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OF RESEARCHES IN ENGINEERING: A

## Mechanical & Mechanics Engineering

Design of the End Grinding Wheel

Highlights

Machine Reliability Optimization

Solar Dryer Technology for Preservation

Outlet Temperature using Meteorology

**Discovering Thoughts, Inventing Future** 

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### GLOBAL JOURNAL OF RESEARCHES IN ENGINEERING: A Mechanical and Mechanics Engineering

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# Simulation of the Outlet Temperature using Meteorology of the City of El Jadida-Morocco

### By Meryem El Badaoui & Abdelatif Touzani

*Abstract-* This article is a continuation of the previous article" Modeling of a parabolic trough using two heat transfer fluids and an economic estimation in the Moroccan dairy industry," presenting new parameters and results. Its objective is to simulate the temperature of the chosen fluid, which is water by using the meteorology of the city of El Jadida, city of the dairy industry.

We presented the energy balance of the parabolic trough then the thermophysical properties of the water, as well as the meteorology of El Jadida by taking the maximum, minimum temperature of the year plus the range of the wind speed influenced the glass cover of the absorber. We finished with a visualization of water velocity within the absorber.

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## Simulation of the Outlet Temperature using Meteorology of the City of El Jadida-Morocco

Meryem El Badaoui <sup>a</sup> & Abdelatif Touzani <sup>o</sup>

Abstract- This article is a continuation of the previous article" Modeling of a parabolic trough using two heat transfer fluids and an economic estimation in the Moroccan dairy industry," presenting new parameters and results. Its objective is to simulate the temperature of the chosen fluid, which is water by using the meteorology of the city of El Jadida, city of the dairy industry.

We presented the energy balance of the parabolic trough then the thermophysical properties of the water, as well as the meteorology of El Jadida by taking the maximum, minimum temperature of the year plus the range of the wind speed influenced the glass cover of the absorber. We finished with a visualization of water velocity within the absorber.

#### I. INTRODUCTION

A parabolic trough using two heat transfer fluids and an economic estimation in the Moroccan dairy industry"[1], We made a comparison between two heat

a) Description of parabolic through

transfer fluids based on several parameters including the heat exchange coefficient, the Grashof number as well as their environmental and economic impact.

This comparison made it possible to choose water as the heat transfer fluid within the industry. It is in this context, and based on the metrology of the city of el Jadida-Morocco, the simulation proposed below was established under Comsol in transient mode using water as heat transfer fluid.

#### II. Thermal Balance of Parabolic Trough

Accordant with the previous article, we focused on the description of the parabolic trough as well as we presented its thermal balance. Below we will briefly introduce it. [2][3]





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#### b) Thermal balance

The characteristic equation using water

$$\rho_f C_p \pi D_{ai} \frac{\partial T_f(x,t)}{\partial t} = \rho_f C_p D_f \frac{\partial T_f(x,t)}{\partial x} + q_u(x,t)$$

$$q_u(x,t) = h_{af} \pi D_{ai} \left( T_a(x,t) - T_f(x,t) \right)$$

$$T_{fi} = \frac{1}{1 + \frac{\Delta t D_f}{\Delta x \pi D_{ai}}} [T_{f(i-1)} \left( 1 + \frac{\Delta t \rho_{f(i-1)} C_{p(i-1)} D_f}{\rho_{fi} C_{fi} D_{ai} \pi \Delta x} \right) + \frac{\Delta t}{\rho_{fi} C_{pi} D_{ai} \pi \Delta x} q_u (T_{ai}, T_{fi})]$$

Using the constants for simplifications, we have the equations below:

$$T_{fi}^{t+1} = AT_{fi}^{t} + B_{f(i-1)} + C$$

$$A = \begin{bmatrix} 1 - \frac{D_f \Delta t}{\Delta x \pi D_{ai}} \end{bmatrix} \qquad B = \frac{\rho_{f(i-1)} C_{p(i-1)} D_f \Delta t}{\rho_{fi} C_{pi} D_{ai} \pi \Delta x} C = \frac{q_u}{\rho_{fi} C_{pi} D_{ai} \pi}$$

The characteristic equation of the glass cover

$$\frac{\partial T_a(t)}{\partial t} = \frac{1}{\rho_a C_{pa} A} [q_{ab}(t) - q_{a,v}(t) - q_u(t)]$$

$$q_{ab} = \rho_{sel} \alpha_{ab} \tau_{v} SGq_{a,v} = \frac{2\pi K_{aireff}}{\ln \frac{D_{vi}}{D_{ae}}} (T_{a} - T_{v}) + \frac{\sigma \pi D_{ae} (T_{a}^{4} - T_{v}^{4})}{\frac{1}{\varepsilon_{a}} + \frac{1 - \varepsilon_{v}}{\varepsilon_{v}} (\frac{D_{ae}}{D_{vi}})}$$
$$T_{a}^{t+1} = T_{a}^{t} + \frac{\Delta t}{\rho_{a} C_{pa} A} [q_{ab}(t) - q_{a,v}(t) - q_{u}(t)]$$

$$T_a^{t+1} = T_a^t + D$$
 with:  $D = \frac{\Delta t}{\rho_a C_{pa} A} [q_{ab}(t) - q_{a,v}(t) - q_u(t)]$ 

Water thermophysical proprieties

$$\frac{\partial T_{v}(t)}{\partial t} = \frac{1}{\rho_{v}C_{pv}A_{v}}[q_{a,v}(t) - q_{v,amb}(t)]$$

$$q_{v,amb}(t) = h_{v,amb}S_{ve}(T_{v} - T_{amb}) + \varepsilon_{v}\sigma S_{ve}(T_{v}^{4} - T_{amb}^{4})$$

$$T_{v}^{t+1} = T_{v}^{t} + \frac{\Delta t}{\rho_{v}C_{pv}A_{v}}[q_{a,v}(t) - q_{v,amb}(t)]$$

$$T_{v}^{t+1} = T_{v}^{t} + E \qquad \text{with:} \quad E = \frac{\Delta t}{\rho_{v}C_{pv}A_{v}}[q_{a,v}(t) - q_{v,amb}(t)]$$

Since we chose to work with water as heat transfer fluid, this implies to present its thermophysical properties below. Volumic mass (Kg/m<sup>3</sup>):

$$-0.0032T^{2} - 1.6126T + 799.26;$$

Heat capacity (J/Kg.K):

$$(276370 - 2090, 1T + 8.125T^2 - 0.014116T^3 + 9.3701.10^{-6}T^4)/_{18.051}$$

Thermal conductivity (W/m.K):

$$-0.432 + 0.0057255T - 8.078.10^{-6}T^{2} + 1.86.10^{-9}T^{3} + 1.861.10^{-9}$$

Dynamic viscosity (Pa. s):

$$\exp\left[\frac{3703.6}{T} + 5.866\ln(T) - 5.87910^{-29}T^{10}\right]$$

#### III. DNI OF EL JADIDA DURING THE YEAR

According to Solar Atlas Masen [4][5], we were able to generate the following results



Figure 3: DNI of EL Jadida from March to September



#### Figure 4: DNI of EL Jadida from October to February

	October	November	December	January	February
DNI (Kwh/m²)	130	117	116	120	122

#### IV. Meteorology of EL Jadida-Morocco

In this paragraph, we will look at the meteorology of El Jadida during the year 2019 by presenting the maximum and minimum temperatures and the wind speed.[6][7]

#### a) Temperatures of EL jadida in 2019

According to the Accu Weather website [8], we were able to take the meteorological history of the city in 2019 to identify the maximum and minimum temperatures of the year to use them in our simulation.



Figure 5: Maximum and minimum average temperature for the year 2019

The figure above shows, on the one hand, the daily average maximum and minimum temperatures of the year. On the other hand, the months with high and

low temperatures are September at 26°C and January with 8°C.



Figure 6: Average Maximum temperature in 2019



Figure 7: Average Minimum temperature in 2019

The figures beyond show the number of days per month, reaching peak temperatures for the first diagram, while the second presents the days with the lowest temperatures.



Figure 8: The minimal temperature in January 2019

*Figure 9:* The maximal temperature in September 2019

Figures 8 and 9 present the months having the maximum and minimum temperature of the year, recording on January 6, the lowest temperature of the year: 2 °C as for September 30 marks the highest temperature of the year: 32 °C.

#### b) Wind speed during 2019



Figure 10: Average wind speed in 2019





The figures above show the evolution of wind speed in 2019, varying from 8km/h to 73Km/h. We notice in the second diagram a variation of the wind speed compared to the days of each month of the year.



#### V. Results and Discussions

Figure 12: Ambient temperature on 6 January (1) and on 30 September (2)

The figure above shows us the variation of the ambient temperature during the day, starting from 7h to 19h. We observe on 6 January (1), marked the minimal temperature of the year, reaching a maximum of 293K at 10 a.m.

On the one hand and on the other hand, we notice that a higher temperature: 304K at 1p.m was noticeable on 30 September.



Figure 13: Outlet water temperature on January 6 (1) and September 30 (2) using Comsol Multiphysics



Figure 15: Variation of the outlet temperature according to time on January 6 (1) and September 30 (2)

Figure 13 shows the simulation under Comsol Multiphysics of the water temperature at the outlet on January 6 and September 30. Take an outlet temperature exceeding 290K for January 6, while September 30 marks a temperature exceeding 400k.

For figure 14 of the convergence curve of the simulation converges quickly. This convergence shows us the validity of our simulation.

The figure 15presents the temperature evolution from 7h to 19h of the two days mentioned above.

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#### <sup>C</sup> Variation of Glass cover temperature depending on wind speed



Figure 16: Variation of Glass cover temperature depending on wind speed

In figure 16, we notice a decreasing effect of the wind speed on the glass cover temperature for the three ambient temperatures.



This figure allowed us to visualize the interior of the parabolic by presenting the speed of the water in the absorber by reaching a speed of 0.13m/s at the parabolic through the outlet.



#### <sup>¬</sup> Variation of temperatures depending on solar irradiation





Fig. 19: Temperature variation according to solar irradiation during September 30

The figures above show the variations of the three temperatures during January 6 and September 30 depending on solar irradiation.

It can be seen that solar irradiation has an effect on the three temperatures, more precisely the absorber temperature, its increase implies an increase intemperatures, recording increases in the temperatures of the fluid, the absorber and the glass respectively: 470K, 474K and 327K for a maximum irradiation of 500w / m2 during January 6, moreon September 30 and for a maximum irradiation of 750w / m2 at temperatures of 577K, 581K and 346K.

#### VI. CONCLUSION

This labor made it possible to work with the water chosen at the end of the previous work by simulating its temperature at the outlet.

This study, first of all, made it possible to visualize the meteorology of the city by identifying January 6 as the day with minimum temperature and September 30 having a maximum temperature, as well as the variation of the temperature at the exit during these two days.

Also, we exposed the variant wind speed from 8km / h to 73Km / h in 2019, as well as its influence on the glass cover temperature.

#### Acknowledgment

This work was done in the laboratory "Applied Thermodynamics and Solid Combustibles (ATSC)", Mohammedia School of Engineers (EMI), Rabat-Morocco, under the direction of professor Doctor Abdellatif TOUZANI.

#### References Références Referencias

- 1. EL BADAOUI MERYEM and TOUZANI ABDELATIF, 2020, Modeling of a parabolic trough using two heat transfer fluids and an economic estimation in the Moroccan dairy industry.
- 2. Caliot and Flamant, 2016, Technologie des concentrateurs cylindro-paraboliques.
- 3. Bilal Lamrani, Ahmed Khouya, and Abdeslam Draoui, 2018, Thermal performance of a parabolic trough collector under different climatic zones in Morocco.
- 4. https://solaratlas.masen.ma/, 2020.
- 5. https://globalsolaratlas.info/map, 2020.
- 6. https://www.historique-meteo.net/, 2020.
- 7. https://www.meteoblue.com/, 2020.
- 8. https://www.accuweather.com/, 2020.



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# Results of Comparative Experimental Studies to Identify the Effectiveness of the New Design of the End Grinding Wheel

By Hassan Ahmad Husseynov & Chingiz Mirza Mammadov

Azerbaijan Technical University

Abstract- The article presents the results of comparative experimental studies to identify the effectiveness of the new design of the end grinding wheel. The analysis of the obtained empirical models shows that the roughness of surfaces ground with a new design wheel is much lower than that of a standard grinding wheel. This is due to the fact that the creation of discontinuity on the frontal zone of the working end with the profiling of the protrusions along the Archimedean spiral eliminates periodic impacts, increases the number of cutting grains, creates conditions for a relatively uniform distribution of the allowance between them and increases the meticulous capacity of the continuous part of the working end of the wheel.

Keywords: grinding wheel, roughness, surface quality, empirical model, archimedean spiral, efficiency, cutting conditions.

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## Results of Comparative Experimental Studies to Identify the Effectiveness of the New Design of the End Grinding Wheel

Сравнительные экспериментальные исследования шероховатости поверхности при торцовом шлифовании кругом новой конструкции и стандартным кругом

Hassan Ahmad Husseynov<sup>a</sup> & Chingiz Mirza Mammadov<sup>o</sup>

Abstract- The article presents the results of comparative experimental studies to identify the effectiveness of the new design of the end grinding wheel. The analysis of the obtained empirical models shows that the roughness of surfaces ground with a new design wheel is much lower than that of a standard grinding wheel. This is due to the fact that the creation of discontinuity on the frontal zone of the working end with the profiling of the protrusions along the Archimedean spiral eliminates periodic impacts, increases the number of cutting grains, creates conditions for a relatively uniform distribution of the allowance between them and increases the meticulous capacity of the continuous part of the working end of the wheel.

*Keywords:* grinding wheel, roughness, surface quality, empirical model, archimedean spiral, efficiency, cutting conditions.

Реферат- В статье изложены результаты сравнительных экспериментальных исследований по выявлению конструкции эффективности новой торцевого шлифовального круга. Анализ полученных эмпирических моделей показывает, что шероховатость поверхностей, шлифованных кругом новой конструкции значительно ниже, чем шлифованных стандартным кругом. Это объясняется тем, что созданием прерывистости на фронтальной зоне рабочего торца с профилированием выступов по архимедовой спирали устраняются периодические удары, увеличиваются число режущих зерен, создаются условия для относительно равномерного распределения припуска между ними и повышается выхаживающая способность сплошной части рабочего торца круга.

Ключевые слова: шлифовальный круг, шероховатость, качество поверхности, эмпирический модель, архимедова спираль, эффективность, режимы резания.

#### I. Введение

асштабы шлифовальных применения операций, появление новых машиностроительных материалов и новых алмазно-абразивных инструментов для их обработки вызывает необходимость в более детальном изучении физической сущности этого процесса. Анализ процесса шлифования неуклонно приводит к мысли, что при этомзначительная часть механической работы тратиться на трение и соответственно приводит к повышенному тепловому воздействию на обрабатываемую поверхность, а в последствии, к ухудшению геометрических параметров шлифованных поверхностей снижению физико-механических И свойств поверхностного слоя обрабатываемой детали.

В качестве примера проведем анализ процесса торцевого шлифования, отличающейся с наибольшей площадью контакта. Идея снижения теплового воздействия на обрабатываемую поверхность усовершенствованияшлифовального посредством инструмента, в частности торцевого шлифовального круга, привела к появлению кругов с прерывистыми, эксцентричными, наклонными и др. поверхностями. Этими кругами хотя и удается снижение теплового воздействия на обрабатываемую поверхность, однако, они неуклонно ведут к повышению вибрации в технологической системе из-за ударного воздействия при прерывистом шлифовании и неуравновешенности, при шлифовании с эксцентричными и наклонными кругами. Ударное воздействие и неуравновешенность шлифовальных кругов, в свою очередь, приводит к ухудшению качества шлифованных поверхностей, повышенному износу круга, преждевременному выходу из строя шпиндельного и других узлов станка.

#### II. Постановка Задачи

Анализируя работу кругов с прерывистой рабочей поверхностью нетрудно убедится в том, что работа резания при этом производится в основном зернами, расположеннымина фронтальной части

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рабочего выступа с высотой величины продольной подачи детали на оборот круга. Этому свидетельствует интенсивное выкрашивание зерен этой зоны из связки[1]. По мере износа происходит само оформление внешнего профиля выступа, образуя некоторый угол атаки к плоскости резания.Указанное явление особенно характерно при глубинном и черновом многопроходном шлифовании.

При этом основным очагом тепловыделения в контактной зоне является фронтальная -режущая полоса,а, в последующих, фактически работающие в уже прорезанные зерна попадая царапины работу выхаживания. Причем производят способности выхаживающие условных полос возрастают по мере удаления от фронтальной зоны по убывающей геометрической прогрессии. Таким образом, рабочий торец выступа условно разбивается на две части –первая режущая фронтальная полоса, вторая -последующие выхаживающие полосы. Следовательно, снижение интенсивности тепловыделения в режущей фронтальной части рабочего торца круга, где она имеет доминирующее значение, путем создания прерывистости в этой зоне и устранении очагов возникновения вибраций выполнением выхаживающую часть сплошным, являются наиболее оптимальными решениями повышения эффективности процесса торцового шлифования.

#### III. Конструктивное Решение

Для устранения периодических ударов в прерывистой зоне и тем самым источников вибраций, требуется профилирования режущих выступов прерывистой части рабочего торца шлифовального круга таким образом, чтобы способствовало увеличению количества режущих зерен рабочего созданию условий для относительно выступа и равномерного распределения между ними припуска, приходящего на один выступ прерывистой части фронтальной полосы. Данная проблема решается очертанием профиля режущего выступа по архимедовой спирали, т.е. переход от впадины к выступу в режущей фронтальной полосе выполняется по архимедовой спирали, посредством суммирования двух равномерных движений –поступательного в результате продольной подачи детали и вращательного посредством вращательного движения шлифовального круга. Для реализациивышеизложенных суждений новая конструкция разработана торцевого шлифовального круга, которая была защищена в Государственном комитете ПО стандартизации метрологии и патентам и получен одноименный патент под № 0183 (Рис.1).



Рис. 1: Торцовой шлифовальный круг свыступами, очерченными по архимедовой спирали

#### IV. МЕТОДИКА

Для определения эффективности новой конструкции торцевого шлифовального и рациональных условий ee применения были проведены экспериментальные исследования по ортогональному планированию второго порядка. Входные переменные экспериментов были выбраны исходя из степени их воздействия на исследуемый процесс. Рассматривались все существенные факторы процесса торцового шлифования. Отсев первоначально выбранных факторов был произведен на основе анализа априорной информации и теоретических исследований автора[5]. При отсеве было обращено также внимание на количественной оценки выбранных возможности

факторов, их управляемости, исходя из технических возможностей станка, точности измерения, назначения необходимого уровня в соответствии со строками матрицы планирования и его поддержки во время опыта. С учетом всех этих требований в качестве входных параметров процесса шлифования были выбраны: скорость круга, скорость детали и подачи на глубину , комбинации которых наибольше воздействуют на шероховатость шлифованной поверхности.

Все входные переменные эксперимента являются независимыми и управляемыми.Совокупность этих факторов совместима и представляет режим шлифования, а их комбинации, в соответствии со строками матрицы планирования, исходя из технических и технологических возможностей операции торцового шлифования, осуществимы.

В качестве выходных переменных экспериментальных исследований выбраны параметры шероховатости шлифованной поверхности. Теоретические исследования, проведенные в работах [1-3], позволили определить параметры новой конструкции шлифовального круга, в том числе характеристику архимедовой спирали и оптимальное количество выступов прерывистой зоны. Исходя изстепени влияния факторов на величину выходных параметров процесса шлифования и величину ошибки их измерения были определены интервалы варьирования факторов и (Табл.1).

Уровни факторов	Обозначение	V <sub>k,,</sub> (n в об/мин) м/сек	V <sub>d</sub> , м/мин	<i>t,</i> мм	
Основной уровень	0	15,7(3000)	3	0,03	
Интервал варьирования	$\nabla X_i$	1,05	1,5	0,015	
Верхний	+1	16,75(3200)	4,5	0,045	
Нижний	-1	14,65(2800)	1,5	0,015	
Звёздные Верхний	+1,215	16,97575(3536)	4,8225	0,048225	
Нижний	-1,215	14,42425(2464)	1,1775	0,011775	

#### Табл 1: Уровни факторов и интервалы варьирования

Экспериментальные исследования были проведены науниверсально-заточном станке мод.3А64Д, оборудованном гидравлической продольной подачей.Для сравнительной оценки выходных параметров проведенных опытов, эксперименты были проведены с применением стандартного чашечного круга типа ЧК 100x25x20 с характеристикой 14А40СМ1К со сплошной рабочей поверхностью И новой конструкции торцового шлифовального круга с прерывистой режущей частью рабочей поверхности. При этом обеспечивая идентичность всех условий эксперимента, менялся только шлифовальный круг. Опытные образцы заготовок были приняты из стали 40Х с твердостью 40 HRC с размерами поперечного сечения 30x20.

Измерение геометрических параметров производилось с использованием нижеперечисленных методов и средств измерений:

 Шероховатость –среднеарифметическое отклонение профиля профилографам мод. 130 завода «Калибр» г Москва;

- 2. Волнистость —высота волн  $W_B$ -по волнограммам, снятым на профилограф —профилометре 130 с применением приспособления для измерения волнистости;
- Погрешности геометрической формы непрямолинейность- на приборе «Самописец -260» конструкции завода «Калибр» г. Москва.

#### V. Эксперименты

Опыты были поставлены по составленной планирования (Табл.2) обладающей матрице оптимальными свойствами. На основе априорных данных о характере искомой зависимости установлено, что[1-3] для определения зависимости шероховатости поверхности от скорости круга, скорость детали и подачи на глубину, описания поверхности отклика полиномом первого порядка недостаточно, поэтому для получения адекватной аппроксимации исследуемого процесса воспользовались полиномом второго порядка. Математическая модель второго порядка представляется в виде [4]

$$M\{Y\} = \eta = \beta_0 + \sum_{i=1}^k \beta_i X_i + \sum_{i>j}^k \beta_{ij} X_i X_j + \sum_{i=1}^k \beta_{ii} X_i^2$$
(1)

 $eta_{_0}$ -свободный член

 $eta_i$ - коэффициенты при линейных членах

## $eta_{_{i_j}}$ - коэффициенты при взаимодействии факторов.

Кодирование значение факторов произведено с помощью формулы преобразования [4]

$$X_{i} = \frac{\widetilde{X}_{i} - \widetilde{X}_{i_{0}}}{\Delta \widetilde{X}_{i}}$$
<sup>(2)</sup>

V	X1	X2	X3	X1	X2	X3	R <sub>as</sub>	<b>R</b> <sub>an</sub>
1	-	-	-	14,65	1,5	0,015	0,49	0,4
2	+	-	-	16,75	1,5	0,015	0.29	0.2
3	-	+	-	14,65	4,5	0,015	0.55	0.4
4	+	+	-	16.75	4,5	0.015	0.41	0.3
5	-	-	+	14.65	1,5	0.045	0,64	0.52
6	+	-	+	16.75	1,5	0.045	0,44	0,35
7	-	+	+	14.65	4,5	0.045	0.7	0,6
8	+	+	+	16,75	4,5	0,045	0,56	0,46
9	-1,215	0	0	14,424	3	0,03	0,6	0,51
10	+1,215	0	0	16,976	3	0,03	0,4	0,38
11	0	-1,215	0	15,7	1,1775	0,03	0,35	0,24
12	0	+1.215	0	15,7	4,8225	0,03	0,65	0,55
13	0	0	-1,215	15,7	3	0,012	0,43	0,31
14	0	0	+1.215	15.7	3	0,048	0,57	0,45
15	0	0	0	15,7	3	0,03	0,5	0,4

Табл. 2: Ортогональный план второго порядка для к=3

Оценка коэффициентов регрессии производятся по формулам [4] с учетом численных значений моментов и вспомогательных коэффициентов

$$b_{0}' = \frac{\sum_{\nu=1}^{n} r_{\nu} \overline{y}_{\nu}}{N};$$

$$b_{ii} = \frac{\sum_{\nu=1}^{n} r_{\nu} X_{i_{\nu}}^{2} Y_{\nu}}{\sum_{g=1}^{n} (X_{i_{g}}^{4} - X_{i_{g}}^{2} X_{i_{g}}^{2})};$$

$$b_{ii} = \frac{\sum_{\nu=1}^{n} r_{\nu} X_{i_{\nu}} \overline{Y}_{\nu}}{\sum_{g=1}^{n} X_{i_{g}}^{2}}; \quad i \neq 0$$

$$b_{ii} = \frac{\sum_{\nu=1}^{n} r_{\nu} X_{j_{\nu}} \overline{Y}_{\nu}}{\sum_{g=1}^{n} X_{i_{g}}^{2} X_{j_{g}}^{2}}$$

(3)

Оценка коэффициента  $b_{
m o}$ , входящего в исходную модель производится по формуле [4]

$$b_0 = b_0^1 - \lambda_2^1 \sum_{i=1}^{k} b_{ii}$$
(4)

где  $\lambda_2$  момент второго порядка.

$$\lambda_2 = \frac{\sum_{g=1}^{N} X_{i_g}^2}{N}; \quad i = 1, 2, \dots k$$

где N - общее число опытов;  $r_{_{\!\mathcal{V}}}$  — число повторных опытов в  ${}^{\mathcal{V}}$ -й точке плана;

n -число разных точек в плане; y-порядковый номер точки плана;

 $\overline{Y_{_{v}}}$  - средний отклик по  $\,\,r\,$  опытом в точке с номером  $\,r\,;\,k\,$  - число факторов;

$$\widetilde{Y}$$
 -оценка математического ожидания отклика  $M\{Y\} = \eta$  ;

 $oldsymbol{X}_i$  - переменной факторы;  $oldsymbol{Y}_u$  - параметр оптимизации, подлежащий изучению;

*i* -номер повторения испытания; *j* -номер уровня фактора. Построчные дисперсии подсчитываются по формуле[4]

 $S_{v}^{2} = \frac{\sum_{j=1}^{r} (Y_{v_{j}} - \overline{Y}_{u})^{2}}{r - 1}$ (5)

объединенная дисперсия параметра оптимизации по формуле[4]

$$S^{2}\{Y\} = \frac{\sum_{j=1}^{r} (Y_{v_{j}} - \overline{Y}_{u})^{2}}{r - 1}$$
(6)

Дисперсия коэффициента регрессии  $S^2\{b_i\}$  при равномерном дублировании опытов по точкам с числом повторных опытов r определяется по формуле[4]

$$S^{2}\{b_{i}\} = \frac{S^{2}\{Y\}}{nr}$$
(7)

Дисперсия адекватности  $\,S_{ag}^{\,\,2}\,$  определяется по формуле [4]

$$S_{ag}^{2} = \frac{SS_{ag}}{f_{ag}} = \frac{\sum_{\nu=1}^{n} (\overline{Y}_{\nu} - \hat{Y}_{\nu})^{2}}{n - m}$$

где m-число коэффициентов в модели;  $SS_{_{ag}}$ -сумма квадратов отклонений

(8)

 $f_{ag}$  - число степеней свободы для дисперсии неадекватности. Расчет коэффициентов уравнения произведем по формулам(3) Для стандартного круга

$$b'_{0} = \frac{\sum_{\nu=1}^{15} \overline{Y_{\nu}}}{15} = 0,5053$$

$$b_{i} = \frac{1}{10,954} \sum_{\nu=1}^{15} X_{i\nu} \overline{Y_{\nu}}; \quad b_{1} = -0,084 \ b_{2} = 0,066; \quad b_{3} = 0,07$$

$$b_{ij} = \frac{1}{8} = \sum_{\nu=1}^{15} X_{i\nu} X_{j\nu} \overline{Y_{\nu}}; \quad b_{12} = 0,015; \ b_{13} = 0; \quad b_{23} = 0$$

$$b_{ii} = 3,45 \times \frac{1}{45} \sum_{\nu=1}^{15} X_{i\nu}^{2} \overline{Y_{\nu}}; \quad b_{1}^{2} = 0,0748; \quad b_{2}^{2} = 0,062; \quad b_{3}^{2} = 0,062$$

Для круга новой конструкции

$$b'_{0} = \frac{\sum_{\nu=1}^{15} \overline{Y_{\nu}}}{15} = 0,4$$

$$b_{i} = \frac{1}{10,954} \sum_{\nu=1}^{15} X_{i\nu} \overline{Y_{\nu}} ; \quad b_{1} = -0,07 \ b_{2} = 0,06 ; \quad b_{3} = 0,073$$

$$b_{ij} = \frac{1}{8} = \sum_{\nu=1}^{15} X_{i\nu} X_{j\nu} \overline{Y_{\nu}} ; \quad b_{12} = 0,016 ; \quad b_{13} = -0,00125 ; \quad b_{23} = 0,01125$$

$$b_{ii} = 3,45 \times \frac{1}{45} \sum_{\nu=1}^{15} X_{i\nu}^{2} \overline{Y_{\nu}} ; \quad b_{1}^{2} = -0,062 ; \quad b_{2}^{2} = 0,058 ; \quad b_{3}^{2} = 0,065$$

Табл. 2

v	X1	X2	Х3	X1	X2	Х3	R <sub>as</sub>	R <sub>an</sub>
1	-	-	-	14,65	1,5	0,015	0,49	0,4
2	+	-	-	16,75	1,5	0,015	0.29	0.2
3	-	+	-	14,65	4,5	0,015	0.55	0.4
4	+	+	-	16.75	4,5	0.015	0.41	0.3
5	-	-	+	14.65	1,5	0.045	0,64	0.52
6	+	-	+	16.75	1,5	0.045	0,44	0,35
7	-	+	+	14.65	4,5	0.045	0.7	0,6
8	+	+	+	16,75	4,5	0,045	0,56	0,46
9	-1,215	0	0	14,424	3	0,03	0,6	0,51
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12	0	+1.215	0	15,7	4,8225	0,03	0,65	0,55
13	0	0	-1,215	15,7	3	0,012	0,43	0,31
14	0	0	+1.215	15.7	3	0,048	0,57	0,45
15	0	0	0	15,7	3	0,03	0,5	0,4

Оценку коэффициента  $b_0$ , входящего в исходную модель, находим по формуле(4) [4]

$$b_0 = b_0' - 0,7303(b_1^2 + b_2^2 + b_3^2)$$

Для стандартного круга

 $b_0 = 0,456$ 

для круга новой конструкции

 $b_0 = 0,355.$ 

Уравнение регрессии в кодированных переменных будет: для стандартного круга

 $\hat{Y} = 0,456 - 0,085 X_1 + 0,066 X_2 + 0,071 X_3 + 0,015 X_1 X_2 - 0,0748 X_1^2 + 0,062 X_2^2 + 0,06 X_3^2,$ (9)

для круга новой конструкции

$$Y=0,355-0,07 X_{1}+0,06 X_{2}+0,073 X_{3}+0,016 X_{1} X_{2}-0,00125 X_{1} X_{3}+0,01125 X_{2} X_{3}-0,062 X_{1}^{2}+0,058 X_{2}^{2}+0,065 X_{3}^{2}-0,00125 X_{1}^{2} X_{3}-0,062 X_{1}^{2}+0,058 X_{2}^{2}+0,065 X_{1}^{2}-0,00125 X_{1}^{2} X_{1}^{2}-0,00125 X_{1}^{2}-0,00125 X_{1}^{2} X_{1}^{2}-0,00125 X_{1}^{2} X_{1}^{2}-0,00125 X_{1}^{2} X_{1}^{2}-0,00125 X_{1}^{2} X_{1}^{2}-0,00125 X_{1}^{2}$$

Для проверки достоверности полученных моделей была проведена проверка ряд гипотез: об однородности дисперсий, значимости коэффициентов регрессии и об адекватности модели.

Построчные дисперсии подчитываем по формуле (5)

$$S_{v}^{2} = \sum \frac{\sum_{j=1}^{r} (Y_{v_{j}} - Y_{v})^{2}}{r-1},$$

Дисперсию параметра оптимизации S<sup>2</sup>{Y}подсчитаем на основе данных таблицы по формуле (6): для стандартного круга

$$S^{2}{Y} = \frac{\sum_{\nu=1}^{n} S_{\nu}^{2}}{n} = \frac{0,365}{15} = 0,02434$$

для круга новой конструкции

$$S^{2}{Y} = \frac{\sum_{\nu=1}^{n} S_{\nu}^{2}}{n} = \frac{0,3801}{15} = 0,02534$$

где  $S_v^2$ -дисперсия отклика по результатам в *v*-й точке плана, где производится *rv* повторных опытов

Проверку значимости каждого коэффициента проводим по t –критерию Стьюдента. При равномерном дублировании опытов по точкам с числом повторных опытов r дисперсия коэффициента регрессии  $S^2{b_i}$  определяется по формуле

для стандартного круга

$$S^{2}{b_{i}} = \frac{0,2434}{nr} = \frac{0,2343}{15 \cdot 3} = 0,0005$$
  
 $S{b_{i}} = 0,023$ 

для круга новой конструкции

$$S^{2}{b_{i}} = \frac{0,2534}{nr} = \frac{0,2434}{15 \cdot 3} = 0,00056$$
$$S^{2}{b_{i}} = 0,0237$$

Определим значениеt- критерия по формуле

$$t_i = \frac{\left|b_i\right|}{s\{b_i\}}$$

для стандартного круга

 $t_0 = 0,456/0,023 = 19,8;$   $t_1 = 0,085/0,023 = 3,69;$   $t_2 = 0,066/0,023 = 2,87;$   $t_3 = 0,07/0,023 = 3,04;$   $t_{12} = 0,015/0,023 = 0,652;$   $t_{11} = 0,0748/0,023 = 3,25;$   $t_{22} = 0,062/0,023 = 2,69;$   $t_{33} = 0,0620/0,023 = 2,69$  для круга новой конструкции

 $t_o=0,355/0,0237=15$   $t_1=0,07/0,0237=3$ ;  $t_{2=}0,06/0,0237=2,5$ ;

*t*<sub>3</sub>=0,073/0,0237=3

t<sub>12</sub>=0,016/0,0237=0,675; t<sub>13</sub>=0,00125/0,0237=0,05; t<sub>23</sub>=0,01125/0,47

 $t_{11}$ =0,062/0,0237=2,6;  $t_{22}$ =0,058/0,0237=2,44;  $t_{33}$ =0,065/0,0237=2,74

Критическое значение*t<sub>кp</sub>* находится по таблице работы [4] при *n(r-1)=30* степенях свободы и заданном уровне значимости *a=5% t<sub>кp</sub>=1,697*.Если *t>t<sub>кp</sub>*, гипотеза отвергается, и коэффициент *b<sub>i</sub>*признается значимым.

Построим доверительный интервал длиной  $\Delta b_i$  : для стандартного круга

$$\Delta b_i = t_{kp} S\{b_i\} = 1,697 \cdot 5, 1 = 8,8$$

для круга новой конструкции

$$\Delta b_i = t_{kp} S\{b_i\} = 1,697 \cdot 0,0237 = 0,04$$

Коэффициент значим если его абсолютная величина больше половины длины доверительного интервала.В модели стандартного круга коэффициенты, b<sub>23</sub>,b<sub>33</sub>, в модели круга новой конструкции коэффициенты b<sub>12</sub>,b<sub>23</sub>,b<sub>33</sub> являются незначимыми.

Таким образом, математическая модель зависимости шероховатости шлифованной поверхности от элементов режима шлифования в виде уравнения связи выходного параметра Yu переменных X<sub>i</sub>, включающего только значимые коэффициенты получается:

для стандартного круга

$$\hat{Y} = 0,456 - 0,085 X_1 + 0,066 X_2 + 0,071 X_3 + 0,015 X_1 X_2 - 0,0748 X_1^2 + 0,062 X_2^2 + 0,06 X_3^2,$$
(9)

для круга новой конструкции

$$Y=0,355-0,07 X_{1}+0,06 X_{2}+0,073 X_{3}-0,062 X_{1}^{2}+0,058 X_{2}^{2}+0,065 X_{3}^{2}.$$
 (10)

Для получения уравнения в в натуральных значениях элементов режим шлифования вместо *x*, поставим их значения из формул преобразования [4]

$$X_3 = \frac{V_k - 15.7}{1.05}; \quad X_2 = \frac{V_d - 3}{1.15}; \quad X_3 = \frac{t - 0.03}{0.015}$$

Таким образом, получим математическую модель зависимости шероховатости от параметров режима

шлифования: скорости круга  $V_k$  , скорости детали  $V_d$  и глубины резания t в натуральных значениях: для стандартного круга

$$\hat{Y} = -14,337 + 2,025 V_{k} - 0,281 V_{d} - 11,799 t + 0,01 V_{k} V_{d} - 0,068 V_{k}^{2} + 0,028 V_{d}^{2} + 275,556 t^{2}$$
(11)

для круга новой конструкции

$$Y=-11,69+1,6634V_{k}-0,288V_{d}-12,721\ t-0,056V_{k}^{2}+0,026V_{d}^{2}+288,889\ t^{2}$$
(12)

Статистические данные обработки результатов для стандартного круга и круга новой конструкции были приведены соответственно в таблицах 3 и. 4.

Точки плана <i>v</i>	$Y_1$	$Y_2$	<i>Y</i> <sub>3</sub>	$\overline{Y_{_{_{\mathcal{V}}}}}$	$S_v^2$	$\hat{Y_v}$	$(\overline{Y_{v}}^{2}-\hat{Y_{v}}^{2})$
1	0,43	0,65	0,39	0,49	0,0196	0,481	0,000081
2	0,43	0,19	0,25	0.29	0,0156	0,28	0,0001
3	0,45	0,45	0,75	0.55	0,03	0,581	0,00096
4	0,6	0,27	0,36	0.41	0,0341	0,4645	0,0029
5	0,54	0,8	0,58	0,64	0,0196	0,6233	0,00028
6	0,37	0,35	0,6	0,44	0,019	0,42255	0,0003
7	0,85	0,6	0,65	0,7	0,0175	0,72355	0,0005
8	0,46	0,74	0,48	0,56	0,0244	0,5865	0,0007
9	0,8	0,5	0,5	0,6	0,03	0,45976	0,0196
10	0,34	0,28	0,58	0,4	0,0252	0,255	0,021
11	0,5	0,23	0,32	0,35	0,0189	0,481	0,017
12	0,53	0,84	0,58	0,65	0,0277	0,641	0,017
13	0,61	0,29	0,39	0,43	0,0267	0,4735	0,00189
14	0,52	0,43	0,76	0,57	0,0291	0,646	0,005776
15	0,69	0,38	0,43	0,5	0,0277	0,46823	0,00095
				7 58	0 3651	7 587	0.089037

#### Табл. 4

Точки плана <i>v</i>	$Y_1$	$Y_2$	<i>Y</i> <sub>3</sub>	$\overline{Y_{v}}$	$S_v^2$	$\hat{Y_{v}}$	$(\overline{Y}_v^2 - \hat{Y}_v^2)$
1	0,25	0,6	0,35	0,4	0,033	0,37	0,0009
2	0,35	0,1	0,15	0.2	0,018	0,21	0,0001
3	0,6	0,3	0,3	0.4	0,03	0,52	0,0144
4	0,2	0,25	0,45	0.3	0,018	0,33	0,0009
5	0,42	0,72	0.42	0.52	0,03	0,52	0
6	0,55	0,2	0,3	0,35	0,033	0,33	0,0004
7	0,55	0,78	0,47	0,6	0,0259	0,61	0,0001
8	0,36	0,4	0,62	0,46	0,0196	0,5	0,0016
9	0,7	0,41	0,42	0,51	0,0271	0,351	0,0253
10	0,28	0,53	0,33	0,38	0,018	0,16	0,0484
11	0,18	0,14	0,4	0,24	0,0196	0,366	0,0159
12	0,4	0,75	0,50	0,55	0,032	0,51	0,0016
13	0,46	0,21	0,26	0,31	0,018	0,2	0,0121
14	0,4	0,33	0,62	0,45	0,0279	0,383	0,0045
15	0,6	0,3	0,3	0,4	0,03	0,2	0,04
				6,07	0,3801	5,56	0,1662

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Табл. З

Проверим полученную модель на адекватность по формуле(8): для стандартного круга

$$\sum \overline{Y}_{\nu} = 7,58; \qquad \sum \hat{Y}_{\nu} = 7,587$$

$$S^{2} \{Y\} = \frac{\sum_{\nu=1}^{n} S_{\nu}^{2}}{n} = \frac{0,365}{15} = 0,02434$$

$$S_{ad}^{2} = \frac{r}{(n-m)} \sum_{\nu=1}^{n} \left[\overline{Y}_{\nu} - \hat{Y}_{\nu}\right]^{2} = 0,038$$

$$F = \frac{S_{ad}^{2}}{S^{2} \{Y\}} = \frac{0,038}{0,02434} = 1,56$$

для круга новой конструкции

$$\sum \overline{Y} = 6,07 ; \qquad \sum \hat{Y} = 5,56 .$$

$$S_{ad}^{2} = \frac{r}{(n-m)} \left[ \overline{Y}_{v} - \hat{Y}_{v} \right]^{2} = 0,038$$

$$F = \frac{S_{ad}^2}{S^2 \{Y\}} = \frac{0,038}{0,02534} = 1,499$$

где *M* -число членов аппроксимирующего полинома(включая свободный член).

Табличное значение критерия Фишера для числа

степеней свободы  $f_{ad}=\!15\!-\!10=\!5$ , общему числу степеней свободы для объединенной дисперсии S²{Y},

 $f_e = 45 - 15 = 30$  и уровня значимости  $\alpha = 10\%$ 

равно  $F_{kp}=1,6$  поскольку для рассмотренных обоих

варианто  $F < F_{kp}$ , полученные моделишероховатости при шлифовании стандартным чашечным кругом и кругом новой конструкции являются адекватными реальным процессам.

#### VI. ГРАФИЧЕСКАЯ ИНТЕРПРЕТАЦИЯ

На основе математических моделей (11) и (12) были построены графические зависимости шероховатости поверхности от элементов режима резания при шлифовании со стандартным кругом и кругом новой конструкции (рис.2, а,б,с).













 $V_{\scriptscriptstyle d}\,$  (c) при шлифовании со стандартным кругами и кругом новой конструкции.

#### VII. Заключение

Полученные модели(11) и (12) позволяют определить эффективность новой конструкции торцевого шлифовального круга с прерывистостью во фронтальной зоне рабочего торца и переходом от впадины к выступу по архимедовой спирали по сравнению со стандартным чашечным кругом. На основе анализа модели (12) можно определить рациональное сочетание элементов режима резания для торцевого шлифовального круга новой конструкции. Анализ графических зависимостей (рис.2а,b,c) показывает, что шероховатость поверхностей, шлифованных торцевым шлифовальным кругом новой конструкции значительно ниже, чем шлифованных стандартным кругом. Это объясняется тем, что созданием порывистости на фронтальной зоне рабочего торца с профилированием выступов по архимедовой спирали устраняются периодические удары, число режущих зерен, создаются увеличиваются условия для относительно равномерного распределения между ними припуска и повышается выхаживающая способность сплошной части рабочего торца.

#### VIII. Выводы

- Разработана 1. новая конструкция торцового шлифовального круга с прерывистой режущей и сплошной выхаживающей частями рабочей поверхности, с переходом от впадин к выступам по архимедовой спирали. Характеристика архимедовой спирали представляет из себя сумму двух равномерных движений - поступательного в результате продольной подачи детали и вращательного, посредством вращательного движения шлифовального круга и практически обеспечивает постоянство угла атаки зерен, расположенных по всей ее длине. Предложенная конструкция торцового шлифовального круга была защищена в Государственном комитете по стандартизации метрологии и патентам и получен одноименный патент под № 0183.
- 2. Установлено, чтосозданием прерывистости в режущей- фронтальной зоне с переходом от выступа к впадине по архимедовой спирали и части выполнением выхаживающей рабочей шлифовального поверхности торцового круга сплошным, можно значительно повысить эффективности процесса шлифования, путем:
  - -снижения температурного воздействия на обрабатываемую поверхность;
  - -снижения шероховатости шлифованной поверхности;

-относительно равномерного распределения припуска на выступ между режущими абразивными зернами.

-снижения ударного воздействие на обрабатываемую поверхность и тем самым уменьшения вибраций технологической системы СПИД.

- З. Путем реализации ортогонального плана второго порядка были получены математические модели зависимости показателей шероховатости шлифованной поверхности от параметров режима шлифования: скорости шлифования, скорости детали и глубины резания, при шлифовании как стандартным кругом, так и кругом новой конструкции.
- 4. Сравнительный анализ графических зависимостей полученных на основе эмпирических моделей показывает, что при применении новой конструкции торцового круга наблюдается значительное(до 30%) уменьшение шероховатости шлифованной поверхности. Применяемый метод экспериментальных исследований позволяет на основе полученных моделей изучить механизм формирования поверхностей, шлифованных кругом новой конструкции и оптимизировать его.

#### ЛИТЕРАТУРА

- 1. Husseinov, H.A.; Mamedov, Ch. M. A. (2010) New Design for End Grinding Wheels. Russian Engineering Research, 2011, Vol.31, 1, p. 37-40.
- Husseinov, H.A.; Bagirov, S.A.; Krehel, R.; Kociško, M. (2014) The increased production efficiency and optimization terms of stationarity by flat grinding with abrasive circle surface," by. Advancede in Material Science and Technoloji. 108797.
- Huseynov Hassan1, Bagirov Sahib1, Radoslav Krehel'2 and Marek Kočis ko2 (2 017) Increase of accuracy of geometric forms of surfaces ground by a grinding wheel of various grain sizes. Advances in Mechanical Engineering.2017, Vol. 9(8) 1–12.
- Katsev, P. G. (1974) Statistical methods a research of the cutting tool. M.: Mechanical engineering, p. 239.
- 5. Yakimov A.V. Optimization of the grinding process. M.: Mechanical engineering, 1975.173s.



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## A Research Study to Determine if Solar Dryer Technology for Preservation of Agro-produce is needed in Botswana

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Abstract- High postharvest loss is a significant challenge to actors in the agro-produce value chain. The application of solar dryers for preservation of agro-produce has become an increasingly popular mitigation method for the high postharvest losses in sunny-belt countries. However, the adaptation of this technology is quite nascent in some of these countries. This study investigates if solar dryer technology is needed in Botswana. The methodology covered the assessment of the challenges faced by agro-dealers in Botswana and conducted a survey to determine the need for solar dryer technology for preservation of their agro-produce. Secondary and primary data were collected by means of literature and questionnaire administered using the opportunistic sampling method. The data was analysed using Statistics package for social scientists, SPSS computer program. The results established that there was need for solar dryer technology in Botswana for drying of produce to reduce postharvest losses.

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## A Research Study to Determine if Solar Dryer Technology for Preservation of Agro-produce is needed in Botswana

Ebangu Orari Benedict  $^{\alpha}$  & Dintwa Edward  $^{\sigma}$ 

Abstract- High postharvest loss is a significant challenge to actors in the agro-produce value chain. The application of solar dryers for preservation of agro-produce has become an increasingly popular mitigation method for the high postharvest losses in sunny-belt countries. However, the adaptation of this technology is guite nascent in some of these countries. This study investigates if solar dryer technology is needed in Botswana. The methodology covered the assessment of the challenges faced by agro-dealers in Botswana and conducted a survey to determine the need for solar dryer technology for preservation of their agro-produce. Secondary and primary data were collected by means of literature and questionnaire administered using the opportunistic sampling method. The data was analysed using Statistics package for social scientists, SPSS computer program. The results established that there was need for solar dryer technology in Botswana for drying of produce to reduce postharvest losses.

#### I. INTRODUCTION

he discussions on the various options for methods to alleviate the high global postharvest losses that negatively impact on agro-produce value-chain are on-going (Gbaha et al., 2007; Mujumdar, 2007).Recent research work has focussed on using renewable energy technologies for drying of agro-produce as possible preservation methods to reduce postharvest losses (Gustafsson et al., 2013). Solar dryers have increasingly become popular especially on account of their favourable relative costs of investment and operation. However solar dryers have not yet being adopted in Botswana despite the country's endowment with abundant sunshine (Weiss and Buchinger, 2015). As part of an effort to intimately understand the challenges of the agro-producers and to establish the need for solar drying technology in the country, a survey was conducted. The study area for this survey was Gaborone and its environs. The survey targeted a cross section of stakeholders that included farmers. distributors, and retailers.

#### a) Research Questions

The main objective of this study was to assess the challenges being faced by stakeholders of agroproduce and to establish if there is need for solar dryer technology for preservation by drying. Hence, the survey was conducted to answer the following research questions:

- 1. Which are the agro-materials in need of preservation by drying in Botswana?
- 2. What are the challenges of preservation of agroproduce that are faced by agricultural communities of Botswana?
- 3. Is there a need for solar drying technology for agroproduce in Botswana?

#### b) Objectives

The specific objectives of this study were:

- 1. To establish the profile of agro-produce that are in need of preservation by drying in Botswana
- 2. To establish the challenges of preservation of agroproduce that are faced by agricultural communities of Botswana
- 3. To determine if there is need for solar dryer technology for agro-produce in Botswana.

#### II. METHODOLOGY

The research methodology used in the realisation of these objectives comprised of secondary data collection, primary data collection and data processing. The responses to social-demographic questions in the questionnaire that included name, sex, age, and education were of relevance for qualitative analysis; but providing name of respondent was optional and was not included in this analysis. Analyses using SPSS descriptive statistics and binary regression were performed.

#### a) Secondary data collection

Secondary data was obtained from journals, annual reports and general literature particularly from Botswana Ministry of Agriculture and Food Security. The data was used to profile the agro-produce in the country and additionally gave indication on the commercial trend of the agricultural enterprises.

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#### b) Primary data collection

Primary data was obtained through a survey conducted in Botswana in June 2016 amongst targeted stakeholders. A questionnaire was administered, as the major tool for primary data collection distributed to various respondents who were contacted on voluntary basis. A variety of questions in the questionnaire were designed to collect data that would be analysed for the assessment of the need for solar dryer technology in Botswana as the intended purpose of the research study. The survey was conducted in Gaborone city and its environs including Mochudi and Mogoditshane.

### c) Sampling methods

Four possible sampling methods for conducting the needs assessment survey were identified as: Random, Stratified, Systematic and Opportunity(Gamli, 2014; Sadeghi et al., 2013). The choice of a sampling method is based on the survey objectives and good representation of the target population. The execution time and accessibility of participants are the other important considerations. The Random, Stratified and Systematic Sampling methods apply probability-based sampling techniques whereas the Opportunity sampling method applies a non-probability-based sampling technique. The choice of the most appropriate sampling method for the study was made after analysing the opportunity cost of each of the four methods.

The Random Sampling method eliminates sampling bias, represents a target population but requires a great amount of time, effort and money. The chance of using the Random method in Gaborone was analysed. The target population in this survey was the consumer of the proposed solar drying technology in Botswana. The sample size corresponding to the population of Gaborone of 232,000 indigenous people by the 2013 national population census can be estimated. For a confidence level of =1.96 from the nominal tables corresponding to 95% confidence interval, error margin of 5% and proportion ratio , of 0.5, assumed half of target population. The sample size determined would require using at least 385 respondents by the formula (Cochran, 2007):

$$n = \frac{Z^2 p \left(1 - p\right)}{e^2} \tag{1}$$

This would have required distribution of at least 1,153 questionnaires to potential respondents if the proportion of actual filled questionnaires was to be at least 30% of the total number of questionnaires distributed to the sample population. This is because of the high attrition rate (70%) that is associated with this type of survey (Barlett et al., 2001). To accomplish this exercise would have needed more research time and financial resources for implementation. Hence, the Random Sampling method was considered unsuitable for this research.

In Stratified Sampling, the weighted participation of the target population makes it highly representative, but costly in time, effort and money. The number of strata in respect of the objective of the questionnaire would be very large and difficult to organise so as to get a representative sample population of Gaborone and its environs. In view of the time required to perform stratification of the sampling frame, the Stratified Sampling method was not considered for use in this research.

The Systematic Sampling method uses defined participants with similar experiences and at same conditions and is representative of the target population. The method pre-supposes well-defined and identifiable participants of the sampling population, which is not practically possible. In view of the difficult task of establishing the sampling framework and the high expenses incurred in implementation of the task, the Systematic Sampling method could not be applied in this survey.

The Opportunity Sampling method, uses people from a target population, available at the time and willing to participate. It is based on convenience; it is quick and easy, but may be biased as the target population may not be very representative. This is the sampling method that was chosen for this study. To secure a representative population, the target population was identified and it was composed of all categories of agroproduce value-chain stakeholders, namely, agrofarmers, major distributors of agricultural products, wholesalers, and retail supermarkets and vendors. These were essentially independent participants who accepted to participate in the survey on voluntary basis.

### d) Survey questionnaire

A questionnaire constituting 16 named/defined variables formulated as 16 questions was developed as given in Table 1. These variables comprised of the participant's name, gender, age, education level, location, actor, produce handled, challenges faced, oversupply, preservation methods, drying problems, methods for improving preservation, need for solar drying technology, and suggestions by respondent for preservation of agro-produce. The questions that included name, sex, age, and education were of relevance for demographic analysis. Providing the name of the respondent was optional. The purpose for which each question in the questionnaire was meant to achieve has been provided.

A Research Study to I	Determine if Solar Dryer	TECHNOLOGY FOI	r Preservation	OF AGRO-PRODUCE IS	NEEDED IN
		Botswana			

Variable	Code Name	Purpose		
Name	Not applied	Identification		
Gender	Gender	Categorisation of participants by sex; males or females		
Age	Age	Identification of participants by age group categories		
Education	Education	Categorisation of participants according to classical education levels; University, Tertiary, Secondary, Primary and Non-formal		
Location	Location	Categorisation of participants according to their arears of operation; Gaborone or Outside Gaborone		
Actor	Actor	Categorisation of participants according to specific roles performed in agro-produce value chain; Farmer, Wholesaler, Retailor, Vendor		
Produce	Produce	Establish agricultural produce handled by participant		
Challenges	Challenges	Identification of challenges experienced by participant in handling agro- produce after harvest		
Oversupply	Oversupply	Determination of amount of produce handled in excess of demand by actor		
Preservation Methods	PreservationM	Determination of methods currently used for preservation of agro- produce after harvest		
Drying Methods	DryingM	Determination of methods currently used for drying of products		
Drying Problems	DryingP	Identification of problems encountered in application of a drying method		
Improvement	Improvement	Establish if respondent wants improvement in methods of postharvest preservation of agro-produce		
Solar Technology	SolarT	Determine if subject thinks solar technology is needed for preservation by drying		
Suggestions	Suggestions	Get opinions on other methods of postharvest handling of agro- produce.		

Table1:	The	named	variables	and their	apr	olications
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### e) Data Processing

First, the secondary data was analysed to give the profile of agro-produce in Botswana categorised as horticultural products and grains and pulses. The challenges faced by the stakeholders were analysed with respect to the postharvest losses experienced in each agricultural enterprise. Secondly, analysis of the primary data that was collected from the responses to the questionnaire was accomplished with the aid of Excel and Statistics Package for Social Scientists, IBM SPSS® Version 20. The data filled in the questionnaires were coded. Each question or variable was categorised as nominal, ordinal or scaled. The nominal category takes the binary coding form of 0, 1. The ordinal variables were coded as 1, 2, 3, etc. The scaled variables were coded according to the levels of the judgment of their impact, by the scale of 1-5 (with 1 being the lowest and 5 highest). The demographic and explanatory variables used in the questionnaire are shown in Table 2.

Demographic variables		
Variables	Category	
Gender	Nominal	
Age	Ordinal	
Education	Ordinal	
Actor	Ordinal	
Location	Nominal	

### Table 2: Variable categories

Explanatory variables			
Variables	Category		
Produce	Ordinal		
Challenges	Scale		
Oversupply	Nominal		
PreservationM	Ordinal		
DryingM	Ordinal		
DryingP	Scale		
Improvement	Scale		
SolarT	Nominal		
Suggestions	Ordinal		

SPSS models were applied in the analysis: Descriptive statistics was applied for evaluation of frequency/percentages of variable occurrences. This was to give the statistics of the variable responses. Descriptive statistics and cross-tabulation were applied for teasing out demographic participants. Some variables were considered as predictor variables because of their relevance to precise prediction of solar drying as a method of preservation to be used in Botswana. The predictor variables were:

- 1. Preservation methods, PreservationM, that asked if the respondent wants to improve upon the preservation methods being used,
- 2. The drying methods, DryingM, that asked if the respondent wants to improve the drying method they are already using
- 3. The drying problems, DryingP, that asked if there were challenges or disadvantages associated with the respondent's method of drying the products
- 4. The solar technology SolarT, that asked if the respondent thought that solar drying technology is needed for preservation of agricultural products in Botswana.

Descriptive statistics and cross-tabulations of these variables was done with the socio-demographic variables that comprised of

- 1. Gender that asked if the participant was female or male
- 2. Age asked for the number of years the participant has lived
- 3. Education asked for level of education attained by the participant,
- 4. Actor, asks for the agri-business role played by each respondent in the sample population in the agro-produce value-chain.

Binary logistic regression was applied in the prediction of likelihood of adaptation of solar drying technology in Botswana. Logic codes 0, 1, are used in the coding of nominal variables,  $Y_i$  expressed in binary format given as 1=agree and 0=disagree. The linear regression model for the odds probability expressed as,  $P(Y_i = y_i) = \pi_i = x_i\beta$  is not sustainable because of overflow of values on the right hand side of the equation comprising of covariant and regression coefficient  $\beta$  that exceed the boundary conditions of the probability domain (of 0-1). Hence the creation and transformation of the odds ratio  $\eta_i$  to a linear model by taking its natural logarithm, thus resulting into Logit model which opens the boundary restrictions to limits of  $-\infty$  to=  $+\infty$ . The odds ratio  $\pi$  is expressed as

$$\pi_i = \frac{p_i}{1 - p_i} \tag{2}$$

Where  $p_i$  is the instantaneous probability of the covariant.

The Logit model is expressed as

logit = 
$$\eta_i = \log(\pi_i) = \log\left(\frac{p_i}{1-p_i}\right)$$
 (3)

Thus the generic multivariate logistic binomial distribution model is given as

$$\eta_i = \beta_0 + \dots \beta_i x_i \dots + \beta_n x_n \tag{4}$$

Where n is the number of occurrences,  $x_i$  are the independent variables, and  $\beta_i$  are the binomial coefficients.

The probability is evaluated by

$$p_{i} = \frac{\exp(\eta_{i})}{1 + \exp(\eta_{i})}$$
(5)

Logit model is the binary model used to predict likelihoods of occurrences by applying a stochastic approach. The SPSS Regression and Binary Logistic model was applied in this analysis to predict the likelihood of adaptation of solar drying technology, Solar T, for preservation of agricultural products in Botswana using five variables that were considered to have great influence over such outcome. The identified variables were Gender, Actor, Oversupply, Drying M, and Produce. These variables were identified as categorical; nominal, ordinal dependent variables and were coded accordingly. The dependent variable encoding is as given in Table 3.

Table 3: Dependent Variable Encoding

Original Value	Internal Value
Disagree	0
Agree	1

Table 4 is the classification table of the observed and predicted likelihoods of adapting solar dryer technology, SolarT, in Botswana. Table 5 presents the notations used to describe the classification cases.

Table 4: Classification Analysis of Cases

	Predicted				
Observed	Dependent dichotomous variable, <i>Solar T</i>		Dependent dichotomous variable, <i>Solar T</i>		Percentage correct
	Disagree	Agree			
Disagree	TN	FP	ON		
Agree	FN	TP	OP		
	PN	PP	Тирр		

# Table 5: Case Notations

Case	Notation
ΤN	True negative
FN	False negative
FP	False positive
TP	True positive
PN	Predicted-Negative=TN+FN
PP	Predicted-Positive=FP+TP
ON	Observed-Negative=TN+FP
OP	Observed-Positive=FN+TP
Tot	Total cases = $TP + FP + FN + TN$
Тирр	Total true cases = $TN + TP$

The overall accuracy of the logistic regression model is measured from the fit of the model. The accuracy of the model prediction is its likelihood of occurrence calculated using the relationship

$$Likelihood = \frac{Tupp}{Tot} = \frac{(TN + TP)}{(TN + TP + FN + FP)} \quad (6)$$

# III. Results and Discussions

### a) Horticultural agro-products

This study clearly shows that a large variety of horticultural produce is grown in Botswana. The produce includes cabbage, broccoli, green peas, garden peas, mustard. tomato. chillies, rape, Swiss-chard, choumoliver, onion, egg-plant, butter nut, courgettes, green mealies, water melons, beetroot, carrots, herbs, green pepper, potatoes, and mango (MoA, 2012). However, some horticultural produce is imported from neighbouring countries, particularly South Africa, to bridge the local supply gaps. The cumulative production and cumulative sales for the produce commodities in the month of March 2015 is presented in Figure 1 which shows the cumulative production in metric tonnes versus cumulative sales in Pula. The trend of commodity transactions on horticultural produce in Botswana for March 2015 indicated that products of highest commercial significance were tomatoes, potatoes, cabbage, beetroot and onions.



Figure 1: The trend of Horticultural Production in Botswana, March 2015 (MoA, 2012)

The production growth rate is depicted in hort Figure 2. It shows that the growth rate of production of This

horticulture increased from 20% in 2014 to 60% in 2018. This is a positive trend for the country.



Figure 2: The production growth rate of horticultural products (MoA, 2012)

### b) Grains and pulses

Figure 3 depicts the result of performance of grains and pulses analysed from the data obtained during the period 2007-2012. Botswana's crops of commercial and economic significance in the category of grains and pulses were sorghum, maize, pulses and sunflower. These are staple food crops for most

households in Africa. Botswana is a net food importing developing country (NFIDC). Sorghum and maize are the main cereals, the basic foodstuffs with their national demand standing at 200,000 metric tons per year, of which only 17% is supplied through local production (BITC, 2019). The demand gap of 83% was met by importation from other countries.



Figure 3: Five-year production trend, 2007-2012, for grains and pulses in Botswana ((MoA, 2012)

c) Challenges faced by agro-produce value-chain actors

The challenges faced by the agricultural communities of Botswana are categorized as: i) postharvest losses on agro-produce and ii) preservation of the agro materials after harvest.

# i. Postharvest losses of agro-produce

The ranking of average losses of agro-produce in Botswana in 2015 is depicted in the pie chart of Figure 4. Tomatoes posted the highest loss of 28%, followed by spinach at 18%, sorghum at 16% and maize at 14%. It is clear from the pie chart that the main grains (sorghum and maize) constitute 30% and the horticultural produce constituted 70% of the postharvest losses of agro-produce in Botswana. The spoilage percentages obtained from the respondents indicated varying losses for the different commodities with some agro-produce incurring more losses than others. The horticultural products were found to be generally the more perishable commodities. Tomato and spinach were overall the highest ranked in postharvest losses of agro-produce in Botswana.



*Figure 4:* The postharvest loss ranking of the common Botswana agro-produce in 2015

# ii. The challenges of preservation of agro-produce after harvest

Table 6 gives the summary of challenges faced by the farming community of Botswana with regard to agro-produce handled and preservation methods used. The level of each challenge was rated as either low or both high. One of the major challenges encountered was that of quality deterioration issues and oversupply during the harvest season and low supply otherwise, resulting in loss of the produce, and by extension, income. Preservation challenges included inaccessibility of conventional technologies in rural locations and the high cost of the technologies. The open sun method, while cheap, has a major challenge of difficulties in assuring the quality of the products, due to a variety of factors such as long drying times, contamination due to exposure to the environment, encroachment by pests and vermin, as well as uncontrolled drying rates. These challenges indicated the need for alternative methods using affordable technologies such as solar based technologies, to improve on the existing methods.

ltem	Challenges	Rating of challenge		Remarks
		Low	High	
	Oversupply	✓	✓	Loss of value
Agro-produce	Quality deterioration	1	1	Non/Perishability
<b>U</b> .	Storage facilities		√	Lacking in rural settings
	Transport	✓		Inappropriate
Conventional	Quality of product	✓		Limited shelf-life
preservation	Availability		1	Inaccessible in rural settings
methous	Cost		√	High investment
	Quality of product	√	√	Not quality assured
The open sun	Availability	✓		Intermittent
arying method	Cost	~	1	Free but affected by weather
	Low awareness		1	Not disseminated
Solar dryer	Non availability		√	Nascent technology
-	Cost of technology	~	✓	Unknown

#### Table 6: The challenges faced by the agricultural communities in Botswana

d) Need for solar dryer technology in Botswana

The analysis of the data to establish the need for solar drying technology in Botswana was performed with the help of the SPSS Statistics package (Version 20, developed by IBM Corporation, Corporate headquarters, 1 New Orchard Road, Armonk, New York 10504-1722 USA). The results were categorized as Demographic statistics, Cross Tabulation statistics and Likelihood estimates.

# i. Demographic statistics

Figure 5 shows the responses according to gender. The total number of responses was 32 and comprised of 17 males and 15 females. Demographic statistics showed that there was fairly good gender balance with 46.9% female and 53.1% male.



Figure 5: The pie chart of gender classification

Figure 6 shows the responses according to age group. All the respondents were of adult age above 20 years old and comprised of 37.5% of age group 20-25 years; 25% of 26-30 years; 18.8% being of the 31-35

year's group; and, 18.8% being of the group above 35 years. The youthful age group of 20-25 years was highest.



Figure 6: The pie chart according to age groups

Figure 7 shows the education level of the respondents. All of the respondents were literate and understood the English language that was used in the questionnaire. By education, 40.6% of the respondents

were of university level, 21.9% college level, 21.9% Secondary school level, 12.5% primary school level and 3.1% non-formal education. The highest number of respondents was of University level education.





Figure 8 shows the location of respondents. All the respondents were located in Botswana with 68.8% of

the respondents coming from Gaborone City and 31.2% from Gaborone environs.



Figure 8: The responses according to location

Figure 9 gives the responses to the questions about the preservation methods presently used for preservation of agricultural products in Botswana. Various methods of preservation of agricultural products are used by respondents of whom 25% were drying agricultural products, 28.1% cooking, 28.1% freezing, 3.1% bottling and 15.6% used other preservation methods. The method of refrigeration/chilling was highest and was followed by drying and cooking.



Figure 9: Responses on preservation methods

An overwhelming majority (84.4%) of the respondents agreed that the use of solar technology, SolarT, could be the better method for preserving their

produce while 15.6% did not agree as depicted in Figure 10.



*Figure 10:* Responses on solar drying technology

The result indicates the responses of Actor variable are: 37.4% for Farmer, 6.3%, for Distributor, 18.8% for Retailer, 25% for Vendor, and 12.5% for

Consumer. The farmer had the highest respondents, signifying the most agreeing stakeholder in the survey as depicted in Figure 11.



*Figure 11:* Responses by the agro-business value-chain actors

#### ii. Cross-tabulation statistics

The results of the cross-tabulation model analysis show that out of the total 32 respondents, 8 responded to the question on typical methods of preservation; 11 responded to the question on the drying methods used; 12 responded to the question regarding problems encountered with the drying method used; and 27 responded to the question on the need for solar drying technology.

The results of the cross-tabulations of Gender are presented in Table 7. The results indicate that of the 8 respondents for the variable PreservationM, 5 were females and 3 were males. For the variable DryingM, 7 out of the 11 respondents were males; and for DryingP, 5 of the 12 respondents were females and 7 were males. Further, the cross-tabulation of the SolarT variable with Gender indicted that of the 27 respondents, 12 were females and 15 were males.

# Table 7: Cross-tabulation of drying variables with Gender

Variables	Gen	der
	Female	Male
PreservationM =8/32	5	3
DryingM=11/32	4	7
DryingP=12/32	5	7
SolarT =27/32	12	15

Table8 shows the cross-tabulation model results of drying variables with Age. It was observed that the age group 20-25 years was the highest represented in all the four variables: 5 out of 8 for PreservationM; 4 out of the 11 respondents for DryingM; 4 out of the 12 respondents for Drying P; and 9 out of the 27 respondents for SolarT.

Table 8: Cross-tabulation of drying variables with Age

Variables		Age		
	20-25- 25yrs	21-30	31- 35	35+
PreservationM	5	1	1	1
DryingM = 11/32	4	3	2	2
DryingP=12/32	4	4	1	3
SolarT =27/32	9	6	6	6

The cross-tabulation model results for Education with the drying variables are given in Table 9. The table shows that for all the four variables, the level of education with the highest number respondents was University Level. The highest number, 4 out of 8 of respondents for Preservation M were of university level, while for Drying M it was 5 out of 11. Of the 12 respondents of Drying P, University level was again highest with 6 respondents. Finally, of the 27 respondents of Solar T variable, University level was highest with 12.

Table 9: Cross-tabulation of drying variables with
Education

	Education						
Variables	Unive rsity	Coll ege	Secon dary	Prima ry	Non- form al		
PreservationM 8/32	4	2	1	0	1		
DryingM=11/3 2	5	3	2	0	1		
DryingP=12/3 2	6	4	1	0	1		
SolarT =27/32	12	5	6	3	1		

The cross tabulation results for Actor are given in Table 10. As shown, of the 14 respondents of Preservation M, 6 of the respondents were retailers, followed by farmers at 5 respondents; and the distributer, vendor and consumer at 1 respondent each. Of the 12 respondents of Drying M, 4 were Farmer, Distributer, Retailer and Consumer were each at 2 respondents and Vendor received 1 respondent. Of the 12 respondents of the Drying P, Farmer was the highest with 6 out of the 12 respondents; followed by Distributer and Consumer with 2 respondents each. Finally, of the 27 respondents of Solar T, 11 were farmers, 6 were vendors. 4 were retailers/consumers while 2 respondents were distributers.

# Table 10: Cross-tabulation of drying variables with Actor variable

Variables	Actor					
	Far mer	Distrib uter	Reta iler	Ven dor	Consu mer	
PreservationM =14/32	5	1	6	1	1	
DryingM=11/3 2	4	2	2	1	2	
DryingP=12/32	6	2	1	1	2	
SolarT =27/32	11	2	4	6	4	

iii. Likelihood estimates

The results of the binomial regression using logic model are given in the Classification Table 11 whereby the overall percentage of likelihood is predicted as 87.5%.

Observed		Predicted			
		Sola	Percentage		
		Disagree	Agree	correct	
Disagree		2	3	40	
SolarT	Agree	1	26	96	
	Ove	87.5			

a=the cut off value of overall percentage is 50%

Table 12 shows the results of the predictor variables evaluated using Equation 4, depicting respective binomial regression terms. These predictor

variables include the constant term. The variables are characterised by the binomial regression coefficient  $\beta$ , standard error (S.E), estimate of the regression coefficient divided by its standard error defined as Wald. The one degree of freedom, d f, for the standard normal distribution, the significance, p-values that are statistically significant except for the constant term which is below 0.05. The odds ratio probability ( $\eta$ )is expressed as Exp  $\beta$ , for each variable. The confidence intervals (95% C.I), depicting lower and upper values for each variable are expressed in terms of the odds ratio values Exp  $\beta$ .

Table 12: The Results of Binominal Regression

Variable	B SE	SE	Wald	df	<i>p</i> - value	Ехо <b>В</b>	<i>Εxp</i> <b>β</b> with 95% C.I.	
	T-					- <del>7</del> - <b>1</b> -	Lower	Upper
Gender	0.229	1.306	0.031	1	0.861	1.257	0.097	16.269
Actor	0.564	0.613	0.847	1	0.357	1.757	0.529	5.837
Produce	-0.805	0.488	2.72	1	0.099	0.447	0.172	1.164
Oversupply	-3.512	1.881	3.485	1	0.062	0.03	0.001	1.192
DryingM	1.06	1.403	0.57	1	0.45	2.885	0.184	45.138
Constant	5.199	2.544	4.175	1	0.041	181.059		

From the Table 12, the odds ratio is >1 for Drying M, Actor and Gender but <1 for Produce and Oversupply variables. Therefore, Drying M, Actor and Gender are key parameters in motivating the likelihood of acceptance of solar drying technology. Using Equation 4, the Logit model for this study that fits the regression data for giving an estimated evaluation of the probability of accepting solar dryer technology in Botswana is given as

$$logit = log\left(\frac{pi}{1 - pi}\right) = 5.199 + 1.06 * DryingM + 0.564 * Actor + 0.229 * Gender$$
  
-0.805 \* Produce - 0.512 \* Oversupply

# IV. Conclusion

The determination of the need for solar dryer technology in Botswana was satisfactorily accomplished. The assessment provided answers to the questions of agro-produce profile that need to be preserved by solar drying, the challenges encountered by the agricultural communities and the determination of whether there was need for a solar dryer technology in Botswana as follows:

The profile of agro-produce grown in Botswana covers a limited range of grains and pulses and a large variety of horticultural produce despite being a semi-arid country. There was a positive trend of production of horticultural produce in Botswana for March 2015 with tomatoes, potatoes, cabbage, beetroot and onions as the top commercial commodities. However, Botswana is a net food importing developing country. Sorghum and maize are the main cereal foodstuffs with their national annual demand of 200,000 metric tons, of which only 17% was supplied through local production while the supply demand of 83% was met by importation from other countries in 2019. The overall postharvest loss distributions were: i) the main grains (sorghum and maize) constituted 30%, and ii) horticultural produce constituted 70%. Tomato posted the highest loss ranking of 28%, followed by spinach at 18%, sorghum at 16% and maize at 14%. The loss ranking clearly showed that tomato was the most in need of preservation by drying.

The greatest challenge faced by actors in agroproduce value-chain is the postharvest loss. Moreover,

(7)

conventional preservation methods are generally unaffordable by the poorer rural communities. These communities often use the inappropriate methods of preservation such as the open sun drying method which is not quality assured. And yet solar dryer technology is scarce in Botswana.

The study answered the question of whether there was need for solar dryer technology in Botswana. Demographic statistics indicated 84.4% acceptance of solar dryer technology in Botswana. Additionally, there was fair gender balance with the youthful age bracket (20-25 years), university level education, and the farmer among the actors; these were identified as the highest respondents in favour of solar drying technology; indicating the sustainability of the technology when adapted. The study has established that there is need for solar drying technology in Botswana and, by the Logit model, predicted that the likelihood of acceptance of the technology was 87.5%.

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# References Références Referencias

- Barlett, J. E., Kotrlik, J. W., & Higgins, C. C. (2001). Organizational research: Determining appropriate sample size in survey research. Information technology, learning, and performance journal, 19(1), 43.
- 2. BITC. (2019). Investment Opportunities Grain/fruits and vegetables Value Chains Investment. BITC Agriculture Newsletter Quarter 1-2019.
- Gamli, F. (2014). A review based on the relationship among drying, curve fitting and mathematical models in food systems. Advance Research in Agriculture and Veterinary Science. ISSN 2348-5353. Adv. Res. Agri. Vet. Sci. Vol. 1, No. 2, 2014: 47-53
- Gbaha, P., Andoh, H. Y., Saraka, J. K., Koua, B. K., & Toure, S. (2007). Experimental investigation of a solar dryer with natural convective heat flow. Renewable Energy, 32(11), 1817-1829.
- Gustafsson, J., Cederberg, C., Sonesson, U., & Emanuelsson, A. (2013). The methodology of the FAO study: Global Food Losses and Food Wasteextent, causes and prevention"-FAO, 2011: SIK Institutet för livsmedel och bioteknik.

- 6. MOA. (2015). Sector Value Chain Analysis and Action PlanFINAL DRAFTAugust2015. Botswana Ministry of Agriculture Horticulture.
- Mujumdar, A. S. (2007). Book Review: Handbook of Industrial Drying: A Review of: "Publisher: CRC Press. Boca Raton, FL, 2007": Taylor & Francis.
- Sadeghi, S.-H., Peters, T. R., Cobos, D. R., Loescher, H. W., & Campbell, C. S. (2013). Direct calculation of thermodynamic wet-bulb temperature as a function of pressure and elevation. Journal of Atmospheric and Oceanic Technology, 30(8), 1757-1765.
- Weiss, W., & Buchinger, J. (2015). Solar drying. Training course within the scope of the project: establishment of a production, sales and consulting infrastructure for solar thermal plants in Zimbabwe, Arbeitsgemeinschaft ERNEUERBARE ENERGIE Institute for Sustainable Technologies: AEEIntec, Austria Development Corporation, Gleisdorf, Austria.

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# Machine Reliability Optimization by Genetic Algorithm Approach

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Abstract- To define the reliability network of a system (machine), we start with a set of components arranged in an appropriate topology (series, parallel, or parallel-series), choose the best terms of the ratio performance / cost, and gather by links with the aim to combine them. This process requires a long time and effort, given the very large number of possible combinations, which becomes tedious for the analyst. For this reason, it is essential to use an appropriate optimization approach when designing any product. However, before trying to optimize, it is necessary to have a reliability assessment method. The objective of this paper is to display a meta-heuristic method, which is sustained on the genetic algorithm (GA) to improve the machines reliability. To achieve this objective, a methodology that consists of presenting the functionalities of genetic algorithms is developed. The result achieved is the proposal of a reliability network for the optimal solution.

Keywords: reliability, cost, reliability network, topology. GJRE-A Classification: FOR Code: 091399

# MACH I NERELIA BILITYOPTIMIZATION BY GENETICALGORITHMAPPROACH

Strictly as per the compliance and regulations of:



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# Machine Reliability Optimization by Genetic Algorithm Approach

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Abstract- To define the reliability network of a system (machine), we start with a set of components arranged in an appropriate topology (series, parallel, or parallel-series), choose the best terms of the ratio performance / cost, and gather by links with the aim to combine them. This process requires a long time and effort, given the very large number of possible combinations, which becomes tedious for the analyst. For this reason, it is essential to use an appropriate optimization approach when designing any product. However, before trying to optimize, it is necessary to have a reliability assessment method. The objective of this paper is to display a meta-heuristic method, which is sustained on the genetic algorithm (GA) to improve the machines reliability. To achieve this objective, a methodology that consists of presenting the functionalities of genetic algorithms is developed. The result achieved is the proposal of a reliability network for the optimal solution.

Keywords: reliability, cost, reliability network, topology.

### I. INTRODUCTION

he fundamental function of a system is to provide its customers with a fairly economical cost, acceptable reliability required. These constraints require an optimal design. In the engineering context, the fundamental interest of manufacturers is to find a balance between the reliability of a system and its cost. These two factors constitute the most important decision variable for optimizing a system. This is generally manifested in minimizing the cost under the constraint of reliability on the one hand, and in improving performance to meet the needs of customers under the constraint of cost on the other.

In this area, researchers have developed and improved many methods and algorithms. The set of methods can be divided into two main categories: exact methods, which guarantee to obtain an optimal solution for problems of reasonable size, and approximate methods (heuristics and meta-heuristics), which give good solutions. Quality, without guarantee of optimality, but for the benefit of shorter calculation time. If the exact methods are based on the enumeration, often implicitly, for the search for the set of solutions of the search space, then the approached methods rather require random processes in the exploration of potential solutions, and this to deal with the combinatorial explosion generated when using the exact methods. In this perspective, we are essentially seeking in this work to integrate an efficient and adapted optimization method to solve the problem of optimizing reliability by taking into account the most relevant constraints.

Given the large number of configurations that can result from a set of components, the procedure of enumerating all the possible architectures is no longer pleasant. Consequently, it is necessary to opt for an approximate method, which will make it possible to find the solution closest to the optimal solution because it is not obvious to examine all the possibilities.

In this perspective, we opted for the method of genetic algorithms as an optimization technique. It is considered an effective meta-heuristic method in the field of dependability. It is inspired by genetic biology and is based on the principle of the search for evolution. It does not guarantee an exact solution, but it generates a solution close to the optimum (Painton and Campbell [1], Levitin and Lisnianski [2]).

# II. The Functioning of the Genetic Algorithm

### a) Origin and principle

Genetic algorithms (GA) are heuristic optimization algorithms based on the principles of natural selection and genetics. The researcher Rechenberg [3], is the first scientist who introduced evolutionary algorithms by publishing his work "Evolution strategies." These algorithms are broadly inspired by Darwin's theory of evolution published in 1859. Next, Holland [4] proposed the first genetic algorithms to solve combinatorial optimization problems, and they were also developed by the work of David Goldberg published in 1989 (Goldberg [5] and Goldberg [6]).

The aim of the genetic algorithm is to bring up, from one generation to another, the candidates (potential solutions) most suited to solving the problem. Each generation is made up of a defined number of individuals, these form a population, and each of them represents a point in the search space. Each individual (chromosome) has information coded in the form of a

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chain of characters that analogically constitutes genes. Then the passage from one generation to another is carried out based on the process of evolution by the use of evolutionary operators like selection, crossing, and mutation.

Their operating principle is quite simple. From an initial population created at random, composed of a set of individuals (chromosomes), we proceed to the evaluation of their parent qualifications to highlight the best suited, as long as the least effective are rejected. Then, the most qualified individuals are chosen by privileged selection by giving them a chance to reproduce by crossing and mutating via the two operators of crossing and mutation. Then by relaunching this process several times, the optimal solution can be refined by passing from one generation to another (Douiri et al. [7]).

### b) Description of the formalism used

Clustering is a process that partitions a set of data into meaningful subclasses (clusters or clusters).

The convergence of genetic algorithms has been demonstrated for many problems, although optimality cannot be guaranteed. The ability of a genetic approach to find the right solution often depends on the adequacy of the coding, the evolution operators, and the measures of adaptation to the problem being addressed. The method proposed here is based on genetic algorithms (Goldberg [6]) and evolutionary strategies (Schewefel [8]). It combines the principle of survival of the ablest individuals and genetic combinations for an elitist research mechanism. The genetic method produces new solutions (children) by combining existing solutions (parents) selected from the population, or by mutation. The central idea is that parent solutions will tend to produce superior child solutions in terms of adaptation so that ultimately a solution obtained is optimal.

In this study, we used a genetic method previously defined by Bicking et al. [10] with a definition of the chromosome and the operators of selection, combination, and mutation concerned. Unlike genetic algorithms, the genetic method used is designed to minimize and not maximize. This method, like genetic algorithms, is not limited by assumptions about the objective function and research space, such as continuity or differentiability. It uses a population of points simultaneously by contrast with usual methods using only one point. Genetic operators are elitistically improving the search process to find the global optimum. There are more complicated genetic operators, but the basic operators and their various modifications can generally be applied. The choice of these operators depends on the nature of the problem and the performance requirements. The genetic algorithm that we are going to implement is as follows, where the process is applied to iteration *k*:

- 1. Data coding;
- 2. Generation of the initial population  $P_o$  of N individuals;
- 3. Assessment of the adaptation of all individuals in the population;
- 4. Selection of a proportion of the best individuals (parents for the production of new individuals);
- 5. The Crossing of all individuals in the population  $P_k$  two by two with a probability  $P_m$ , we will have N children noted  $C_k$ ;
- 6. Mutation of all individuals in the population, we will have *N* elements noted  $M_k$ ;
- 7. Choice of the most suitable individuals, i.e., those who optimize the objective function;
- 8. If the stop test is verified, stop, otherwise return to step a.

We will choose, as a stop test in our implementation, a finite number of iterations.

It is important to note that the stopping criterion can be several cycles of the algorithm (number of generations), the average of the adaptations of individuals, a convergence factor, etc.

An individual represents a vector of decision variable (parameters), and its adaptation is measured by the objective function. The formalism and the genetic operators are detailed below.

i. Data coding

The first step is to properly define and code the problem. That step associates with each point of the search space a specific data structure called a chromosome, which will characterize each individual in the population. This step is considered to be the most important step in GA because the success of these algorithms depends heavily on how individuals are coded.

There are different choices for coding a chromosome, this choice being a very important factor in the progress of the algorithm so it must be well suited to the problem being addressed:

- Binary coding: It is the most used coding. The chromosome is coded by a string of bits (which can take the value 0 or 1) containing all the information necessary to describe a point in space;
- Multi-character coding: this is often more natural. We are talking about multiple characters as opposed to bits. A chromosome is then represented by a series of numbers or characters, each representing a gene;
- Coding in the form of a tree: this coding in tree structure starts from a root (comprising several parts equal to the number of initial individuals), from which one or more children can be derived. The tree then builds up gradually, adding branches to each new generation.

# ii. Generation of the initial population

Each chromosome is the potential result of the optimization problem. We define a chromosome as a chain composed of genes, which are the parameters (decision variables) to find. The value of a gene is called an allele. The possible value of an allele is an integer or a real value. Each gene is created randomly, using equation 1.

$$a_{j} = \left(a_{j}\right)_{l} + \left(\left(a_{j}\right)_{u} - \left(a_{j}\right)_{l}\right) \times \gamma_{j}$$
(1)

Where:

 $- \qquad \gamma_j \in \left\{0;1\right\} \text{ is chosen randomly}$ 

 $-(a_j)_l, (a_j)_u$  are the minimum and maximum limits of the allele  $a_j$ . They are chosen according to the problem to be treated.

Each chromosome, called an individual in a haploid representation, can be written:

$$X_i = \begin{bmatrix} a_1, \dots, a_j, \dots, a_m \end{bmatrix}$$

With:

- *m* is the number of genes
- *i* = 1,..., *N* and *N* is the size of the population (number of individuals).

All the constraints are taken into account in the initial phase of population creation. When an individual is created, if the constraints are respected, this individual is integrated into the initial population; otherwise, it is not. At the start of the algorithm, the initial population contains individuals.

The length of the chromosome m and the size of the population N is two of the four adjustment parameters of the genetic method.

# iii. Objective function and adaptation

We evaluate the different solutions proposed to treat them according to their relevance and to see which the best are. For this, we use the objective function.

This function measures the performance of each individual. To be able to judge the quality of an individual and thus compare him to others. The objective function of our case is to minimize the cost while maximizing reliability.

The evaluation of each individual in the population then makes it possible to make the selection. For a system made up of n components in parallel, the reliability to be maximized is given by equation 2.

$$R = 1 - \prod_{i=1}^{n} \left( 1 - r_i \right)$$
 (2)

Where:

- *n* is the number of components
- $r_i$  is the reliability of the component *i*

For a parallel-series system, the reliability to be maximized is given by equation 3.

$$R = \prod_{i=1}^{p} \left[ 1 - \prod_{j=1}^{n_i} \left( 1 - r_{ij} \right) \right]$$
(3)

Where:

- p is the number of stages of the system
- $r_{ij}$  the reliability of the  $j^{\text{th}}$  element of the  $i^{\text{th}}$  stage

-  $n_i$  is the number of components of the *i*<sup>th</sup> stage

The cost function to be minimized deducted from the work of (Gutha and Vadlamani [9]) for a parallel -series system (machine) with p stages is gave by equation 4.

$$C = \sum_{i=1}^{p} C_{i} \left[ X_{i} + e^{X_{i}/4} \right]$$
(4)

Where:

- C<sub>i</sub> is the cost vector of the components of the X<sub>i</sub> chromosome
- p is the number of stages of the machine.

# iv. Selection of the most suitable individuals

When the entire population is assessed at generation *t*, individuals are ranked in ascending order of objective function. Then the selection is made. Selection helps to statistically identify the best individuals in a population and eliminate the bad ones from one generation to the next. This operator also gives a chance to the bad elements because these elements can, by crossing or mutation, generate relevant descendants compared to the optimization criterion.

The first  $N \times G$  individuals (the best  $N \times G$ ) are selected to be parents. G is the third setting parameter of the genetic method. G is called the generation gap. G makes it possible to select a part of the population to provide sufficient genetic material without decreasing the speed of convergence (Goldberg [6]).

There are different selection techniques:

- Selection by rank: This selection method always chooses the individuals with the best adaptation scores, without allowing chance to intervene;
- Selection by wheel: For each parent, the probability of being selected is proportional to their adaptation to the problem (their score by the fitness function). This selection be imaged by a casino roulette wheel, on which all the chromosomes of the population are placed, the place is given to each of the chromosomes being proportional to its adaptation value. Also, the higher an individual's score, the more likely he is to be selected. We spin the wheel as many times as we want individual sons. The best will be able to be drawn several times, and the worst never;
- Selection by tournament: Two individuals are chosen at random, their adaptation functions are compared, and the best suited is selected.;
- Uniform selection: We are not interested in the adaptation value of the objective function ,and the selection is made in a random and uniform manner

such that each individual has the same probability P(i) = 1 / N as all other individuals, where N is the total number of individuals in the population;

• Elitism: The passage from one generation to another through the crossing and mutation operators creates a great risk of losing the best chromosomes. Therefore, elitism aims to copy the best (or first - best) chromosome (s) from the current population to the new population before proceeding to the mechanisms of crossing and mutation. This technique quickly improves the solution because it prevents the loss of the most qualified chromosome when passing from one generation to another.

### v. Crossing

The selected population is divided into N / 2 couples formed randomly. Two parents, and are chosen randomly from the potential parents  $P_1$  and  $P_1$  their genes are combined according to equation 5.

$$a_{j}(k) = a_{j}(P_{1}) + (a_{j}(P_{2}) - a_{j}(P_{1})) \times \gamma_{j}$$
 (5)  
Where:

- $\gamma_i$  is a uniform random number,
- $k = N \times G + 1, ..., N$ , the k th individual, mode can

− j = 1,..., *m*.

The newly created individual is then evaluated. If its adaptation is better than that of the worst parent, it is integrated into the population to training the next generation. If it is not the case, we repeat the combination.

### vi. Mutation of all individuals in the population

The mutation operator is a process where a minor change in the genetic code is applied to an individual to introduce diversity and thus avoid falling into local optima. This operator is applied with a probability  $P_{\rm m}$ .  $P_{\rm m}$  generally lower than that of the crossing  $P_{\rm c}$ . This probability must be low. Otherwise the GA will turn into a random search.

### vii. Choosing the best solutions

This choice consists in retaining the solutions which have a lower value of the objective function, and putting them in the population  $P_{k+1}$ .

### viii. Stopping criterion

The stopping criterion is evaluated in the current population. If it is filled, the whole population has converged on the solution. Otherwise the reproduction pattern will be repeated. The stopping criterion used in this method expresses that all individuals have converged on the same solution and assumes that evolution is no longer possible, that is to say, that no better solution can be found.

The whole strategy is elitist because only the best individuals are selected for survival from one generation to the next and can be the parents of new and better individuals. To ensure convergence of the algorithm, the parameters N and G must be adjusted with care. The size of the population N affects both the performance and efficiency of the algorithm (Bicking et al. [10]). The algorithm is less efficient with very small population sizes. Large population size may contain more interesting solutions and discourage premature convergence towards sub-optimal solutions, but requires more assessments per generation, which can lead to a low convergence rate. The generation gap Gdetermines the proportion of the population that remains unchanged between two generations.

It is chosen to select individuals as severely as possible, without destroying the diversity of the population too much. The global strategy used assumes that all the individuals who make up the population, from generation to generation, satisfy all the constraints.

The best solution for the latest generation represents the solution to the problem by the defined criteria.

# III. Application

Consider a machine made up of five components mounted in parallel (see Figure 1). Our goal is to define an optimal reliability network, to ensure operation with minimum reliability  $r_{min} = 0.80$  while minimizing the cost of the structure.



Figure 1: Structure (machine) to optimize

Table 1 groups the parameters of the five components  $C_1$ ,  $C_2$ ,  $C_3$ ,  $C_4$  and  $C_5$ :

Table 1: Parameters of the structure components

Components	Reliability	Cost
<i>C</i> <sub>1</sub>	0.95	15
<i>C</i> <sub>2</sub>	0.97	17
Сз	0.9	14
<i>C</i> <sub>4</sub>	0.89	12
<i>C</i> 5	0.96	16

### Step 1: Data coding

We choose binary coding using a 5-bit character string. Bits 1 through 5 represent the components of  $C_1$  through  $C_5$ , respectively. If a component exists in the generated solution, then its

corresponding bit takes the value "1"; otherwise, it takes the value "0".

# Step 2: Choice of GA parameters

This choice is random while waiting to improve it afterward. The parameters of the GA are as follows:

- The size of the population: N = 4;
- The number of generations: K = 10;
- The probability of crossing:  $P_c = 0.6$ ;
- The probability of mutation:  $P_m = 0.01$ .

# Step 3: Generation of the initial population

We randomly generate a population of 4 noted chromosomes  $X_1,\,X_2,\,X_3$  and  $X_4\,:$ 

 $X_1 = [01001], X_2 = [10110], X_3 = [10011]$  and  $X_4 = [11001].$ 

Figure 2 represents the reliability network of the configuration corresponding to the chromosome  $X_1$ .



*Figure 2:* The reliability network corresponding to the chromosome X<sub>1</sub>.

Step 4: Definition of objective function

The objective function f to optimize is defined by equation 6.

$$\begin{array}{l} \text{minimize } f(X_i) = C(X_i) \\ s.t \qquad r(X_i) \ge r_{min} \end{array} \tag{6}$$

With:

- *r<sub>min</sub>*: the minimum reliability of the structure to be optimized;
- C  $(X_i)$ : the cost of the solution.

Step 5: Evaluation of the reliability of each  $X_i$  chromosome in the population

For each  $X_i$  chromosome generated, the reliability and the cost are evaluated respectively by relations 2 and 4.

So:

- 
$$r(X_1) = 0.9988$$
 and  $f(X_1) = 41.25$ ;

$$-r(X_2) = 0.99945$$
 and  $f(X_2) = 66.25$ ;

- 
$$r(X_3) = 0.99978$$
 and  $f(X_3) = 66.5$ ;

-  $r(X_4) = 0.99994$  and  $f(X_4) = 75$ .

Step 6: Selection of the most suitable chromosomes

The best chromosomes in terms of cost in descending order are:  $X_1$ ,  $X_2$ ,  $X_3$  and  $X_4$ .

We select the chromosomes  $X_1$ ,  $X_2$  and  $X_3$  for reproduction and we eliminate the chromosome  $X_4$ because it is the worst as far as cost is considered.

# Step 7: Crossing

We cross a couple among the selected chromosomes with a crossover rate of 0.6 to form new children. Consider the couple  $(X_1, X_2)$ :

$$\begin{array}{c} X_1 = [01001] \\ X_2 = [10110] \end{array} \Longrightarrow \begin{cases} X_1^{'} = [01010] \\ X_2^{'} = [10101] \end{cases}$$

Step 8: Mutation

We do a random draw of a single chromosome gene  $X'_1$ ,  $X'_2$  and  $X_3$ ; then the selected bit will be mutated with a mutation probability of 0.01. Consider the second bit of the chromosome  $X'_2$ :

$$X_{2}' = [10101] \Longrightarrow X_{2}'' = [11101]$$

Step 9: Substitution

We are replacing the new population with the new chromosomes. Chromosomes  $X_3$  and  $X_4$  will is eliminated because they are the least suitable, and the chromosome  $X_1$  and  $X_2$  will be kept .After all, they are the best qualified among the individuals of the population. So the new population will be made up of chromosomes  $X_1$ ,  $X_2$ ,  $X_1$  and  $X_2$ .

 $X_1 = [01001], X_2 = [10110], X_1 = [01010]$  and  $X_2^{"} = [11101].$ 

# Step 10: Repeat steps 4 to 9

The algorithm stops either after the reproduction of 16 generations or when we notice that the solution does not improve after a defined number of generations.

# Step 11: Optimal solutions

 The corresponding chromosome that optimize objective function is:

$$X_{a} = [10001], X_{b} = [11000], X_{c} = [10100],$$
  
$$X_{d} = [01001], X_{e} = [00101], X_{f} = [01010]$$

- The optimum reliability and costs for each solution are:

$$r(X_{a}) = 0.998 \text{ and } f(X_{a}) = 39,$$
  

$$r(X_{b}) = 0.9985 \text{ and } f(X_{b}) = 40.01,$$
  

$$r(X_{c}) = 0.995 \text{ and } f(X_{c}) = 40.5,$$
  

$$r(X_{d}) = 0.9986 \text{ and } f(X_{d}) = 40.25,$$
  

$$r(X_{e}) = 0.9966 \text{ and } f(X_{e}) = 37.5,$$
  

$$r(X_{f}) = 0.9967 \text{ and } f(X_{f}) = 36.25,$$
  

$$r(X_{e}) = 0.989 \text{ and } f(X_{g}) = 32.5.$$

By considering the components selected by the genetic algorithm in the previous optimal solutions, we generate all the possible paths (connections) between the component of the machine. In solution 1 ( $X_a$  chromosome), we retain the components in parallel C<sub>1</sub>

and  $C_5$ ; in solution 2, we retain the components  $C_1$ and  $C_2$  (thus defining a path); in solution 3, we retain the components  $C_1$  and  $C_3$  (defining a path) and from end to end until the last solution ( $X_g$  chromosome), the last path connecting the components  $C_3$  and  $C_4$  is shown. From where the network of optimal reliability of the machine is given by Figure 3.



Figure 3: Optimal network reliability of our machine

By evaluating the overall reliability of the reliability network, we obtain a reliability of 0.88, higher than the minimum reliability set. Similarly, by evaluating the overall cost of the machine by applying relation 4, for the reliability network we obtain a cost of 88.75, which is much lower than the overall cost generated by the initial system, which is 103.75. Objectively, the reliability network has favored cost reduction on the one hand reliability increase on the other.

# IV. CONCLUSION

Having completed the writing of this paper, which concerns the optimization of the reliability of a system by the genetic algorithm, it appears that the general objective has been achieved. Indeed, through the functionality of genetic algorithms, implemented on a structure with five components, we were able to reduce the cost and increase the reliability of the parallel structure. However, although the genetic algorithm is easy to implement, it might require an infinite number of iterations to the best approach of optimal solution. This would make the algorithm less robust. In perspective for this work, it would be wise to develop or implement another meta-heuristic that would not require a large number of iterations.

# Data Availability

The data needed to support these results are available in the text, specifically in Table 1. Conflicts of Interest All authors declare that there are no conflicts of interest regarding the publication of this paper.

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# **References Références Referencias**

- L. Painton and J. Campbell, "Genetic algorithm in optimization of system reliability", IEEE Trans Reliab, 44:172–8, 1995.
- G. Levitin and A. Lisnianski, "Optimizing survivability of vulnerable series–parallel multi-state systems", Reliability Engineering and System Safety, 79:319– 331, 2003.
- I. Reichenberg, "Cybernetic solution path of an experimental poblem", Library Translation 1122, Royal Aircraft Establishment, Famborough, UK, 1965.
- 4. J. H. Holland, 'Adaptation in natural and artificial systems', University of Michigan press, 1975.
- 5. D. Goldberg, "Genetic algorithms", Addison Wesley, ISBN, 0- 201-15767-5, 1989a.
- 6. D. Goldberg, "Genetic algorithms in search, optimization and machine learning", Addison Wesley, 1989b.
- S.M. Douiri, S. Elbarnoussi and H. Lakhbab, "Course of Heuristic and Metaheuristic Exact Resolution Methods', Mohammed V University, Faculty of Sciences of Rabat, Morocco, Mathematics, Computer Science and Applications Research Laboratory, 2013.
- 8. H.P. Schewefel, "Numerical Optimization of computer models, Editions Wiley, 1981.
- 9. J. K Gutha, and R. Vadlamani, "Modified Harmony Search Applied to Reliability Optimization of Complex Systems", Advances in Intelligent Systems and Computing 382, 2016.
- F. Bicking, C. Fonteix, J.P. Corriou, and I. Marc, "Global optimization by artificial life: a new technique using genetic population evolution", RAIRO-Operations Research, vol. 28(1), 23-36, 1994.

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# PREFERRED AUTHOR GUIDELINES

### We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

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- 5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
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### Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

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# Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.



# Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11<sup>1</sup>", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

### Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

- a) A title which should be relevant to the theme of the paper.
- b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
- c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
- d) An introduction, giving fundamental background objectives.
- e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
- f) Results which should be presented concisely by well-designed tables and figures.
- g) Suitable statistical data should also be given.
- h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

- i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
- j) There should be brief acknowledgments.
- k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.



# Format Structure

# It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

### Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

### Author details

The full postal address of any related author(s) must be specified.

### Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

### Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

### **Numerical Methods**

Numerical methods used should be transparent and, where appropriate, supported by references.

### Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

#### Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

### Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

# Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

# Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

# Tips for Writing A Good Quality Engineering Research Paper

Techniques for writing a good quality engineering research paper:

**1.** *Choosing the topic:* In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

**2.** *Think like evaluators:* If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

**3.** Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

**4.** Use of computer is recommended: As you are doing research in the field of research engineering then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

**5.** Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.



**6.** Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

**8.** Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

**9.** Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

**10.** Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

**12.** *Know what you know:* Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

**13.** Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

**14.** Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

**15.** Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

**16.** *Multitasking in research is not good:* Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

**17.** *Never copy others' work:* Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

**19.** Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

**20.** Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

**21.** Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

**22. Report concluded results:** Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

**23.** Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

# Informal Guidelines of Research Paper Writing

### Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

### **Final points:**

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

*The introduction:* This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

### The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

### General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

### Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.

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- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

### Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

**Abstract:** This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

### Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

### Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

### The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- o Briefly explain the study's tentative purpose and how it meets the declared objectives.

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# Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

# Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

#### Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

#### Methods:

- o Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- o Simplify-detail how procedures were completed, not how they were performed on a particular day.
- o If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

#### Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

#### What to keep away from:

- Resources and methods are not a set of information.
- o Skip all descriptive information and surroundings—save it for the argument.
- o Leave out information that is immaterial to a third party.

#### **Results:**

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.



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# Content:

- o Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- o In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

# What to stay away from:

- o Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- o Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- o A manuscript should complement any figures or tables, not duplicate information.
- o Never confuse figures with tables—there is a difference.

# Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

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# Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

# Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- o Recommendations for detailed papers will offer supplementary suggestions.



# Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

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Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
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Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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