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Conference Schedule Overview

Day 1: Oxford University Natural History Museum

Day 2: St. Anne's College, University of Oxford, Oxford OX2 6HS, U.K

Day 3: Group Punting (boating) in RIVER CHERWELL, Magdalen Bridge Boathouse, High St, Oxford OX1 4AU, United Kingdom

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On the Optimum Scenarios for Single Row Equidistant Facility Layout Problem

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Abstract

Single Row Equidistant Facility Layout Problem SREFLP is with an NP-Hard nature to mimic material handling costs along with equally spaced straight-line facilities layout. Based on literature, it is obvious that efforts of researchers for solving SREFLP turn from exact methods into release the running time tracing the principle of the approximate methods in time race, regardless searching their time complexity release in conjunction with a provable quality of solutions. This study focuses on Lower bounding LB techniques as an independent potential solution tool for SREFLP. In particular, Best-known SREFLP LBs are reported from literature and significantly LBs optimum scenarios are highlighted. Initially, one gap of the SREFLP bidirectional LB is enhanced. From the integration between the enhanced LB and the best-known Gilmore-Lawler GL bounding, a new SREFLP optimum scenario is provided. Further improvements to GLB lead to guarantee an exact Shipping/Receiving Facility assignment and propose a conjecture of at most 4/3 approximation scheme for SREFLP.

Keywords— Facilities Sequences, From-Between Chart, From-To Chart, Lower Bound, Single Row Equidistant Facility Layout Problem

1. Introduction

In almost any Facility Layout Problem, one can think of productivity is best served by an efficient flow of the elements that move through the facilities. It might be said that the overall success of a Layout,

or at least the layout profitability, is a direct reflection of the effort that goes into flow planning. Accordingly, it is reflected on material handling cost minimization. The solution key in Facility Layout and Material Handling Problems is to form optimum effective facilities sequence/s. If all the facilities are assigned on equally-spaced same side of the material-handling track, the layout is referred to as a Single Row Equidistant Facility Layout SREFLP. A literature review on SREFLP enormous applications can be found in detail by (Palubeckis, 2012).

SREFLP is a well-known operations research problem with a permutation-based manner. A key issue of SREFLP is the NP hard nature. That means there is no polynomial time algorithm for solving it exactly unless P = NP. To out of this dilemma, literature tackled the Problem exactly then heuristically. We consider only the four recent contributions of SREFLP approaches to be reviewed: lower bounds-based exact algorithms (Hungerländer, 2014; Palubeckis, 2012) and the best-known solutions using approximate-based methods (Atta & Sinha Mahapatra, 2019; Palubeckis, 2015) as follows: In (Palubeckis, 2012), the specialized (LP)-based approach, using the best-known B&B lower bound LB* of SREFLP, was able to solve instances size up to 35 facilities. Recently, (Hungerländer, 2014) reported the superior results of applying (SDP)-based approach of the general Single Row Facility Layout Problem SRFLP. It was proposed by (Hungerländer & Rendl, 2011) to solve SREFLP instances up to 42 facilities. Reference (Hungerländer, 2014) computationally improved LB* tightness (Palubeckis, 2012) to emerge it in (SDP)- based approach for heuristically solving larger instances. However, it seems that improved LB* is not the absolute condition for improving the quality of the proposed heuristic. As observed in the results of SREFLP instances Y with size 45-60 departments (Hungerländer, 2014), the best layouts are obtained by the help of LB* from (Palubeckis, 2012), which is weaker than the improved LB* of (Hungerländer, 2014). For improvement the quality of solution, (Hungerländer, 2014) proposed a note to treat this gap using his improved LB* for the specialized (LP)-based approach of (Palubeckis, 2012). Although no computational results reported this procedure till now, it is expected that either no running time release

with approximate solutions or a running time release with again approximate solutions.

In this context, (Palubeckis, 2015) proposed simulated annealing SA algorithms for the same instances Y with size 45-60 departments. It conjectured that SA algorithms produced optimal results with less computational effort; it is unproven. Reference (Atta & Sinha Mahapatra, 2019) is considered the recent study on SREFLP results. Similarly, as derived in (Palubeckis, 2015; Hungerländer, 2014), it tailored a SRFLP heuristic to be applied on SREFLP which outperformed on computational time while agreed with all optimum results of (Hungerländer, 2014; Hungerländer & Rendl, 2011; Palubeckis, 2012) that is up to 35 facilities. The running time of (Atta & Sinha Mahapatra, 2019) is comparable to (Palubeckis, 2015) for agreed results of instances ($110 \leq n \leq 300$). Regarding the literature, it is obvious that efforts of researchers in exact methods turn into release the running time tracing the principle of the approximate methods in time race, regardless searching their time complexity release in conjunction with a provable quality of solutions.

From this context, the implicit object of this study is to mine the SREFLP LB techniques, reanalyze it, and highlight every possible scenario in support of solving SREFLP exactly and optimally (conjecture P=NP). Based on this perspective, this paper enhances the primitive SREFLP LB from literature which has a conceptual limitation and introduces:

I. A new Optimum Scenario for SREFLP LB resulted from the possible integration between the best-known Gilmore Lawler bound and the Enhanced LB.

II. An Exact Shipping/Receiving Facility Assignment generated from partially considering GLB as a solution-tool.

III. Conjecture on a 4/3 fully input polynomial-time approximation scheme for SREFLP related to fully consider GLB as a solution-tool taking into account the Exact Assignment of Shipping/ Receiving Facility.

2. Single Row Equidistant Facility Layout Problem

SREFLP can be considered as a Frequency From-To Chart FFTC Problem reduced to a Frequency From-Between Chart FFBC through the following

structure from (GAMAL et al., 2020) and (Palubeckis, 2015), respectively:

$$\text{Min FFTC} = \sum_{i=1}^{n-1}\sum_{j=i+1}^{n}(f_{ij} + f_{ji})(j-i) \quad (1)$$

$$\min_{\pi \in \Pi} \text{FFBC} = \sum_{i=1}^{n-1}\sum_{j=i+1}^{n} f^{t}_{\pi(i)\pi(j)}(j-i) \quad (2)$$

where π is a set of all $n!$ permutations. For $i \neq j$, i= 1, 2, .., n-1. and j= 2, 3, .., n. $f^{t}_{\pi(i)\pi(j)}$ represents the Forwards and Backtracks frequencies sum $(f_{ij} + f_{ji})$ of the material flow between facilities i and j. Term $(j-i)$ states the distance between facilities i and j. Equation (2) may be referred as $f^{t}_{ij_{(j-i)}}$ (see **Fig.1**).

From \ Between	Facility 1	Facility 2	Facility 3	Facility 4	Facility 5
Facility 1	0	f_{12_1}	f_{13_2}	f_{14_3}	f_{15_4}
Facility 2	0	0	f_{23_1}	f_{24_2}	f_{25_3}
Facility 3	0	0	0	f_{34_1}	f_{35_2}
Facility 4	0	0	0	0	f_{45_1}
Facility 5	0	0	0	0	0

Fig. 1 Frequency From-Between Chart Skeleton

SREFLP could be categorized as:

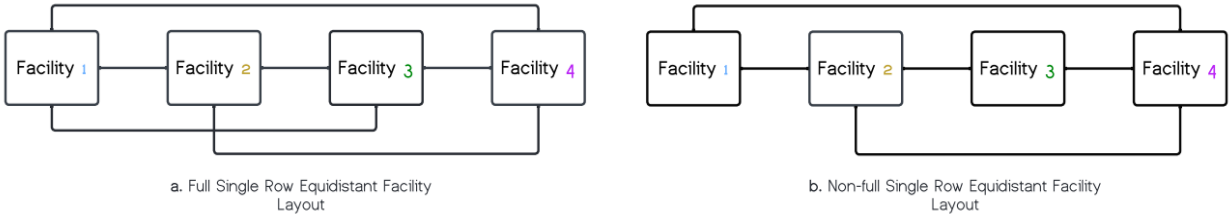
I. Full SREFLP whose all (n(n-1)/2) total cells of frequencies are non-zeros. It practically means that every facility has at least one directional flow among all other (n-1) facilities (see **Fig. 2a.**).

II. Non-full SREFLP whose some of (n(n-1)/2) total cells of frequencies are zeros. It practically means that one facility at least doesn't have any directional flow among all other (n-1) facilities (see **Fig. 2b.**).

Fig. 2 Single Row Equidistant Facility Layout Skeletons

3. SREFLP Lower Bounding Techniques

In most cases of SREFLP, LB is used as an aid tool for reaching exact



a. Full Single Row Equidistant Facility Layout

b. Non-full Single Row Equidistant Facility Layout

solutions or as a basis for measuring the performance of heuristic approaches. That is through either computing an infeasible bound or maybe an optimum one; it is unprovable.

In the following sections, four types of LB related to SREFLP are discussed and reanalyzed in support of the conjecture P=NP.

3.1 Enhancement of SREFLP Bi-directional Lower Bound

From literature, Initially, we enhance a previous version of Frequency From-To Chart FFTC computing Bi-directional LB for SREFLP. It was suggested by (Sarker et al., 1998) and continued to be used as a measuring tool of the heuristic performance in (Sarker, 2003). It claimed an effect of Backtracking Minimization over Moment Minimization, which has been numerically proven to be incorrect by (GAMAL et al., 2020).

In general, for $n \times n$ FFBC, setting the frequencies set f_{ij}^{t} of $n(n-1)/2$ non-diagonal cells $\{f_N^t\}_{N=1}^{n(n-1)/2}$ in descending order array, i.e., such that $f_N^t \geq f_{N+1}^t$ for all N. Then, the distance array is provided by $1< k < n+1$. Finally, Enhanced LB Model can be formulated as:

$$\text{Enhanced LB= Sum}\left[f_1^t \;\; f_2^t \;..\; f_{\frac{n(n-1)}{2}}^t\right].\left[\underbrace{1 \;\; 1 \;..\; 1}_{n-1\ times} \;..\; \underbrace{k \;\; k \;..\; k}_{n-k\ times} \;..\; n-2 \;\; n-2 \;\; n- \right]$$

The Enhanced LB computation is based on the skeleton of Objective Function (2), as follow:

From the following **Comparative Example** and **Experimental Example**, Enhanced LB is expected to be an infeasible solution or Optimum LB, which is an optimum solution; it is unproven.

3.1.1 COMPARATIVE EXAMPLE

Illustration of Enhanced LB for bidirectional flow (Moment Minimization) problem versus Bi-directional LB computed in (Sarker et al., 1998).

Consider a From-To Chart FTC matrix for a 5-machine problem:

$$\text{FTC} = \begin{bmatrix} 0 & 2 & 2 & 3 & 0 \\ 1 & 0 & 5 & 2 & 3 \\ 6 & 1 & 0 & 4 & 2 \\ 1 & 2 & 6 & 0 & 3 \\ 1 & 5 & 3 & 3 & 0 \end{bmatrix}$$

Regarding (Sarker et al., 1998) : Forward Lower Bound is computed by firstly choosing the larger frequencies between every pair of (f_{ij}, f_{ji}) such that {(2,6,3,1), (5,2,5), (6,3), (3)}, then placing in an array with an ascending order: [1 2 2 3 3 3 5 5 6 6]. And the distance array

is placing in descending order: [4 3 3 2 2 2 1 1 1 1]. Thus, Forward Lower Bound equals to 56 by taking the product of both arrays.

Backtracking Lower Bound is computed by firstly choosing the smaller frequencies between every pair of (f_{ij}, f_{ji}) such that {(1,2,1,0), (1,2,3), (4,2), (3)}, then placing in an array with an ascending order: [0 1 1 1 2 2 2 3 3 4]. And the distance array is placing in descending order: [4 3 3 2 2 2 1 1 1 1]. Thus, Backtracking Lower Bound equals to 28 by taking the product of both arrays.

Hence, Bi-directional LB = Forward Lower Bound + Backtracking Lower Bound = 84.

Regarding Enhanced LB:

From-Between Chart FBC = $\begin{bmatrix} 0 & 3 & 8 & 4 & 1 \\ 0 & 0 & 6 & 4 & 8 \\ 0 & 0 & 0 & 10 & 5 \\ 0 & 0 & 0 & 0 & 6 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$

$\{f_N^t\}_{N=1}^{10} = \{3, 8, 4, 1, 6, 4, 8, 10, 5, 6\}$

$f_{(N)descend}^t = [10\ 8\ 8\ 6\ 6\ 5\ 4\ 4\ 3\ 1]$

Distance array = $[1\ 1\ 1\ 1\ 2\ 2\ 2\ 3\ 3\ 4]$

Enhanced LB = $\text{Sum}\,[10\ 8\ 8\ 6\ 6\ 5\ 4\ 4\ 3\ 1].\,[1\ 1\ 1\ 1\ 2\ 2\ 2\ 3\ 3\ 4] = 87$

Hence, Bi-directional LB equals 84 (Sarker et al., 1998) < 87 (Enhanced LB) < 90 (Optimal solution). Thus, Enhanced LB outperforms Bi-directional LB and produces infeasible solution.

3.1.2 EXPERIMENTAL EXAMPLE

Consider a From-To Chart FTC matrix for a 5-machine problem:

FTC = $\begin{bmatrix} 0 & 2 & 2 & 1 & 1 \\ 0 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 4 & 2 \\ 0 & 1 & 0 & 0 & 2 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$

Regarding Enhanced LB:

FBC = $\begin{bmatrix} 0 & 2 & 2 & 1 & 1 \\ 0 & 0 & 2 & 2 & 1 \\ 0 & 0 & 0 & 4 & 2 \\ 0 & 0 & 0 & 0 & 2 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$

$\{f_N^t\}_{N=1}^{10} = \{2, 2, 1, 1, 2, 2, 1, 4, 2, 2\}$

$f_{(N)descend}^t = \{4, 2, 2, 2, 2, 2, 2, 1, 1, 1\}$

Distance array = $[1\ 1\ 1\ 1\ 2\ 2\ 2\ 3\ 3\ 4]$

Enhanced LB = Sum $[4\ 2\ 2\ 2\ 2\ 2\ 2\ 1\ 1\ 1].[1\ 1\ 1\ 1\ 2\ 2\ 2\ 3\ 3\ 4]$

= 32 (OPT-LB)

According to (**Experimental Example**), Enhanced LB may generate OPT-LB which is the optimum solution, but it is unproven.

Hint: Full FFBC for SREFLP seems practical for the full computation skeleton of Enhanced LB more than Non-Full SREFLP, whose some of $(n(n-1)/2)$ total frequencies are zeros. Although Enhanced LB outperforms Bi-directional LB results (Shown in **Table 1**), it is still the least minimum (primal) LB and the best time complexity $O(n^2)$ for SREFLP regarding literature (Shown in **Table 2**).

3.1.3 LIMITATIONS

From (**Comparative Example and Experimental Example**) context, Enhanced LB is considered problematic as an independent-solution tool because it does not provide any gain for the algorithm (solution/s in permutation forms). In the next section, we proposed a technique for adapting SREFLP LB in support of being an independent solution tool.

Problem Size n	Bi-directional LB (Sarker et al., 1998)	Enhanced LB
P-5	1138	1138
P-6	1544	1547
P-7	1943	1960
P-8	2463	2572
P-9	2936	2982
P-10	3523	3570
P-11	4077	4174
P-12	4760	4854
P-13	5565	5697
P-14	6211	6395
P-15	6927	7099
P-16	7955	8119
P-17	8766	8998
P-18	9527	9861
P-25	16615	17159
P-30	22559	23488

Table 1- Performance of Enhanced LB versus Bi-directional LB

Problem Size n	Bi-directional LB (Sarker et al., 1998) and (Sarker, 2003)*	Enhanced LB	GLB (Palubeckis, 2012)	LB* (Palubeckis, 2012)
S-12	4008*	4094	4122	4312
S-13	5260*	5384	5432	5730
S-14	6548*	6693	6748	7108
S-15	8002*	8199	8267	8702
S-16	9870	10104	10176	10686
S-17	11713	11979	12069	12759
S-18	13949	14279	14378	15224
S-21	21861	22450	22632	24059
S-22	25095	25779	25994	27543
S-23	28980	29757	29982	31823

S-24	32893	33747	34015	36238
S-25	37048	38064	38355	40856

Table 2- Performance of Enhanced LB versus Bi-directional LB, GLB and LB*

4. Gilmore-Lawler Bound

Regarding (Palubeckis, 2012), GLB is tailored for SREFLP also based on FFTC as illustrated in the following numerical example.

4.1 NUMERICAL EXAMPLE

FROM OBATA BENCHMARKS, INSTANCE O FLOW MATRIX IS

To / From	**Facility 1**	**Facility 2**	**Facility 3**	**Facility 4**	**Facility 5**
Facility 1	0	1	5	5	7
Facility 2	1	0	8	3	4
Facility 3	5	8	0	1	5
Facility 4	5	3	1	0	7
Facility 5	7	4	5	7	0

Table 3- From-To Chart for Instance O

Step 1: Computing the lower bound on the part of the QAP objective function corresponding to the placement of facility 1 to all positions as follows: The descending sequence of flows of facility 1 = [7 5 5 1], then the ascending sequence of distance *(j-i)* for Location 1 and 5 = [1 2 3 4], Location 2 and 4 = [1 1 2 3], and Location 3 = [1 1 2 2].

Step 2: Taking the component wise-product of these sequences. Therefore, 7*1+5*2+5*3+1*4=36 is the lower bound imposed by assignment facility 1 to location 1. Other values of facility 1 locations are calculating in the same way. Also, facility 2,3,4, and 5 values are obtained for every location.

Step 3: Constructing a linear assignment matrix for all the O-5 lower bounds values where every row represents the placement of every facility to all positions P(1) to P(5).

	Facility 1	**Facility 2**	**Facility 3**	**Facility 4**	**Facility 5**
P(1)	36	29	37	30	52
P(2)	25	21	26	21	36

P(3)	24	20	25	20	32
P(4)	25	21	26	21	36
P(5)	36	29	37	30	52

Table 4- Linear Assignment Problem for Instance O

Step 4: By calculating the optimal solution of linear assignment matrix. The optimal value is 142 which is the GL bound for O-5.

4.2 LIMITATIONS

As observed, SREFLP is now tailored to be solved by GLB. The question is: "how to guarantee optimum assignment permutations by SREFLP LB?". In particular, "how to satisfy feasible assignment permutations by GLB?"

5. Integration between Enhanced LB and Gilmore-Lawler Bound

In order to search the gap between the functionality of LB as a measuring/aid tool and as a potential solution tool. We studied the possibility of integrating the Enhanced LB and the well-known GLB. Accordingly, we developed the following rationale proof of a new Optimum Scenario for SREFLP.

5.1 RATIONALE PROOF FOR SREFLP OPTIMUM SCENARIO

Lemma 1 (OPT-Scenario)

Suppose GLB = Enhanced LB for a SREFLP instance, it can be concluded that the optimal solution (permutation matrix) follows either **Sequencing Strategy 1** = P(1), P(n), P(n-1), P(2), P(n-2), P(3), P(n-3).. etc. or **Sequencing Strategy 2** = P(1), P(n), P(2), P(n-1), P(3), P(n-2), P(4).. etc. or both of them if they agree in the objective function value.

Proof

Sequencing Strategies 1 and **2**, corresponding to Flow Matrix term *f* and Distance Matrix term *(j-i)*, are implicitly considered the best sequencing scenario of positioning *f* into *(j-i)* according to the objective function Skelton for SREFLP in (1).

Regarding Enhanced LB, it is computed by taking the wise-product of both the arrays of the descending flow components and ascending distance components. While GLB entries (in the form of a linear assignment problem) are computed as in the product of Enhanced LB but wisely in separate way. It is done by taking every lower bound

on the part of the QAP objective function - from equation (1) - of From-To Chart corresponding to the assignment of *n* facilities per every position (the diagonal zero entries are ignored). The value of GLB is the optimal solution to the Linear Assignment Problem LAP. ***The rationale*** behind the OPT-Scenario of Enhanced LB = GLB can be deeply interpreted by the assignment procedure of Optimal Permutation/s with the potential feasible minimum objective function as follows:

1) The minimum lower bound of the worst-case distance matrix part (which is related to Shipping and Receiving Facility Positions = [1 2 3 4 .. n-1]).
2) The minimum lower bound of the following worst-case distance matrix part (which is related to Positions P(2) and P(n-1) = [1 1 2 3 4 .. n-2]) ...etc.

In addition, from the part *(j-i)* of From-To Chart, it can be noticed that Sequencing Strategies follow a mirror assignment for the positions corresponding to the distance part and then as a result also for the flow part shown in the wise-product value in LAP.

Hint: Sequencing Strategies (in **Lemma 1**) aim to efficiently reduce the trials of LAP optimal solutions into only two possible optimum ones.

5.2 Assignment of Optimum Shipping/Receiving Facility

As a result of **lemma 1**, we found that assignment of the minimum Lower Bound on the part of the QAP objective function corresponding to the first Position P(1) rationally always returns an Optimum Shipping/Receiving Facility Layout/s (shown in **Fig. 3.**). It is reviewed by (Atta & Sinha Mahapatra, 2019) from the table of SREFLP best layouts.

Hint: For SREFLP, this result agreed with Symmetry Breaking Constrain mentioned in (Shabani et al., 2020). It is stated that: the objective value of sequence (1 2 3 4) is equal to the one from (4 3 2 1). Therefore, as long as only the first facility of sequence/s is guaranteed to be assigned, there is no clue if it is the Shipping or Receiving one.

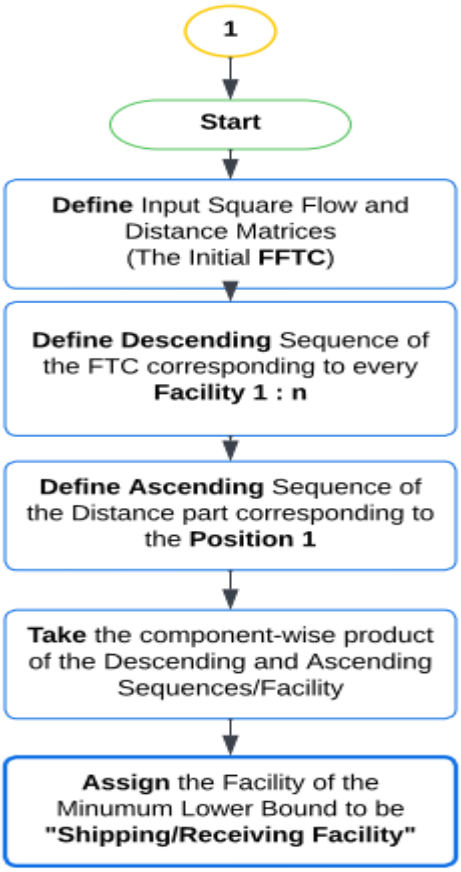


Fig. 3. Flow Chart of Exact Assignment of Shipping/Receiving Facility

5.3 Conjecture on SREFLP Approximation Scheme

We modified the assignment algorithm mentioned in **Fig. 4.** followed by Five Sequencing Strategies SSs proposed to be merged into the Exact Assignment of Shipping/Receiving Facility. SSs are assigned as follows:

SREFLP - Five Sequences Strategies SSs	
Strategy 0	P(1), P(2), P(3), P(4), .., P(n-1), P(n).
Strategy 1	P(1), P(n), P(n-1), P(2), P(n-2), P(3), P(n-3)..etc.
Strategy 2	P(1), P(n), P(2), P(n-1), P(3), P(n-2)..etc.
Strategy 3	P(1), P(n), P[2:1:n-1].
Strategy 4	P(1), P(n), P[n-1:-1:2].

Table 5- The Proposed Sequencing Strategies for Facilities Assignment

According to **Fig. 4.** and **Table 5**, the SREFLP family of five algorithms (also called Optimum Shipping/Receiving Facility scheme) has a running time strongly polynomial in (n) and is computationally performed $O(n^2\log(n))$. Hence, the scheme is assumed to be fully input polynomial-time approximation class as defined in (van Leeuwen and van Leeuwen 2012), it is unproven.

Experimental analysis claims that the values of objective function for all the benchmark results -from optimal assignment of the Shipping/Receiving Facility- are equal to at most 4/3 the optimal solution (see **Fig. 5.**). It is available to see all Full FFBC benchmarks tested by Optimum Shipping/Receiving Facility scheme through: https://anonymousaricon22.github.io/OPT/. The optimal value/s OPT for all tested benchmarks are known and reported from (Palubeckis 2012).

5.4 Further Related Comments

This paper aims to demonstrate and collect the whole study related to optimum SREFLP scenarios. Hence, it is worthy to mention the only OPT Scenario in the literature by (Meskar and Eshghi 2020) which has two formulas: Firstly, if **Trace** $(\mathbf{CP^TDP})$ is equal to **Trace** $(\mathbf{DP^TCP})$. Where **C** and **D** are the flow and Distance matrices while **P** is an optimum permutation matrix. Therefore, the gap $|\mathbf{CD}-\mathbf{DC}|$ will be zero. Secondly, if **C** is a coefficient $\propto$ of **D**, **C** $=\propto$ **D**. For every QAP Scenario, the Optimum Solution is known by the identity matrix in case of transforming **C** into symmetric matrix, if it's not.

Regarding the superior LB in the literature, LB* in (Palubeckis, 2012) and improved LB* in (Hungerländer, 2014) aim implicitly to maximize GLB to be a tighter bound for various solution approaches. As a result, it is clear that they served the non-polynomial exact/approximate solutions and did not serve the thrust research direction of this paper toward P=NP.

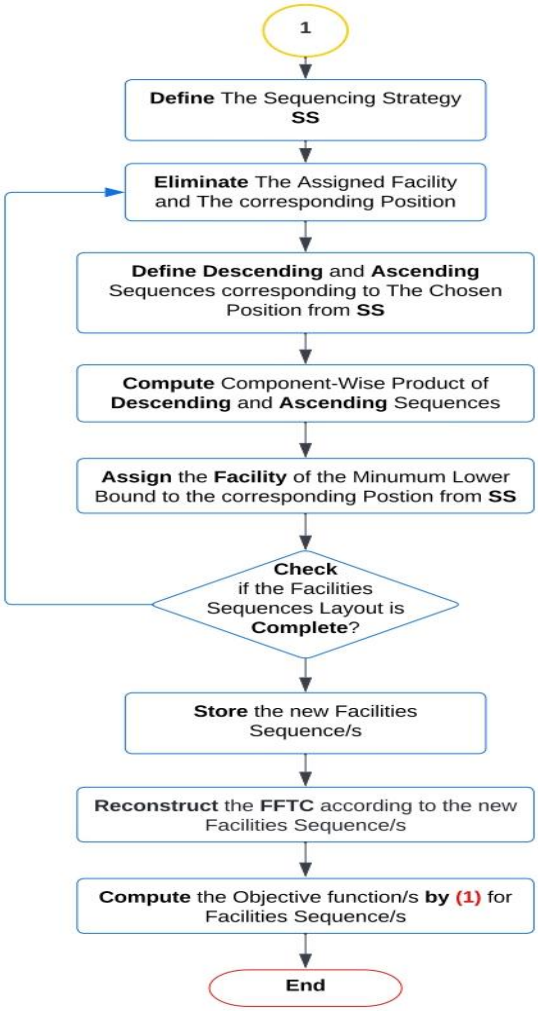


Fig. 4. Flow Chart of the Proposed SREFLP Approximation Scheme

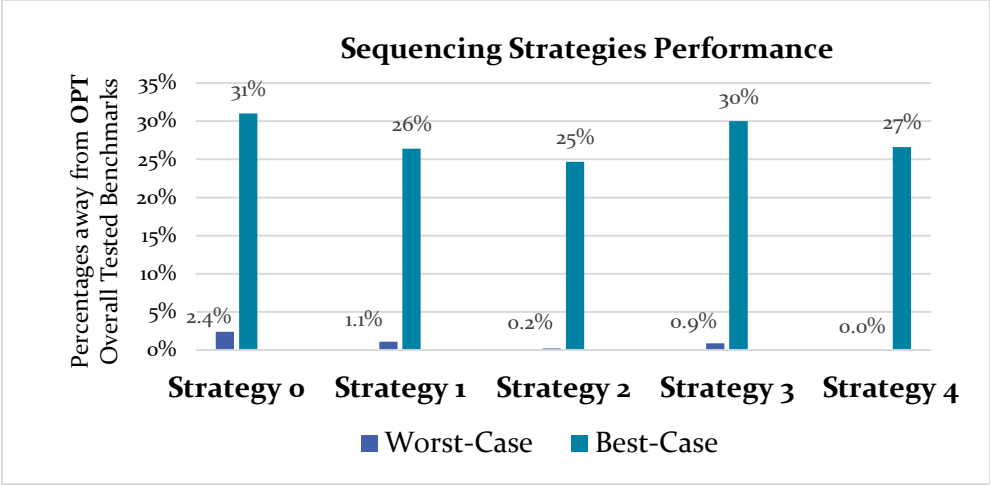


Fig. 5. Recap of experimental analysis for the conjecture on SREFLP Approximation Scheme

6. Conclusion and Future Works

In this paper we adapted the history of SREFLP Lower Bounding LB techniques for the first time in support of P is equal to NP. Enhanced LB is initially proposed to modify the conceptual limitation of the primitive SREFLP LB from literature. Considering the polynomial time and the exact solution, we proposed an Optimum Scenario for SREFLP and an optimum assignment of Shipping/Receiving Facility for the layout. Considering the polynomial-time and the potential quality of solutions, we established a conjuncture on a family of five fully input polynomial-time approximation algorithms. It returned objective functions equal at most 4/3 the optimal objective function of SREFLP. That was seen absolutely for the full class of SREFLP.

There are some interesting directions and open questions for our further research:

I. Is there a proof on the conjuncture of the 4/3 fully input polynomial-time approximation scheme for the full SREFLP?

II. Can it apply also to the non-full SREFLP?

III. Can we improve the approximation factor of SREFLP scheme?

IV. Is there a fixed approximation ratio for the nature of SREFLP skeleton?

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Restorative Housing: A Model for Future Home in Erbil City

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With the increasing emergence of epidemics, the demands of our future homes have changed. Concerns about nature degradation have been joined by concerns about human survival. In addition to providing for the emotional and physical needs of humans, the home has become a possible place for quarantine, recovery, and more, a place to work. In Erbil city, where the concept of sustainability is still in its infancy, the housing industry faces many challenges due to the increasing emergence of housing projects as a result of population growth and economic prosperity that is paralleled by the lack of sustainable concepts or regulations. Having access to regional practices helps implement appropriate technologies and designs that take into account regional contexts and physical capabilities. In the Middle East region, despite the natural constraints and underlying political and social issues, some countries have taken serious and distinctive steps towards more sustainable design and construction practices. Two main models in

sustainable architecture have been identified, one of which is revivalist, the other is progressive, and there is a hybrid that combines the two. This study aims to present a healthy sustainable model for housing projects in Erbil city based on the Middle-eastern practices in sustainable architecture with considering the new function of the home. The study resulted in a restorative housing model that fuses modern and old strategies in resource efficiency with design patterns that bring health and well-being to the residents while healing the urban ecology.

Detection and diagnosis the cracks of pipeline using investigation robot.

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Cracks on pipelines result in rapid deterioration. Access to these places is sometimes very difficult for people and complicated to detect. Robots are devised in such a way to dispose of human intervention from labor extensive and hazardous work environments. Most of the pipeline segments have tiny internal diameters or bends which end up unreachable to humans. This research aims to design and develop a pipeline inspection robot programed by Arduino and equipped with a VPF camera which is a live camera. Canny filter in Image Processing of MATLAB is used to remove noise from the image and makes the image smooth. Furthermore, it selects all edges in the image and the extreme edges. Then, MATLAB will set the possible and real cracks in red. There are several features of the robot such as it will be placed inside the pipe and wireless due to having a transmitter that can be worked for more than 1 km. In addition, there is a receiver connected directly to the camera app in the computer that will show a live video of the pipe, and the monitor could take photos of the cracks and upload it to MATLAB directly.

Keywords—pipeline, inspection, cracks, MATLAB, Image Processing

DEVELOPMENT OF A NEW FUNCTIONAL INGREDIENT ENRICHED WITH PROBIOTIC AND BIOACTIVE METABOLITES

This research is funded by Tecnalia Research and Innovation
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A healthy diet is essential to preserve human welfare and prevent the development of cardiovascular, neuronal, or metabolic diseases. Therefore, the development of new functional foods fortified with probiotics, prebiotics, or bioactive compounds such as polyphenols, carotenoids, vitamins, or minerals, have been widely studied to satisfy the current nutritional requirements of consumers. Following this trend, this thesis has been focused on developing a new functional ingredient composed of a probiotic microorganism coupled with the bioactive metabolite (post biotic) γ-amino butyric acid (GABA). It is essential to highlight that a probiotic could be characterized due to its immunomodulatory effect, protection against pathogens or maintenance of the structure of the micro biota, among other features. Furthermore, GABA is a non-protein amino acid mainly involved in the modulation of the nervous system in humans. Thus, it could have a neuroprotective effect against diseases such as Alzheimer´s, Parkinson´s, Huntington´s or Multiple sclerosis. As well, GABA could help reduce blood pressure and anxiety. The development of this bioactive ingredient has been performed in stages. The first step of this research was achieved through the isolation, identification, and characterization of the probiotic microorganism. Then, its ability to produce GABA was assessed and optimized by modifying key fermentation parameters such as incubation temperature, nutrients source, initial pH or fermentation time. Afterwards, optimized parameters were applied to produce GABA using fermentation media of natural origin, obtained from agri-food by-products, giving, as a result, a high nutritional product. Finally, micro-capsules were designed to preserve the probiotic viability through the stressful environment of the gastrointestinal tract and arrive at the gut, where this ingredient will perform a beneficial effect. Moreover, this capsule also avoids GABA degradation and enhances its release in the intestine.

Acknowledgements
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THE ARCHITECTURE OF RETREAT: FROM SPIRITUAL TO SECULAR MINDFULNESS

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ABSTRACT

This interdisciplinary research links architecture and psychology. The research argues that the transformation of the concept of mindfulness led to the emergence of a new building typology known in Egypt as Retreat Centres. The study aims to understand the quality of spaces that help in mindfulness. Two retreat centers in Egypt are analyzed in this qualitative case study. Interviews with the main actors and in-field data collection are used in the research to specify the architectural features. Collected data are analyzed architecturally. Architectural analysis is done on the collected data. The findings highlight the architectural qualities of spaces that promote mindfulness.

Keywords: Mindfulness, Retreat, Spirituality, Wellness, Solitude, Retreat Centre.

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INTRODUCTION

Mindfulness as a concept has transformed from a theological practice that aims to connect with the creator to become a secular practice, a practice that aims to connect with the self and a method to find balance between body, mind, and spirit. There is a relationship between religion, mindfulness, and well-being. Many researchers, such as Kabat-Zinn, highlighted the relation between mindfulness and physiology, while few investigated mindfulness's associations with architecture and space (Jazaieri & Shapiro, 2017). This research examines mindfulness in relation to architectural spaces. by analyzing two retreat centres in Egypt as a case. The first case study (R1) is a spiritual retreat centre managed by the Coptic Orthodox Church in Egypt. While the second case study (R2) is a secular retreat managed privately. The study traces the spatial qualities and characteristics of the spaces that contribute to the user's experience of mindfulness.

From Spiritual Mindfulness to Secular Mindfulness

The research traces the transformation of mindfulness from a religious to a secular practice. Originally mindfulness aimed to connect with God and is practiced in all religions, as Trousselard et al. (2014) explained

"It is important to include that the history of mindfulness should not be reduced to Buddhism and Hinduism, as mindfulness also has roots in Judaism, Christianity, and Islam." (Trousselard, Steiler, Claverie, & Canini, 2014, p.475)

All known religions practice different forms of mindfulness, with the same objective, but each in a unique way, through special symbols, stories, teachings, and practices. Most focus on contemplative practices. As this research aims to study a case related to the Coptic Orthodox Church in Egypt, it is important to understand the application of mindfulness in Christianity in particular. Christian forms of mindfulness have a long history; desert monks established the basis of solitary life either individually or in groups, known later as monasticism. Monasticism highlights one of the elements of Christian mindfulness, known as solitude. Solitude is an essential practice for religious mindfulness.

Weaver et al. (2006) argue that despite the link between religion and spirituality, there is a common understanding that both concepts differ but still are interconnected. Spiritual mindfulness is not related to religion. It aims to connect the body, mind, and spirit (Abd-El-Kafy & Seddik, 2020). In conclusion, spirituality is an experience of secular mindfulness. On the other hand, mindfulness is a practice of spirituality. Both are interconnected and linked together (Lazaridou & Pentaris, 2016). Mindfulness is a physical experience of the body with a focus on the mind and the spirit in the sense of solitude

Contemporary Application of Mindfulness: Retreat Centres

As the power of the built environment goes beyond the fulfilment of basic human needs, from shelter and safety, there are certain qualities of spaces that open our minds and make us aware of ourselves and the space around us. Humans have sought through architecture to build spaces of solitude by using different materials or methods (Dixon, 2009) In his study, Odor (2015) recommends that architects consider three elements when creating a space for solitude and retreat: balance, simplicity, and emptiness. Balance the harmony between built and unbuilt natural spaces. Emptiness is the perception of the incomplete space that helps the human mind to relax and feel tranquil, whereas simplicity is the process of creating fewer distracting environments for the user.

Retreat, as defined in Merriam-Webster's dictionary, is the act of withdrawal or a place for refuge. It is also defined as a group withdrawal from activities such as prayers or meditation (Webster, n.d.). The purpose of retreats is to temporarily leave the daily distractions, to focus on the present moment through mindfulness. Retreat's main objective is internal spiritual development achieved through reflection rather than exposure to information or inspiration. A retreat is a space for solitude and repose.

Lately, retreat centres act as treatment venues that aim to balance mind, body, and spirit. A new multi-functional institution has appeared to meet the community's needs. Such institutions provide liturgical functions and social functions to provide recreational leisure and educational activities. The design of retreat centres should correspond to the architectural requirements, which were defined as being "economic, ergonomic, environmental, and aesthetic" in the studies of Holubchak (2019). Any space ought to have an environmentally and economically sustainable design. Being economically viable involves using design strategies and building methods, and materials that attempt to reduce costs both during the building's construction phase and during operation. The use of natural building materials, the introduction of renewable energy sources, and the utilization of green open areas all contribute to an environmentally sustainable design. The construction of comfortable physical environments for visitors based on factors such as spatial orientation, insolation, noise reduction, and others is known as ergonomics. The use of elements that appeal to and engage visitors is referred to as aesthetic. Structure, shape, space, light, colours, and materials—the fundamental components of architecture—must be considered to design a building that is emotionally and spiritually rich.

Holubchak (2017) analyzed the spatial arrangement of retreat centres, especially in Ukraine, from an architectural perspective and found many tactics used in the internal design. Firstly, flexible planning: designing a place that can be adapted to varied functions

and activities. Secondly, colour selection is a psychological factor that affects a visitor's mood and emotions. Construction materials and techniques may create unique textures and colors. Natural surface finishes contribute to a healthy and comfortable atmosphere while constructing retreats. Thirdly, natural and artificial lights are used to emphasize sacred symbols. Light highlights the spiritual meaning and creates a spiritual ambiance. Fourthly, green and sustainable design uses natural textures, raw surfaces, plants, and water. This strategy achieves unity with nature and inner silence. Holubchak recommends retreat rooms should view a natural landscape to visually extend the area and promote comfort, integrating architecture and nature. Lastly, the orientation toward the spiritual component, most retreat centres have a spiritual core, according to Holubchak. It depends on the retreat's objective, whether it's spiritual growth or wellness. Mostly the retreat’s main space reflects its spiritual core.

In conclusion, the idea of retreat has gained popularity in Egypt; numerous lodges and hotels are promoting themselves as spaces for retreat. This resulted in a new architectural typology called retreat centres. The research chose two retreats to understand how mindfulness is manifested in architecture and the quality of spaces associated with mindfulness.

RESEARCH METHODOLOGY

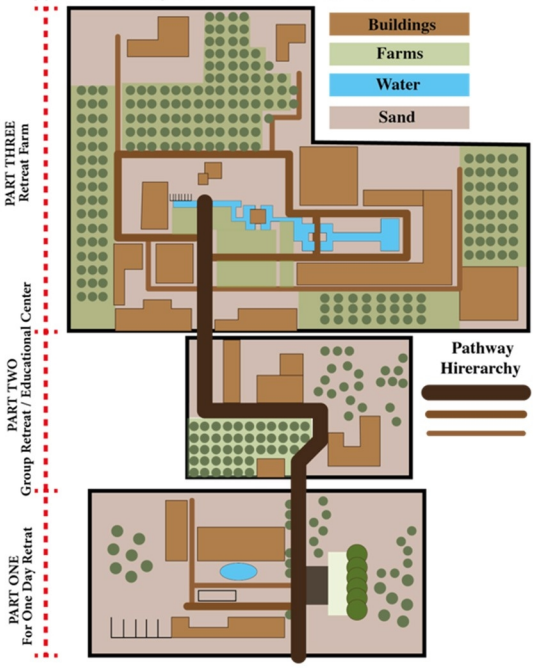
The paper adopts a case study as a methodology. It aims to understand the quality of spaces that help in mindfulness and the spaces where it is practiced. Two retreat centres in Egypt were chosen and analyzed. Pseudonyms R1 and R2 are used to identify the two retreat centres. The rationale for choosing these two retreat centres is their similarity in geographical locations, where both are located on the Cairo-Alexandria desert road. On the other hand, there is a difference in the objective of both centres. R1 is a spiritual retreat Centre founded and managed by the Coptic Orthodox Church, while R2 is a secular retreat managed privately. Data was collected in-field. Data collection includes documentation of the architectural features through sketches, photographs, observations, and interviews with the main actors. Collected data is analyzed architecturally and in relation to the literature.

ANALYSIS

Retreat Centre 1

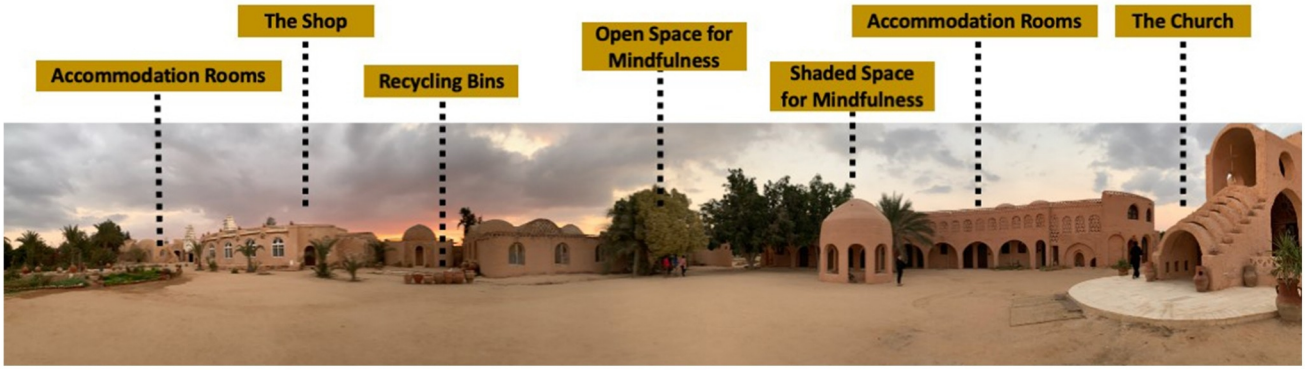
Introduction

Figure 1: Layout of retreat Centre 1



R1 is a farm located about 75 Km north of Cairo, Egypt. R1 is a "non-profit organization" retreat funded by donations of visitors. It hosts people of different backgrounds to join activities such as conferences, seminars, and spiritual retreats. R1 aims to uplift people beyond their natural boundaries and limitations: *"It is a place of love and acceptance to all people with different backgrounds and beliefs"* (Anon., 2017). R1 is designed to create a space that holds peace and serenity. In their words, *"it is inspired by the spirituality of the monastic life in Egypt"*. R1 is divided into three parts: a group one-day retreat, an educational centre, and a spiritual farm for retreat, (Figure 1). R1's facilities, especially the retreat farm, are clustered around the church and pool. The main functions of R1 are the church, the chapel, two sets of accommodation rooms, the farm, the amphitheater, and open space for mindfulness. From the service facilities in R1, the restaurant's kitchen and the dining area provide their own made food on the site, and the shop allows visitors to purchase the products and crops grown in R1. The library, the space where mud bricks are made on-site, handicrafts, and the animal farms are R1's auxiliary functions.

Figure 2:Shows a panorama of R1 with different spaces and activities, adopted by the authors



Accommodation rooms in R1 include communal housing that accommodates from two to four visitors per room and individual cells. As mindfulness is a state of awareness and focus on the present moment, the accommodation buildings in R1 are designed "to appear as a question mark in the layout, and the dot of the question mark is the church,"

(one of the main actors in R1). He argues that this resembles the idea that the answers to all life questions are found when you are alone and in a mindful state in the church, the main space for spiritual solitude and mindfulness. However, the study questions if the visitors could understand such a concept through the layout, an unseen projection. The accommodation buildings are grouped around the pool and others around the church. The buildings around the pool are one storey with an accessible roof for each unit (Figure 5 and Figure 6), while those around the church are two stories high (Figure 3 and Figure 4). Both sets of buildings are made of red mud bricks and straw and are coated afterward in mud. R1 produces the used red mud bricks used in construction on site. The interior of the accommodation rooms is simple and white in color. (Figure 7 and Figure 9). The cells are *"designed to be simple, in white color, with small openings."* Each room consists of a private mediations space for solitary indoor retreat, grounded seating with a small wooden table. In the rooms, nothing is luxurious; everything is designed to *"be minimal and bare design to help the visitor focus and meditate and to be less distracted."* The walls are thick and made of natural materials in white colors to ensure that the inside spaces remain cool. Mostly all accommodation rooms are earth-colored, while only a few are painted white (Figure 6). During the interview, it was clarified that *"This design delivers a message that people of all nationalities and religions are welcomed in the retreat. It symbolizes the message that we may differ from the outside. Still, we are essentially the same from inside"*. In addition, it was added that *"the earth color associates in mindfulness as it grounds all the visitors to the earth and reminds them of their origin."*

Figure 3:Shows the accommodation rooms in front of the Church

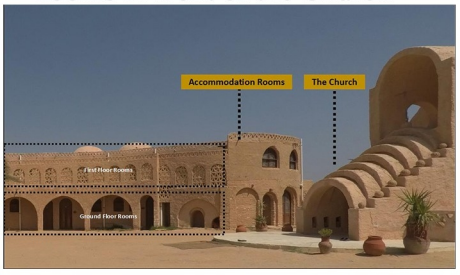


Figure 4:Shows the elevation of the accommodation rooms in front of the Church

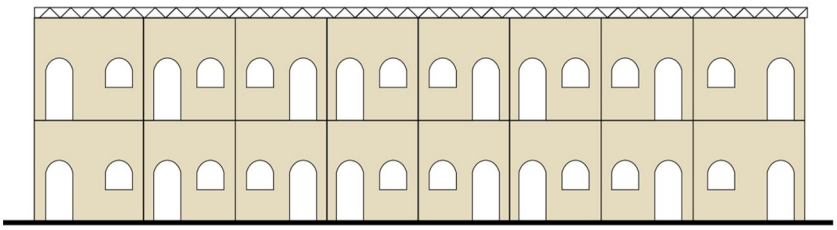


Figure 5:Shows the accommodation rooms in front of the pool

Figure 6:SShows the elevation of the accommodation rooms in front of the pool with the roof

Figure 7: The interior of the accommodation room

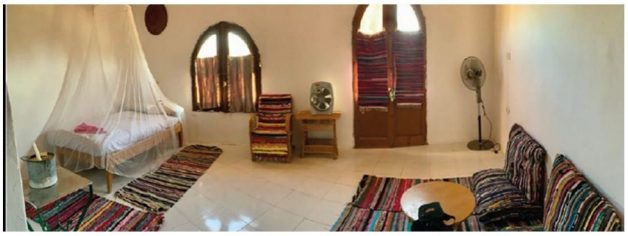
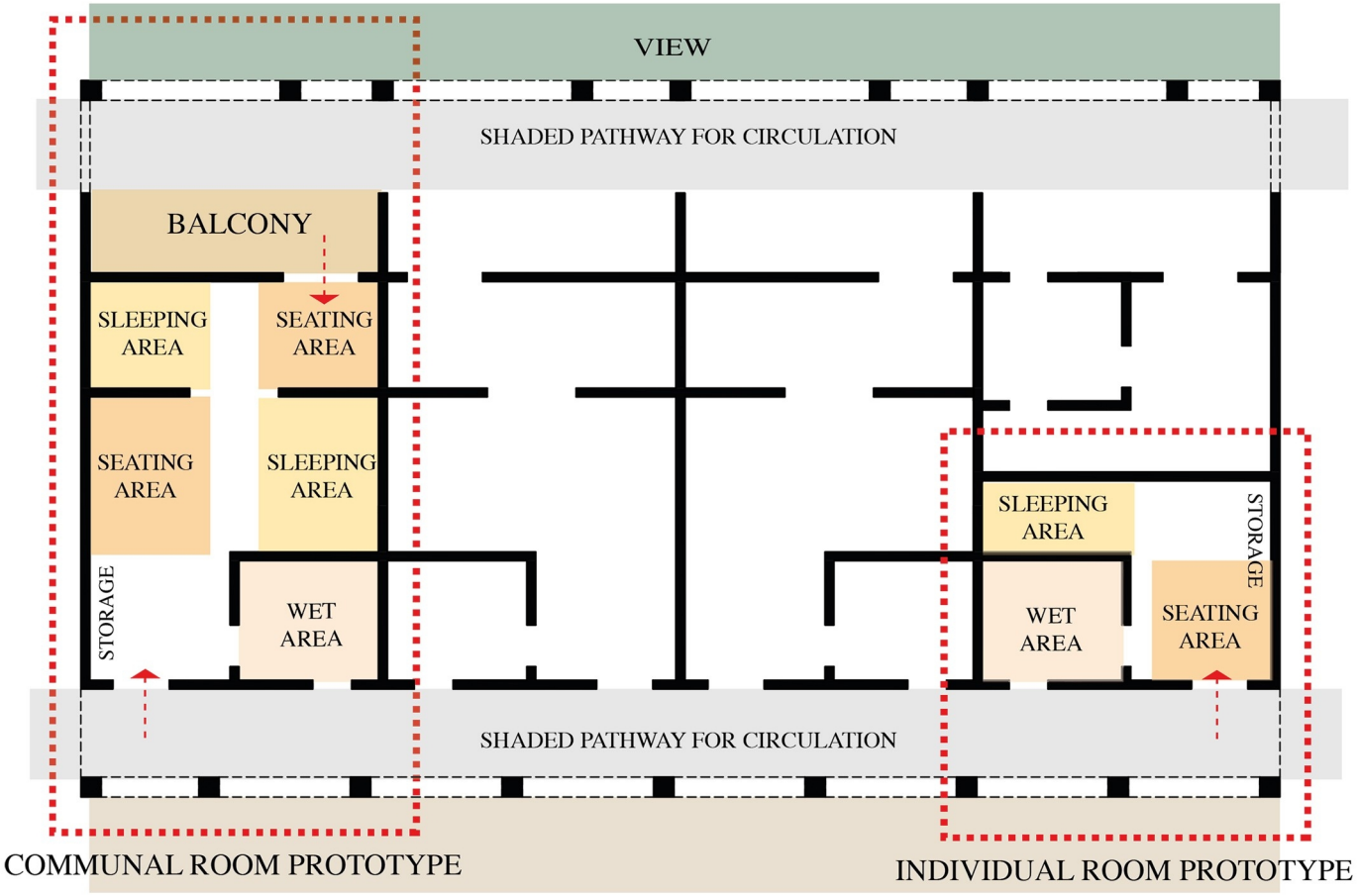


Figure 7: Elevation of the accommodation rooms with balconies

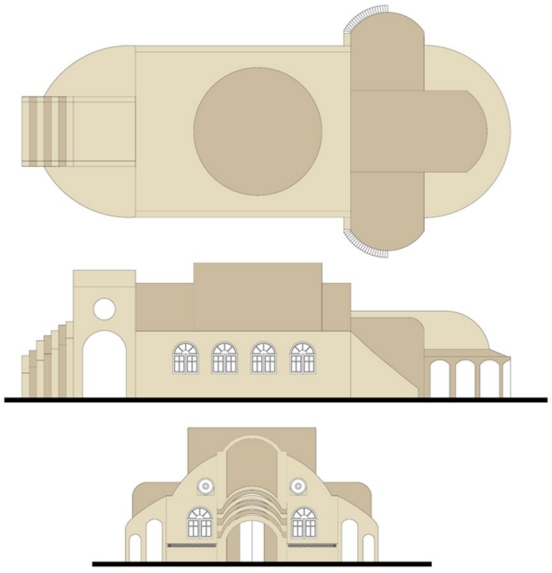
Figure 9:Shows the plans of the accomodation rooms in R1



R1 Main Space – The Church

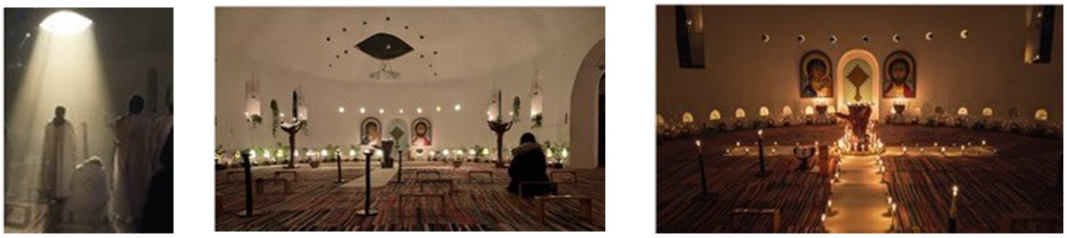
The church is the main space in R1. It is also called the mediation Centre or the chapel. The church is circular in shape with no straight lines. *"Curves increase the sense of spirituality inside the church. In addition, it improves acoustics; no microphones are used. The church's ceiling is shaped as a dome; the dome represents perfection and eternity"* (Figure 11). The church's exterior resembles a ship, which carries Christian symbolic connotations. The church is symmetrical in geometry, with openings on both sides. The entrance to the church is reached through a large pathway with arches, which is associated with the sublime

Figure 8:The Elevations and the layout of the Church



experience of visitors (Figure 10). The roof of the church is accessible to visitors The church's interior is white in color and undecorated. The walls are blank except for recessed niches (Figure 11). The number of niches has a biblical significance. In the church, there is no electricity or artificial lighting; it is lit by candles placed in the niches. The use of candles associated with the experience of mindfulness inside the space. The church floor is covered with a multi-colored handmade rug. *"Multi-colored rugs resemble the idea that*

Figure 9: The Interior of the Church

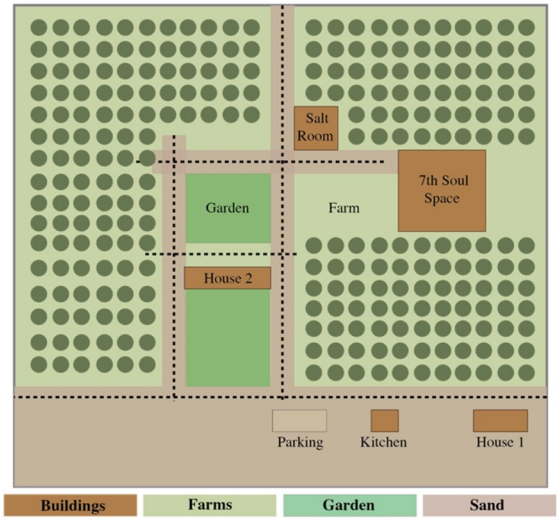


multi-nationalities and beliefs may join in R1". In the ceiling and towards the East, there is an opening cut in the shape of an eye through which the light enters the space (Figure 11). *"This eye symbolizes the meaning that God is always watching over and is close to the prayers."* Such details in the church allow the visitors to mediate and think during their prayers and visit.

Retreat Centre 2

Introduction

Figure 10 Layout of Retreat Centre 2



R2 is an agri-touristic project in Egypt located about 58 Km north of Cairo. R2 represents itself as a gateway for visitors to enjoy their well-being journey. It offers visitors wellness and health education workshops, such as yoga, meditation, music, and agriculture teaching. It's a family-run farm that offers a place for retreats and well-being workshops. Upon arrival, visitors will find several venues on-site to spend time. *"The feel and the architecture reflect well-being, with a design that reflects peaceful light colors, natural, and comfortable spaces"* as mentioned by R2. The layout of R2 is intended to fit different buildings in a chaotic manner to create open spaces between them for meditation and walking (Figure 12). The retreat is divided into five main spaces: a large domed hall where most of the indoor events and

workshops are hosted, accommodation rooms, and a salt room inspired by Siwa and constructed by craftsmen from Siwa. The walls of the salt room are made of salt and salt bricks transported from Siwa. The walls are very thick and yellow in color. "*The floor of the salt room is made of salt, based on scientific theories that salt absorbs negative energy*. The kitchen; R2 has three outdoor underground ovens for slow cooking and serves home-cooked, healthy, and organic food freshly prepared on site. Finally, the open gathering space with the gateways. R2 has a variety of antique gateways collected over the years in the open space. "*This symbolized the idea that each visitor has a unique gateway to experience his way to the retreat*".

Accommodation Rooms:

R2 has two mud brick houses for accommodation. The founder made the bricks herself with the help of craftsmen. The rooms are domed and painted in white color with openings in the dome. Most of the furniture inside is old, recycled furniture. Both houses look similar on the exterior in terms of elevation and massing (Figure 13), while they differ from the interior. The first mud-brick house accommodates 4 persons with a seating area and a dining area and provides a space for storage, it is a more private space. On the other hand, the second accommodation house hosts 2 persons and provides a mini kitchen for all the visitors and an open communal space for seating and games. (Fgure 14).

Figure 11: R2 accommodation houses

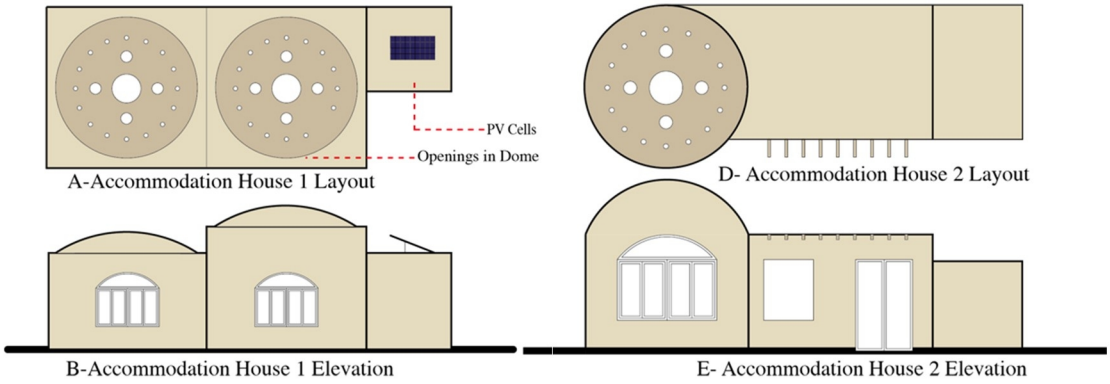
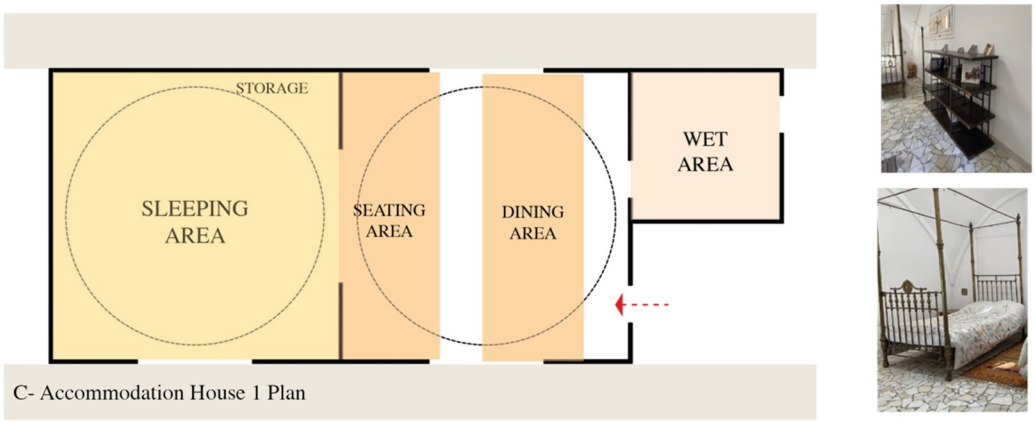
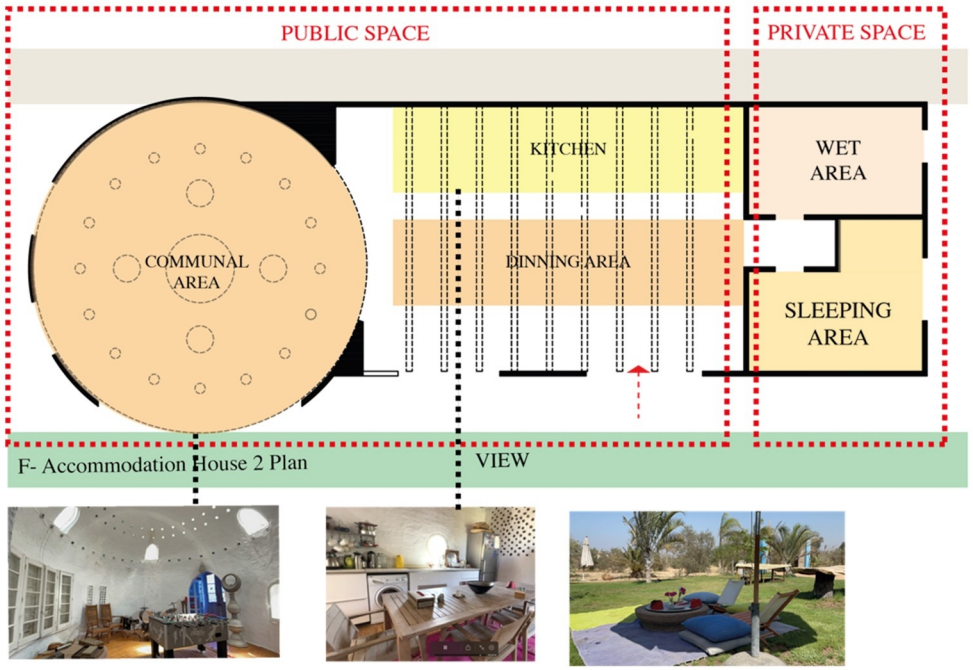


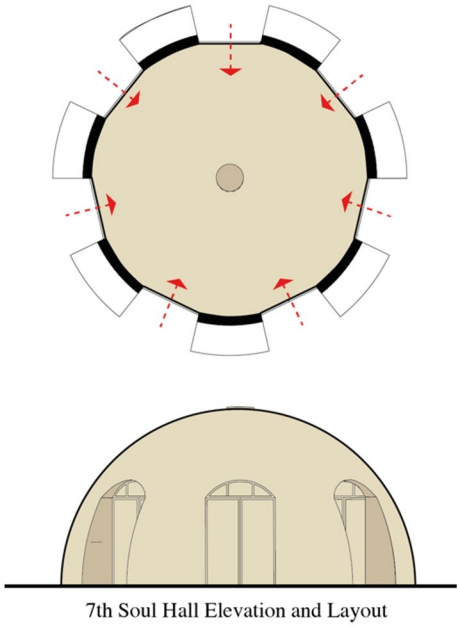
Figure 12: Zoning of accommodation house in R2





R2 Main Space - 7th Soul Venue:

Figure 13: Plan and main elevation of the 7th soul venue.



The 7th soul venue is the main space in R2. Most of the events take place in this space. It is a domed hall has seven wooden doors with mirrored glasses (Figure 15 and Figure 16). The seven doors resemble *"the seven gates of spirit pointing to Love – Imagination – Life – Meditation – Beauty – Wisdom, and Giving, and these are the main objective of R2"*, as mentioned. The room is painted in bright and warm colors for *"fewer distractions and help the visitors to focus more."* The doors' openings and the dome provide a well, naturally lighted space and help in acoustics. The dome was designed by an Egyptian architect and was constructed by craftsmen. The founder asked him to *"create a place that had a piece of Egypt in it, using the past and the new, built in a way that an ancient Egyptian would"* The dome is inscribed with poetic verses in Arabic calligraphy (Figure 16). The 7th Soul venue accommodates different events with different settings and designs.

Figure 14: The 7th Soul Venue interior and exterior shots.

DISCUSSION & FINDINGS

The purpose of the study is to comprehend how architecture and mindfulness are related. The study focuses on finding out how mindfulness is impacted by the built environment's spatial features and how people interact with their surroundings. R1 and R2 reflect parallels related to mindfulness. The findings demonstrate that both retreats met the recommendations of previous research on the architecture of retreats (Holubchak,2017). The aim of R1 and R2 was to provide an environment that is self-sufficient and sustainable (Holubchak, 2019). An environment that promotes connection to self by being immersed in nature and practicing meditative activities, using environmental sustainability by producing its own food on-site, recycles waste, uses renewable energy, and can support itself by selling its products for funding. This vision aids in meeting the retreat's economic and

ecological needs. R1 and R2 use locally manufactured mud bricks in construction for cost reduction. R1 produces the bricks on-site in the mud house to be used in construction. While in R2, the founder built the mud bricks with the assistance of the craftsmen on-site in the accommodation houses. Using natural and available materials in both retreats revealed the emptiness of the materials used in the space (Odor,2015). Mud bricks were used in both retreats' interior design to create the impression of an unfinished room. The visitors' psychological comfort is enhanced by this sense of the unfinished space, which also makes mindfulness practice less distracting due to the minimal distractions found in the finishing of the space. The use of natural materials associated with keeping the space cool in both R1 and R2 and decreased use of air conditioning and electricity helped the retreat meet its environmental standards. Regarding the choice of colors in R1 and R2, both retreats had exteriors painted in earth tones and interiors painted in white and bright colors. R1 places greater emphasis on using natural light than artificial lighting. By lighting candles at night, R1 seeks to convey the experience of mindfulness. The usage of built space and the outdoor open space in the retreat is balanced in R1 and R2 (Odor,2015; Holubchak,2017). A crucial component of mindfulness is open green space because it encourages visitors to engage with nature and concentrate on the present. To enhance the visitor's experience and to support noise reduction and the weather cooling, R1 integrated the pool as a natural feature in the outdoor space while R2 added the antique gates in the open space, each resembling a story. As a result, the outdoor spaces in R1 are associated with mindfulness by creating a quiet contemplative mediating space with the help of the white noise of the pool. While R2’s outdoor spaces are associated with mindfulness through symbols, interpretation, and reflection of the visitors.

The relation between mindfulness and architecture is represented in the architecture of retreat, despite many psychologists dismiss the significance of space in relation to the practice of mindfulness. In both case studies, architecture in terms of space, shape, light, materials, and colors was used to assist retreat visitors in silencing all outside distractions so they may concentrate on the present and practice mindfulness. Whether they want to use mindfulness to connect with the creator or to create well-being and harmony between mind, body, and spirit, this is achieved in space. This space helps in creating a sense of repose and a connection with nature through materials, colors, and light.

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Gender, Intersectionality and Boardroom Decision-Making in the MENA region

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Abstract

Over the last decade the role of gender diversity in society has seen a dramatic rise in areas which were traditionally dominated by men. For instance, industry has seen the rise of women leaders across major businesses in different sectors. However, there still appears to be a divide between Eastern and Western regions globally in view of the role of gender diversity in roles that require crucial decision making. Therefore, the purpose of this study was to investigate the impact of gender diversity on boardroom decision making leading to improved business growth in the MENA (Middle East and North Africa) region. Based on a systematic literature review, this paper identified a lack of clarity on the role of gender diversity in boardroom decision making leading to improved business productivity. Additionally, a lack of primary research was identified in the geographic context of the MENA region which therefore informed a survey based study involving 154 male and 146 female business owners/hierarchy figures.

The sampling was informed by the Convenience sampling method where the initial sample of business leaders was retrieved from an MBA/DBA student population in universities based in the MENA region. A means score differentiation analysis between the male and female participants identified the dominance of male decision makers over their female counterparts within businesses based in the MENA region. Therefore, the findings from this research contributed to the lack of clarity highlighted from the results of the SLR. Additionally, practical, policy and theoretical implications were identified from the findings of the research. However, limitations of this research based on survey strategy and limited representation of gender were also highlighted. Therefore, future recommendations based on the identified research implications and limitations are outlined in the final section.

Keywords: Gender; Corporate; Boardrooms; Performance; Decision-making; United Kingdom; Theoretical Framework; Theoretical Model; Systematic review; MENA region.

Article Classification: Primary research study involving a survey approach.

Introduction

The debate about gender involvement in corporate boardroom decision making has been ongoing with varying views about the phenomenon (Boutchkova et al , 2020). Moss (2018) and Reddy and Jadhav (2019) highlight that there is no relationship between increased boardroom gender diversity and the performance of businesses especially in the area of business growth and annual revenue.

Alternatively, another school of thought disagrees with the above assertion and this has led to an ongoing debate on the 'real' impact of gender diversity in decision making within boardrooms (Ahmed and Ali, 2017; Alazzani et al., 2017). Therefore, the effect of gender diversity on business' boardrooms has created a form of debate among worldwide studies. In Spite of this ongoing debate, there are also inadequate studies that have tried to look at the impact/role of gender in corporate boards within a UK context. Additionally, studies that have tried to clarify some of the confusion in the area, have been done neglecting social, cultural and geographical perspectives that may have an influence on the role of gender in the corporate boardroom. The highlighted debate and the identified limited research related to investigating gender diversity on boardrooms has promoted the need for further research through this paper. Therefore, the purpose of this paper will be to explore and investigate the influence/role of Gender diversity on decision making in boardrooms leading to improved business' performance. This research is therefore meant to answer some of these critical questions and further enhance corporate decision making in the MENA region.

For the purpose of this research, the following terms are identified as follows: *gender* will be represented by the individuals of female, male, transgender, non-binary, gender neutral, pangender, agender, genderqueer, third gender and two-spirit [The World Health Organisation (WHO), 2020]; *boardrooms* will be highlighted as a group of members that plan, organise and develop policies/strategies for

the future direction of the business; *performance* will represent business growth in terms of revenue and size growth.

Literature Review

Review of Worldwide Literature

A systematic literature review (SLR) was adopted in the literature review for this paper which identified, selected, and critically analysed studies in order to determine the presence of worldwide research investigating the role of gender diversity in the boardroom in terms of geographic context and primary/secondary research. An SLR method is highlighted by Saunders et al. (2016) to follow a defined plan where the relevant prerequisites are clearly defined before the review is initiated. The reason behind the selection of SLR in this research was that it provided a clear and comprehensive overview of available evidence along with information on the given topic area (Silverman, 2017). An SLR method also aides in further highlighting a paucity in literature within a specific area which therefore may lead to an overarching understanding of the given topic area (Silverman, 2017).

The SLR in this paper included studies from the period January 2000-December 2021. The rationale behind targeting studies from January 2000 was that the authors were aiming to review studies conducted in the 21st century. Google, Bing, Yahoo and Google Scholar were the online search engines adopted to find the targeted studies. The key terms typed into the search engines were 'decision-making', 'boardrooms' and 'gender', and the key phrases typed into the search engines were "role of gender diversity in business boardrooms", "role of gender diversity in decision-making in businesses" and "gender in boardrooms". The main determining factor for the inclusion of papers in the review was a focus of the study on investigating the influence of gender diversity on decision-making in the boardroom that enables improvement within a business' growth in terms of size and revenue. Basically, the SLR reviewed studies that were aiming to establish a

link/correlation between a gender and decisions that led to improvement in the organisation in key operation areas like employee retention, customer growth and marketing.

An SLR is regarded as effective when five steps are applied (Khan et al., 2003). The five steps that enable a study to conduct an effective systematic review are presented in Table 1.

Step	Explanation
1. Framing questions for a review	The problem(s) to be addressed by the reviewer should be clarified/specified in the form of clearly structured and unambiguous questions before undertaking the systematic review
2. Identifying relevant studies	The search for studies should be extensive where sources can be generated in digital and paper forms and the search should not be restricted by language. The pre-requisite for the selection of a study should be based on Step 1. Reasons behind the inclusion or exclusion of studies in a systematic review should also be recorded
3. Assessing the quality of the studies	Study quality assessment is relevant to every step of a review. Question formulation (Step 1) and study selection criteria (Step 2) should describe the pre-requisites behind selection of a study. Selected studies should be subjected to a more refined quality assessment by adopting critical appraisal practices and design-based quality checklists (Step 3). The detailed quality assessments are adopted for exploring heterogeneity and informing decisions regarding suitability of meta-analysis steps (Step 4). Additionally, the analysis of reviewed studies help in assessing the strength of inferences and making recommendations for future research (Step 5)
4. Summarising the evidence	Data synthesis consists of tabulation of study characteristics, quality and effects as well as use of quantitative/qualitative analysis methods for exploring differences between reviewed studies and combining the effects of their key findings (eg meta-analysis). Advance planning should be involved in the exploration/investigation of heterogeneity along with its sources (Step 3). There is an option of a subgroup meta-analysis if an overall meta-analysis is not possible.
5. Interpreting the findings	The issues identified in each of previous four steps should be addressed. All related biases should be explored, eg publication bias. An exploration for heterogeneity should help identify/determine whether the overall summary can be trusted/legitimatised, and, if not, the effects identified in high-quality studies can be adopted for generating inferences/correlations. Any recommendations should be identified and labelled in reference to the strengths and weaknesses identified after reviewing each study

Table 1: Steps in a SLR

Source: Khan et al., 2003

The five steps identified in the above table informed the development of steps for the SLR in this paper. The steps for this study's SLR, their link to steps outlined by Khan et al (2003) (highlighted as the steps in bold) and their individual explanations are presented in the below table.

Systematic review step	Explanation
1. Research Question (**Steps 1 and 2**)	Selecting studies for review that had a focus/purpose of investigating the influence/impact of gender in decision-making in the boardroom that enables improvement within a business in areas like annual revenue, business size, health and safety, and employee working conditions.
2. Age of the Research Study (**Steps 1 and 2**)	The critical review involved studies from January 2000 to December 2020
3. Research Method (**Step 3**)	To review whether secondary or primary research was adopted in each study
4. Theoretical underpinning (**Step 3**)	To identify whether a theoretical framework/model was included in the reviewed study
5. Context of the Research (**Step 3**)	To identify the geographic location for where the study was based
6. Sector of Businesses involved in the studies (**Step 3**)	To determine whether the sector was identified for the businesses involved in the study
7. Source type (**Step 3**)	To clarify whether the study was from a website, journal or book.
8. Summarising and comparing the findings (**Step 4**)	To summarise and compare the findings through a thematic analysis method in order to identify any emerging themes.
9. **Step 5** from Khan et al (2003)	This will be addressed through a comparison between literature review and systematic review findings

Table 2: Further explanation of steps in an SLR

Source: Authors

Thematic analysis was the data analysis method adopted during the SLR which involved dividing retrieved data in to separate categories through identification of themes and patterns (Mackey and Gass, 2015).

Implementing Steps 1 and 2 (selecting studies from January 2000-December 2020) in Table 2 has led to the SLR identifying 26 studies related to investigating the influence of gender diversity on decision making in the boardroom .

As the aim of this paper was to investigate or understand the influence/role of Gender diversity on boardroom Decision Making in improving a business' financial performance, then, after the application of Step 1 (Table 2), this paper identified studies that were related to investigating the link between gender diversity in decision-making in the boardroom on a business' financial performance.

The 14 selected studies are given in Table 3. As a result of the SLR, the below table presents the author(s), year, location, method, theory, source, sector of businesses and key findings related to each of the reviewed studies (steps 3-7 from Table 2). Steps 3-7 were undertaken for all studies from Table 1. The authors and purpose related to each selected study for the SLR are given in the below Table.

Author	Study Purpose
Nielson and Huse (2010)	To investigates the contribution of women directors to board decision-making and strategic involvement
Alvarado et al (2011)	This study analysed the relationship between gender diversity on Boards of Directors and business success
Doldor et al (2012)	Examined the corporate Board appointment process and the role of the executive search firms in making Boards more gender balanced.
Gregory-Smith et al (2013)	Examined issues regarding the scarcity of women in boardroom positions. The article examined appointments, pay and any associated productivity effects deriving from increased diversity
Christiansen et al (2016)	Examined the link between gender diversity in senior corporate positions and financial performance of 2 million companies in Europe.
Jeong and Harrison (2016)	Conducted a comprehensive synthesis of the research on how female representation in the upper echelons in a business might affect firm performance.
Abad et al (2017)	Examined the relation between the gender diversity on boards of corporations and the levels of information asymmetry in the stock market
Ahmed and Ali (2017)	Investigated the relationship between gender-diverse boards and stock liquidity (value of the business) in Australia.
Alazzani et al (2017)	Aimed to differentiate between the social and environmental performances of companies to examine whether the presence of females on the boards of directors of Malaysian firms could affect social and environmental performances differently
Gordini and Rancati (2017)	Analysed the relationship between board gender diversity and firm financial performance in Italy
Nadeem et al (2017)	This study investigated the impact of boardroom gender diversity on corporate sustainability practices
Nadeem et al (2017)	This study investigates the relationship between boardroom gender diversity and intellectual capital (IC) efficiency in China
Garcia-Izquierdo et al (2018)	Examined the relation of the presence of female directors both at board meetings and at audit and remuneration committees, with CEO pay and the shareholders' consultative vote on managerial remuneration plans
Ghaeli (2018)	Studied recent works on the relationship between gender and firms' financial performance as well as the relationship between gender and firms' interest in global warming
Moss (2018)	Investigated the impact of female directors on the performance of 369 FTSE All Share companies from 2008 to 2014
Sial et al (2018)	Explored whether corporate social responsibility mediates the relationship between boardroom gender diversity and firm performance.
Chen et al (2019)	The study investigated the influence of women board members on controlling over-confidence amongst male CEOs
Nanda et al (2019)	Investigated whether Gender Diversity Makes a Difference in the Boardroom?
Parsons (2019)	Provided a current update (October 2019) on statistics related to the number of women in boardrooms across businesses in the UK
Reddy and Jadhav (2019)	Examined the advancement of literature on gender diversity on corporate boards
Usman et al (2019)	Investigated the question concerning whether gender diversity in the boardroom matters to lenders or not?
Boutchkova et al (2020)	Investigated the circumstances under which board behaviour is affected by gender diversity
Coyle (2020)	Provided a current update (March 2020) on statistics related to the number of women in boardrooms across businesses in the UK
Tran et al (2020)	Aimed to reveal the entire benefits of the appearance of women on board to reduce downside risk in the frontier countries
Zahid et al (2020)	Examined the impact of boardroom gender diversity on corporate sustainability disclosures (CSD) in Malaysia
Zaid et al (2020)	Investigated the effects of board diversity as a multifaceted phenomenon, specifically nationality and gender diversity on the extent of corporate sustainability performance in Palestine

Table 3: Studies addressing Gender Diversity within business boardrooms

Source: Authors

The reviewed studies are summarised in Table 4 in terms of author(s), year, location, method, theory adopted, type of source

(article/website/book, and sector of businesses) involved and the key findings.

Author(s)	Year	Location	Method	Theory	Book/ journal/ website	Sector of involved businesses	Key Findings
Nielson and Huse	2010	Norway	Survey	Stereotype threat theory	Journal (European Management Review)	Unclarified	The study found that women directors influence board strategic involvement through their contribution to board decision-making, which in turn depends on women directors' professional experiences and the different values they bring to the role. Drawing upon stereotype threat theory, we further find that perception of women as unequal board members may limit their potential contribution to board decision-making.
Alvarado et al	2011	Spain	Secondary	None adopted	Website	Unclarified	There is no link between increased women board members and improved performance within a business.
Gregory-Smith et al	2013	UK	Secondary	None adopted	Journal (The Economic Journal)	Unclarified	The article finds no support for the argument that gender diverse boards enhance corporate performance.
Christiansen et al	2016	European	Secondary	None adopted	Website	Unclarified	Addition of women members to corporate boards appears to have a greater positive impact on firm performance in high-tech and knowledge intensive sectors, however, the same does not necessarily apply for organisations in other sectors, eg service sector.
Jeong and Harrison	2016	Worldwide	Literature review	A conceptual framework based on unique resource portfolios, team decision-processes, and role incongruence perception	Journal (Academy of Management)	Unclarified	There is no link between increased gender diversity in the boardroom and improved performance within a business.
Ahmed and Ali	2017	Australia	Secondary	Critical Mass Theory	Journal (Journal of Contemporary Accounting and Economics)	Unclarified	The findings suggest that having women on corporate boards is positively associated with an increase in the value of the business, eg stock value.
Alazzani et al	2017	Malaysia	Secondary	Upper Echelon Theory	Journal (Corporate Governance)	Unclarified	The empirical results suggest a positive association between social performance and the presence of female directors on the board of directors of Malaysian firms. However, no association was found between environmental performance and the presence of female directors on those boards. Additionally, the results identify that the association between a firm's social and environmental performance and gender diversity depends on the culture within which the company operates.
Gordini and Rancati	2017	Italy	Secondary	None adopted	Journal (Management Research Review)	Unclarified	The findings identify that greater gender diversity may generate economic gains; however, companies should focus their efforts on the right mix of men and women rather than on simply the presence of at least one woman on a board of directors
Ghaeli	2018	Worldwide	Survey	None adopted	Journal (Accounting)	Unclarified	The findings identify that firms with the presence of females had more concerns on green gas effects than other male oriented corporations did. The findings also add that when a female member joins the board of directors, most investors consider this as a positive signal for profitability. Therefore, it appears that the presence of female boardroom members contributes to firm's financial performance.
Moss	2018	UK	Secondary	None adopted	Website	Pooled OLS without control variables, pooled OLS with control variables and firm fixed effects with control variables	The study identified that female board representation does not necessarily impact Firms' financial performance, however, in higher-risk environments more female directors significantly improve firms' financial performance.
Sial et al	2018	China	Secondary	None adopted	Journal (Sustainability)	Unclarified	The results show that the existence of female directors on the board can improve the firm performance.
Reddy and Jadhav	2019	Worldwide	Literature review	Agency Theory	Journal (Cogent Economic and Finance)	Unclarified	There is no link between increased women board members and improved performance within a business.
Minerva Analytics Ltd	2020	UK	Survey	None adopted	Website	Unclarified	Companies in the top 25% for gender diversity in corporate boards were 21% more likely than other companies to experience increased profitability.
Tran et al	2020	Vietnam	Secondary	None adopted	Journal (Mathematics)	Unclarified	The findings confirm that the role of female leadership/decision-making within boardrooms in terms of reducing the downside risk depend on their level of management and the firm behaviour towards risk

Table 4: Findings from Systematic Review

Source: Authors

As highlighted in Table 4, a theoretical framework/model was included in 5 of the reviewed studies but the sector for businesses involved in the studies is not clarified in all reviewed studies. In Table 4, 3 of the reviewed studies were based in the UK; a single study was based in each of the countries of China, Australia, Malaysia, Italy, Spain, Norway, and Vietnam, 3 studies were conducted in a worldwide

context, and 1 study was conducted in a European context. In Table 4, the sector for the businesses included in all of the reviewed studies was not clarified. As shown in Table 4, 9 of the reviewed studies were based on a secondary method whereas 3 of the reviewed studies were based on a survey method and 2 of the studies were based on a literature review method. In Table 4, a theoretical model or framework was included in 5 out of the 14 reviewed studies. In all of the reviewed studies in Table 4, 10 were from journals and 4 were from websites.

In Table 4, 6 of the reviewed studies identified that there is no link between increased gender diversity in boardroom decision making and improved productivity within organisations, however, 8 of the reviewed studies indicated that there was indeed a link. An insight is gained from the findings from the SLR regarding the role of gender diversity in boardroom decision towards improved productivity in an organisation. However, all the reviewed studies only consider the male and female genders. Therefore, based on the definition of gender initially clarified in Section 1, for the purpose of this paper, there is paucity in existing literature as other genders outside of female and male have not been addressed in the reviewed studies.

From the findings of the SLR in Table 4, it was highlighted that a majority of the reviewed studies were based on secondary research and a majority of the reviewed studies were in journals articles. Therefore, a lack of primary research focusing on linking *boardroom gender diversity on improved productivity/growth in an organisation* may be limited/lacking.

Therefore, the concluding points from the SLR are as follows.

- A majority of the studies involved secondary research and majority of the studies were journal articles (Table 4). Therefore, a lack of primary research focusing on linking

boardroom gender diversity on improved productivity/growth in an organisation may be lacking/limited.

- As highlighted in Table 4, 6 of the reviewed studies highlighted that there was no link between increased gender diversity in boardroom decision making and improved productivity/growth within an organisation, however, 8 of the reviewed studies indicated that there was indeed a link between gender diversity in boardroom decision making and productivity. An insight is gained from the findings from the SLR regarding the role of gender diversity in boardroom decision towards improved productivity in an organisation. However, all the reviewed studies only consider the male and female genders. Therefore, based on the definition of gender initially clarified in Section 1, for the purpose of this paper, there is paucity in existing literature as other genders outside of female and male have not been addressed in the reviewed studies.

From undertaking the SLR method on the 14 worldwide studies, it can be concluded that there is no primary research investigating the role of boardroom decision-making in the geographic context of the Middle East and North Africa (MENA) region. Hence, primary research related to the MENA region will contribute to knowledge in the literature. Additionally, there will be implications on the wider society as unlike Western countries, the clarification and understanding of gender as well as the sensitivities while considering gender in the workplace are fairly unexplored in the MENA region (Dalacoura, 2019; Kucuk, 2013). Therefore, primary research investigating the role of gender in boardroom decision making leading to business profitability in the MENA region will contribute to knowledge as well as having an impact on the wider population.

Review of Theoretical Frameworks/Models based on Decision Making

According to Saunders et al. (2016), a theoretical framework is a structure that has the ability to back a theory within a research study, however, Saunders et al (2016) describes a theoretical model as a theory that is based on assumptions related to a given system. Steele (2015) explains the decision-making process as a logical but

cumbersome task. Therefore, due to their involvement in previous decision making related research the Stakeholder theory, Rational/Classical Model, Administrative/Bounded Rationality Model, Retrospective Decision-Making Model and Agency theory were selected to be reviewed in this section in order to identify/develop a suitable conceptual framework related to investigating the influence of gender on boardroom decision making. The Rational or Classical Model is widely known to unwrap the decision making process where the model is illustrated in Figure 1 (Li, 2009).

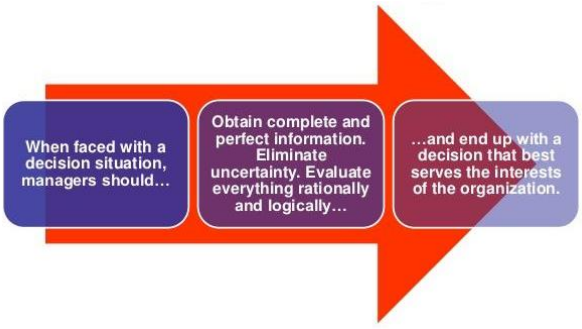

Figure 1: Rational or Classical Model for Decision Making

Source: Li, 2009

The characteristics of the Rational/Classical Model are presented in the below table.

No.	Feature
1	Problems are clear
2	Objectives are clear
3	People agree on criteria and weights
4	All alternatives are known
5	All consequences can be anticipated
6	Decision makes are rational
7	They are not biased in recognising problems
8	They are capable of processing ail relevant information
9	They anticipate present and future consequences of decisions
10	They search for all alternatives that maximises the desired results

Table 5: Characteristics within the Rational/Classical Model

Source: Li, 2009

Gilovich et al. (2002) explains the Administrative or Bounded Rationality Model as a model that involves decision-makers to fully investigate different approaches related to achieving the desired goals/targets. The Administrative/Bounded Rationality Model is illustrated in Figure 2.

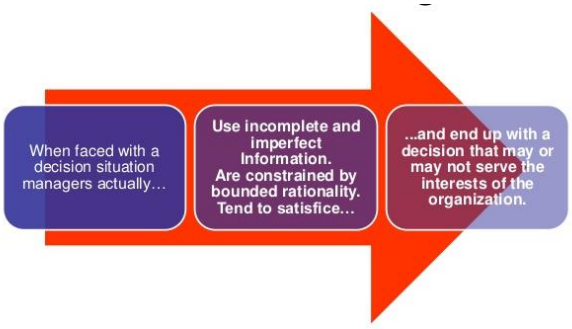

Figure 2: Administrative/Bounded Rationality Model for Decision Making

Source: Wheeler, 2018

Wheeler (2018) identifies that the Administrative model as a comprehensive level of information to be adopted effectively in a research study which would enable it to investigate the full array of avenues available to achieve goals/targets. Wheeler (2018) explains that the model considers the social constructs behind the decision making process, for example, why one avenue to achieve a target was selected over other identified avenues. Additionally, the model is based on concepts ranging from Sequential Attention to Alternative solution, Heuristic and Satisficing (Wheeler, 2018). These concepts related to the Administrative model are explained in the below table.

Source	Explanation
Sequential Attention to alternative solution	The tendency for decision makers to examine/investigate possible solutions individually rather than identifying all the solutions and refrain from searching once an acceptable (not necessarily the best) solution is identified
Heuristic	The assumptions that guide the search for alternatives into areas that have an increased probability for generating success
Satisficing	Selecting a course of action that is satisfactory/sufficient under the circumstances. This involves decision makers in accepting the first alternative that meets their pre-requisites rather than pushing them further for an alternative that generates the best results.

Table 6: The Concepts related to the Administrative Model

Source: Wheeler, 2018

Hansen (2020) explains the Retrospective Decision Making Model as a model that investigates how decision makers rationalise as well as justify their choices after they have made decisions. The Retrospective Decision Making Model is provided below in Figure 3.

Figure 3: Retrospective Decision Making Model

Source: Hansen, 2020

Hansen (2020) describes the Retrospective Decision Making Model as a process involving scientific rigor that is designed to investigate and analyse related decisions that have already been made. This model allows the user to reinforce that their behaviour can be classified as rational and logical through adopting a measured, logical, and reasoned approach while making decisions (Hansen, 2020; Reed, 2017).

The Agency theory is identified by Panda and Leepsa (2017) as a theory that is a adopted to investigate and explain as well as provide solutions for barriers encountered in the relation between principles or concepts related to business and their agents. Additionally, this relationship acts as a bond between shareholders as principals and the business executives as their agents. Figure 4 provides an image of the Agency theory.

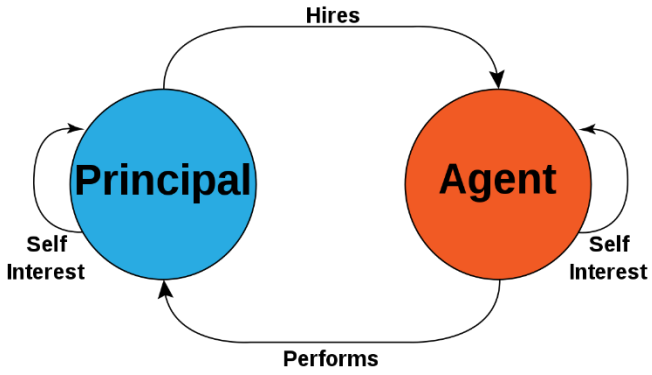

Figure 4: Illustration of the Agency theory

Source: Panda and Leepsa, 2017

Panda and Leepsa (2017) identify an advantage related to the Agency theory of it having an ability to provide a comprehensive insight through a more in depth explanation related to conforming behavioural traits which allows the theory to explain real life scenarios. Panda and Leepsa (2017) identifies another benefit from adopting the Agency theory as its adoption being appropriate during training sessions within businesses where employees along with other stakeholders are made aware of all possible agentic states in order to empower them so that they can be held accountable and responsible for their decisions and actions. For example, employees' conformation to a set of rules, regulations, and policies along with the related penalties are clearly outlined embedded amongst employees within a business where all company stakeholders acknowledge and agree to the outlined policies through their signing of a binding document. However, an inability to distinguish ownership from factors like control, conflict of interest,

risk reduction and information asymmetry are highlighted by Payne and Petrenko (2019) as limitations related to the theory. Factors like ownership structure, executive ownership, and the mechanism of governance like corporate board structure, may actually confuse or misdirect understanding on the role, structure, and implementation of the Agency theory (Payne and Petrenko, 2019).

Bendickson et al. (2016) identify additional limitations related from the adoption of the Agency theory, where the authors identify that the theory overlooks crucial factors related to ethical as well as anti-social implications during the investigation of the role of decision making in a boardroom setting within organisations.

Blackburn (2019) identifies the Stakeholder theory as a theory that involves capitalism and may possibly promote relationships between businesses and the related stakeholders to a given business. Blackburn (2019) explains that the theory involves investigating how a business can generate value for all stakeholders in addition to shareholders. Figure 5 provides an image of the Stakeholder theory.

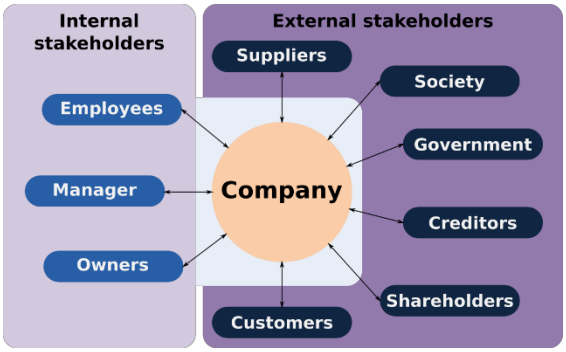

Figure 5: Stakeholder Theory

Source: Blackburn (2019)

The main advantage highlighted for the theory is that it is not merely a model that solely identifies and explains the objectives related to a business. Unlike previously mentioned theories, the Stakeholder

theory considers economical and ethical related factors and queries. Another identified advantage for the theory is that it encourages and promotes equality as well as fairness amongst all stakeholders within a corporation and gives the leadership a guide which involves leadership being motivated to work for the greater good of all stakeholders related to the business (Miles, 2017). The theory presents a balanced combination of economy and ethics related factors where a business cannot ensure survival simply based on a vision directed towards financial gain (Miles, 2017; Wright, 2018). Additionally, the theory can provide feedback from stakeholders like employees, customers as well as suppliers where their role is crucial towards the growth and survival of businesses. Therefore, all business stakeholders are considered through the application of the Stakeholder theory which in other words provides a more comprehensive representation of a business (Wright, 2018). However, an assumption that the value of all stakeholders of a business is identical is highlighted as a limitation for the Stakeholder theory which is not the case for theories like the Agency theory (Freeman et al., 2018). Freeman et al. (2018) explain that this limitation may contribute towards overlooking stakeholders with roles in organisations that may be of more value than other stakeholders. For example, shareholders may have more leverage within a business in comparison to other stakeholders like employees and suppliers.

From the review of the various theoretical frameworks or models it can be concluded that all the reviewed models/frameworks can be incorporated into a research study to investigate factors related to the decision making process within organisations. Additionally, the reviewed models/frameworks all demonstrate the ability to outline decision making based on a set of assumptions. However, the review of the theories has also informed the authors of this paper in evaluating that the importance of appropriateness as well as accuracy related to decisions cannot overshadow the quality related to the decisions which may determine whether a business achieves success or failure. Therefore, the authors of this paper believe that it is crucial for all factors related to decision making to be comprehensively investigated.

Wheeler (2018) explains that soft elements or factors like emotional interference, intuitional, judgemental capabilities, perception of the environment, personality traits, personal values, psychological assessment and intuitional must also be investigated in addition to technological and operational factors in order to gain a more comprehensive outlook of an organisation. Additionally, it is also identified that areas or scenarios where leadership need to review or revisit areas where mistakes regularly occur also need to be evaluated (Reed, 2017; Wheeler, 2018). A summary of the problems or limitations encountered in the decision making process within the reviewed frameworks/models is provided in Table 7.

Problem	Explanation
Indecisiveness	The decision-making process is full of responsibility. The fear of its outcome can lead to some people becoming timid about deciding which may lead to them taking longer to making decisions where an opportunity for success may be lost.
Postponing the decision until the last moment	This results in decision-making under pressure due to time constraints which eliminates the possibility of thorough analysis of a problem which is time consuming.
A failure to isolate the root cause of the problem	Represented by a common practice involving curing the symptoms rather than the causes.
A failure to assess the reliability of informational sources	Taking the reliability and validity of other peoples' opinion for granted in terms of accuracy.
The method for analysing the information may not be the sound one	In the case for most decisions, especially, the non-programmed version have to be based on many factors, information, identification procedure, isolate and select useful information must be sound and dependable. Usually, it is not operationally feasible to objectively analyse greater than five or six portions of information in a given time period. Therefore, the conceptualisation of a model is required which incorporates and handles many variables in order to aid the decision-making process. Additionally, it will be beneficial to define the related constraints, criteria, and objectives earlier in the decision-making process
Do implement the decision and follow through	A decision made is not necessarily the end of the process, rather it may be the beginning. An implementation of the decision along with the results achieved are the true barometer of the decision quality. Additionally, duties/tasks must be assigned, deadlines must be set, evaluation process must be established, and contingency plans must be prepared in advance. The decisions must be implemented whole heartedly to generate the best results.

Table 7: Problems/Limitations identified for the Reviewed Models

Source: Authors

After reviewing the theoretical models/frameworks related to decision making, it can be concluded that none of the reviewed models/frameworks have the ability to address the role of gender in the decision making process. Therefore, there is a paucity in the literature for a theory that has the ability to investigate the role of gender in the decision making process. It should be noted that this section has revealed that the Stakeholder theory has the flexibility to consider all stakeholders within a business which is not possible for other theories. So, the Stakeholder theory can be developed into

a conceptual framework that investigates the role of gender in boardroom decision-making.

Research Methodology

A cross-sectional quantitative research design was implemented. The research questionnaire measuring boardroom decision-making was administered to 560 business leaders of Middle East North Africa region. The business owner/hierarchy sample (total sample was 560) was retrieved in the form of MBA/DBA students from various university databases in the MENA region. Out of 560, only 300 respondents submitted the filled questionnaires. So, the sample of the study consisted of 300 business owners/hierarchy consisted of 154 male and 146 female participants. The sample was selected by using the convenience sampling method. The age range of the retrieved sample was between 32 to 55 years with a mean age of 41.38 years.

The boardroom's decision-making was measured using a self-developed questionnaire. The tool consisted of 7 items in which responses were rated on a 5-point Likert scale ranging from never = 1 to always = 5. All the items were scored in forward direction and a total score was gained by summing the responses from all the items. The higher score on the scale indicated an involvement in active and frequent decision-making behaviour, while the lower score indicated an involvement in diffident, infrequent, and inconsistent decision-making behaviour. The reliability of the tool was checked for the present study by calculating the Cronbach's alpha ($\alpha = 0.78$) to an acceptable range.

Findings

The mean scores for decision making related to the male and female genders amongst the questionnaire respondents are presented in Table 8. It should be noted that the N is the number of respondents, M is the median, SD is the standard deviation, t is the t-test, df is

degrees of freedom and p is the level of marginal significance within the statistical hypothesis test, representing the probability of the occurrence of a given event.

Variables Gender	N	M	SD	t	*df*	*p*
Decision Making Male Female	154 146	28.66 20.43	2.671 4.213	9.507	298	.001**

Table 8: Mean scores for decision making related to the male and female genders

Source: Authors

Therefore, the Hypothesis was initially established as,

Hypothesis: That there is no significant gender difference in boardroom decision-making among leaders.

As shown in Table 8, there is a significance in the mean score difference on decision making highlighted between male and female business owners/hierarchy. An independent samples t-test was employed to measure the difference between the two mean groups. The results highlight that there is a significant difference in the mean scores of decision-making scores between the male and female participants (N = 300, t = 9.507, *df* = 298, *p* = .001 < .01 level of significance, two-tailed). The results in Table 8 show that the mean score of the male gender for decision-making variable (mean = 28.66 with standard deviation = 2.671) is higher than the mean score of the female gender (mean = 20.43 with standard deviation = 4.213) amongst the participants from the MENA region. Therefore, the hypothesis of the study of there being no significant gender difference in decision-making in the boardroom is not supported by the findings of this study. It can be concluded that there is a significant impact of gender in decision-making amongst the business owners/hierarchy in the MENA region where the male gender appears to dominate the female

gender in boardroom decision-making. The mean difference between male and female boardroom decision makers in the MENA region is illustrated in Figure 6.

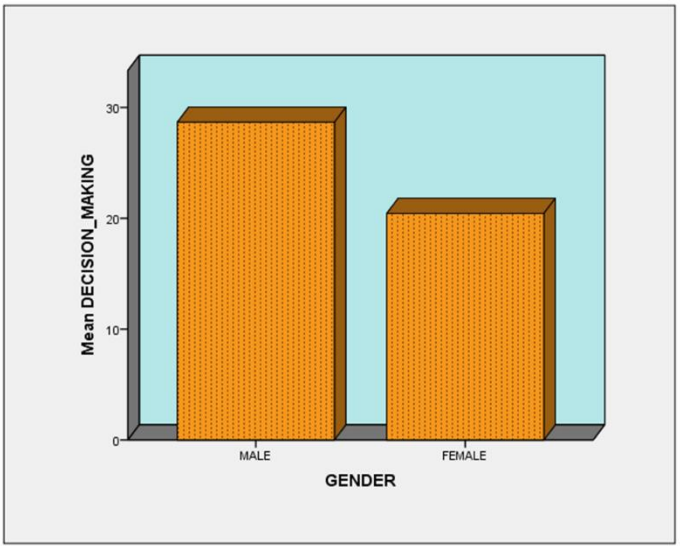

Figure 6: Difference in the Mean between male and female boardroom decision makers in the MENA region.

Source: Authors

Discussion

Gender equality and diversity are recognised to have beneficial effects on organizations, institutions, and the overall economy (Profeta, 2017). This study aimed to examine the impact of gender on boardroom decision-making amongst business owners/hierarchy in the MENA region. The hypothesis of this study outlined that there was no significant gender difference in boardroom decision-making among business owners/hierarchy by calculating the Independent Sample's t-test. The study attempted to examine the significance of gender difference by comparing scores of the boardroom decision-making scale between male and female participants. The study highlighted that there was a

significant gender difference in boardroom decision-making in MENA region based businesses.

The results highlighted that male decision makers were dominant over their female counterparts in the boardroom. Therefore, the study's hypothesis was not supported by the actual results. Consequently, the results suggest that gender has a considerable influence in boardrooms decision-making in a MENA region context. It can be concluded that the male gender is more dominant in boardroom decision-making. The authors believe that this may be attributed to women via stereotype related pressures are led to make more disadvantageous risk decisions than men in the same conditions. Additionally, the authors believe that women fearing negative evaluations are relegated to making more disadvantageous risk decisions in comparison to men. It is the authors belief that the findings highlight the possibility of psychosocial variables based on stereotypes may legitimize and reinforce gender inequality related to decision making in the boardroom. Authors add that this possible disadvantage may aid men in gaining an advantageous position over their female counterparts in the boardroom. Therefore, in terms of the Stakeholder theory there is an inequality highlighted between male and female stakeholders during the decision making process within business boardrooms. There is no actual quantifiable feature provided by the stakeholder theory to measure this inequality, however, the survey results provided in Table 8 and Figure 6 aid the stakeholder theory in providing a quantifiable element in the analytical discussion regarding the stakeholder influence of male and female decision makers in business boardrooms.

The findings of this study support findings from a study conducted by Villanueva-Moya, and Expósito (2021) where they also identified that there is a significant gender difference in boardroom decision-making on a business' growth. Villanueva-Moya, and Expósito (2021) also add that women are globally under-represented in boardroom decision-making positions. According to Profeta (2017), gender diversity in boardroom decision making has a positive effect on a business' growth. While

agreeing with the findings from Profeta (2017) and Villanueva-Moya, and Expósito (2021), Yang and Wu (2007) along with Frigotto and Valle (2018) add that men are greater risk takers in comparison to their female counterparts while making decisions in the boardroom which agrees with the findings of this study. However, the literature review findings in Table 4 are somewhat unclear on the impact of gender diversity in boardroom decision making on a business' growth.

Conclusion

The aim of this paper was to investigate the influence/role of Gender on Corporate Board Decision Making within the MENA region in improving a business' financial performance. The purpose of this paper was initially informed by the key findings from a SLR involving 14 studies. The literature review highlighted no research conducted on the role of gender in boardroom decision making in the MENA region. Additionally, limited primary research was identified in this area on a worldwide scale which therefore informed primary research in the context of the MENA region. Therefore, a survey was conducted with 300 business leaders (154 male and 146 female participants) from the MENA region. The findings from the survey identified that males were dominant over their female counterparts in boardroom decision making in the MENA region.

Not only did the findings of this research contribute to knowledge in addressing a highlighted gap in no present primary based literature on the topic area based in the MENA region but it also further informed the indecision highlighted by the studies reviewed on whether gender diversity has a positive impact on boardroom decision making by confirming that gender diversity does not positively impact boardroom decision making within businesses in the MENA region. In terms of practice, this research may inform business owners/hierarchy in how they arrange decision makers in the boardroom to ensure more balanced decision making in the boardroom to ensure improved productivity for the business. In terms of policy, the findings from this research may inform policymakers to develop policies on recruitment that ensure

more equality, inclusivity, and representation amongst all genders in boardroom decision making positions.

The findings of this study may have theoretical implications where the key findings related to gender based decision making in the boardroom and the Stakeholder theory included in this paper can be combined with more quantitative based theories like the Bayesian decision making model (Gleason and Harris, 2019) to develop a conceptual framework which considers the role of all stakeholders (Stakeholder theory) and the quantitative underpinning related decision making (Bayesian theory) based on gender, especially, in a corporate boardroom context. However, the authors did identify problems/limitations during the research. One of the main problems identified was that a limited number of genders were involved in this study, e.g. this study only involved the male and female genders but there are more genders currently recognised worldwide. The authors believe that the inclusion of more genders in the study may have led to a difference in the findings. Another limitation encountered in this study was the lack of consideration of the social constructs behind boardroom decision making by each gender where such insight could not have been gained by the survey method. Therefore, based on the highlighted research implications and problems/limitations related to this research, the authors make the following recommendations.

- Future researchers in the same area should consider including more genders in addition to male and female in their research studies.
- The inclusion of the interview data collection method to gain insight in terms of social constructs informing owners'/managers' decision making in the boardroom.
- The findings of this research can inform future researchers in developing a conceptual framework based on the Stakeholder theory and the Bayesian decision making model which will add rigor and comprehensiveness in future studies related to the same/similar areas.

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INDIAN GREEN PURCHASING PREDICTORS – A CONSUMER BEHAVIOUR ANALYSIS

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Abstract

Environmental safety has become a grave concern globally. "Social, economic and environmental" deterioration is the result of individuals' ignorance of their purchasing patterns impact and unplanned consumption impact on society and the environment. Hence, the matter of sustainable consumption has appeared as a central aim for scholarly researchers in the current green consumerism arena. It has been argued that varying consumer behaviour plays a vital role in society's reaction to issues concerning sustainability, particularly in developing nations like India. The green behaviour phenomenon has evolved as an innovative paradigm for marketing discipline researchers and marketers in the area of modern-day consumer research. In the Indian setting, green purchase behaviour (GPB) term is comparatively new and the majority of prior studies have focused on studying consumer attitudes towards GPB; very few have studied consumer GPB per se and the literature on sustainable consumer research is a bit scarce. This study is an exploratory and quantitative one, which determines the antecedents of Indian consumers' GPB and examines the causal relationships between them using SEM.

Key Words: Green purchase behaviour, Environmental attitude, Determinants, Structural equation modelling, Indian consumers

INTRODUCTION

The current industrial and technological revolution in the world impacts the environment and our quality of life (Akehurst, Afonso and Gonçalves, 2012). The issues like global warming, deforestation, air/water pollution and other environmental issues forced consumers to think of sustainability issues and these concerns have led to a gradual change in their attitudes, behavioural approaches, and finally

rise in demand for green products. (Akehurst, Afonso and Gonçalves, 2012; Biswas and Roy, 2015; Kanchanapibul et al., 2014). Green products are the ones which are recyclable, non-toxic, biodegradable, and have no detrimental impact on the nature all through their life-cycle aiming to preserve the natural environment (Biswas and Roy, 2015). Lee's (2008) in their study stated that the consumers' perspective and their actions toward green products and green marketing have gone through several stages since the 1980s. The notion of green marketing (GM) is first emerged in the late 1980s. The industries and marketers engaged in different forms of green marketing activities and are expected to generate goodwill and sales from positive consumer responses. In the 1990s green marketing entered its second stage, where the companies experienced a backlash where the marketers realised that the consumer's environmental concern and their desire for eco-friendly products did not translate into buying behavior. The reasons behind the consumer backlash are green cynicism about the products, company claims and practices. In the mid-1990s, consumers became more environmentally aware and demanded a social responsibility from the companies leading to ethical consumerism. From the time of the beginning of green and ethical consumerism, consumers started to have a demand concerning resourcing, production and processing. In late 1990 the concept of sustainability marketing emerged where the GM entered "self-adjusting" mode, where the companies with a proper aim of enduring sustainability persisted to stay in the green business. Since 2000, with the advancement in technology, government rules and regulations, and media and environmental organizations cooperation, consumers gained confidence in green products and green marketing entered the third stage. Finally, with the rise of universal anxiety on environmental quality, green has picked up the energy again and now making a comeback. In the 21st century, the business environment has witnessed stakeholders and consumers becoming more responsive and conscious of ecological issues, specifically, deforestation, pollution and global warming, now for future generations' well-being, they are shifting to sustainable consumption practices (Jaiswal and Singh, 2018). India is among the rapidly rising economies is being characterized by a rise in pollution levels and natural resource depletion due to this growth (Joshi and Rahman, 2016). Moreover, companies in India and China have started observing the consumer acuity related to ecology and have begun reshaping their operations to support ecological practices. (Sharma et al., 2020). Developed countries specify that eco-conscious customers have an activist part in lessening ecological problems (Uddin and Khan, 2018). Collaborative efforts at developing green products are accelerating globally (Uddin and Khan, 2016). Concerning the need for sustainable progress, the research relating to the antecedents that influence eco-friendly behaviours has been increasing rapidly over the last ten years particularly focusing on green purchasing (Do Paco et al., 2019), yet the understanding of determinants Influencing green purchase intention(GPI) and GPB remains inadequate in developing countries like India. The lack of proper explanation regarding the imbalance of consumers' green purchases and additionally, the environmental damage, and the resultant augmented emphasis on manufacturing green products by companies gave undeniable reasons to determine the predictors of Indian consumers' GPB (Joshi and Rahman, 2016). According to Uddin and Khan (2016), globalization

is converging the Indian and western cultures, and parallels in GPB of consumers can be expected. Therefore, the next rational step would be to conduct the Indian centric research for mapping out the cultural dissimilarity that may have a connection to GPB. GPB can motivate society and firms in the search for sustainability whilst balancing the business cycle's demand and supply along with addressing the ecological and social benefits (Jaiswal and Singh, 2018).

THEORETICAL BACKGROUND AND RESEARCH HYPOTHESIS

In the countries other than India, the researchers investigated various factors including green awareness (Ogiemwonyi et al., 2020; Suki et al., 2016), perceived environmental knowledge (Ghazali, Mutum and Ariswibowo, 2018; Kanchanapibul et al., 2014), green behaviour (Akehurst et al., 2012; doPaço et al., 2013), subjective norms (Sun and Wang, 2019; Taufique and Islam, 2021). The exploration of these factors and their casual relationships with the extensively used variables like environmental attitude, GPB and GPI in the Indian scenario is scant. The purpose of this research is:

1. To observe the cognitive or the "attitudes-intention-green purchase" behaviour hierarchy.
2. To study the affect of perceived environmental knowledge on environmental attitude and GPI.
3. To study the impact of subjective norms on GPI and GPB.
4. To study the relationships among the perceived environmental knowledge, subjective norms, and GPB via a holistic approach based on the Theory of Reasoned Action (TRA) and environmentally supportive behaviour (ESB) to identify with consumer actions based on the Straughan and Roberts's (1999) ECCB scale.

Theory of Reasoned Action (TRA)

The TRA by Ajzen and Fishbein (1980), states that the better antecedent of purchase behaviour is the intention which is determined by the attitude and social normative perceptions. This study extends the TRA model by adding on the three additional contemporary and less explored variables like perceived environmental knowledge, green awareness, and green behaviour, and testing it in the Indian scenario.

Environmental attitude (EA) and Green awareness (GA)

EA is the ability of a person to favourably or unfavourably evaluate the environment's condition (Uddin and Khan, 2018). According to Ogiemwonyi et al., (2020), Green awareness refers to the person's emotional judgements on the consequences of their impact on the environment. Consumer's green attitude is a better antecedent for measuring the awareness. Green awareness influences the attitude of the consumers in making a determined choice. Thus, H1: Environmental attitude significantly influences the green awareness is formulated.

Environmental attitude (EA) and Green behavior (GB)

According to Ogiemwonyi et al., (2020) and Akehurst, Afonso and Gonçalves (2012) the terms like "Green Behavior", "ecological conscious consumer behavior", "environmentally supportive behavior", "pro-environmental consumer behavior" is often used interchangeably and explains the behavioral orientation like re-using, re-cycling, green activism participation. If there is a more attitude toward a specific behavior, there is a high chance to perform that behavior and also it can be altered based on the attitude. EA is the most relevant factor in pro-environmental behavior (Uddin and Khan, 2018). Accordingly, the following hypothesis is established. H2: Environmental attitudes have a significant influence on the green behavior.

Environmental attitude (EA) and Green purchase behavior (GPB)

GPB is the buying of eco-friendly products that have no harm to the environment (Jaiswal and Kant, 2018). If the consumers think positively about nature, they will perform in an eco-friendly way, in that way positively affects the green purchase decision. So the environmental attitude is a significant variable influencing the green purchase behavior of consumers. Hence H3: Environmental attitudes have a significant impact on green purchase behavior is formed.

Environmental attitude (EA) and Green purchase intention (GPI)

GPI is the consumer's readiness for purchasing sustainable products for the sake of the environment (Jaiswal and Kant, 2018). A favorable attitude toward green products stimulates the purchase intention and serves as the primary determinant (Kumar et al., 2019; Jaiswal and Singh, 2018). Hence the below hypothesis is formulated. H4: Environmental attitudes positively affect the green purchase intention.

Green awareness (GA) and Green behavior (GB)

An individual who has a considerable environmental awareness will perform the green behavior, and also who are sentient of the sustainable behavior will be self-confident to perform for that reason (Ogiemwonyi et al., 2020). Thus the H5 is formulated. H5: Green awareness significantly affects the green behavior.

Green awareness (GA) and Green purchase intention (GPI)

The awareness of the consequences of their impact on the environment will predict the purchase intention for eco-friendly items (Suki et al., 2016). From the above reasoning, H6: Green awareness significantly affects purchase intention of green products, is posited.

Green behavior (GB) and Green purchase behavior (GPB)

It is more reasonable to evaluate the ecologically conscious consumer behavior before than the effective green purchase behavior, as we expect that green behavior does have a significant effect on the GPB (Akehurst, Afonso and Gonçalves, 2012). So we predict the following hypothesis. H7: Green behavior will positively affect the green purchase behavior.

Green behavior (GB) and Green purchase intention (GPI)

Consumers who avoid plastic bag usage buys natural ingredient products, prefer bio-degradable packaging, and are against animal testing products do have a constructive intent to buy the eco-friendly products (Akehurst, Afonso and Gonçalves, 2012). Hence, the below hypothesis is posited. H8: Green behaviour significantly affects consumers' intention to purchase green products.

Green purchase intention (GPI) and Green purchase behaviour (GPB)

The stronger the intention to buy the sustainable products, the greater will be the intensity that the purchases will be made (Ghazali, Mutum, and Ariswibowo, 2018). The expressed intention of the consumers is the key determinant for predicting their purchase behaviour (Jaiswal and Singh, 2018). Therefore, the study postulates the below hypothesis. H9: Consumers intention to purchase green products significantly affects the green purchase behaviour.

Perceived environmental knowledge (PEK) and Environmental attitude (EA)

It is an individual's cognitive ability in understanding environmental issues (Jaiswal and Kant, 2018) and the necessary actions to be taken (Ghazali, Mutum, and Ariswibowo, 2018). In emerging economies like India, the PEK will have a direct relation with the EA (Jaiswal and Kant, 2018). Hence, we hypothesize that H10: Perceived environmental knowledge significant influences the environmental attitudes.

Perceived environmental knowledge (PEK) and Green purchase intention (GPI)

There is a direct effect of the subjective knowledge of the green phenomenon on the buying intention of sustainable products; that is a stronger level of PEK will lead to a stronger intention to buy the eco-friendly products (Jaiswal and Kant, 2018). From this evidence, the H11 is formulated. H11: Perceived environmental knowledge significantly influences the purchase intention of green products.

Subjective norms (SN) and Green purchase behaviour (GPB)

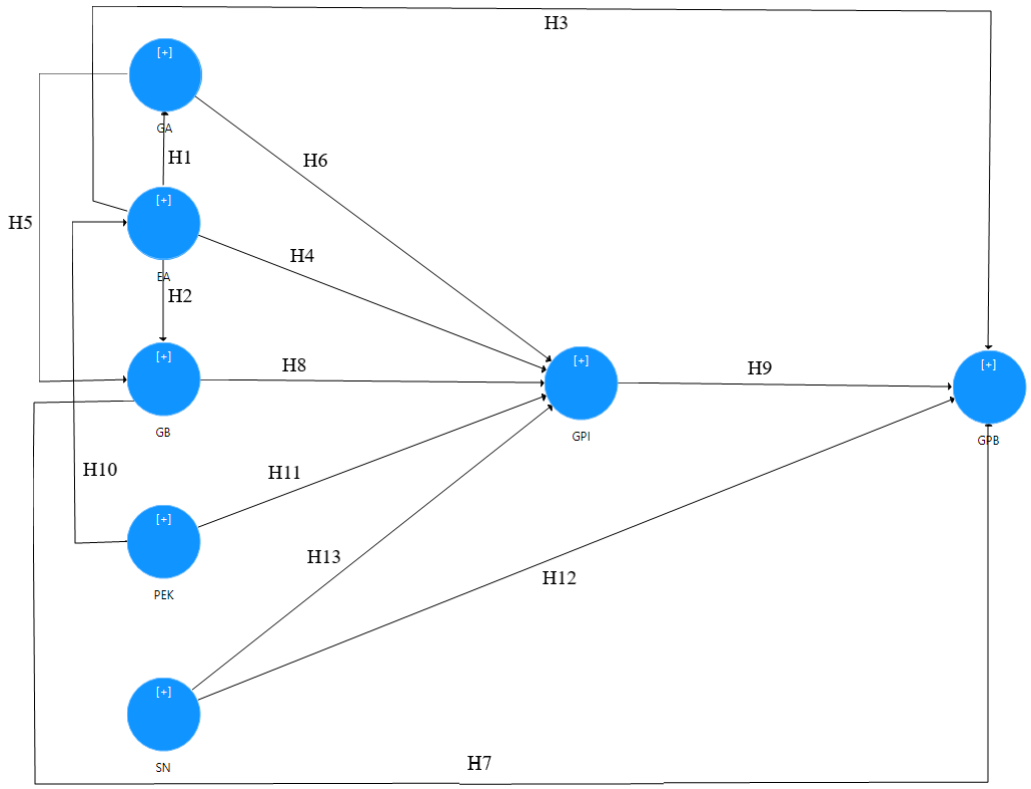
It is the perceived peer pressure for performing or not performing the behaviour. In emerging markets, it is found to significantly influence the GPB (Taufique and Islam, 2021). Hence, H12: Subjective norms significantly affect the green purchase behaviour, is proposed.

Subjective norms (SN) and Green purchase intention (GPI)

When the individuals realise that if their significant others prefer sustainable products, their intention to purchase the products will develop and increase (Sun and Wang, 2019). Hence, this study assumes the following hypothesis. H13: Subjective norms positively affect the consumer's green purchase intention

Figure 1 depicts the conceptual model, built on the TRA incorporating the perceived environmental knowledge, green awareness and green behaviour.

Figure 1: Conceptual model



METHODOLOGY

Questionnaire development

The survey instrument was a structured questionnaire consisting of demographics and the items of study constructs. The items for PEK were adapted from Mostafa (2006); EA (Mishal et al., 2017); GA (Chen et al., 2018); GB (Roberts, 1996b; Ahn, Koo and Chang, 2012's GPB construct and Lee, 2014's recycling participation items); SN (Sun & Wang, 2019); GPI (Chan, 2001); GPB (Lee, 2009).

Sampling

The study is exploratory and quantitative; the sampling technique used was stratified random sampling. A total of 129 questionnaires were collected from Hyderabad which is a metropolitan and smart city in the Telangana state of India. This city is chosen because of its various sustainable and green initiatives implemented in recent times like haritha haram, green India challenge, green fund, mission kakatiya, LED street lighting, smart cities mission, swachh bharat mission. This study used stratified sampling for selecting the particular city, and potential Gen X, Y and Z respondents were chosen randomly. These three generations were chosen to ensure that the study covers a wide range of behaviours. The data is collected online from Feb to April 2022.

Analysis methods

The two-step analysis approach of the measurement and structural model is conducted in the SmartPLS. Partial least squares (PLS), a variance-

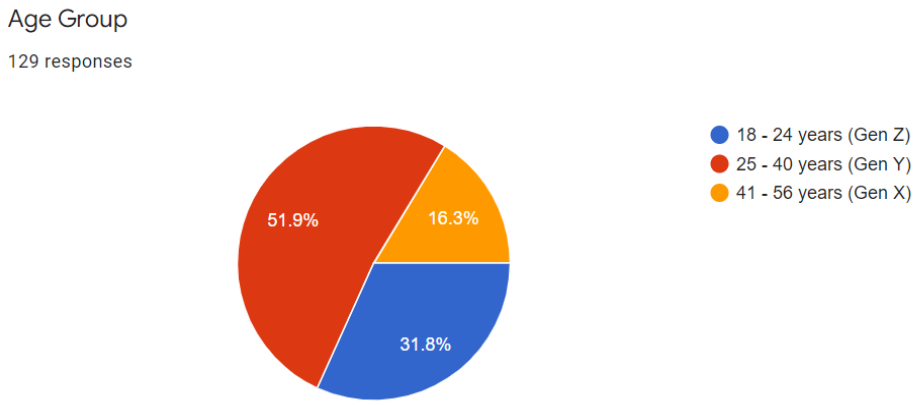
based SEM technique is selected for testing the conceptual model and hypotheses.

RESULTS

Demographic profile

The demographic summary of the sample unveils that most of the respondents belong to Generation Y (51.9%), male (62%), employed (46.5%) and postgraduate (51.2%) categories. In terms of respondents' generations, 31.8% were Gen Z, 51.9% constituted Gen Y and 16.3% constituted Gen X. Figure 2 depicts the pie chart concerning generations.

Figure 2: Age group pie-chart



Measurement model

The measurement model results summary in Table 1suggest that all the requirements were met. According to Hair et al., (2017), the composite reliabilities (CRs) and Cronbach alpha which measure the internal consistency reliability were all in the range of 0.60 – 0.95 for Cronbach's alpha and above 0.7 for composite reliability, indicating the internal consistency and reliability. The average variance extracted (AVE) scores were greater than 0.5 except for the GB construct. By checking the outer loadings, all the individual item loadings were greater than 0.708 or in the range of 0.4 - 0.7, except for the GB1, GB2, GB3, GB7, GB8, GB12 and GB14. The above mentioned items were deleted as their removal improved the AVE and composite CR significantly. By doing so, all the outer loadings are greater than 0.4 and the AVE is also greater than 0.5 for the GB construct, ensuring the convergent validity of all the constructs.

Hair et al., (2017) state, that the discriminant validity can be calculated following the Fornell-larcker, cross-loadings and HTMT criterion. For the Fornell-larcker criterion, as shown in Table 2 all the square roots of the AVE (on the diagonals) were greater than correlations b/w constructs (on the corresponding row and column). For the cross-loadings, all the indicators' outer loadings on the associated construct are greater than any of its cross-loadings (correlation) on other constructs. The HTMT statistic's confidence

interval did not include the value 1 for any construct combinations, suggesting that discriminant validity is achieved.

Table 2: Fornell – Larcker Criterion

Fornell-Larcker Criterion	EA	GA	GB	GPB	GPI	PEK	SN
EA	**0.894**						
GA	0.662	**0.844**					
GB	0.339	0.303	**0.721**				
GPB	0.502	0.389	0.603	**0.797**			
GPI	0.537	0.460	0.405	0.776	**0.901**		
PEK	0.335	0.331	0.665	0.571	0.470	**0.764**	
SN	0.499	0.331	0.550	0.556	0.442	0.499	**0.861**

Structural model

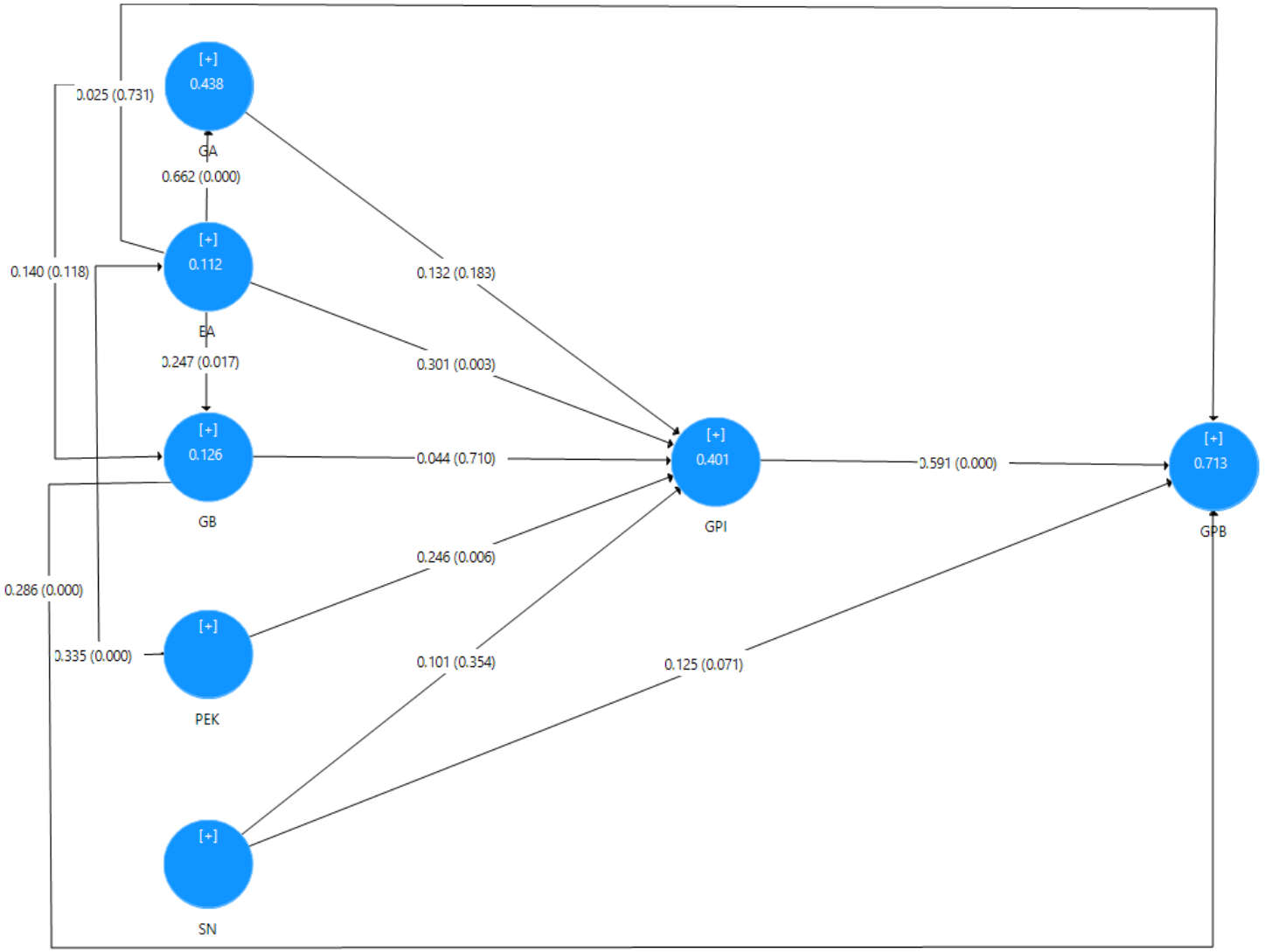
The hypothesis significance is tested using the p-values (assuming the 5% significance level, the p-value must be smaller than 0.05 for concluding the relationship significant), t-statistic (when an empirical t value is greater than the critical value (1.96), the coefficient is statistically significant at a certain significant level i.e. 5% in this case) and the confidence intervals (if the estimated path coefficient's confidence interval does not include zero) (Hair et al., 2017). Figure 3 represents the model's path coefficients along with the significance represented by p-values and explanatory power (R2).

Table 1: Measurement model results

		Convergent validity		Internal consistency reliability		Discriminant validity		
Latent variable	Indicators	Loadings (> 0.70 & 0.4 – 0.7)	AVE (> 0.50)	Composite Reliability (0.60 – 0.95)	Cronbach's Alpha (0.60 – 0.90)	Fornell Larcker criterion	Cross loadings	HTMT confidence interval does not include 1
EA	**EA1**	0.909	0.800	0.923	0.875	MET	MET	YES
	EA2	0.908						
	EA3	0.866						
GA	**GA1**	0.704	0.712	0.908	0.862	MET	MET	YES
	GA2	0.860						
	GA3	0.912						
	GA4	0.884						
GB	**GB10**	0.648	0.520	0.883	0.845	MET	MET	YES
	GB11	0.810						
	GB13	0.710						
	GB4	0.709						
	GB5	0.677						
	GB6	0.782						
	GB9	0.699						
GPB	**GPB1**	0.782	0.635	0.924	0.903	MET	MET	YES
	GPB2	0.877						
	GPB3	0.709						
	GPB4	0.780						
	GPB5	0.871						
	GPB6	0.743						
	GPB7	0.801						
GPI	**GPI1**	0.880	0.813	0.929	0.885	MET	MET	YES
	GPI2	0.919						
	GPI3	0.905						
PEK	**PEK1**	0.761	0.583	0.873	0.825	MET	MET	YES
	PEK2	0.819						
	PEK3	0.793						

	PEK4	0.703						
	PEK5	0.737						
SN	**SN1**	0.842	0.742	0.896	0.827	MET	MET	YES
	SN2	0.865						
	SN3	0.877						

Figure 3: β values and R^2



Standardised path coefficients in the Figure 3 show some remarkable results. First, the high β value for EA (β = 0.662, p < 0.05) in determining the GA (H1 is supported). Second, the high β value for GPI (β = 0.591, p < 0.05) having a significant influence on GPB (H9 is supported). Third, the high β value for PEK (β = 0.335, p < 0.05) in predicting the EA (H10 is supported). In addition to these results, direct effects of EA on GB (β = 0.247, p < 0.05), GPI (β = 0.301, p < 0.05) shows statistical significance supporting the H2 and H4, whereas EA to GPB is found to be Insignificant (β = 0.025, p > 0.05), rejecting H4. Similarly, GB to GPB relationship is found to be significant (β = 0.286, p < 0.05), supporting H7, and its effect on GPI is not significant (β = 0.044, p > 0.05), rejecting H8. The effect of PEK on GPI is significant supporting H11 (β = 0.246, p < 0.05). The effect of GA on both the GB (β = 0.140, p > 0.05) and GPI (β = 0.132, p > 0.05) are not significant, thus rejecting H5 and H6. Similarly, H12 and H13 are also rejected, as the SN does not attribute to the GPB (β = 0.125, p > 0.05) and GPI (β = 0.101, p > 0.05). The significance of the path coefficients along with the VIF values, beta values, and their confidence intervals are clearly specified in Table 3.

Table 3: Hypothesis testing and structural model results summary

Hypothesis	**Relationships**	**VIF**	**Path Coefficients**	**t - values**	**P values**	**95% confidence intervals**	**Significance (p<0.05)?**
H1	**EA → GA**	1.000	0.662	10.170	0.000	[0.518,0.770]	YES
H2	**EA → GB**	1.781	0.247	2.380	0.017	[0.054,0.465]	YES
H3	**EA → GPB**	1.595	0.025	0.343	0.731	[-0.110,0.176]	NO
H4	**EA → GPI**	2.111	0.301	2.977	0.003	[0.090,0.491]	YES
H5	**GA → GB**	1.781	0.140	1.562	0.118	[-0.039,0.314]	NO
H6	**GA → GPI**	1.836	0.132	1.332	0.183	[-0.071,0.318]	NO
H7	**GB → GPB**	1.504	0.286	5.034	0.000	[0.180,0.405]	YES
H8	**GB → GPI**	2.030	0.044	0.372	0.710	[-0.170,0.290]	NO
H9	**GPI → GPB**	1.550	0.591	9.389	0.000	[0.457,0.703]	YES
H10	**PEK → EA**	1.000	0.335	3.846	0.000	[0.158,0.502]	YES
H11	**PEK → GPI**	1.920	0.246	2.745	0.006	[0.076,0.432]	YES
H12	**SN → GPB**	1.730	0.125	1.804	0.071	[-0.016,0.257]	NO

H13	**SN → GPI**	1.763	0.101	0.926	0.354	[-0.116,0.315]	NO

From Figure 3, the model's explanatory power (R^2) is determined. The GPI, GA and GPB were explained by 40.1%, 43.8% and 71.3% of the variance respectively. In general, all the endogenous variables achieved the minimum explanatory power i.e., three large, one reasonable, and one weak. This classification is done as per the Cohen (1988) guidelines, where R^2 values of 0.26 are considered large, 0.13 as reasonable and 0.02 as weak explanatory power respectively. Coming to the predictive capability of the research model, calculated by blindfolding technique, the results from Table 4 imply that all the five endogenous variables achieved predictive relevance as their Q^2 values were greater than zero (Hair et al., 2017). Multicollinearity was evaluated by using the VIF values, being less than 5 (Hair et al., 2017). From Table 3, it is clear that there were no multicollinearity issues between the constructs as the VIF values ranged from 1.000 to 2.111. The effect size f^2 is assessed using the Cohen (1988) values of 0.02 (weak), 0.15 (reasonable/moderate) and 0.35 (large/strong) effects, correspondingly, suggesting three strong and ten weak relationship effects for this study.

Table 4: Predictive relevance

	SSO	SSE	Q^2 (=1-SSE/SSO)
EA	387.000	356.543	**0.079**
GA	516.000	363.697	**0.295**
GB	903.000	847.857	**0.061**
GPB	903.000	506.939	**0.439**
GPI	387.000	271.273	**0.299**
PEK	645.000	645.000	
SN	387.000	387.000	

In Table 5, the direct, indirect and total effects were specified. The relevance of each variable for their respective endogenous constructs can be assessed in Table 5.

Table 5: Effects summary

From	To	Direct	Indirect	Total
EA	GA	0.662	-	0.662
	GB	0.247	0.093	0.339
	GPB	0.025	0.336	0.361
	GPI	0.301	0.103	0.404

GA	GB	0.140	-	0.140
	GPI	0.132	0.006	0.138
	GPB	-	0.122	0.122
GB	GPB	0.286	0.026	0.312
	GPI	0.044	-	0.044
GPI	GPB	0.591	-	0.591
PEK	EA	0.335	-	0.335
	GPI	0.246	0.135	0.381
	GA	-	0.222	0.222
	GB	-	0.113	0.113
	GPB	-	0.266	0.266
SN	GPB	0.125	0.060	0.185
	GPI	0.101	-	0.101

The significant specific indirect effects are specified in Table 6. These paths show the causal relationships of the model depicted in Figure 1.

Table 6: Significant casual relationships

Relationships	**Path coefficients**	**t values**	**p values**	**95% C.I**	**Significance (p<0.05)?**
PEK →GPI→ GPB	0.145	2.543	0.011	[0.042,0.267]	YES
EA →GPI→ GPB	0.178	2.625	0.009	[0.049,0.316]	YES
PEK →EA→ GA	0.222	3.249	0.001	[0.095,0.364]	YES
PEK →EA→ GPI	0.101	2.333	0.020	[0.025,0.196]	YES
PEK →EA→ GPI→ GPB	0.060	2.126	0.034	[0.013,0.123]	YES
EA→ GB→ GPB	0.071	2.149	0.032	[0.015,0.147]	YES

DISCUSSION AND CONCLUSION

The findings give practical support for a holistic model of Indian consumers' sustainable or eco-friendly behaviour, built on the extended TRA model, which incorporates the PEK, GB and GA. It also points out the part of the attitude component in predicting the GPB of Indian consumers. EA does not significantly directly affect GPB, but it affects GPB indirectly through the GPI, and also by the GB. The EA acts as a direct predictor for both the GPI and GB. The role of PEK in predicting the GPB is also significant. PEK affects the GPB through the EA and GPI. PEK also predicts GA through the EA, but there is no role of GA in predicting the GPB. So, it is found that having PEK positively influences GPB, but the GA doesn't direct any green purchase. An additional finding worth noting was that PEK directly

influenced EA and GPI in a significant way with a considerable beta value. There was a extensive difference in the β values of the EA - GPI (0.301) path, EA - GPB relationship (0.025), and GPI - GPB (0.591) path, suggesting that although EA translates to GPI, the translation of EA to GPB directly is low, but indirectly via GPI is more. The results from Table 6 also show that PEK positively affects GPB and is mediated by the EA, GPI (PEK →EA→ GPI→ GPB) and also only by the GPI (PEK →GPI→ GPB). This shows the relevance of former PEK and latter EA in predicting the GPI and GPB of Indian consumers. The PEK significantly affects GA through the EA as a mediator, but the GA does not translate into the green purchases, so efforts should be taken on translating the GA to the GPI and GPB. Another interesting finding is that along with PEK and EA, one more variable GB has a significant influence on the green purchase decisions of the consumers (EA→ GB→ GPB). The GB directly influences GPB, and the mediation effect of GPI on the GB → GPB relationship is insignificant. It can be stated that the green initiatives in Telangana have a major influence on the consumers' day to day eco-friendly activities and their sustainable purchase decisions. There is no role of subjective norms in predicting the GPB (directly or indirectly) and GPI. The pressure from the approval of peer groups or family does not influence the green purchase decisions comparatively with the other determinants like PEK, EA and GB.

Hence it can be concluded that for the Indian consumers, the PEK, EA and GB act as better predictors or determinants of their GPB. The SN and GA constructs do not necessarily translate to the GPB (Table 7) and can be no further given more importance until there is an effort conducted to find the reasons behind it. The insignificant total effects are specified in bold and it is evident that the SN and GA relationship to other constructs are clearly insignificant.

Table 7: Total effects of study constructs

Paths	Total Effect	T Statistics	P Values
EA → GA	0.662	10.170	0.000
EA → GB	0.339	4.108	0.000
EA → GPB	0.361	3.640	0.000
EA →GPI	0.404	4.742	0.000
GA → GB	**0.140**	**1.562**	**0.118**
GA → GPB	**0.122**	**1.775**	**0.076**
GA → GPI	**0.138**	**1.391**	**0.164**
GB → GPI	**0.312**	**3.614**	**0.000**
GB → GPI	0.044	0.372	0.710
GPI → GPB	0.591	9.389	0.000
PEK → EA	0.335	3.846	0.000
PEK → GA	0.222	3.249	0.001
PEK → GB	0.113	2.223	0.026
PEK → GPB	0.266	3.512	0.000
PEK → GPI	0.381	3.862	0.000
SN → GPB	**0.185**	**1.708**	**0.088**
SN → GPI	**0.101**	**0.926**	**0.354**

Finally, the outcomes (Table 5 and Table 7) suggest that multiple determinants influence the GPB. From the strongest to weakest, the determinants of GPB were GPI, EA, GB, PEK, SN and GA. The multiple determinants that influence GPI from the strongest to weakest are EA, PEK, GA, SN and GB.

IMPLICATIONS

The results have several implications for managers and policymakers, indicating that Indian consumers who have more PEK, EA and GB are expected to make more favourable green purchase decisions. This indicates the importance of these attributes for making green decisions. Green marketers in their product promotions and advertisements should illustrate the benefits of various green activities like recycling, using energy-efficient devices, planting trees, avoid excessive packaging of products, on the society and environment. The marketers should also focus in their campaigns on letting the public know how purchasing their products will help them in accomplishing their day-to-day GB activities. The government should also continue to implement various green initiatives and motivate the public to participate in them for a better future. The findings suggest that only a few types of green activities like using low phosphate detergents, recycling the garbage, purchasing recycled, biodegradable products and also the products with less packaging, actually motivate the Indian consumers in their GPB. The managers should develop their environmental image in society and become ecologically responsible. Marketers and retailers should employ strategies like targeting Gen Y male consumers and attracting them by tailoring the products to meet their needs and increase sales. The consumers' environmental knowledge will have a noteworthy role in influencing the GPB, the marketers and the policymakers should educate the consumers on the impact of their consumption on the ecology, the significance of nature protection, and the role of green products in ecological conservation. Environmental education should be a part of the children's education curriculum and various NGOs should also organise campaigns on "going green". The EA influences GPB indirectly via GB and GPI. So there is a need to improve the ecological attitude of the public to promote the GB and GPI and ultimately the GPB. The attitude can be developed by focusing on the perceived consumer effectiveness (Sun and Wang, 2019), behavioural beliefs (Yadav and Pathak, 2017) and values (Vermeir and Verbeke, 2006) of the public.

DIRECTIONS FOR FUTURE RESEARCH

The rapidly changing Indian consumers' GPB needs to be studied, so that future researchers can conduct longitudinal rather than cross-sectional studies to address the dynamic nature of green consumers. Due to the budget and time constraints, the research has been conducted in only Hyderabad and only over a less sample, so potential research can be conducted in other cities of Telangana and also can cover Andhra Pradesh with larger sample size. This research addressed the

general GPB for no specific category of products; later studies can cover a wide variety of product categories. The other less explored exogenous variables must be included and their casual relationships with the GPI/GPB need to be studied. The variables studied in the other developed regions must be examined cross-culturally and the effects need to be addressed.

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Digital Selves: Omani Students' Expressions of Identities

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This paper sets out to address the research question which is formulated as follows: How do Omani students represent their identities online? This study embraces Dornyei's (2009) L2 Motivational Self System (L2MSS), as well as Deci and Ryan's (2002) Self-Determination Theory (SDT), and Yashima's International Posture (2009) as the primary conceptual frameworks, while investigating other context-dependent motivational powers. In discussing the research question from three theoretical standpoints, I problematized them in terms of their limitations and to further extend their boundaries. Thus, I present complementing perspectives grounded on these theories, functioning in a reciprocally reinforcing manner. In so doing, this research sharpened our understanding of the intimate relationship between people's lives, encompassing their institutional, digital, and social settings where they inextricably intersect. Given the multifaceted nature of second language identity, I would contend that exploring this construct entails methods that can capture its complexities. Arguably, it is beyond the pragmatic capacity of quantitative methods. Therefore, reflective focus group discussions and language learning histories were geared towards addressing this topic. What is of significant contribution is that the data is timely, as it is congruent with the contemporary thinking in the area of L2 identity, bringing fresh and genuine insights from the Omani context. It would be reasonable to comprehend learners' digital identities, requiring further research to explore the ways in which the digital context affects our self-concepts, our motivations, and our abilities to actively navigate and engage in cyberspace. Prior research studies in Oman have neglected to investigate significant motivational dimensions of language learning. Particularly, those studies have not focused on the chances afforded by virtual social spaces for the development of English language learning. This present study addressed this gap in the research. This would lead to increasing students' motivation

through relating to their identities to optimize greater engagement in language learning.This study makes original and well-grounded contributions to the existing body of literature in the realm of language learning identity, motivation, autonomy and digital social spaces, drawing out specifically Omani-Islamic identity and media influence. I argue that investigating the influence of digital context on L2 motivation research is topical in that it corresponds to an urgent need to systematically explore the digital context driven by motivation theories at a time when students' cyber-lives become a necessity for the expression of personal and social identity.

Improving English Communication Skills through Tour-Guide Experience

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The author held an event for Japanese junior high school students to foster English communication skill through tour-guide experience in English. Tokimeki Science financially supported the project, which was adapted for KAKENHI, i.e., Grants-in-Aid for Scientific Research. Fourteen junior high students participated for a day. The agenda included attending English class in the author's college, moving to Asakusa by subways, and serving as tour guides in Asakusa for assistant native and nonnative English-speaking graduate students from a national university in the Kantō area. They walked around Sensō-ji Temple together, and the junior high students introduced sightseeing spots and explained Japanese cultures. In addition, six Japanese college students accompanied as assistants and helped participants with the tour-guide task throughout the day. Results of a questionnaire conducted after the event showed clearly that the activity was challenging, and the junior high students learned a great deal through it. Moreover, the college student assistants also showed that they had a good time supporting younger students as seniors and English learners. In this study, the other college students considered the revised points to this activity in a class and the improved activity plan is shown. As a conclusion, it is necessary for EFL learners to have more chances for speaking English outside classrooms to nurture the English skills of future leaders.

Keywords: communication skills, grant, EFL, KAKENHI, sightseeing, tour-guide experience

Promoting the Rights and Dignity of Women in Calabar-Nigeria through educational contributions of Mother Mary Charles Magdalene Walker (RSC)

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Education has been part of human society from the very beginning. Human societies throughout the ages have vested interest in education.In Africa, women are regarded as the weaker sex and are looked upon as people who cannot stand on their own unless they are entrusted to men. What we see in Nigeria is the attitude of the nation. Nigerian society has been patriarchal in nature, which is the nature feature of traditional society.Patriarchy is founded on an erroneous understanding of human nature. With its misguided reading of human nature, it formulates ingrained social norm that privileged the men and disadvantaged women. Mother Charles Magdalene Walker's vision to uphold the right and dignity of women is one of the most elating of the events of her era. Women were under the stringent traditional, social, and cultural structures before her arrival to Calabar. The dominance patriarchy coupled with discrimination against women placed Calabar women under unfavorable conditions. Being regarded as second hand citizens, mother Mary Charles Magdalene Walker in imitation of Jesus' esteem for women set out to raise their status. She knows that the essence of physical, intellectual, social and psychological well-being of women, she therefore adopted approach that would help promote their dignity and this she did through education. Education was one way to lift women and bring about positive attitude that could mobilize untapped ingenuity in them for societal change. Mother Mary Charles Magdalene Walker's missionary activities in promoting the rights and dignity of women through education was clear demonstration of one who believed that every creature of God deserved a right to personal, communal, environmental and transcendental well-being. However, it is pertinent to state that Mother Mary Charles Magdalene Walker has willingly and effectively contributed in promoting the dignity of women in Calabar-Nigeria. Consequently, her contributions cannot be undermined. Her prophetic vocation was nowhere more evident than in her creative imagination made manifest in her ability to foresee and respond to the situation in southern Nigeria (Calabar) where girls were deprived of their rights to education. Hence, the focus of this work is to recognize the

immeasurable successful educational contributions of Mother Mary Charles Magdalene Walker in promoting the rights and dignity of women in Calabar South Eastern Nigeria.


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