relationship' as well, where business relationship implies the profitable relationship between the provider of a service or product and its buyer. The supplier-buyer relationship is a particular example of this relationship. Meanwhile, the study proposes a novel definition and construct of supplier work passion. Also, 'innovation' has been introduced in the construct of work passion. Thus, in the current study, a novel framework of supplier work passion has been proposed.

Since the framework is new and original, further research is needed to develop the scale of supplier work passion and test its antecedents and consequences empirically with various constructs. Also, how to quantify or estimate supplier work passion is another area of future research. While noting that the scientific literature is almost silent on the passion demonstrated by an organization, the current study has initiated a debate for future researchers, especially from the disciplines of organizational behavior and supply chain management. How does the scientific community responds to this initiative is yet to be seen.

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