

Emissions of noxes in the case of welding in shielding gases: a systematic literature review

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Abstract. The paper presents the results of a systematic review regarding emissions of noxes in the case of welding in shielding gases. For this paper it was used The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) published in 2009. A total of 65 academic papers retrieved from the ScienceDirect Freedom Collection, Elsevier database, Web of Science - Core Collection, Clarivate Analytics, Scopus, SpringerLink Journals databases were identified and analysed. The main objectives of this review were to answer the following questions: (1) What are the major health issues related emissions of noxes in the case of welding in shielding gases? (2) What are the measures of control for the fumes and gases? The search was conducted in January 2023. The results were organized into two major sections. The first include information on major health issues associated with welding noxes. The second contains studies thought to be relevant on measures of prevention and control.

Keywords: *welding, noxes, prevention, control*

1.Introduction

A systematic review is a research methodology used to answer a specific research question by identifying, evaluating, and synthesizing all available evidence from relevant studies. Systematic reviews are often used to provide a summary of existing research on a particular topic, to identify gaps in the literature, and to provide recommendations for future research.

Systematic reviews are essential not only for researchers, policy makers and other decision makers but also for students, who without them, would be confronted by an overwhelming volume of research on which to base the „state of the art” chapter in their thesis. The methods and results of systematic reviews should be reported in sufficient detail to allow users to assess the trustworthiness and applicability of the review findings.

To conduct a systematic literature review on welding fumes and gases, we started by defining the research question and developing a protocol that outlines the methods to be used. This would include identifying relevant search terms and databases to be used, as well as inclusion and exclusion criteria for studies to be included in the review.

For this paper it was used The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA). The PRISMA has been designed primarily for systematic reviews of studies that evaluate the effects of health interventions, irrespective of the design of the included studies. However, the checklist items are applicable to reports of systematic reviews evaluating other non-health-related

interventions (for example, safety and health, occupational safety), and many items are applicable to systematic reviews with objectives other than evaluating interventions [1]. The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement, published in 2009 (hereafter referred to as PRISMA 2009) was designed to help authors prepare transparent accounts of their reviews, and its recommendations have been widely endorsed and adopted.

2. Research Methodology

To perform a systematic review of the literature it was used The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA). The Preferred Reporting Items for Systematic reviews and Meta-Analyses PRISMA method includes three phases, i.e., literature search, articles selection, and data extraction.

To ensure the quality and reliability of data, only journal papers written in English, Romanian and French were considered; reviews, textbooks, doctoral dissertations, letters, and conference papers were also included in this study. In order to obtain comprehensive and reliable results related to the subject of noxes, a two-level keyword structure shown in Table 1 was adopted. The time span of the literature search was restricted to 1980–2022.

Table 1

Main keywords	Subordinate keywords
Emissions of noxes in the case of welding in shielding gases	GMAW MIG MAG welding fume airborne particles from welding operations welding aerosol chemical analysis of welding fume particle welding fumes exposure health issues related to welding

A total of 66 academic papers retrieved from the ScienceDirect Freedom Collection, Elsevier database, Web of Science - Core Collection, Clarivate Analytics, Scopus, SpringerLink Journals databases were identified and analyzed. The main objectives of this review are to answer the following questions: (1) What are the health issues related to emissions of noxes in the case of welding in shielding gases? (2) What are the measures of control for the fumes and gases?

The Preferred Reporting Items for Systematic reviews and Meta-Analyses PRISMA is published as a suite of three papers: a statement paper, the PRISMA abstract checklist, and the flow diagram [3]. Because we were carried out the review as a members of a wider team, we consulted the other members of our team regularly in order to prevent misunderstandings. Different people may use the terminology in different ways depending on their geographical location or profession.

For the first step, following the flow diagram, once the topic has been clearly defined, there were set up **limits** by language and date of publication. Then there were defined **the search terms** by running a couple of wide searches on the most commonly used databases in our subjects. We found some relevant articles and read through them highlighting key words or phrases. Then we used them as the basis for our search strategy. We made a list of the core terms and any synonyms and spelling variations. Because the most precise way to search any database was to use the words included in the thesaurus for the individual database, as new articles were added to a database, they were indexed using a list of approved keywords or thesaurus. This is why we always searched one database at a time - remembering that thesauri vary from database to database. Even natural language words can vary in the way they are used. Using this type of search produced very focused results. Also, because the research protocol required to widen out the search to ensure that is not miss out any research and many grey literature sources and

search engines do not use thesauri, we used a combination of terms, alternative keywords when searching.

To complete the PRISMA diagram it was printed out a copy of the diagram to use alongside our searches. It is most efficient to search databases individually, so we printed out a copy for each database searched, plus a copy for the totals.

For each database we entered each key search term individually. This included all our search terms. We combined all the search terms in the different combinations using Boolean operators like AND OR as appropriate. We applied all our limits (such as years of search, full-text only, English language only and so on). Once all search terms have been combined and we have applied all relevant limits, we obtained a number of records or articles and entered this in the top left box of the PRISMA flow chart for each database. Because we have searched databases individually, we added all the 'records identified' up and fill this total number in the PRISMA flow diagram. This process of adding up the number of records in individual database searches to a total was repeated at each step.

For the articles identified through other sources than databases (like manual searches through reference lists of articles found, or search engines like Google Scholar), we entered the total number of records in the box on the top right of the flow diagram.

To avoid reviewing duplicate articles, it was removed manually any articles that appear more than once by going through all the records or articles found in the database. The number of records left after the removal of the duplicates was entered in the second box from the top.

The next step was to add in the number of articles that we have screened. This is the same number as we have entered in the duplicates removed box.

In this step we screened the titles and abstracts for articles which were relevant to our research question. Any articles that appeared to help us provide an answer to our research question it was included. The number of articles excluded based on this screening process it was recorded in the appropriate box (next to the total number of screened records) with a short reason for excluding these articles.

Then it was subtracted the number of excluded articles following the screening phase from the total number of records screened and entered this number in the box titled "Full-text articles assessed for eligibility". The full text for these articles was reviewed for eligibility.

We reviewed all full-text articles for eligibility to be included in the final review. At this stage we checked in our guidelines and with our supervisor, how many articles we should be left with. The number of articles that were excluded at this point was entered in the box titled: Full text articles excluded and we write in a short reason for excluding the articles (it may be the same reason used for the screening phase).

The final step was to subtract the number of excluded articles or records during the eligibility review of full-texts (step 8) from the total number of articles reviewed for eligibility. The number obtained may varied depending on the type of assignment and it was entered in the final box.

3. Results and discussion

The search was conducted in January 2023. The results were organized into two major sections presented below. The first include information on major health issues associated with welding noxes. The second contains studies thought to be relevant on measures of prevention and control.

For the category health issues associated with welding noxes a total of 1500 papers were initially derived based on the above search strategy (fig.1). After deleting duplicate items, 1260 records were remained for further analysis. In the second phase, we reviewed titles, abstracts, and whole text of the remaining articles to exclude unrelated ones. This research is only focused on the papers dealing with major health issues associated with emissions of noxes in the case of welding in shielding gases. Finally, 34 articles were considered within the scope of our inclusion criteria after title, abstract, and full-text.

For the category measures of prevention and control associated with welding noxes a total of 1745 papers were initially derived based on the above search strategy (fig.2). After deleting duplicate items, 1100 records were remained for further analysis. In the second phase, we reviewed titles, abstracts, and

whole text of the remaining articles to exclude unrelated ones. This research is only focused on the papers dealing with major health issues associated with emissions of noxes in the case of welding in shielding gases. Finally, 32 articles were considered within the scope of our inclusion criteria after title, abstract, and full-text.

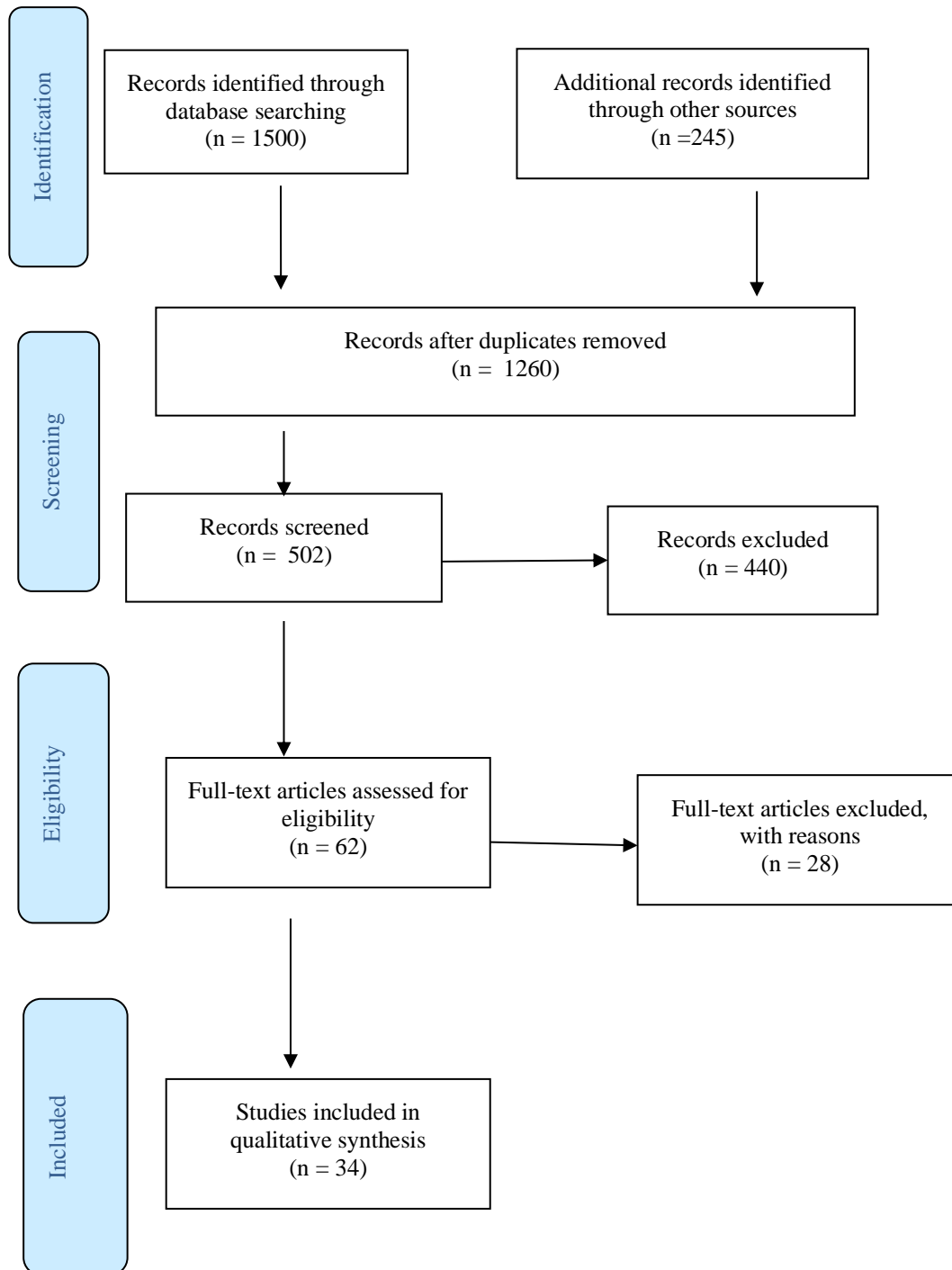


Figure. 1. PRISMA flow diagram for category „health issues associated with welding noxes,,

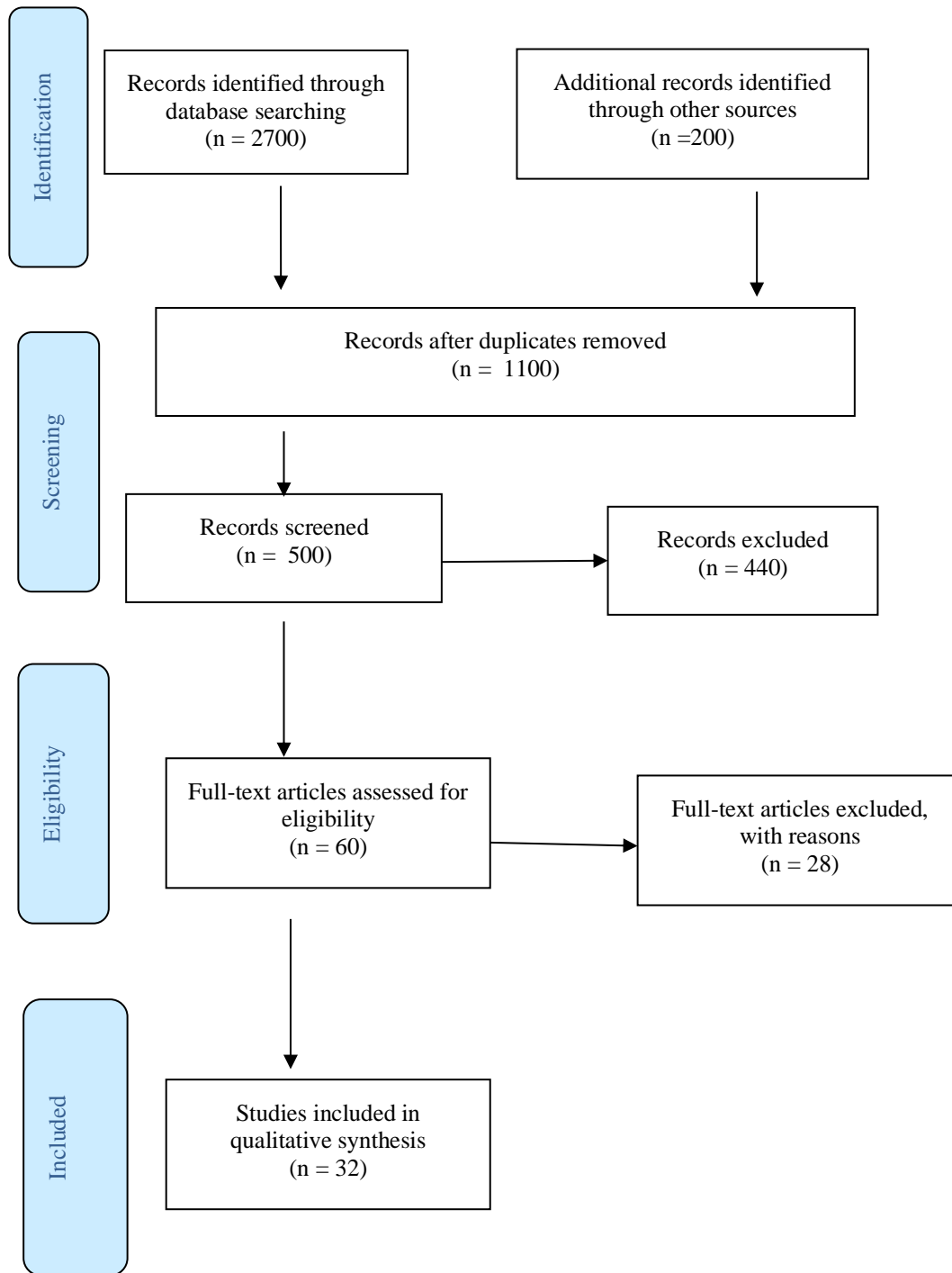


Figure 2. PRISMA flow diagram for category „measures of prevention and control”

3.1 Major health issues associated with welding noxes

Any material is a potential source of fume when heated to high temperatures. The process of heating the base metal with the electrode above its boiling point can evaporate part of those components to the atmosphere. The welding fume is a result of the condensation of the gases and vapour mixture created during the welding. Those fumes are composed by a complex micron and sub-micron size mixture of

fine solid metal particles that may contain metallic oxides, silicates, and fluorides. Those particles will be suspended in the air until some eventual force (air movement, gravity, or some electrical fields) will settle them down.

The suspended particles in the atmosphere can be easily inhaled and can penetrate deeply into the respiratory tract, being carried inside to inner parts of the lungs, causing severe damage to the body. If the welders have been exposed to those particles over time, it can be extremely harmful to their health, causing severe respiratory, neurological, and reproductive damage to their organism. Knowing how to decrease and control the emission levels of welding fumes by selecting the right process parameters and operating conditions can be very useful for the workers at workplace. For this reason, accurate fume formation data is necessary to understand better the welding mechanisms that can reduce the fume emissions, to create a more sophisticated fume control strategy.

The findings from our literature survey on the major health issues associated with welding are reported to be i) respiratory problems (caused by particulate emission from the welding source) ii) skin cancer (caused by UV emitted from the welding arc) iii) metal fume fever (by exposure to Al_2O_3 , ZnO , and Fe_2O_3 emanating from the welding process). [2]

It is very important to specify that, in 2018, welding fumes were classified as “carcinogenic to humans” by International Agency for Research on Cancer 2018. Welding fumes are a mix of fine solid particles, including metal oxides, silicates, and fluorides that are released during welding. IARC based this assessment on “sufficient evidence” from the >50 epidemiologic studies on the effect of exposure to welding fumes (generally assessed indirectly through welding process or material, branch of industry, occupation, job title, job task, expert assessment or self-report) on lung cancer [3]. We also found four published meta-analyses reporting on the effect of welding fume exposure on development of lung cancer [4], [5], [6], [7].

3.2 Measures of control

Welding is regarded as being a hazardous activity, requiring measures to be in place to minimise the risk. Welding fume is an important topic that has been studied widely over many years and public awareness of the hazards of fume from arc welding processes has increased significantly recently. The control of fumes and gases can be done by enclosure and local exhaust ventilation (LEV); respiratory protective equipment (RPE) may also be necessary in certain circumstances, in particular in confined spaces.

Increasing attention must be paid to the investigation and development of consumables with minimum fume emissions and for the selection of process parameters which minimise emissions because the adverse health effects can be effectively controlled by reducing the fume emission, evolved gas emission, and harmful radiations at the source itself. From the systematic literature survey, it was found that reactive metal addition, nano-calcite addition, nano-alumina addition, titania addition, and composite coating can reduce these harmful effects to the welders. The addition and coating of reactive metals can bring tremendous changes in fume formation rate (FFR) and hexavalent chromium formation. Other measures of control found in literature are: selecting welding mode (voltage) to minimise spatter; selecting shield gas to facilitate smooth metal transfer, using modern power sources allowing good control of electrical parameters, high purity wires including surface (avoid Na lubricants), optimising oxygen in primary shield gas [8].

4. Conclusions

The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) was a great help for authors to prepare transparent accounts of their reviews. Systematic reviews are essential not only for researchers, policy makers and other decision makers but also for students, who without them, would be confronted by an overwhelming volume of research on which to base the „state of the art” chapter in their thesis. With the help of PRISMA the methods and results of systematic reviews can be reported in sufficient detail to allow users to assess the trustworthiness and applicability of the review findings. For this paper it was used The Preferred Reporting Items for Systematic reviews and Meta-Analyses

(PRISMA) published in 2009. A total of 65 academic papers retrieved from the ScienceDirect Freedom Collection, Elsevier database, Web of Science - Core Collection, Clarivate Analytics, Scopus, SpringerLink Journals databases were identified and analysed. The main objectives of this review are to answer the following questions: (1) What are the health issues related emissions of noxes in the case of welding in shielding gases? (2) What are the measures of control for the fumes and gases? The search was conducted in January 2023. The results were organized into two major sections. The first include information on major health issues associated with welding noxes. The the second contains studies thought to be relevant on measures of prevention and control.

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The stick-slip phenomenon occurring between human skin and other surfaces

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Abstract. This paper analyses the stick-slip phenomenon in tribosystems that include human skin and biocompatible polyethylene UHMWPE. The study focuses on the theoretical stability conditions of the movement of the UHMWPE polyethylene specimen in contact with human skin, considering the rheological and tribological properties of human skin, the rigidity of the system, and the speed of training. The proposed dynamic model involves the equation of relative motion of the UHMWPE polyethylene specimen relative to the finger, considering the force of friction, axial stiffness, hysteresis damping, and frequency of oscillation. The results can be useful for choosing materials for lower and upper human endoprosthesis and designing robot gripping systems. The paper presents experimental and analytical models and explores the effects of contact pressure, real contact area, and kinetic friction coefficient on the phenomenon. The study aims to improve the understanding of the stick-slip phenomenon and contribute to the development of more reliable tribological systems.

Keywords: *stick-slip, biotribology, rheological model of human skin, UHMWPE.*

Introduction

In tribosystems with relative moving elements, the stick-slip phenomenon occurs as a result of the variation in the friction coefficient as a function of velocity. This phenomenon is frequently observed at low and very low speeds, depending on the system's rigidity in the direction of the drive speed. The amplitude of this phenomenon is influenced by the system's rigidity characteristics, working speed, and skin-synthetic materials' friction behavior [1, 2, 3].

It is known that the dynamics of the micro-contact friction process (real area) depend on the elasto-visco-plastic properties of the materials. In the case of conventional dry rubbing (no special lubricant), two specific phenomena are observed: stick-slip (intermittent) movement occurring when the dynamic friction coefficient decreases with increasing speed and rigidity, and the slip direction has a certain value; steady motion occurs when the dynamic friction coefficient increases with the sliding speed increase.

The visco-elastic properties of human skin are investigated in various papers, revealing a behavior close to the Voight-Kelvin rheological model [4-8]. Models of friction coefficient between human skin and different artificial or natural materials take into account the effect of adhesion and the effect of loss through hysteresis [5], [6], [9]. The stick-slip phenomenon's experimental results are analyzed in detail in the paper [5].

Our paper aims to analyse the theoretical stability conditions of the movement of a UHMWPE polyethylene specimen in contact with human skin based on our experimental results and literature [4-7]. The amplitude of the stick-slip phenomenon is analysed as a function of the rheological and tribological properties of human skin, system rigidity, and training speed. The analytical model's applicability is evaluated in selecting the material needed for the lower and upper human endoprosthesis and designing robot gripping systems.

Experimental model and analytical model

To analyse the stability of the movement and highlight the amplitude of the stick-slip phenomenon between the human skin and the biocompatible polyethylene UHMWPE, we consider a simplified model consisting of a mass (m_s) fixed in an elastic rigidity system (k) and subject to the friction of a continuous or stepwise (v_0) test specimen. The friction coefficient (μ) between the skin and the UHMWPE depends on the relative velocity between the specimens and the contact pressure. We press the polyethylene sample to the finger with a known displacement and continually measure and record the normal force, friction force, and time. The tribological experimental system is shown in Figure 1.

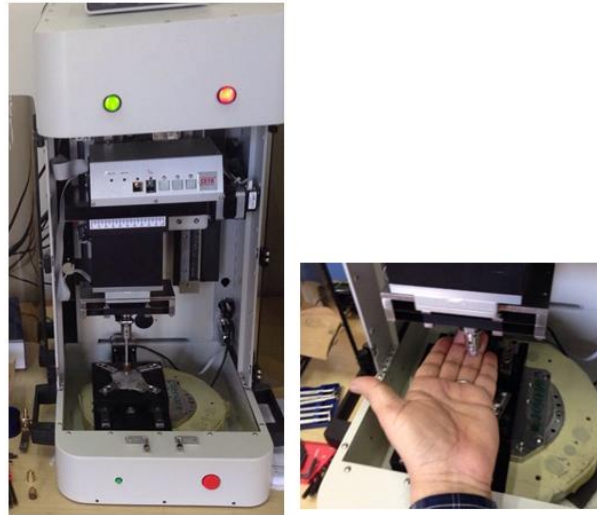


Figure 1. CETR test bench adapted for skin tribology

For the proposed dynamic model (Figure 1), the equation of relative motion of the UHMWPE polyethylene specimen relative to the finger (fixed in the stand support) is given by [2], [3] when the specimen moves at a velocity v_0 :

$$m_s \ddot{x} + F_f(\dot{x}, \gamma_s) + \frac{h}{\omega} \dot{x} + kx = kv_0 t + \frac{hv_0}{\omega_n} \quad (1)$$

The mass of the specimen is denoted by m_s , where x represents the displacement in the direction of slip. The variables t , $\dot{x} = dx/dt$, and $\ddot{x} = d^2x/dt^2$ represent time, instantaneous linear velocity, and acceleration, respectively. The force of friction $F_f(\dot{x}, \gamma_s)$ represents the resistance to motion of the mass, which depends on the sliding velocity ($v_0 - \dot{x}$) and the state of contact area γ_s ("age" of contact-saturation contact area). The axial stiffness is represented by k , h represents the hysteresis damping in UHMWPE polyethylene, and ω represents the frequency of oscillation if the system is excited from the outside or the frequency of natural oscillation ω_n if the system is a free vibratory system.

It is well-known that static friction depends on the contact time. The transfer of contact pressure from one friction element to the other is comprised of elastic, elasto-plastic, relaxation, and creep deformations. The real contact area can be used to trace the geometric appearance of this transfer. The coefficient of static friction is dependent on the real area's size, deformation resistance, and shearing of the roughness. This transfer results in an increase in the static friction coefficient with time, and it is

known as "contact saturation." The real contact area is used to measure the saturation of contact [1], [2]. The variable of state γ_s is assumed to follow the simple kinetic equation [1], [2].

For the variable state γ_s , the following simple kinetic equation is assumed:

$$\frac{d\gamma_s}{dt} = \frac{1-\gamma_s}{t_{cr}} - \frac{\dot{x}}{D} \quad (2)$$

The solutions of this differential equation for the two extreme cases are:

1. For stick time $\frac{dx}{dt} = 0$, γ_s

$$\gamma_s(t) = 1 - e^{-\frac{t}{t_{cr}}} \quad (3a)$$

2. For $\frac{dx}{dt} = v_o$ (steady state) γ_s increases exponentially with time

$$\gamma_s(t) = (1 - \frac{v_o t_{cr}}{D}) (1 - e^{-\frac{t}{t_{cr}}}) \quad (3b)$$

The saturation parameter (real contact area, γ_s) is expressed by developing the exponential function (3) in series and considering the first two terms.

- for the stick time

$$\gamma_s \approx \frac{t}{t_{cr}} \text{ if } \frac{t}{t_{cr}} \leq 1 \text{ and } \gamma_s \approx 1 \text{ if } \frac{t}{t_{cr}} > 1 \quad (4a)$$

- for steady state

$$\gamma_s \approx 1 - \frac{v_o}{D} t \quad (4b)$$

When the body is set in motion, the variable of state decreases more rapidly at higher velocities. The parameter t_{cr} in equation (3a) represents the characteristic relaxation time of γ_s when the system is at rest, while D is the characteristic "relaxation length" or the "age" [1] of this parameter at the onset of motion. From a physical perspective of contact between two rough surfaces, t_{cr} can be viewed as the characteristic time of the creep process, and D represents the average real contact diameter. The creep velocity can be expressed as $v_{cr} = \frac{D}{t_{cr}}$.

To investigate friction between the UHMWPE specimen and the skin (located on the lower area of the ring finger), experiments were conducted under the following conditions: normal force $F_n = 1N$, sliding velocity $v_o = 0.1 \text{ mm/min}$, and rigidity in the sliding direction, $k = 1470 \text{ N/m}$. Under these conditions, the "relaxation length" D was determined to be $37.4 \mu\text{m}$ and the creep time t_{cr} was 0.5 s . Therefore, the creep velocity was calculated to be $v_{cr} = 75 \mu\text{m/s}$ as seen in Figure 2.

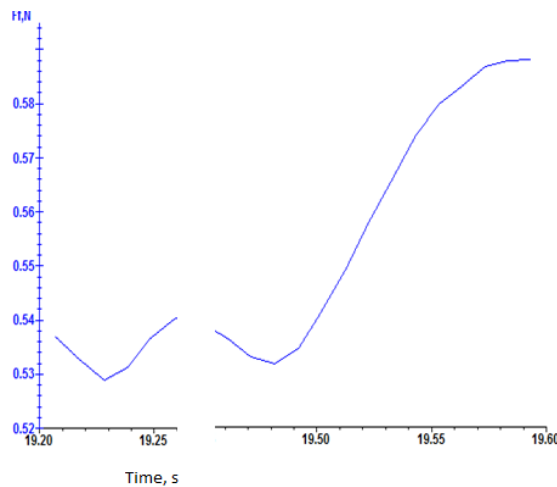


Figure 1. Friction force (F_f , N) vs time(s) on the lower area of the ring finger

The friction force will be:

$$F_f(\dot{x}, \gamma_s) = F_k + (F_s - F_k)\gamma_s = ((\mu_k + (\mu_s - \mu_k)\gamma_s)pA_c) \quad (5)$$

where F_s and F_k are the static and kinetic friction forces, μ_s , μ_k are the static and kinetic friction coefficients, p is the contact pressure and A_c is the nominal contact area.

It has been widely accepted, as supported by numerous studies [4-7, 10, 13], that the kinetic friction coefficient is dependent on the sliding velocity. Specifically, it is commonly acknowledged that the coefficient exhibits a linear variation relative to the steady velocity (v_o).

$$\mu_k = \mu_{k0} + \Delta\mu_k(1 - \exp(-a|V_{rel}|)) \approx \mu_{k0} + \Delta\mu_k a(v_o - \dot{x}) \quad (6)$$

where $\Delta\mu_k = \mu_{kmin} - \mu_{k0}$; $V_{rel} = v_o - \dot{x}$; μ_{k0} is the friction coefficient at the beginning of the sliding phase; μ_{kmin} is the minimum friction coefficient for the velocity Striebeck curve; a is the inverse of the velocity constant (velocity gradient).

Derler and Rotaru [5] conducted experiments to investigate the friction of human skin with smooth glass at low velocities, specifically focusing on the stick-slip phenomena. Their measurements included friction as a function of sliding velocity and normal load (F_n , N), revealing the dependence of kinetic friction on velocity (v_o , m/s) and contact pressure (p , N/m^2):

$$\mu_k = 0.25v_o^{-0.37} \mu_k = 0.7F_n^{-0.4} = 57.9p^{-0.526} \quad (7)$$

It is possible to non dimensionalise the system (1)-(7) using the relations provided by [3], [11]:

$$\xi = \frac{\omega_n}{v_o} x; \zeta = \frac{h}{2k}; \omega_n = \sqrt{\frac{k}{m_s}}; v_a = av_o; \tau = \omega_n t;$$

$$\tau_{cr} = \omega_n t_{cr}; \Delta\mu_s = \mu_s - \mu_{k0} v_{acr} = \frac{v_o}{v_{cr}}; w = \frac{pA_c}{v_o \sqrt{m_s k}}$$

The equation of motion (1) in dimensionless form can be written as:

$$\ddot{\xi} + 2\alpha\dot{\xi} + \xi = M\tau - N = f(\tau) \quad (8)$$

Where:

$$\alpha = \zeta + \Delta\mu_k \frac{v_a w}{2} \quad (9a)$$

$$M = 1 + \Delta\mu_s \frac{w}{\tau_{cr}} \quad (9b)$$

$$N = (\mu_{k0} + \Delta\mu_k v_a) w \quad (9c)$$

The solutions to the non-homogeneous differential equation (6) are dependent on the value of the parameter α . Depending on the value of α , the solution may exhibit damped vibration if α is positive, vibrations without damping if α is null, or self-friction vibration if α is negative. Therefore, the associated homogeneous differential equation is:

$$\ddot{\xi} + 2\alpha\dot{\xi} + \xi = 0 \quad (9c)$$

and it describes vibrations of the type:

- 1) vibration without damping $\alpha=0$;
- 2) small damping $0 < \alpha < 1$;
- 3) critical damping $\alpha = 1$;
- 4) strengthening damping $\alpha > 1$;
- 5) self excitation by friction $\alpha < 0$.

For the initial conditions $\xi = \xi_o$ and $\dot{\xi} = \dot{\xi}_{v0}$ at $\tau = 0$, the solutions of the non-homogeneous differential equation are obtained from the homogeneous equation (6b) and the Duhamel type

integrals. For example, the solution of movement UHMWPE sample to human skin in the slip stage without damping ($\alpha = 0$) is:

-displacement:

$$\xi(\tau) = \xi_o \cos(\tau) + \xi_{v0} \sin(\tau) + \int_0^\tau \sin(\tau - t) f(t) dt \quad (10a)$$

-velocity:

$$\xi_v = \frac{d\xi}{d\tau} \quad (10b)$$

-acceleration:

$$\xi_a = \frac{d\xi_v}{d\tau} \quad (10c)$$

Figure 3 illustrates the movement characteristics (phase plane) during the slip cycle for undamped vibration of UHMWPE on human skin.

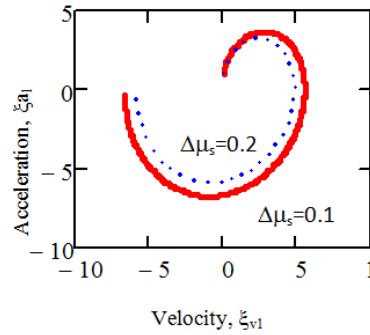


Figure 3. Phase plane of slip without damping

Stability of polyethylene movement on human skin

To analyse the stability of the movement and highlight the amplitude of the stick-stick phenomenon the homogeneous differential equation for the sliding period is used:

$$\ddot{\xi} + 2\alpha\dot{\xi} + (\xi - \xi_o) = 0 \quad (11)$$

is the displacement at the end of slip phase.

The slip period begins when the displacement:

$$\xi_p = \frac{\mu_s p A_c \omega_n}{v_o k} = \mu_s W \quad (12)$$

The dimensionless displacement of mass m_s at dimensionless time τ is:

$$\xi(\tau) = \xi_o + e^{-\alpha\tau} \left[(\xi_p - \xi_o) \cos(\tau\sqrt{1-\alpha^2}) + \frac{1}{\sqrt{1-\alpha^2}} \sin(\tau\sqrt{1-\alpha^2}) + \frac{\alpha}{\sqrt{1-\alpha^2}} (\xi_p - \xi_o) \sin(\tau\sqrt{1-\alpha^2}) \right] \quad (13)$$

The velocity:

$$\xi_v(\tau) = \frac{d\xi}{d\tau} \quad (14)$$

If the system described by equations (11) and (12) is at the boundary of stick-slip, both expressions become zero simultaneously. To determine the slip phase duration and implicitly the amplitude of the movement, we need to examine the conditions under which the space $\xi(\tau)$ attains its maximum. This condition is met when the velocity is zero. Therefore, we can infer that:

$$\tau_{max} = \frac{1}{\sqrt{1-\alpha^2}} \operatorname{atan} \left[\frac{1}{\frac{\alpha}{\sqrt{1-\alpha^2}} + \sqrt{1-\alpha^2} (\xi_p - \xi_o) (1 + \frac{\alpha^2}{1-\alpha^2})} \right] \quad (15)$$

The amplitude of oscillation

$$A_\xi = \xi_{max} - \xi_o = \xi(\tau_{max}) - \xi_o \quad (16)$$

Figure 4 illustrates the impact of friction on the amplitude of the stick-slip motion of UHMWPE polyethylene on the skin of the finger region.

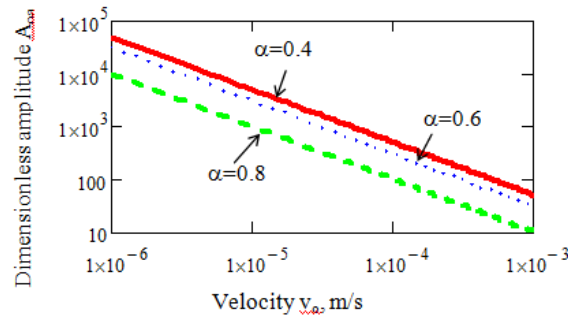


Figure 4. The amplitude of stick-slip

The times at which the mass has zero acceleration can be written as:

$$\tau_{oc} = \frac{1}{\sqrt{1-\alpha^2}} \operatorname{atan} \left[\frac{\sqrt{1-\alpha^2} \Phi_c}{2\alpha^2 + \Phi_c \alpha - 1} + n\pi \right] \quad (17)$$

where $\Phi_c = w(\Delta\mu_s - v_a)$ and n is the integer number in the periodic function.

If eq. (17) is substituted into the condition for zero velocity (14):

$$\xi_v(\tau_{oc}) = 0 \quad (18)$$

An implicit relationship between the damping complex parameter (α) and loading parameter (Φ_c) was obtained. The numerical solution of equation (18), denoted by $\Phi_{cr}(\alpha, n)$, is presented in Figure 5, indicating the stability limit of stick-slip between the skin and the UHMWPE polyethylene.

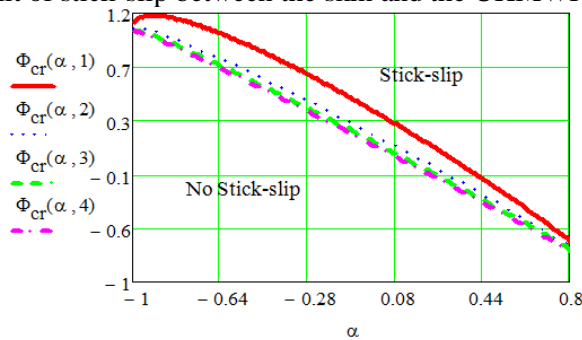


Figure 5. Loading parameter vs hysteretic and friction parameter

Based on the experimental results and those of previous studies [4-6], the value of the load parameter (Φ_c) was determined.

At the end of the slip time, the relative speed is zero, $V_{rel} = v_o - \dot{x}$, $\xi_v = 1$ and the acceleration is zero. The system of equations formed by (2), (3), (4) and (8) has a steady – state solution:

$$\dot{\xi} = 1, \gamma_s = 1 - v_{acr} \text{ if } v_{acr} \leq 1 \quad \gamma_s = 0 \text{ if } v_{acr} > 1$$

The sliding at $v_{acr} \leq 1$ is unstable, when the oscillation time is much larger than the characteristic creep time (t_{cr}).

To obtain the stability limit as a function of sliding velocity, friction, and damping, we applied a small perturbation to the steady-state solution [2], [14].

$$\xi = \xi_o + \tau + \delta\xi \quad (19)$$

and:

$$\gamma_s = \gamma_{so} + \delta\gamma_s \quad (20)$$

The linearised equations of (19) and (20) are:

$$\delta\ddot{\xi} + 2\zeta\delta\dot{\xi} + \delta\xi + \alpha[1 - \Delta\beta(1 - e^{-v_a})]\delta\gamma_s = 0 \quad (21)$$

and:

$$\delta\gamma_s = \frac{-1}{\tau_{cr}} (\delta\gamma_s + v_{acr} \delta\xi) \quad (22)$$

A solution to system of equations (21) and (22) is exponential :

$$\delta\xi = Ae^{\varphi\tau}; \delta\gamma_s = Be^{\varphi\tau} \quad (23)$$

Manipulating (22) and (23) the constants A, B and φ can be obtained. The linear system of equations (unknowns A, B) has a non-trivial solution, when determinant vanishes.

$$\begin{vmatrix} \varphi^2 + \zeta\varphi + 1 & \alpha \\ \varphi \frac{v_{acr}}{\tau_{cr}} & \varphi + \frac{1}{\tau_{cr}} \end{vmatrix} \quad (24)$$

The stability of the system is determined by the roots of equation (22). In the case of damped oscillations, two out of three solutions of the third-order algebraic equation of φ are purely imaginary and complex conjugates, while the third solution is real and negative:

$$\varphi_1 = -\Phi, \varphi_2 = i\Omega_c, \varphi_3 = -i\Omega_c \quad (25)$$

The stability limit can be written as:

$$\left(\frac{1}{\tau_{cr}} + \zeta\right) \left(1 + \frac{\zeta}{\tau_{cr}} - \frac{v_{acr} \alpha}{\tau_{cr}}\right) = \frac{1}{\tau_{cr}} \quad (24)$$

The critical friction parameter is defined:

$$\Pi_{fc} = \alpha v_{acr} = \frac{\Delta\mu_s p A_c}{v_{cr} \sqrt{m_s k}} = \frac{\zeta^2 \tau_{cr} + \zeta(1 + \tau_{cr}^2)}{1 + \zeta \tau_{cr}} \quad (25)$$

The stability curve depicting the movement of skin in contact with the hysteretic UHMWPE is presented in Figure 6.

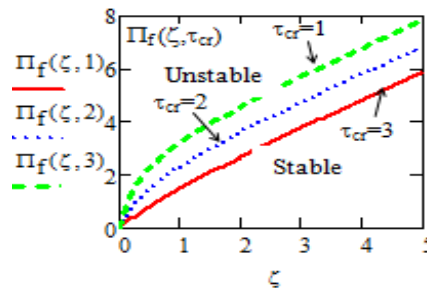


Figure 6. Critical friction parameter vs hysteretic coefficient of UHMWPE

The stability of sliding between skin and biocompatible polyethylene depends on the friction parameter, which is denoted by Π_{fc} . When the friction parameter is smaller than Π_{fc} , the sliding is stable. Conversely, when the friction parameter is larger than Π_{fc} , the sliding becomes unstable. Figure 6 illustrates the stability curve of the skin's movement in contact with the hysteretic UHMWPE. Notably, the hysteretic damping of UHMWPE polyethylene has a strong effect on the stability of the sliding movement.

Conclusions

By using a model system consisting of biocompatible UHMWPE material in contact with human skin, the dynamics of dry and limited friction at low velocities have been studied. In vivo analysis of stick-slip phenomena of UHMWPE sliding on human skin was conducted using a modified tribometer. The normal force and both static and kinetic friction forces were determined for stationary sliding and stick-slip friction. During stick time, creep phenomena were observed, and the static friction force increased. An analytical model for stick-slip of skin and UHMWPE was proposed, where the amplitude of stick-slip phenomena was defined by the difference between static and kinetic friction.

The stability conditions of movement between skin and UHMWPE polyethylene were determined by the contact pressure, sliding velocity, and rigidity of the system.

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Theoretical approach of studying human fingers modelled as inflated membranes and experimental validation of study

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Abstract. The human hand has evolved to become the most complex and versatile grasping and manipulation tool. The fingers play a crucial role in acquiring information about touched objects through tactile and thermal sensors. Specifically, the fingertips are densely packed with touch and thermal receptors, which have the highest concentration of cells responsible for transmitting stimuli to the brain.

Keywords: *grip, human finger, biotribology, human skin.*

Introduction

A novel approach to modeling the behavior of human fingertips has been achieved by utilizing an inflated membrane model to simulate the skin and other materials that comprise the human finger. The theoretical model was developed and compared with experimental results obtained using the CETR UMT-2 (Universal Mechanical Tester) Tribometer, which was used to perform indentation tests with various shapes and sizes of indenters. The in vivo testing method was used to capture the internal tensions present in the finger under natural conditions, resulting in a comprehensive set of data used to describe the mechanical behavior of the fingertips.

There are two types of testing used for tissues: ex vivo and in vivo. In this study, the in vivo procedure was employed to evaluate the mechanical properties of the skin in conditions that are closest to its natural state. This non-destructive method allowed only four types of tests (torsion, tension, suction, and indentation), and indenting was chosen for this study. A punch or indenter was pressed on the skin's surface, and the skin deformed in direct proportion to the applied force. The size of the punch or cup was used to highlight the properties of different layers of skin. A small diameter was used to test the upper layers, while a larger diameter was used to measure the properties in depth. Alternatively, compressed air was blown on the skin, and the deformation was measured.

This model is a refinement of the models proposed by previous researchers [3], [4], and [5].

Experimental model

The tests conducted were designed to capture the behavior of the skin and substrate in various contact conditions. The size of the indenters (diameter of 8 mm, 14 mm, and 28 mm), the force applied (3N and 5N), and the soak time (30 seconds and 2 minutes) were varied to perform a set of experiments. The step-up time for the force was fixed at 30 seconds for each test. The indenters used were manufactured out of brass, which has an elastic modulus of approximately 100 GPa, orders of magnitude greater than the skin that was tested. Therefore, the contact can be approximated as being between the human fingertip and a perfectly rigid body. The indenter used was a cylinder with the

actual part used for indenting being a hemisphere. The size of the hemisphere was varied to capture the behavior of the fingertip in contact with indenters with radii of 8, 14, and 28 mm. The tests involved capturing the creep phenomena that occurs during loading by keeping the force constant throughout the experiment and capturing the time and displacement.

Furthermore, the surface roughness of each indenter was measured to ensure that the surfaces in contact with the fingertip were similar.

Theoretical model for defining the material characteristics of human fingers

The theoretical model employed in this study used a material consisting of an envelope filled with fluid at varying pressures to simulate the different layers of the human fingertip. This layer can be filled with a pressure that alters the behavior of the entire system when subjected to an external force. The resulting shape is a 3D ellipsoid, and the contact region can be described as a degenerate ellipse, as shown in Figure 1.

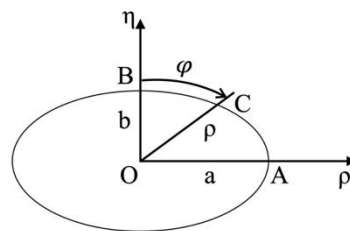


Figure 1. Ellipse coordinates

The shape of the finger in axial section can be considered to be an ellipse. Thus, the coordinates of the ellipse of semiaxes a and b with a > b can be written as a function of ρ and η.

Thus the equation for the ellipse becomes:

$$\frac{\rho^2}{a^2} + \frac{\eta^2}{b^2} = 1 \tag{1}$$

Parameter notation:

Shape parameter:

$$\varepsilon = \frac{l_0}{a} \leq 1 \tag{2}$$

Horizontal nondimensional coordinate:

$$\rho_a = \frac{\rho}{a} \tag{3}$$

Vertical nondimensional coordinate:

$$b_a = \frac{b}{a} \tag{4}$$

Thus, the equation for the ellipse becomes:

$$\frac{\rho^2}{a^2} + \frac{\eta^2}{a^2 \varepsilon^2} = 1 \tag{5}$$

Or:

$$\rho_a^2 \varepsilon^2 + \eta_a^2 = \varepsilon^2 \tag{6}$$

Thus:

$$\eta_a = \pm \varepsilon \sqrt{1 - \rho_a^2} \tag{7}$$

The coordinates of the important points on the ellipse:

$$A(a, 0) \text{ or } A(1, 0)$$

$$B(0, b) \text{ or } B(1, \varepsilon)$$

A random point on the ellipse:

$$C(\rho, \eta) \text{ or } C(\rho_a, \varepsilon \rho_a)$$

For the analysis of the various parameters of the elliptical membrane, the parametric equation of the ellipse is considered. A random point C of the ellipse is characterised by the vector radius r and angle φ measured from the vertical axis $O\eta$ expressed as $C(r, \varphi)$.

In this case, the coordinates of point C are:

$$\rho_c = r \sin \varphi \tag{8}$$

$$\eta_c = r \cos \varphi \tag{9}$$

The ellipse equation becomes:

$$\frac{\rho_c^2}{r^2} + \frac{\eta_c^2}{r^2} = 1 \tag{10}$$

$$r^2 = \frac{a^2 \varepsilon^2}{\cos^2 \varphi + \varepsilon^2 \sin^2 \varphi} \tag{11}$$

Non dimensionalising with regards to the major axis (a):

$$r_a = \frac{r}{a} = \frac{\varepsilon}{\sqrt{\cos^2 \varphi + \varepsilon^2 \sin^2 \varphi}} \tag{12}$$

$$\rho_a = \rho_{ac} = \frac{\varepsilon \sin \varphi}{\sqrt{\cos^2 \varphi + \varepsilon^2 \sin^2 \varphi}} \tag{13}$$

$$\eta_a = \eta_{ac} = \frac{\varepsilon \cos \varphi}{\sqrt{\cos^2 \varphi + \varepsilon^2 \sin^2 \varphi}} \tag{14}$$

Figure 2 (a,b,c) below show the radius and coordinates of a point on the ellipse as a function of the parameter φ for different eccentricities ε .

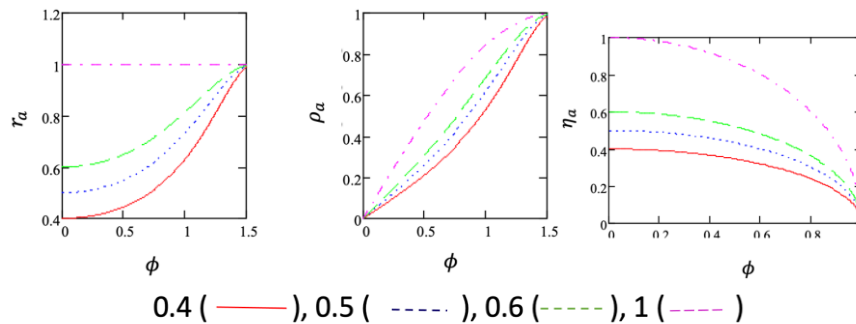


Figure 2. Radius coordinates

The finger is considered to have a truncated cone axial section of radii R_{OS} , r_{OS} and heights H_{OS} . The skin of thickness $2h_0$ is defined as an elastic membrane of the finger-bone system that envelops the tissue defined as a very viscous, incompressible fluid.

The membrane is elliptical with regards to the cone's slant height. The semiaxis of the ellipse (a, b) describe the state of the membrane at different stages. Thus, the initial state can be expressed as:

$$(a_0, b_0, \varepsilon_0 = b_0/a_0) \tag{15}$$

The inflated state can be expressed as:

$$(a, b, \varepsilon = b/a) \tag{16}$$

And the compressed stage with the use of the indenter:

$$(a_c, b_c, \varepsilon_c = b_c / a_c) \tag{17}$$

The specific extensions of the membrane in the meridional (λ_1) and circumferential (λ_2) directions are defined as the ratios between the infinitesimal linear deformations of the deformed membrane and the membrane in the initial state.

$$\lambda_1(l) = \frac{dl}{dl_0} = \frac{\sqrt{d\rho^2 + d\eta^2}}{r_0 \times d\rho} = \frac{\sqrt{\frac{d\rho^2}{d\varphi^2} + \frac{d\eta^2}{d\varphi^2}}}{r_0} = \frac{\sqrt{\rho'^2 + \eta'^2}}{r_0} = \frac{\sqrt{\rho'_a(\varphi^2) + \eta'_a(\varphi^2)}}{r_{0a}(\varphi)} \tag{18}$$

With the initial vector radius in the initial state, r_0 :

$$r_0^2 = \frac{1}{\frac{\cos^2 \varphi}{b_0^2} + \frac{\sin^2 \varphi}{a_0^2}} = \frac{a_0^2 \varepsilon_0^2}{\cos^2 \varphi + \varepsilon_0^2 \sin^2 \varphi} \tag{19}$$

$$\lambda_2(l) = \frac{r(\varphi) \sin \varphi}{a_0 \sin \varphi} = \frac{r(\varphi)}{a_0} \tag{20}$$

Assuming that the membrane (skin) is an incompressible material, the specific stretch in the direction of the membrane axis (λ_3) is:

$$\lambda_3(\varphi) = \frac{1}{\lambda_1(\varphi) \times \lambda_2(\varphi)} \tag{21}$$

Figure 3 (a, b, c) shows the same parameters ($\lambda_1, \lambda_2, \lambda_3$) that characterize the elastic deformations of the membrane, as a function of the angle φ , the shape of the initial ellipse ε_0 and the deformed state ε .

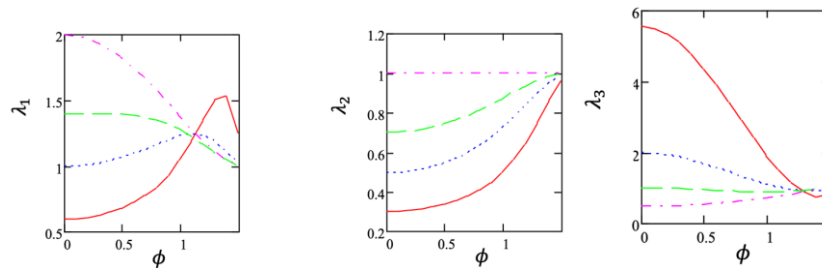


Figure 3. Elastic deformations of membrane

The invariants of the main displacements vary in the meridional (I_1) and circumferential (I_2) directions and are constant in the axial (I_3) direction (incompressible material).

Thus:

$$I_1(\varphi) = \lambda_1^2 + \lambda_2^2 + \frac{1}{\lambda_1^2 \lambda_2^2} \tag{22}$$

$$I_2(\varphi) = \frac{1}{\lambda_1^2} + \frac{1}{\lambda_2^2} + \lambda_1^2 \lambda_2^2 \tag{23}$$

$$I_3(\varphi) = 1 \tag{24}$$

Figure 4 exemplifies the evolution of these invariants in the meridional (λ_1) and circumferential (λ_2) directions on the elliptical membrane.

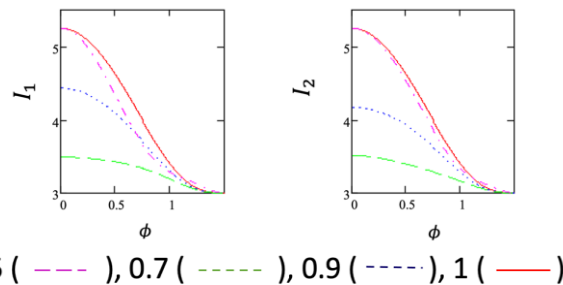


Figure 4. Evolution of invariants

For the axially symmetrical membrane, the equilibrium conditions in the tangential (meridian) and normal (latitude) directions are:

$$\frac{dT_1}{d\rho} + \frac{1}{\rho}(T_1 - T_2) = 0 \tag{25}$$

$$\kappa_1 T_1 + \kappa_2 T_2 = P \tag{26}$$

Where T_1 and T_2 are the forces per unit length of the deformed membrane, κ_1 and κ_2 are the southern and circumferential curves, P is the result of the pressures on the normal direction of the membrane. The results of the main stresses per unit length of the deformed surface of the membrane (T_1 and T_2) are determined by the specific stretches ($\lambda_1, \lambda_2, \lambda_3$) and the behavior of the membrane material (skin), characterized by the deformation energy function (W):

$$T_1 = 4h_0\lambda_3(\lambda_1^2 - \lambda_3^2) \left(\frac{\partial W}{\partial I_1} + \lambda_2^2 \frac{\partial W}{\partial I_2} \right) \tag{27}$$

$$T_2 = 4h_0\lambda_3(\lambda_2^2 - \lambda_3^2) \left(\frac{\partial W}{\partial I_1} + \lambda_1^2 \frac{\partial W}{\partial I_2} \right) \tag{28}$$

Where, W is the function of the energy of changing the shape of the membrane material per unit volume and h_0 is the semi-thickness of the membrane.

It is accepted that the skin has a behaviour similar to that of rubber, considering a material with Mooney type behaviour.

$$W = C_1(I_1 - 3) + C_2 I_2(I_2 - 3) = C_1 \left[(I_1 - 3) + \frac{C_2}{C_1} (I_2 - 3) \right] = C_1 [(I_1 - 3) + \Gamma_m (I_2 - 3)] \tag{29}$$

Where C_1, C_2 și $\Gamma_m = C_2/C_1$ are specific material parameters [J/m^3].

If the unit forces from within the membrane (T_{1a}, T_{1b}) are adimensionalised for the Mooney type material:

$$T_{1p} = \frac{T_1}{4h_0C_1} = \lambda_3(\lambda_1^2 - \lambda_3^2)(1 + \lambda_2^2\Gamma_m) \tag{30}$$

$$T_{2p} = \frac{T_2}{4h_0C_1} = \lambda_3(\lambda_2^2 - \lambda_3^2)(1 + \lambda_1^2\Gamma_m) \tag{31}$$

Figure 5 presents the adimensionalised unit forces within the elliptical membrane, for different shapes.

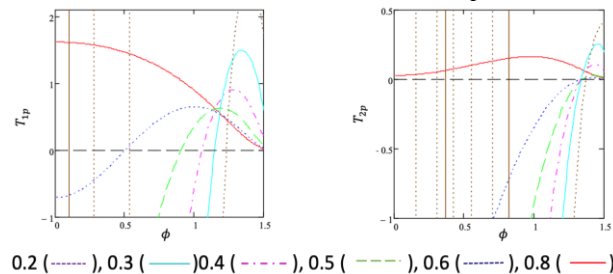


Figure 5. Unit forces

From the evolution of the forces with the current angle φ of the ellipse, it can be observed that when the ellipse is rounded from the initial shape ($\varepsilon > \varepsilon_0$), at large angles φ , the forces in the membrane are traction forces. At small angles (in the pole area), ($\varphi < 30^\circ$) and ($\varepsilon < \varepsilon_0$), the unit forces are compressive forces.

It is possible to highlight the existence of ellipse points with null forces ($T_{1a} = 0$ or $T_{1b} = 0$).

Thus, the adimensionalised main curves towards the curvature ($1/a$)(κ_1, κ_2) of the membrane evaluated using the parametric adimensionalised equation are:

$$\rho_a = \frac{\varepsilon \sin \varphi}{\sqrt{\cos^2 \varphi + \varepsilon^2 \sin^2 \varphi}} \tag{32}$$

$$\eta_a = \frac{\varepsilon \cos \varphi}{\sqrt{\cos^2 \varphi + \varepsilon^2 \sin^2 \varphi}} \tag{33}$$

$$\kappa_{1a} = \frac{-[\rho'_a \eta''_a - \rho''_a \eta'_a]}{(\rho'^2_a + \eta'^2_a)^{3/2}} \tag{34}$$

$$\kappa_{2a} = \frac{-\eta'_a}{\rho_a \sqrt{\rho_a'^2 + \eta_a'^2}} \quad (35)$$

Where $[\]'$, $[\]''$ are the derivatives of order 1 and 2 respectively in relation to the parameter φ . The variation of these principal membrane curvatures are illustrated in the Figure 6.

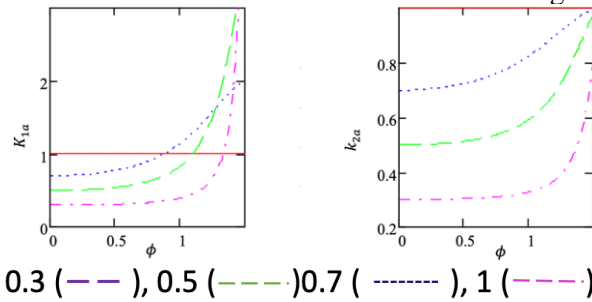


Figure 6. Variation of membrane curvature

Knowing the dependencies of unit forces (T_{1a}, T_{2a}), elliptical membrane horizontal coordinate (ρ_a) and the main curves (κ_{1a}, κ_{2a}) by the angular parameter φ , determine the appearance of the ellipse (ε).

For a planned flat curve by the parametric equation, the main curves can be determined.

Knowing the dependencies of unit forces (T_{1a}, T_{2a}), elliptical membrane horizontal coordinates (ρ_a) and the main curves (κ_{1a}, κ_{2a}) by the angular parameter φ , determine the appearance of the ellipse (ε) from the system of differential equations as a function of pressure P , initial aspect of the ellipse (ε_0), and the Mooney material coefficient (Γ_m).

The differential equation $T_1(\rho) = T_1(\rho, \varepsilon, \varepsilon_0, P, \Gamma_m)$ is a first order differential equation.

$$\frac{dT_{1P}}{d\varphi} + A(\varphi)T_{1P} = B_1(\varphi) \quad (36)$$

The solution for this equation is:

$$T_{1Pa} = \exp(-\int A(\varphi) d\varphi)(C_t + \int B(\varphi)\exp(\int A(\varphi)d\varphi)d\varphi) \quad (37)$$

In which C_t is an integration constant determined from the boundary condition:

$$T_{1P} = T_{1P0} \quad (38)$$

For any point in the incompressible fluid found on the bone; T_{1P0} is the unitary force of the fluid that binds it to the bone, experimentally determinable.

For example, $\varphi_0 = 0.001, \varepsilon_0 = 0.5, \varepsilon = 0.6, P_p = \frac{P}{4h_0C_1} = 0.008, \Gamma_m = 0.1, C_t = -0.704$. Figure 7 exemplifies the solution (T_{1Pa}) for three nondimensionalised loads P_p , with the parameters of the ellipse $\varepsilon = \varepsilon_0 = 0.5$ and the Mooney coefficient of material $\Gamma_m = 0.1$.

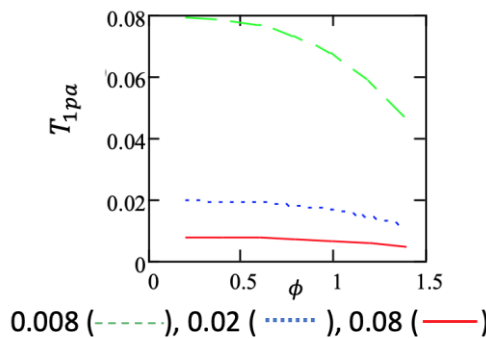


Figure 7. Example of solution

To determine the appearance of the inflated membrane, the unit force T_{1Pa} determined from the equation coincides with unit force in the membrane in the same point of the membrane (φ). From the transcendental equation:

$$T_{1Pa}(\varphi, \varepsilon, \varepsilon_0, P_p, \Gamma_m) = T_{1Pa}(\phi, \varepsilon, \varepsilon_0, P_p, \Gamma_m) \quad (39)$$

The ε_e appearance for any point is characterized by the angle φ , under the load conditions P_p , material Γ_m and the initial aspect of the membrane ε_0 .

Knowing the geometry of the inflated finger, $((\varepsilon, \rho, \eta, r))$ as a function of angle (φ) for different loads (pressure differences, P_p) initial aspect ε_0 specific to each finger and phalange and the parameter of material Γ_m the problem of skin tensions as a membrane in the model presented comes to light.

In the case of a contact between a finger and a rigid plane, prior to compression, the inflated finger as a result of the pressure difference $P = P_1 - P_2$, (the adimensionalised loading parameter P_p) is characterized by the elliptical appearance (shape) ε , semiaxis $a, b = \varepsilon a$, and the skin material as a membrane, by parameter Γ_m .

If the finger is compressed with a rigid plane with a force F_n , the shape of the finger will be B_c, A_c, A'_c, B'_c . Compression in the pole area in the direction of normal force F_n is $\overline{AD} = \delta$, and the separation angle between the flat zone ($A_c A'_c$) is Γ .

The parametric equation of the compressed finger by the rigid plane is:

$$\eta(\varphi) = \begin{cases} b - \delta, & \text{if } 0 \leq \varphi \leq \gamma \\ r_c \cos \varphi, & \text{if } \gamma \leq \varphi \leq \frac{\pi}{2} \end{cases} \quad (40)$$

$$\rho(\varphi) = \begin{cases} (b - \delta) \tan \varphi, & \text{if } 0 \leq \varphi \leq \gamma \\ r_c \sin \varphi, & \text{if } \gamma \leq \varphi \leq \frac{\pi}{2} \end{cases} \quad (41)$$

Where:

γ is the angle defined by the rigid plane and the compressed finger (compression angle);

δ is the finger compression.

The radius profile of the inflated and compressed finger is:

In the flat zone for $0 \leq \varphi \leq \gamma$

$$r_p = \frac{(b - \delta)}{\cos \varphi} = \frac{a(\varepsilon - \delta_a)}{\cos \varphi} \quad (42)$$

In the elliptical area at an angle $\gamma \leq \varphi \leq \frac{\pi}{2}$

$$r_e = \frac{a_c \varepsilon_c}{\sqrt{\cos^2 \varphi + \varepsilon_c^2 \sin^2 \varphi}} \quad (43)$$

From the continuity condition of the inflated and compressed finger profile, the large semiaxis of the deformed ellipsis a_c can be expressed as:

$$a_{ca} = \frac{a_c}{a} = \frac{(\varepsilon - \delta_a) \sqrt{\cos^2 \varphi + \varepsilon_c^2 \sin^2 \varphi}}{\varepsilon_c \cos \varphi} = \frac{\varepsilon - \delta_a}{\varepsilon_c} \sqrt{1 + \varepsilon_c^2 \tan^2 \varphi} \quad (44)$$

In the hypothesis of the incompressible fluid present in the finger, the volume in the inflated phase V_u and the inflated and compressed phase V_{uc} are equal, thus the angle of contact between a rigid plane and a modelled finger depends on the compression and deformation of the ellipse as well as the exterior force applied and the initial pressure within the fluid.

$$V_u = 2 \int_0^b \rho^2 d\eta = 2\pi \int_{\frac{\pi}{2}}^0 r^2 \sin^2 \varphi (r' \cos \varphi - r \sin \varphi) d\varphi = 2\pi a^3 \int_{\frac{\pi}{2}}^0 r_a^2 \sin^2 \varphi (r'_a \cos \varphi - r_a \sin \varphi) d\varphi \quad (45)$$

$$V_{uc} = 2 \int_0^{b-\delta} \pi \rho^2 d\eta_c = 2\pi a^3 \int_{\frac{\pi}{2}}^{\gamma} r_{ae}^2 \sin^2 \varphi (r'_{ae} \cos \varphi - r_{ae} \sin \varphi) d\varphi \quad (46)$$

From the volume equality, $V_{ua} = \frac{V_u}{2\pi a^3} = V_{uac} = \frac{V_{uc}}{2\pi a^3}$, the contact angle of the plane with swollen finger, γ , can be calculated for the shapes of the ellipse before, ε , and after compression, ε_c , when relative compression, δ_a , changes. This compression depends on the external force, F_n , and the fluid pressure in the finger. Figure 8 presents the schematics of the different states studied.

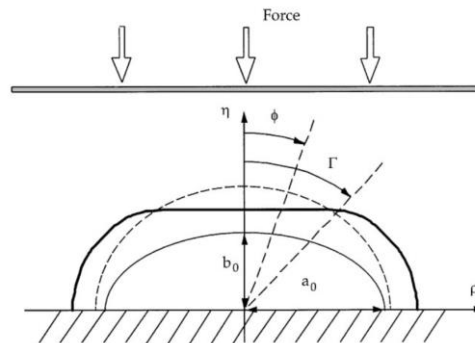


Figure 8. Representation of the axisymmetric membrane showing the uninflated, inflated, and compressed membrane [6]

Experimental results

All experiments were performed on a CETR UMT-2 (Universal Mechanical Tester) Tribometer, a versatile tribometer, for testing mechanical and tribological properties. The experimental setup is fairly simple. Three differently sized spherical tipped indenters were used (diameter of 8, 14, 28 mm). Each finger was tested with each indenter at 3 and 5 Newtons force. The force was applied using a ramp-up time of 30 seconds and a soak time of 30 and 120 seconds. The experimental setup can be seen in Figure 9.

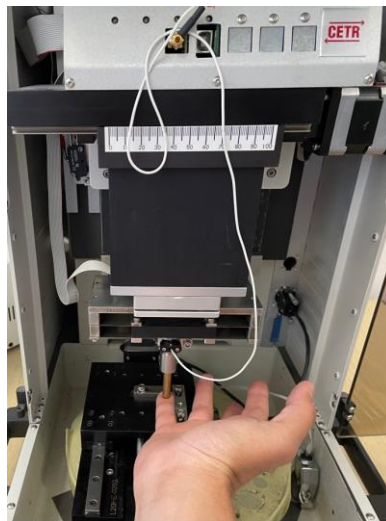


Figure 9. Experimental setup

The aim of the experiments is to measure the creep behaviour of the tissue of a human finger. This was achieved by measuring the deformation of the finger with respect to time when a constant force (3 or 5 N) is applied and maintained for a certain duration (30 or 120 seconds).

In Figures 10, 11 and 12 the general behaviour of the fingertip are shown. The results presented were gathered for the index finger using the 14 mm diameter indenter, a soak time of 30 seconds, a creep time of 120 seconds and an unloading time of 30 seconds using a 5N force.

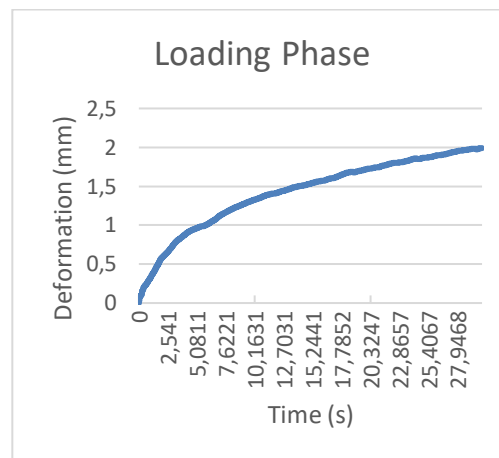


Figure 10. Loading phase (30s from 0 to 5N)

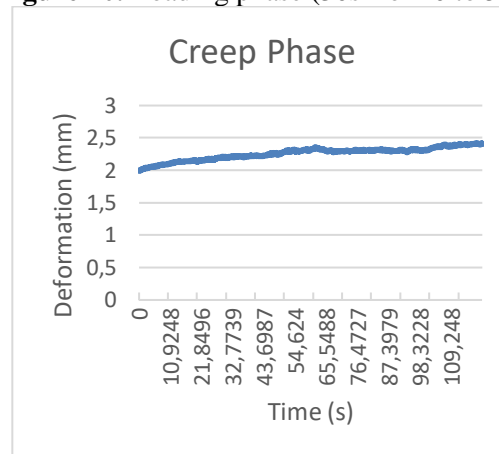


Figure 11. Creep phase (120s at 5N)

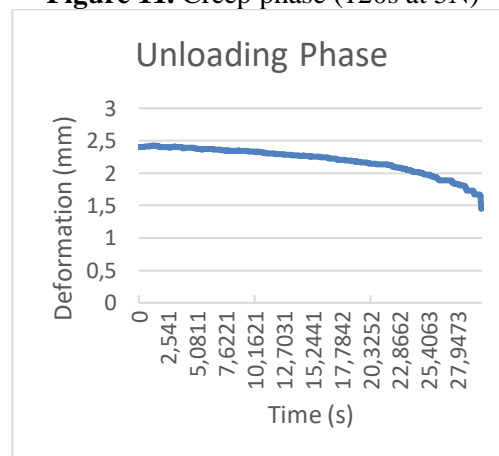


Figure 12. Unloading phase (30s from 5 to 0N)

The results presented are relevant for all fingers tested regardless of the experimental setup (indenter diameter, force applied, creep time). It can easily be observed that the majority of the deformation occurs in the loading phase. This behaviour demonstrates the classical model that involves the three phases of the stress-strain relation of human skin as discussed by [7]. This behaviour can be seen in Figure 13.

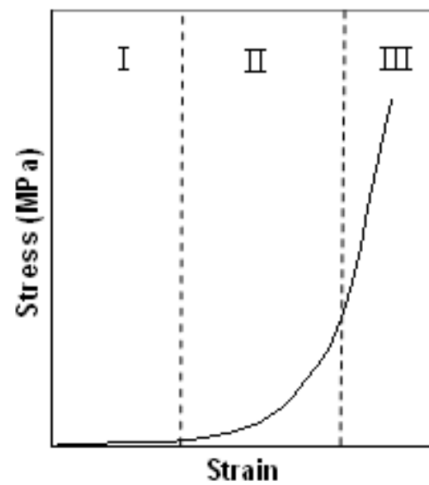


Figure 13. Stress-strain curve for skin [8]

Another interesting aspect arises by studying the deformation with respect to the force applied in the loading phase. As seen in Figure 14, the majority of the deformation occurs at a force that is less than half of the target force (5N). The force is negative because the direction of its vector is upwards.

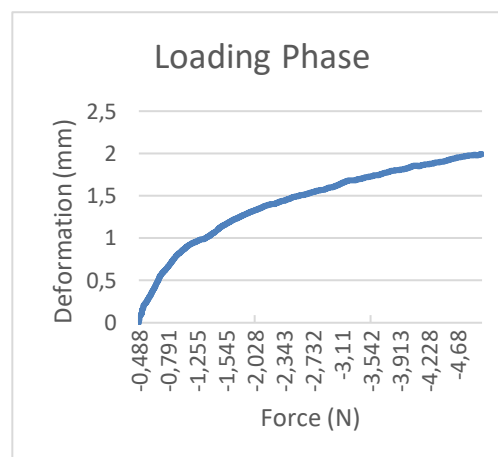


Figure 14. Loading phase (30s from 0 to 5N)

Conclusions

The results from these exploratory creep tests of fingertips indicate that the theoretical model needs to be developed further to include the relaxation phase of the phenomena as the material of the fingertip is of viscoelastic nature. Nevertheless, the model provides a simple and reasonably good quantitative method that evaluates the material characteristics of fingertips. Furthermore, the model can be also applied to other aspects such as analysis of bulk both bulk and membrane polymers.

The initial inflation causes a nonlinear distribution of stresses and stretches that are present in the membrane. Contact with the indenter makes the ellipsoid membrane to revert to a shape that is similar to the uninflated membrane at low contact forces. At higher forces, the membrane deforms up to a point and stiffens with the application of an increasing force. This can be attributed to the underlying tissues such as bone as well as the collagen fibres present in the skin.

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Could renewable sources achieve an energy independence?

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Abstract: In a modern and constantly developing society, electrical energy plays a pivotal role in its development. Nowadays, due to the Ukraine-Russia military conflict, ensuring energy independence and security is more important than ever. Subsequently, the transition from the energy obtained from fossil fuels to green energy must become a priority for decisionmakers. This transition not only contributes to diminishing dependence on Russian gas, but it could also provide stability in the economic sector, produce a positive impact on the environment, reduce the occurrence of disruptive attacks on the networks, and contribute to ensuring energy independence. Another asset of renewable energies lies in the fact that they are diversified (wind energy, solar energy, hydraulic energy, energy obtained from biogas) and can be installed in hard-to-reach areas. Therefore, this article explores the sources of renewable energy and the significant advantages they bring to society in times of peace/war.

Keywords: biogas, energy independence, energy security, renewable sources

Introduction

Electrical energy plays a key role in the socio-economic development of each country, emerging as a vital component in its development [1]. Furthermore, in a modern society, electrical energy has become indispensable to life. It supports all economic activities ranging from production to transport, access to modern education and communication [2]. That is why energy independence can positively impact the economic development of each country, by ensuring an affordable energy price. Therefore, the price of energy is considered the development engine of modern economies [3]. Energy independence refers to ensuring the necessary amount of energy from own sources [4]. Basically, every country provides its own transport base, maintenance and workforce [5]. Moreover, energy independent countries can create a "shield" in order to defend their national interests. Likewise, these countries can be considered real pawns, which can exert a significant impact on the economy and politics worldwide [6]. Unfortunately, this is not applicable to countries which are energy dependent on fossil fuel imports. The dependence can generate serious problems in terms of energy security [6]. As a result, ensuring energy security is one of the most important tasks of every state, as it ensures the continuous operation of the economy and the population's access to modern and clean energy [7]. Therefore, energy security has nowadays become a topical issue worldwide, being featured in multilateral discussions and international forums [8].

Energy security does not only entail the ability to maintain the constant supply of energy at reasonable prices, but it is also considered a much more complex concept [9], given its connections with the diversity of fuels, physical risks [10], the threat of suspending or even canceling deliveries [11].

While the transportation of oil, gas and coal is relatively easy on water or land, this is not applicable to electrical energy, which must be transmitted through physical cables. This is why countries which are dependent on electricity imports are forced to import only from their neighbors [12].

Figures 1, 2 and 3 below depict the country of origin corresponding to the primary energy imports to the European Union (EU) between 2018 and 2020.

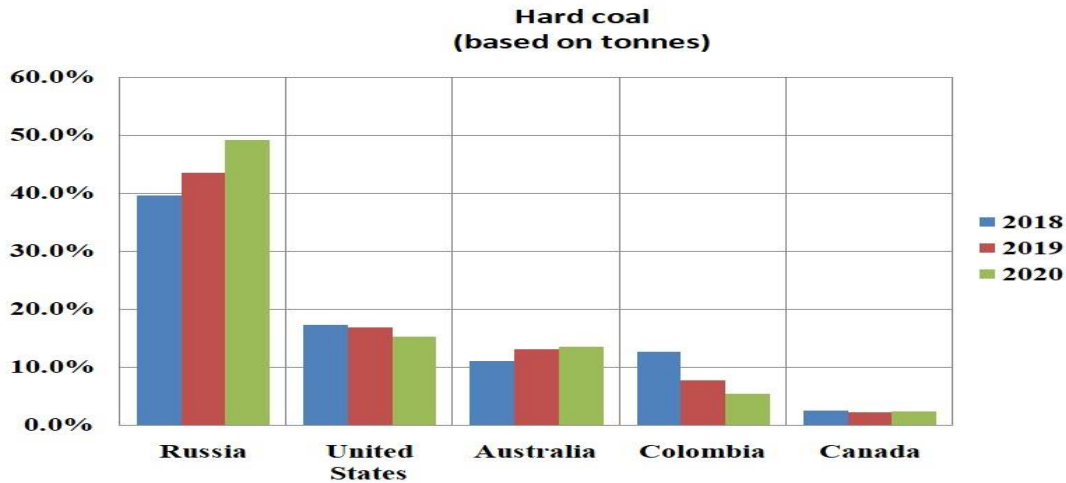


Figure 1. The main exporting countries of hard coal to the EU [13].

Figure 1 depicts the main exporting countries of hard coal to the EU between 2018 and 2020. This graph shows that Russia and Australia were the main exporting countries of hard coal between 2018 and 2020. Referring to the year 2020, one can see that Russia exported hard coal in 49.1 percent, Australia exported 15.2 percent, with Canada occupying the last position with 2.3 percent in relation to the primary energy imports.

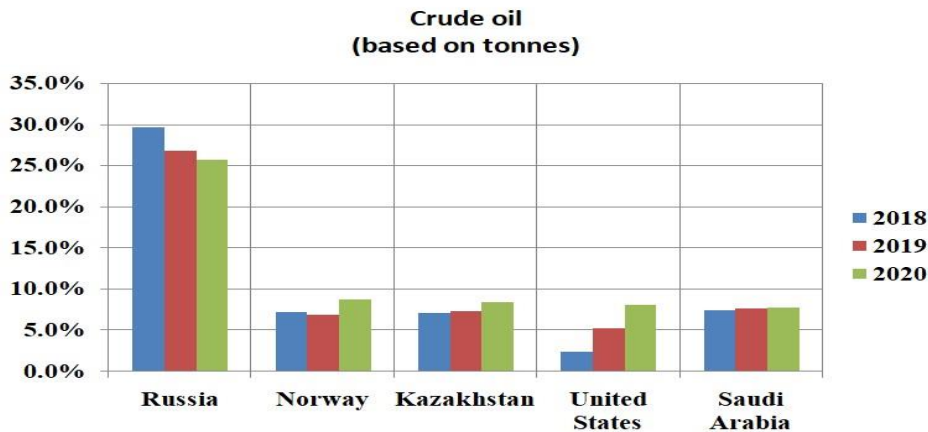


Figure 2. The top 5 exporting countries of crude oil to the EU [13].

Figure 2 shows the most important primary energy suppliers across the EU. Analyzing this graph carefully, it should be noted that Russia holds the monopoly regarding the export of crude oil. The deliveries of this country (between 2018 and 2020) range between 29.6 and 25.7 percent. While in Norway, Kazakhstan and Saudi Arabia, there were no significant differences between 2018 and 2020, the United States increased its supply, rising from 2.4 percent in 2018 to 8.1 percent in 2020.

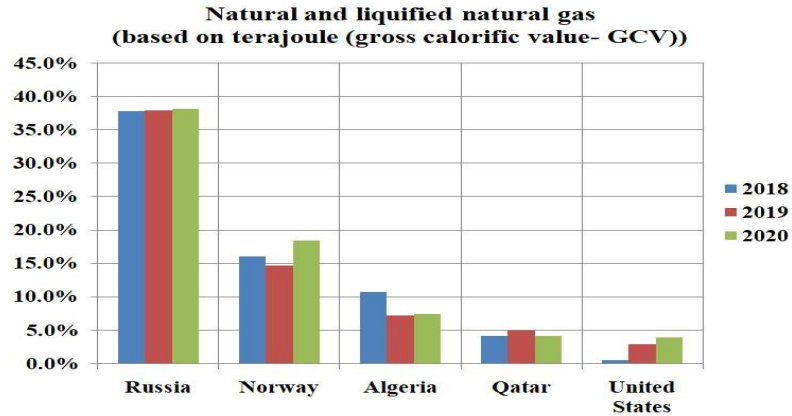


Figure 3. Graphical representation of the natural and liquified gas supplier countries [13].

The leading natural and liquefied gas supplier countries are illustrated in Figure 3 above. Russia emerges as the top supplier followed by Norway and Algeria, with the United States occupying the last position. The difference between Russia and the United States is very big, particularly if considering the year 2020, as it can be noticed that Russia supplied natural and liquefied gas at a rate of 38.2% of the raw energy imports for the EU. By contrast, the United States exported 4.0 percent to the EU in 2020. Figures 1, 2 and 3 depict Russia as the main supplier of fossil fuels between 2018 and 2020.

Due to the tense relationship recently established between the EU and Russia, EU countries must immediately identify potential solutions in order to give up the primary energy imports from Russia. Otherwise, the economy of many EU countries will be affected, in terms of availability, lack of independence and non economic prices. These aspects are also illustrated in Figure 4.

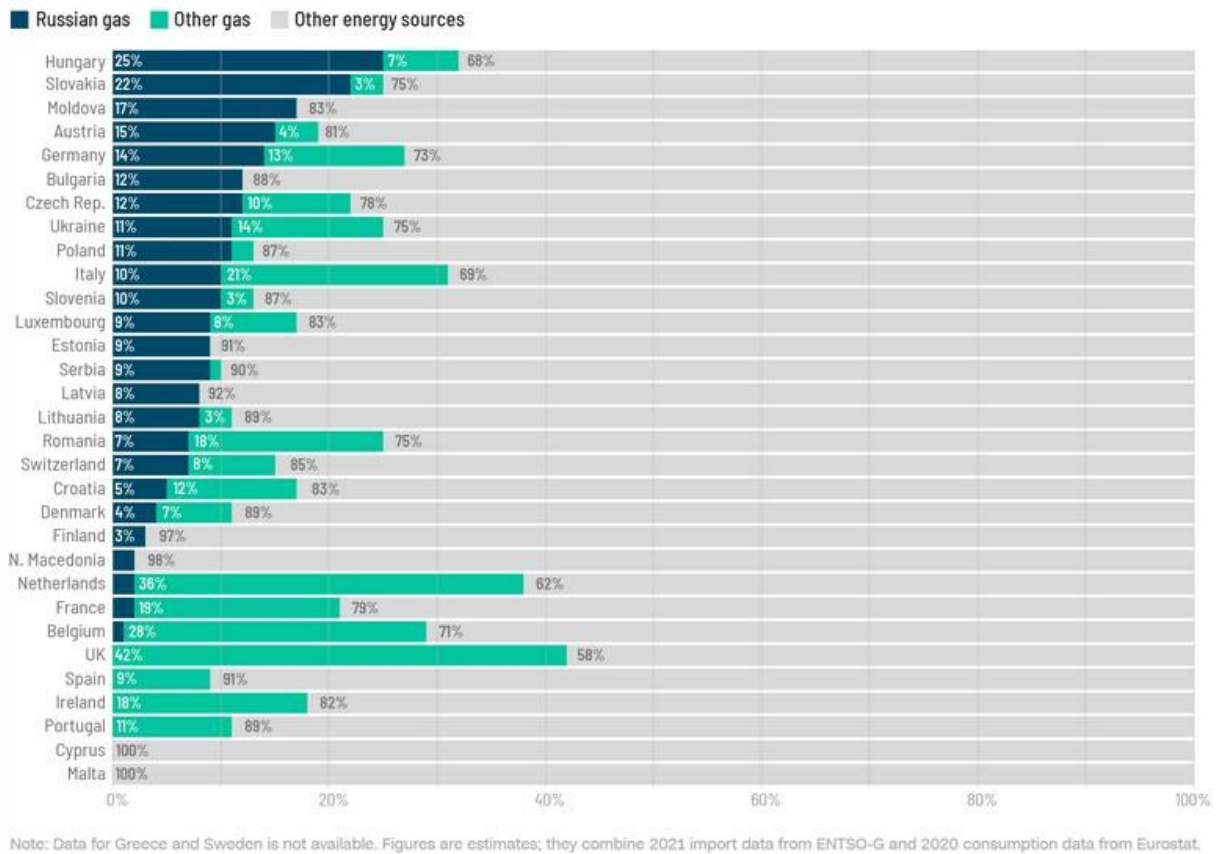


Figure 4. European countries' dependence on Russian imports [14].

Nowadays, due to geopolitical conflicts, achieving energy independence has become the main goal pursued by many countries. Achieving energy independence has become a very attractive and appealing target [15]. Countries like the Republic of Moldova, Macedonia, Bosnia and Herzegovina are almost entirely reliant on the gas supply from a single supplier. Similarly, more developed countries like Germany and Italy depend on Russian gas at a rate of 14% and 10%, respectively [14].

The outbreak of military conflicts jeopardized the energy security of several countries, which were forced to review their energy supply policy. A potential solution to diminish or even remove the dependence on the import of fossil fuels is represented by renewable energy sources. These now have two uses: reducing pollution and ensuring energy independence to a lesser or greater extent.

Until quite recently (three months ago), renewable energy sources were talked about as the only solution to replace fossil fuels, as they were considered non-renewable and limited [16]. At the same time, fossil fuels are known to exert a negative impact on the environment, contributing to global warming and air pollution. Not only do they affect the environment, but they can also negatively impact human health [17]. Studies have shown that inhaling polluted air affects the lungs, causing diseases such as asthma, lung cancer and respiratory infections [18].

1.1. Potential renewable energy sources

Renewable energy represents the energy obtained from inexhaustible energy sources with a low level of greenhouse gases [19].

Renewable energy resources include: wind energy, solar energy, hydraulic energy, energy produced from biogas [20].

Solar energy constitutes a renewable energy source, which exerts no negative effects on the environment and which is inexhaustible [21]. This type of energy is particularly used to generate electricity for lighting [22]. In order to obtain as much energy as possible, the following aspects must be taken into account: wind speed, environmental temperature and solar radiation intensity [23]. It should also be stressed that both energy sources (wind and photovoltaic) generate a reduced amount of energy in the summer when temperatures reach over 36 degrees Celsius [24].

Wind energy: The construction of wind power plants is based on an ancient technique of several millennia that emerged with the first windmills [25]. The main advantage of wind power plants is that they can be built even in the middle of the sea, which means that no land is needed [26].

Wind energy production is greatly impacted by the wind (at least 20 km/hour) [27] and by different natural conditions and seasonal influences [28]. Although the use of wind and solar energy can be very extensive, non-polluting, and sustainable [29], these two energy sources pose a significant disadvantage. The disadvantage lies in the fact that they cannot ensure a continuous supply of energy. In order to overcome these disadvantages, there are two solutions: creating an energy mix and energy storage.

The energy mix entails a multiple energy combination, sold as a package []

Energy storage is the key to maximizing the potential of these two energy sources [31]. It must, however, be noted that energy storage cannot be implemented at the moment, because maintenance costs and storage technologies are very expensive.

Hydropower: Hydropower plants constitute an important source of renewable energy, providing 19% of energy production worldwide [32]. Moreover, the use of hydropower to obtain electricity instead of coal is very useful, because it prevents the release of 148 million tons of particles, 62 million tons of sulfur dioxide and 8 million tons of nitrogen oxide per year [33]. Although the energy produced by hydropower plants is a clean energy, their construction can exert negative effects on the ecosystem [34].

Biogas production may represent an important source of worldwide renewable energy supply, also contributing to diminishing climate change [35].

Biogas can be obtained through anaerobic digestion using biodegradable food waste, waste from the agro-zootechnical industry, municipal waste [36] sewage treatment plants. Through the biological conversion of the waste, biogas rich in methane (CH₄) [37], carbon dioxide (CO₂) and nitrogen (N₂) [38] is obtained.

Compared to the other sources of renewable energies presented previously, biogas production contributes to the development of the circular economy. This is thanks to the use of biodegradable waste in the process of obtaining biogas and the recycling of nutrients in agriculture [39]. At the same time, biogas provides a wide range of uses: it generates electricity and thermal energy, biomethane, bio-fertilizers. All these uses make biogas production a sustainable and competitive source of energy [40].

The main advantage of renewable resources is that they are inexhaustible. The quantities consumed are only temporarily depleted, they do not generate a fixed quantity, but they can be regenerated at any time in larger quantities [41, 42]. Renewable energy is a source of domestic energy [43], which can simultaneously replace domestic consumption of fossil fuels and fuel imports. At the same time, research has indicated that they are less harmful, often cheaper [44], (in 2020 solar energy became the cheapest electrical energy in the world) [45], more durable [46] and contribute significantly to environmental security [47]. These resources have the ability to be converted in order to produce heat, electricity and

liquid fuels [48]. By replacing oil with biofuels, greenhouse effect emissions are reduced, and costs and sales prices are acceptable [49]. It should be noted that renewable energy can be used both in rural areas and in urban areas [50], regardless of the landforms.

Renewable energy does not only exert a positive impact on the environment, it can also have positive effects on the macro economy [51].

In order for the energy from renewable energy sources to be profitable, the specificity of the location must be taken into account. This entails complex resource evaluation research [52].

Even though renewable energy sources were not as attractive for investors and companies at the beginning, they have recently changed their opinion thanks to the government subsidies and major investments associated with the production of solar energy, photovoltaics and wind turbines [53, 54]. It is hence estimated that by (year) 2040 the renewable energy industries could become very profitable businesses generating huge amounts of money [55].

The development of the renewable energy industry contributes significantly to raising the living standard of the population by creating new jobs, especially in those areas where the renewable energy source is located [41].

So far, several benefits provided by renewable energy to the environment and the economy have been briefly described. Now, the time has come to review the impact these sources have on energy dependence.

To be able to understand the importance that renewable sources have on energy dependence, one must first define energy dependence.

Energy dependence occurs when a country fails to meet the energy demands from its own sources, being forced to supplement the energy difference with imported energy [56].

In order to reduce or even eliminate energy dependence, each country must implement policies to find solutions to adequately use indigenous energy resources [57].

These resources have the ability to actively contribute to energy security through the variation of energy sources. An additional key aspect points towards the fact that renewable energy sources are independent from the point of view of supply. This aspect is essential in ensuring good conditions for any economy [58]. By contrast, the energy supply from fossil fuels can be intentionally disrupted [59].

Ensuring energy independence from renewable sources leads to avoiding price fluctuations [60]. Furthermore, the risks of accidents, terrorist attacks or natural disasters are relatively low [61].

1.2. Romania's renewable energy situation

As with other countries, the energy sector in Romania is paramount for the development of the industrial and agricultural sector, for raising the standard of living and providing environmental protection. Moreover, Romania had to align its energy policy with European policies, which have three benchmarks: achieving energy security, competitiveness and sustainability [62]. Compared to other countries, our country has managed to ensure its energy security. Thanks to the landform diversity, Romania is rich both in renewable energy resources [63] and in fossil fuel resources. Since the demand for fossil fuels is very high, they are quickly depleted before new sources are discovered [64]. Thus, fossil fuels constitute a limited source of energy, which contributes to global warming [17] and accelerates the process of environmental degradation [65]. That is why the diversity of renewable energy sources is an asset for our country, as they can accelerate the transition to an economy with low carbon emissions [66]. Romania is part of the countries that have reached their 2020 target of 24% for renewable resources [63]. For 2030, Romania has set itself the goal of reducing ETS emissions by 43.9% compared to the values recorded in 2005 [67].

Figure 5 shows the breakdown of energy production, occurring in Romania on 29.01.2023. It can be noticed that Romania acquires a significant amount of energy from hydropower plants. Another important

energy generating source is fossil energy (coal). Therefore, Romania has a great advantage in that it has both fossil and renewable energy sources.

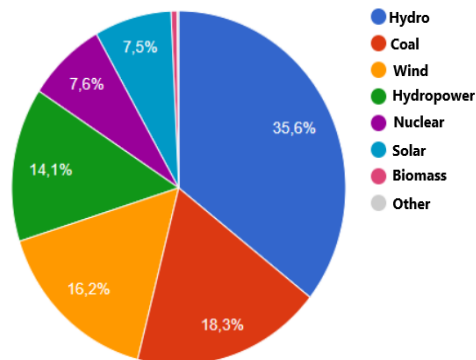


Figure 5. Installed power in electricity production capacities [68].

1.3. Achieving energy independence in the agro-zootechnical sector through biogas production

Biogas production represents a new means of generating renewable energy resulting from the decomposition of biomass [69]. Biomass includes all plant resources, human and animal plant and biological residues, capable of generating energy [70]. Additional sources of biogas production are: household waste, municipal waste and industrial waste.

Compared to other renewable energy sources, biogas can be processed in order to generate electrical energy, it can be used for heating/cooling or for generating fuel for vehicles [71]. Another advantage is that biogas production is not influenced by the state of the weather as it happens in the case of solar and wind energy. Additionally, the biogas production process can be carried out on a household, agricultural and industrial scale [72]. Biogas production also helps in terms of reducing waste disposal costs, creating new jobs and ensuring energy independence.

The agro-zootechnical sector does not only constitute a source of food for the population, it also emerges as a source of waste and pollution. It is estimated that by 2050 the planet's population will increase to approximately 9-9.5 billion inhabitants. As a result, the strengthening of the agro-zootechnical sector is extremely necessary, as it ensures the food security of the country [73].

The modernization of the agro-zootechnical sector fostered its consolidation as a significant consumer of energy. The main energy-consuming sources are: grain drying, lighting and heating, fertilizer production [74], food preparation and grain grinding.

In order to avoid unintentional disconnection and cyber attacks on the energy system, but also to reduce costs, it is necessary for the agro-zootechnical sector to direct its attention to biogas production and implement projects, which foresee and ensure low costs of obtaining energy.

Conclusions

The expansion of the electricity network has steadily led to the economic development of modern society. Electrical energy is used for lighting, for powering household and industrial appliances and for heating. It hence significantly contributes to the comfort associated with the everyday life. This is why it is difficult to imagine the chaos that could be caused if one runs out of energy. It is not an exaggeration to say that electricity has nowadays become indispensable.

Unfortunately, the EU is currently facing a double energy crisis. The first stems from the uncontrolled closure of power plants operating on coal. Such decision was reached in order to reduce carbon emissions and save fossil fuels (sources considered exhaustible). The second crisis has been caused by the Russian invasion in Ukraine, which has since generated insecurity regarding the supply of natural gas to the EU, further aggravating the already existing energy crisis. The negative effects of this crisis are experienced in the substantial increase in the price of energy. The increase has inevitably produced major effects on prices in general, leading to higher prices for all products and services and affecting both producers and consumers.

In order to be able to reduce the dependence on the import of Russian gas and halt the increase in energy prices, the decisionmakers are forced to find solutions to these two major problems immediately.

A potential measure could be the reopening and modernization of coal-fired power plants, which until recently have been considered "dead-end resources", and the support for hydropower plants. Additional steps include supporting mining by increasing the exploitation capacity and creating new jobs in the mining areas.

The second measure consists of supporting economic agents and vulnerable consumers by capping the price of energy and allocating subsidies. Through the aforementioned measures, the bankruptcy of many companies can be avoided, the unemployment rate kept at a low level and implicitly ensuring a decent living standard for the population.

Concurrently, it is necessary to accelerate the transition process towards green energy sources (considered inexhaustible and cheap). The transition from fossil energy to green energy will bring many advantages. It stabilizes the economic sector, reduces the import of Russian gas, and energy sources will be diversified. It also provides the opportunity of being installed in hard-to-reach areas for fossil energy. They can provide the necessary heat and electricity and ensure the creation of jobs. It eliminates the probability of intentional disruptive attacks and reduces the risks of natural disasters. It also ensures the possibility of reducing the amount of waste, eliminates greenhouse effect emissions, ensures and strengthens energy security and independence.

Achieving energy independence brings numerous advantages to a country. Here one mentions the possibility of offering citizens and the industrial sector affordable prices for the purchase of electricity, the elimination of vulnerability and constraints in case of war or other political decisions.

Unfortunately, the transition to renewable energy cannot be undergone abruptly. This must be achieved gradually by maintaining the energy mix, with the tendency to reduce fossil fuels. It is hence crucial to find substitutes for fossil fuels with other fuels that can ensure continuity in the process of transformation into thermoelectric energy.

It is also necessary to support green energy investors by simplifying the procedures for granting licenses and authorizations in the energy sector. Additional solutions should consider the development of the industry producing equipment for energy systems, energy efficiency and the development of energy accumulators.

Fortunately, Romania is one of the few countries that have diversified and complex landforms. This could help Romania benefit from all forms of renewable energy, thus ensuring the energy independence coveted by all countries in these turbulent times. Taking full advantage of this potential, our country could become an important player on the energy market. Unfortunately, however, it has not achieved

actually the most of this huge advantage. Renewable energy sources can cover all energy needs in Romania and in the EU countries only in parallel to developing new and cheaper technologies, especially for energy accumulators. Only reshaping the energy sector is not sufficient for assuring a reasonable CO₂ emission reduction world wide. It is important to keep in mind that using natural gas is only a transition to the final step for CO₂ neutral energy sources, even major investments are foreseen presently. A mix of energy sources, including the nuclear sources, must be fulfilled, in order to assure the stability, continuity, security and low price of the available sources in energy management.

All countries must make efforts in this direction, assuring local, long term, sustainability, by using country specific resources, Transportation systems must also be simultaneously “cleaned up”, in addition waste in all its forms must be much more used and turned into energy resources, including also industrial wastes.

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Considerations on Prevention and Protections Measures Against Occupational Risks

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Abstract. A general trend, manifested at the European and international level, is to promote the use of scientific methods in preventive activity, both in terms of the design of work security measures, and the motivation of employers for the application of these measures. The argument to which any entrepreneur reacts positively is profit. As a result, prevention specialists have tried to demonstrate that efforts to reduce the number of occupational accidents and illnesses ultimately bring financial benefits to the company. The paper presents the classification, prioritization and distribution of prevention and protection measures on the 4 components of the work system: the worker, the workload, the means of production, the work environment. Also, a case study on taking measures for a job is presented.

Keywords: *occupational safety and health, prevention and protection measures, identification of professional risks, assessment of risks*

1. Introduction

Protection at the workplace aims to improve working conditions and prevent work accidents and occupational diseases. Consequently, Community legislation requires Member States to adopt measures to compel employers to create safe and healthy working conditions. The way in which the European Union seeks to achieve social objectives in the field of work is the tripartite consensus: legislator - employer - employees. For dialogue to be fruitful, appropriate arguments are needed for all parties involved.

According to the International Labour Organization (ILO), work-related accidents are still far too frequently. Globally, work-related mortality accounts for 5% of all deaths; but this percentage has increased dramatically in last few years due to the COVID-19 pandemic. However, in the context of COVID-19, new requirements on the labour market, such as remote working, appropriate protective measures and the appropriate use of personal protective equipment when physical presence cannot be avoided, require new approaches to ensure health and safety. The modern approach to preventive activity, which requires its organization according to the principles of scientific management, as well as the integration of occupational safety management into the general management of industrial organizations, necessarily requires the design of tools to measure the economic efficiency of preventive

activity [4]. Directive 89/391/EEC regarding the implementation of measures aimed at improving the safety and health at work of workers clearly establishes the relationship between the risks of occupational injury and disease and preventive measures, as well as the obligations of employers in this regard. [16]. The employer must ensure that a risk assessment is carried out for the safety and health of workers, including regarding the choice of technical equipment, chemical substances or preparations and the layout of workplaces. Evaluation is one of the fundamental principles of prevention. It is a fundamental element for the companies preventive strategy, because based on its results, the employer can establish those measures that must be implemented to guarantee the improvement of the level of protection of workers' safety and health.

Specifically, the Directive establishes the following essential elements for the foundation of prevention programs:

- the achievement of safety at work requires the completion of two mandatory stages:
 - assessing risks for the security and health of employees and identifying those that cannot be avoided;
 - establishing, based on the assessment, preventive measures appropriate to the risks that cannot be avoided;
- the adopted measures must ensure a better level of protection of safety and health at work;
- the measures for occupational safety and health of workers must cover all activities and all organizational levels, including situations where employees from several companies work in the same unit. [4, 16].

The development of a Prevention and Protection Plan must start from establishing workplace risks, estimating their size and establishing the necessary steps to control them.

The psychological and mental state of workers is of particular importance, even decisive for the productivity and economic results of companies. It is directly influenced by the psychosocial climate provided by appropriate measures. Signs of an appropriate climate are low absenteeism, tolerance for conflict and uncertainty, a reasonable fluctuation. They are favoured by the positive motivation of the workers, by the ability of the organization to ensure good working conditions, by good management.

2.Method

The general methodology is complex [1,11,12] and includes two main stages:

- A. Assessing the risks of occupational injury and illness through an assessment method that complies with the requirements of the legislation; the assessment will be carried out on the four components of the work system - means of production, work load, work environment and worker.

In our country, the most known and used evaluation method is the INCDPM ALEXANDRU DARABONT method [12]. Other methods used: the ENDESA method [11], the EVA-RISK method [1] - is a new method, developed in the doctoral thesis by the doctoral student Eduard Smidu.

Below we present the evaluation stages for the three methods in comparison:

- ALEXANDRU DARABONT METHOD has the next stages:
 - description of the system to be analysed: in this stage a detailed analysis of the workplace is carried out, aiming at: the identification and description of the components of the system and its mode of operation: the description of the technological process, of the work operations, the machines and equipment used, functional parameters and characteristics , tools etc.; the express specification of the task assigned to the executor in the system (on the basis of the job description, written orders and decisions, verbal instructions currently given, etc.); description of existing environmental conditions; specifying the security requirements for each component of the system, based on work security norms and standards, as well as other relevant normative acts
 - identification of risk factors in the system: in this stage, essential for the quality of the analysis, it is established for each component of the evaluated work system (respectively workplace), based on the pre-established list, which dysfunctions it may present, in all foreseeable and probable situations operating.

- assessment of occupational injury and illness risks: quantification of severity, probability and partial level of risk; calculation of the global level of risk.

- the ranking of risks and the establishment of prevention priorities;

- proposing preventive measures.

- ENDESA METHOD has the next stages [11]:

-analysis of the work system highlighting the 4 components: work load, means of production, work environment, executor

- identification of risk factors in the system: definition of risk agents (29);

-defining the types of installations; defining the types of activities; identification of inherent risk agents for each type of facility: (defined as "General", if the person does not perform any activity; for each type of activity);

- generating the risk matrix;

- assessment of occupational injury and illness risks:

a. risk identified in the work area at each work station (from the applicable risk matrix)

b. application of ENDESA questionnaires to relevant samples from each work area (one for each factor)

c. definition of frequency and exposure time definition of exposure time

d. defining the probability of the materialization of the risk and defining the consequences of the materialization of the risk

e. risk assessment by loading on each work station/work station positions

f. ranking risks and establishing prevention priorities;

g. proposing preventive measures.

- application of preventive measures

- intervention on the positions if necessary to apply additional measures to the respective positions.

- reducing the risk to an acceptable level

- Compared to the 2 methods presented above, the EVA-RISK METHOD has the following stages:

- work is done in the electronic application from the Excel program, in five worksheets

- in the description worksheet, the Evaluation of occupational injury and disease risks of the workplace, the entity, the evaluation date is presented; a brief description of the entity in which the assessment of occupational injury and illness risks is carried out; the identification data of the workplace, the purpose of the activity and its 4 elements are presented: the means of production, the work load, the work environment, the worker; each component of the work system is described;

- in the risk identification worksheet, based on the 2 checklists, classic risk factors as well as new and emerging ones are identified, using specific Excel functions; the factors and are filtered; it is copied in the risk assessment worksheet, in the assessment sheet, which includes the assessment team component, with at least 2 assessors; working time; the identified professional risks; the severity class of the consequence and the probability class of the consequence, established by data validation, the risk level being generated automatically as well as the general risk level of the workplace; the proposed measures are completed - mitigation and elimination systems, the deadline for the implementation of the measures and the person responsible for the implementation of the measures; in the following worksheet, 4 graphs are generated with the evaluation analysis

- the last worksheet presents the job evaluation report.

Five risk levels are quantified in the EVA-RISK method, 7 risk levels are quantified in the INCDPM and 5 risk levels are quantified in the ENDESA method (Table 1):

Table 1

EVA-RISK risk level		INCDPM risk level		ENDESA risk level	
1	Minimum	1	Minimum	5	Insignificant
2	Low	2	Verz low	4	Tolerable
3	Medium	3	Low	3	Moderate
4	High	4	Medium	2	Important

5	Very high	5	High	1	Intolerable
		6	Very high		
		7	Maximum		

Although they are so different, the three methods have the following points in common:

- they are based on a matrix that includes the place/facility where the activity is carried out;
- take into account the 4 elements of the work system, namely the worker, the work load, the means of production, the work environment.
- the basic steps are the same: identification of risk factors in the system; risk assessment; proposing preventive measures.

B. Establishing prevention and protection measures for each identified risk factor

Preventive measures are taken into account in the following hierarchical order [12]:

1. Eliminating risks - measures must act directly on the source of the risk factors (intrinsic prevention)
2. Isolation of risks - collective protection measures that avoid or reduce the action on workers of risk factors that persist
3. Risk avoidance - organizational measures and regulations that avoid the interaction between risk factors and humans
4. Isolation of workers - measures by which the action of risk factors is limited through individual protection

Even if all the proposed preventive measures are taken, there are risk factors that cannot be eliminated, called residual risk factors in the specialized literature. These risk factors can be kept under control through organizational measures [12].

Statistics show that most accidents are related to non-compliance with OSH instructions. As a result, there is a need to put more emphasis on the professional training of workers for the formation of the safety culture at the workplace and the awareness of the risks to which they are exposed if they do not respect the work procedures.

3. Results and discussion

In the EVA-RISK method, the evaluation sheet is a form made up of 2 parts [1], (Fig. 1.):

- the actual assessment of professional risks, the left half, yellow (L_r - level of job risk - is a weighted average of the levels of risk factors identified for a job; L_p - level of risk of the risk factor - is given by the probability and severity; S – severity; P – probability).
- the mitigation-elimination system consisting of:
 - the proposed prevention measures, the time of implementation of the measures and the responsible persons, the right half, in green. In this part, technical, organizational, sanitary and other measures are taken; measures are also taken such as monitoring the conditions of the workplace, training employees in safety and health issues, measures regarding the provision of first aid in case of medical emergencies - medical kits, training.
 - the deadline for the implementation of the measures - depending on the situation, it can be monthly, quarterly, semi-annually, annually or x days after the risk assessment
 - the person responsible for taking the measure within the set deadline can be the worker, the workplace manager, the employer, the Prevention and Protection Service, other departments.

	A	B	C	D	E	F	G	H	I	J	K
3	ECONOMIC UNIT		ASSESSMENT SHEET Lr			WORKING TIME					
4	DEPARTMENT					ASSESSMENT TEAM: Risk Assessors OSH Responsible Worker Occupational Medicine Doctor					
5	WORK PLACE										
6	1	2	3	4	5	6	7	8	9	10	11
7	COMPONENTS OF THE WORK SYSTEM	RISK FACTORS	S	P	L _r	PROPOSED MEASURES				DEADLINE	RESPONSIBLE
8						technical measures	organizational measures	sanitary measures	other measures		
9	MEANS OF PRODUCTIONS										
10											
11	WORK ENVIRONMENT										
12											
13											
14	WORK TASK										
15											
16	WORKER										
17											

Figure. 1 - Evaluation sheet

This type of sheet was created in order to help OSH specialists to quickly complete the Prevention and Protection Plan, the left side of this form contains practical elements of the prevention plan - the green part. The Prevention and Protection Plan is imposed by Law 319/2006 and more precisely, by the Methodological Norms for the application of this law, in art. 15, paragraph 2, which establish the format of this plan. It is prepared annually and can be modified at any time, taking into account the events that take place during the current year.

Below are the prevention and protection measures for the OCCUPATIONAL MEDICINE PHYSICIAN workplace, which were established following the assessment of occupational injury and illness risks using the EVA-RISK assessment method.

38 risk factors were identified for which 56 preventive measures were proposed, as follows:

- 39.29% measures for the risk factors specific to the means of production
- 35.71% measures for risk factors specific to the work environment
- 10.72% measures for the risk factors specific to the work load
- 14.28% measures for the worker's own risk factors

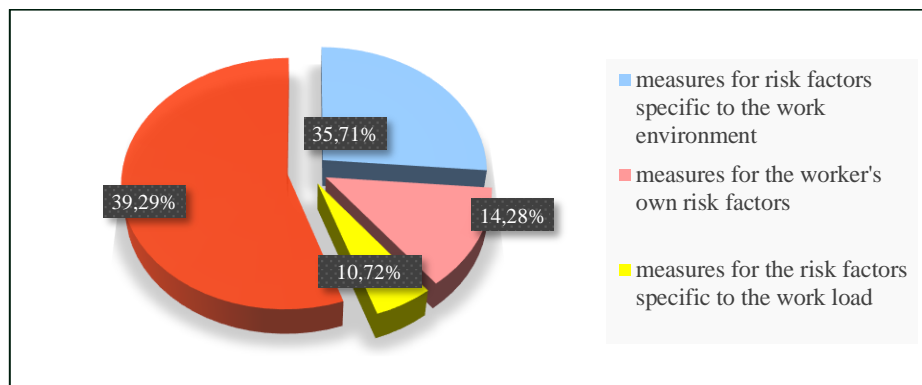


Figure 2 - Distribution of prevention and protection measures

The risk factor specific to the medical field for which most prevention and protection measures have been proposed is *Contamination with biological agents*

- *airborne, groups 2 and 3*: bacteria (*Chlamydia pneumoniae*, *Mycobacterium tuberculosis*, etc.), viruses (*Cytomegalovirus*, *Herpesvirus varicella-zoster*, etc.), fungus (*Aspergillus fumigatus*, etc.)
- *from blood and other contaminated bodily fluids group 2 and 3*: bacteria (*Streptococcus pyogenes*, *Salmonella typhi*), viruses (*Epstein-Barr virus*, *Hepatitis B virus*), parasites (*Ancylostoma duodenale*, *Echinococcus granulosus*)

The 10 prevention and protection measures necessary to mitigate/eliminate this risk are:

- correct use of personal protective equipment (mask, disposable protective gloves, etc.)
- carrying out vaccinations to prevent certain diseases
- performing medical control and supervising the health of doctors
- control regarding the way in which prevention and protection measures are respected
- the development of own security instructions regarding the establishment of biological risk prevention and control methods
- the use of special safety containers to store used hypodermic needles and scalpels until their disposal
- avoiding agglomeration of work spaces
- repeated washing of hands and other exposed skin surfaces that could come into contact with biological fluids
- the work space and the objects necessary for the activity will be regularly disinfected.

According to the legislation in force, the measures for the analyzed workplace - OCCUPATIONAL MEDICINE PHYSICIAN are presented in the Prevention and Protection Plan of the medical clinic. The plan accurately contains the measures for each risk factor, the deadline for the implementation of each measure, the persons and/or departments responsible. The plan is drawn up based on the identification and assessment of occupational risks and is finally approved by the employer, the OSH specialists and the employee representatives. Planul se întocmește pe baza identificării și evaluării riscurilor profesionale și în final este aprobat deopotrivă de angajator, specialiștii SSM și reprezentanții angajaților.

4 Conclusions and perspectives

From the considerations presented, the methods for assessing the risks of occupational injury and disease propose most of the times that the prioritization of taking preventive and protective measures should be done according to the level of risk, the risk factors with the highest level of risk have priority. In practice, employers analyse first the cost-benefit relationship for each measure and then establish the order in which the measures proposed in the evaluation are taken. According to the legislation in force, the Prevention and Protection Plan, prepared annually by the OSH specialists, contains exactly the measures that will be taken in the economic unit. The Plan is drawn up based on the identification and assessment of professional risks for each workplace and is finally approved by the employer, OSH specialists and employee representatives.

In addition to preventive and protective measures, we recommend increasing the workers ability to manage dangerous situations and emergency situations. It is also necessary to develop a safety and health culture at the workplace and to be aware of the risks to which workers are exposed through:

- organizing workshops for managers, in which will be presented practical information on how safety and health at work can be improved;
- teambuilding exercises through which people are encouraged to tell the problems they have and to propose solutions;
- increasing the degree of awareness of the dangers to which they are exposed by developing and presenting materials (e.g. posters) and thematic films that induce a state of emotion and implicitly an increase in their responsibility.

Acknowledgments:

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FEM modeling of a tooth behavior depending on mineralization state

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Abstract. The problem of mineralization of bone structures has been a subject of research and discussion for a long time due to the influence it has on the functioning of the entire human system. In practice, to improve the concentration of minerals in the bones, there are currently multiple dietary supplements that act on them. However, less research has been done on the chemical composition of teeth and how these mineral concentrations influence their behavior. The present research refers to the way in which a tooth behaves under the action of forces acting on its enamel surface. For this, the finite element method was used, which lends itself very well in this situation where, based on the specialized literature, mechanical properties and forces acting on a tooth were used as input data. Its mechanical properties, such as the modulus of elasticity, have different values for the situation of a normal tooth or a demineralized one. The article thus presents the state of tension and deformation that appears in a tooth in the two situations presented, resulting in interesting conclusions in this sense useful to a practitioner in the field of dentistry.

Keywords: *mineralization, tooth, FEM, displacement, stress*

1. Introduction

Many factors influence the strength of your tooth enamel, and demineralization and remineralization are among the many. Throughout the life, teeth are at high risk of demineralization, due to the fact that they are in direct contact daily with food, drinks and microbiota of the mouth. However the body continuously struggles to alleviate the impact of demineralization through a process called tooth mineralization.

Demineralization is a natural process and during the first stage, your teeth lose their vital minerals. When this happens, you'll notice white spots on the surface of your teeth. The minerals lost from these areas indicate the beginning of tooth decay. If tooth decay continues and you fail to take any preventive measures, there will be further damage to the enamel. Now what you'll see is white spots on the tooth turning to dark brownish color. Weakened enamel is also prone to dental cavities or caries, and the result is tiny holes in your teeth. The layer under the tooth enamel is dentin, which is softer and can more easily be damaged by the mouth acids. This means that if tooth decay reaches the dentin, it will cause rapid damage. [1] On the other hand, tooth remineralization is a natural repairing process that covers both prevention and cure of demineralization-it can be stopped or even reversed, especially in the early phase. An important role in prevention is played by saliva, diet control, probiotic bacteria and fluoride therapy. When your teeth are remineralizing, the eroded tooth enamel is being repaired, which helps prevent cavities. By definition, tooth enamel remineralization means giving the essential minerals back

to the enamel to strengthen the teeth and fight against cavities and other oral issues. Saliva plays a vital role in neutralizing the harmful acids in the mouth, providing your teeth phosphate and calcium ions to remineralize your teeth. If saliva is circulated continuously, it can help prevent the debris from accumulating and eliminates the bacteria that can produce mouth acids. When bacteria are removed, your tooth enamel can absorb the available calcium. So, a healthy supply of saliva can help remineralize your teeth. In conclusion, the processes of demineralization or mineralization of the teeth, like all bones, play an extremely important role in the general health of the human organism [2].

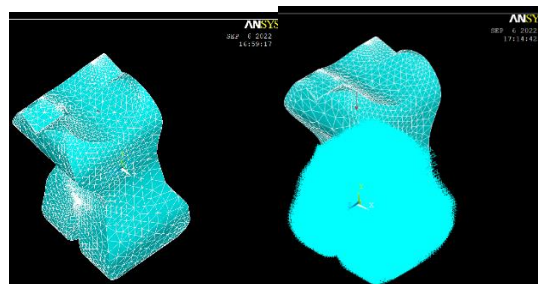
2. Finite element modeling of the behavior of a normal tooth compared to a mineralized one

2.1 Input data for FEM model of the tooth

The mineralization process that takes place throughout the human body is thus reflected, similarly, in any bone structure. In this sense, in order to verify the changes produced by the mineralization process, the behavior of a tooth in its normal structure and in the situation in which it is mineralized will be studied. In general, the mechanical properties of a mineralized tooth increase by approximately 70-80% compared to those of a normal tooth. The studies on the mechanical properties of the teeth are very numerous, as are the methods by which they were determined. Ya-Rong Zhang*, Wen Du*, Xue-Dong Zhou and Hai-Yang Yu present a well-done study in which the properties of the different areas of the tooth are presented: dentin, enamel and pulp [3]. Similarly, Paul Zaslansky, Asher A. Friesem, Steve Weiner studied the areas at the interface of dentine and enamel [4]. Methods for determining the mechanical properties of the three areas of the tooth have been well studied and realized experimentally by KJ Chun, HH Choi, and JY Lee in [6] or R. G. CRAIG, F. A. PEYTON, and D. W. JOHNSON [5]. Regarding the values of the mechanical properties in the studied articles, in the present study the values shown in table 1 were used, in which the density values calculated by Reina Tanaka, Yo Shibata, Atsufumi Manabe, Takashi Miyazaki [5] or by Reina Tanaka, Yo Shibata, Atsufumi Manabe, Takashi Miyazaki [8]. To create the mathematical model, a meshed geometry was used, which is presented in figure 1 a.

Table 1 Mechanical properties of the enamel, dentine and pulp in the studied cases (normal od mineralised tooth).

	Young modulus E	Poisson coefficient	Density [Kg/m ³]	Young modulus for minersalised tooth E
Enamel	88 [Gpa]	0.3	3000	125 [Gpa]
Dentina	19.7 [Gpa]	0.3	1840	35 [Gpa]
Pulp	2.07 [Mpa]	0.45	100	2.07 [Mpa]



a. b.

Figure 1 a - Meshed volume of the tooth; b – inputa data of the model: Force F and displacement presentation

The meshing was done using the ANSYS program with the SOLID187 discretization element, which provides as output data the displacements of the structure under the conditions of the application of a force and the stress state that develops in the body, also as a result of the application of a system of forces.

3. Case study

The present study was carried out, taking into account several variables. As previously presented, the first variable is the degree of mineralization of the tooth. The second variable is represented by the value of the forces applied to the tooth surface during the mastication process. In this sense, there are currently many researches that offer different values of the applied forces that take into account the position of the tooth, the type of food, the type of force application (gradual or with impact), etc. In his work Rosa Alicia Hernández-Vázquez, Beatriz Romero-Ángeles, Guillermo Urriolagoitia-Sosa, Juan Alejandro Vázquez-Feijoo, Ángel Javier Vázquez-López, and Guillermo Urriolagoitia Calderón study the masticatory forces applied as pressure and measured in N/m^2 [9]. At the same time, the mechanical properties of the structure of a tooth are presented, close in value to those used in this study. In the work Masticatory Force in Relation with Age in Subjects with Full Permanent Dentition: A Cross-Sectional Study [10], Ottavia Poli, Licia Manzon, Tarcisio Niglio, Evaristo Ettore and Iole Vozza do a complete analysis, by age group, of the forces which appear during mastication in both men and women. Taking into account the studied bibliography, the values of the forces acting on the tooth were defined as $F1 = 124\text{ N}$ and $F2 = 190\text{ N}$. The direction, meaning and position relative to the target surface of the studied forces are shown in figure 1b.

As a result of the mechanical analysis carried out with the help of ANSYS software, images were obtained for each loading case and for each type of tooth. Since the space of the article does not allow displaying all the images, in the following only the results obtained in the case of the action of the force $F2 = 190\text{ N}$ will be presented. In the case of the action of the force $F1 = 124\text{ N}$, the displacement results are presented in Tab.2.

Table 2 Displacement values for normal teeth in the two load cases

	Tn F=124 N	Tn F=190
Ux [mm]	0.014	0.017
Uy [mm]	0.073	0.011
Uz [mm]	0.016	0.019

Thus, figure 2 shows the displacements on OX, OY, and OZ axis in the second loading case for the normal tooth, and figure 4 shows the displacements resulting from the action of the force $F2 = 190\text{ N}$ for the mineralized tooth.

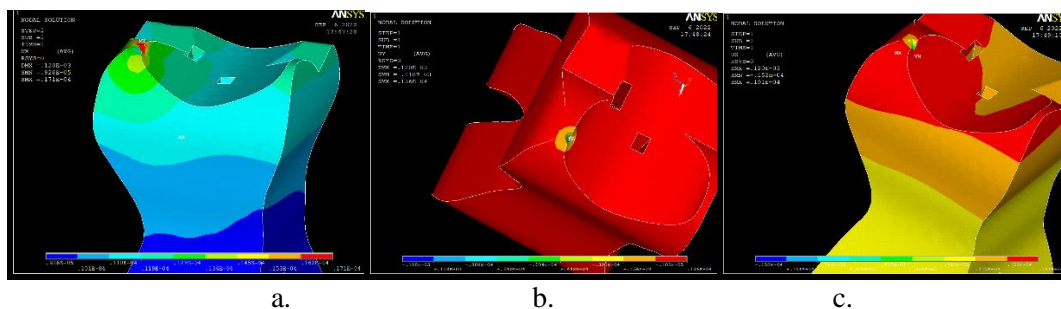


Figure 2 Displacements: a.- UX, b.- UY, c.- UZ under the action of the force $F = 190\text{ N}$ for a non-mineralized tooth

For the mineralized tooth, table 3 shows the displacements of the structure in both loading cases.

Table 3 Displacement values for mineralized teeth in the two loading cases

	Tm F=124 N	Tm F=190 N
Ux [mm]	0.012	0.014
Uy [mm]	0.036	0.061
Uz [mm]	0.013	0.015

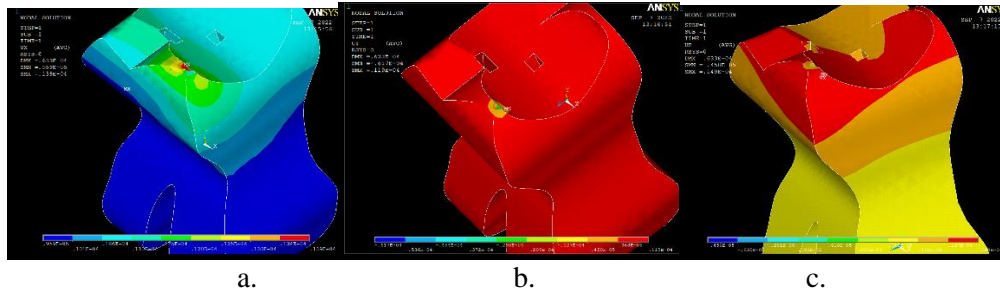


Figure 3 Displacements UX, UY, UZ for F=190 N for a mineralized tooth

As can be seen in all four situations, the tooth undergoes movements of the order of hundredths of a millimeter, noting that:

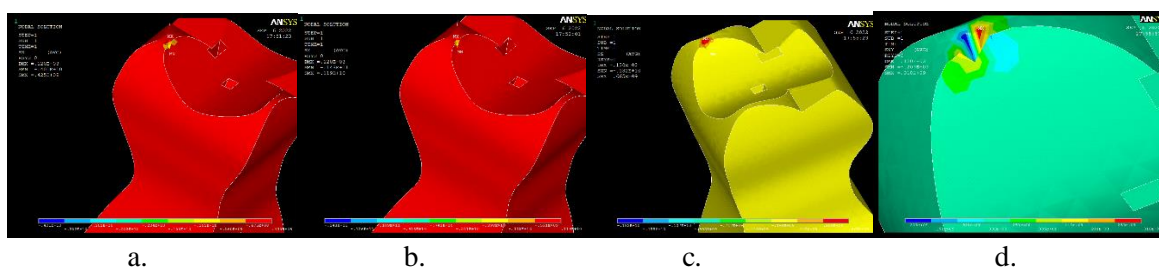
- In the case of applying force F2, the displacements are greater for both types of tooth;
- In the case of tooth mineralization, the calculated displacements are smaller than in the case of a normal tooth.

The second category of results refers to the stress map that appears in the structure of the tooth. At the present time in the theory of material resistance, the state of stress cannot be defined using a single criterion so that, in order to obtain a complete picture of the integrity of a structure, several types of stress must be analyzed such as those corresponding to the axes OX, OY, OZ, the shear stresses in the XOY, XOZ and YOX planes, such as the S1, S2, and S3 type stresses that describe the predominantly tensile stress state, the balanced stress state between extension and compression, respectively the compression stresses. In this sense, figure 5 shows the stresses S_x , S_y , S_z , S_{xy} , S_{yx} , S1, S2, S3 characteristic of the normal tooth on which the force $F_2 = 190\text{ N}$ acts, while table 3 shows the mechanical stresses that appear in both loading situations.

As can be seen, the values of the stresses that appear in the tooth structure are close to the values of the Young modulus of the dentine and being somewhat lower than the modulus of elasticity of the enamel (according to Tab. 1). This level of stress is an important one, even if the modulus of elasticity of the materials in the tooth structure is not exceeded. The stress appeared as a result of the application of a chewing force corresponding to the crushing of a crust of bread. But if this force is exceeded in other specific mastication situations, the tensions will increase and may even exceed the elasticity modules of the dentine and enamel. As a result, cracks or even cracks may appear in the tooth structure.

Table 4 Mechanical stress maximum values in the case o applied force $F_1 = 124\text{ N}$ (mastication of a meat loaf) and $F_2 = 190\text{ N}$ (mastication of crust of bread) for a normal tooth

	Tn F=124 N	Tn F=190 N
S_x [Gpa]	2.6	4.1
S_y [Gpa]	9.3	14
S_z [Gpa]	1.1	1.8
S_{xy} [Gpa]	2	0.31
S_{yz} [Gpa]	2.2	2.29
S_{xy} [Gpa]	2	0.31
S1 [Gpa]	1.06	1.63
S2 [Gpa]	2.6	4
S3 [Gpa]	9.7	19



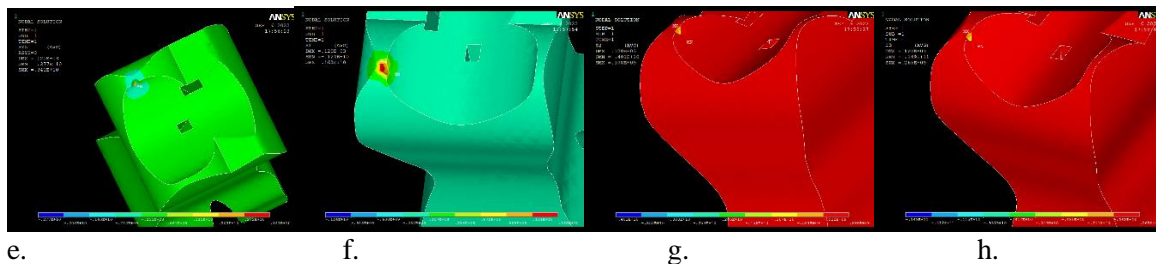


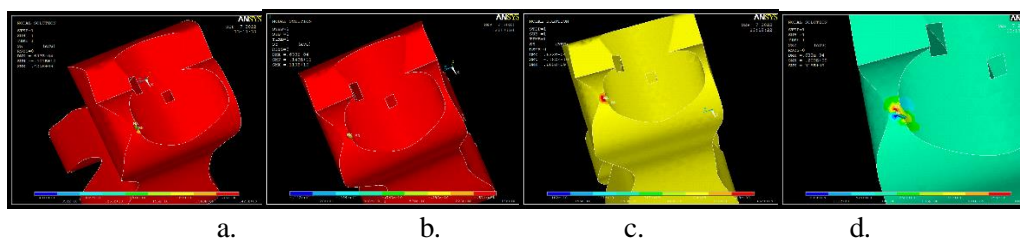
Figure 4 Stresses calculation: a - S_x , b - S_y , c - S_z , d - S_{xy} , e - S_{yx} , f - S_1 , g- S_2 , h- S_3 at $F=190$ N for a normal tooth

The mineralization of the teeth implies, as is natural, the increase of their mechanical properties. The presentation of the maximum values of the stresses that appear in the mineralized tooth in the case of loading with force $F_1 = 126$ respectively $F_2 = 190$ N that occurs when chewing a bread with a hard crust is done in table 5. As can be seen from the comparison with the stress states presented in table 3, in the case of loading with force $F_1 = 124$ N, the stresses in the tooth structure are very similar. In the case of loading with force $F_2 = 190$ N, however, a decrease in the maximum stress values is observed in the case of tooth mineralization. The decreases are not very big, but they still exist. It can be emphasized, however, the presence of important stresses, close to the value of the modulus of elasticity of the dentin, which must be taken into account. The modulus of elasticity of the enamel, being higher, shows an elastic behavior, in the case of a normal mastication process, but in the situation where the forces accidentally exceed the studied values and the integrity of the enamel is not perfect, the situation can change. Cracks or cracks may appear and the integrity of the tooth may be endangered.

Table 5 Mechanical stress maximum values in the case o applied force $F_1 = 124$ N (mastication of a meat loaf) and $F_2 = 190$ N (mastication of crust of bread) for a mineralized tooth

	Tm F=124 N	Tm F=190
S_x [Gpa]	2.6	4
S_y [Gpa]	9.3	14
S_z [Gpa]	1.2	1.8
S_{xy} [Gpa]	0.2	0.32
S_{yz} [Gpa]	2.2	3.4
S_{xy} [Gpa]	0.2	0.31
S_1 [Gpa]	1	1.6
S_2 [Gpa]	2.6	4
S_3 [Gpa]	9.7	14

Next, figure 5 shows the stress states that appear in a mineralized tooth when a concentrated force $F_2= 190$ N is applied.



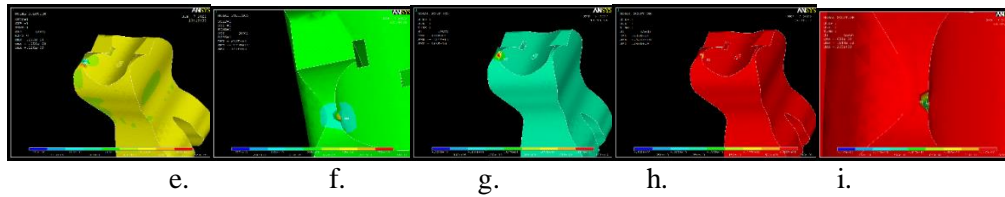


Figure 5 Type of stress: a - S_x , b - S_y , c - S_z , d - S_{xy} , e - S_{yx} , f - S_1 , g- S_2 , h- S_3 at $F=190$ N for a normal tooth

4. Conclusion

The mineralization process contributes to changing the properties of bones or teeth in the human body. In addition to other benefits that are exclusively part of the medical field, engineering can study what happens to bone structures that undergo such beneficial changes. Teeth have a relatively similar structure to that of bones and are characterized by mechanical properties that can be evaluated through mathematical engineering models. In the presented article, the behavior of a tooth was studied in the situation in which it underwent a process of additional mineralization and in the situation in which this process did not take place. As input data in the modeling and simulation software, two cases were considered in which two forces acted on the tooth, one during the mastication process of a piece of meat and a force that appears in the situation of masticating a piece of rind bread. These situations are considered normal in a mastication process and the results obtained both for the mineralized tooth and for the normal one, prove an elastic behavior, at the limit, immediately below the modulus of elasticity of the dentin or enamel.

It is important to note that in the case of a mineralized tooth, its displacements are smaller, while the state of mechanical tension, if the applied force is the highest, is lower than in the case of a normal tooth. From the point of view of mechanical stress states, it can be said that the mineralization process of a tooth makes its effect felt in the situation where the tooth is subjected to more difficult functional situations, which represents an important benefit. In normal functional situations, big differences between the two types of teeth are not felt. In order to characterize the state of mechanical stress that appears in the presented situations, figure 6 shows a graph in which:

- horizontally, the studied stress types are presented;
- vertically, the stress values

With colors are presented: TM F124, F190 – the values for the mineralized tooth on which the force acts $F=124$ N respectively 190 N; TN values corresponding to the normal tooth.

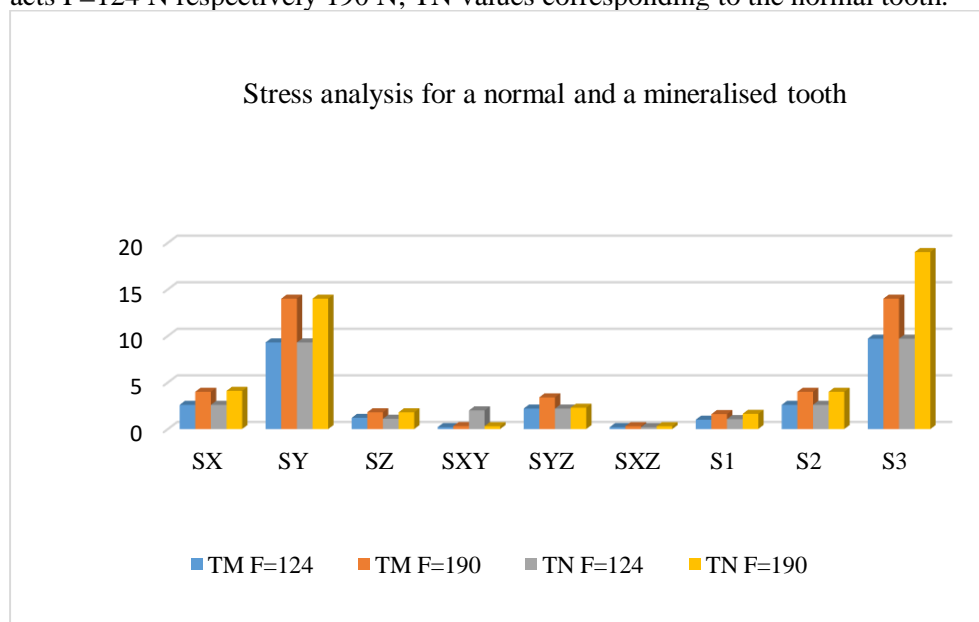


Figure 6 Stress analysis for a normal and a mineralised tooth

As can be seen, the highest values of the stresses are found in the case of the stresses on the OY axis, which is the axis on which the chewing force acts, and the S3 type stresses, which represent the compression stresses, the force representing a compression on the tooth. In general, the stresses corresponding to the TM mineralized tooth are lower than in the case of the normal tooth. The smallest stresses are the shear stresses in the XOZ plane, so the rotation of the teeth in this plane cannot produce important effects.

In conclusion, it can be said that the mineralization process is beneficial to the structure of the teeth, their resistance being observed especially at higher, potentially critical forces that may appear in the mastication process.

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- [7] Mineralization Potential of Polarized Dental Enamel Reina Tanaka¹, Yo Shibata^{1*}, Atsufumi Manabe², Takashi Miyazaki¹ ¹Department of Oral Biomaterials and Technology, Showa University School of Dentistry, Tokyo, Japan, ²Division of Aesthetic Dentistry, Showa University School of Dentistry, Tokyo, Japan <https://click.endnote.com/viewer?doi=10.1371%2Fjournal.pone.0005986>
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Business continuity framework in a COVID-19 pandemic. A case of the Zimbabwe Health Insurance Industry

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Abstract.

In today's volatile, uncertain, complex and ambiguous environment, business continuity is frequently threatened in various organizations. The emergence of the COVID-19 pandemic has triggered lifestyle changes economically, socially and businesswise. Due to restrictions and prohibitions implemented by governments, companies were forced to close down physical operations to curb the spread of the virus. The pandemic affected organizations in terms of sales revenue especially those that are still using the brick and mortar business model, thus Zimbabwean companies have not been spared from the devastating effects of the COVID-19 pandemic. This is evidenced by 88% of employees within the ZHII, who agreed that the pandemic affected membership growth due to non-payment of subscriptions by individual members, hence reducing the monthly sales revenue. Thus, it is important for companies to be prepared and adapt to such disruptive market challenges as the COVID-19 pandemic. The study explores the effects of disruptive market challenges towards business continuity with the COVID-19 pandemic as a case. A mixed method approach was adopted to assess the impacts of disruptive market challenges towards company survival. Data was collected through questionnaires and structured interviews. A sample of 65 respondents from companies within the Zimbabwe Health Insurance Industry was used. The study revealed that Innovation and business continuity planning plays a critical role in enhancing business continuity during market disruptions, as companies will be proactive rather than reactive. A business continuity-planning framework is introduced to help companies in ensuring continual business operations during disruptive market challenges.

Keywords: *COVID-19 pandemic, Business Continuity Management, Zimbabwe Health Insurance Industry, Disruptive market challenges, Innovation Continuity Planning, Business Continuity Planning*

1.0 Introduction

Market disruptions such as natural disasters, pandemics and artificial disruptions etc. affect company performance in terms of revenue generation and stakeholder value creation, thus threatening the business continuity of a company (Heikkila, et al., 2018; Schmid, et al., 2021). The emergence of the COVID-19 pandemic resulted in companies facing major financial and operational challenges in continuing their business hence calling for them to slim down or shut down their operations (Schmid, et al., 2021). Though (Schmid, et al., 2021) focused on Kenyan companies, Zimbabwean companies have not been spared by the pandemic as evidenced by the high rate of retrenchments among companies

between 2020 and 2021 especially within the banking industry (Marawanyika, 2021). In Zimbabwe, the first COVID-19 case was confirmed on 20 March 2020. On 31 March 2020, the Zimbabwean government implemented restrictions with severe noncompliance penalties. After waves of easing and tightening restrictions, multiple restrictions remained towards the end of 2020, 2021 and recently depending on the severity of the current cases and nature of the new variants, such as the current national curfew (12am-5.30am). As of 17 March 2022, the global statistics of confirmed cases and deaths is **462,758,117** and **6,056,725** respectively (WHO, 2022).

Most companies are affected as they are losing their key employees to the pandemic. Business continuity is threatened due to various prohibitions and restrictions put in place to curb the spread of the various, thus adversely affecting production and service delivery processes. Following the rapid spread of the COVID-19 pandemic, the restrictions and prohibitions has negatively affected productivity and service delivery within organisations. Constant total national lockdowns and travel restriction have forced the business world to switch to a remote working model (İrkey & Tüfekci, 2021), hence going digital is the only solution for business continuity. During this fast-developing period, companies that did not have a business continuity plan have suffered business and financial losses hence the importance of business continuity and knowledge management in predicting unforeseen circumstances such as pandemics and disasters (İrkey & Tüfekci, 2021).

Past disruptions and the recent effects of the COVID pandemic are forcing companies to secure ways of maintaining their operations and remain resilient (Heinonen & Strandvik, 2020; Schmid, et al., 2021). Companies within the Zimbabwean Health Insurance Industry (ZHII) core business is offering medical aid services to the public through member registration, claims processing and handling member queries. These companies have not been spared from the effects of the COVID-19 pandemic, as they had to constantly shut down operations during the total lockdown periods. This affected service delivery as members could not access services given the most companies within the ZHII mainly concentrates on the brick and mortar business model. Members could not be able to pay their subscriptions due on time, thus a number of memberships lapsed hence affecting the companies' revenue and membership.

Given the already volatile, uncertain, complex and ambiguous environment (VUCA) which Zimbabwean companies are operating in, a strategic managerial thinking and response to the effect of the COVID-19 pandemic is therefore required to ensure business continuity. The emergence of pandemics such as the COVID-19 pandemic stimulated unexpected attentiveness in innovation to enhance business continuity globally, nationally or at organisational level (Heinonen & Strandvik, 2020). Companies should focus on the effects of any disruption on organisational performance rather than the cause itself and have contingent plans (Kiniger-Passigli, et al., 2011). These include efforts to encourage, initiate and organize innovations further than those already planned and implemented, hence the emergence of imposed service innovations (Heinonen & Strandvik, 2020). Companies should remain proactive concerning future unforeseen market disruptions, hence the need for business continuity planning.

The paper is based on the link between pandemics and business continuity. An analysis of the impacts of disruptive market challenges towards business continuity will be undertaken. Innovative solutions to address or counter the effects of the business challenges brought by pandemics with the COVID-19 pandemic, as a case will be identified. A business/ Innovation Continuity Plan framework will be developed that will assist companies within the Zimbabwe Health Insurance Industry (ZHII) to deal with the effects of the COVID-19 pandemic and other future unforeseen market disruptions that will affect business performance. The suggested innovative solutions act as attempts to continue service delivery, retain customers and create customer value in changing conditions for success and strategic reorientation in response to disruptive market challenges (Heinonen & Strandvik, 2020).

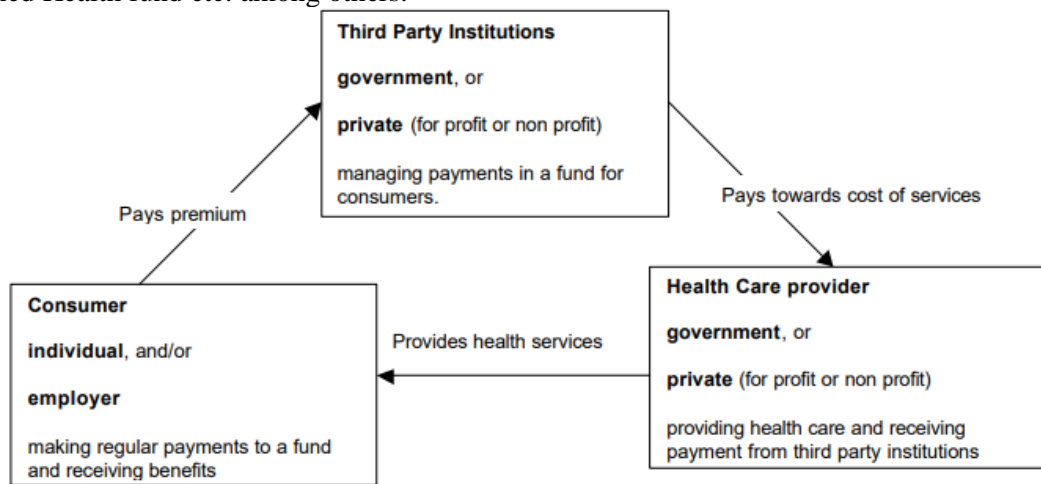
2.0 Literature Review

2.1 Health Insurance Industry

Health insurance is a contractual agreement between the insurer and the insured requiring the insurer to cover the insured's healthcare costs in exchange of a monthly premium (Kagan & Catalano, 2022).

Health insurance companies pool risks across their members and pay part of or all health-care expenses for their defined population of members from premiums contributed by individuals or employers (Faden, et al (2011). Fig 2.1 below is the health insurance process adapted from (Conn & Walford, 1998) known as the traditional medical aid concept.

Although the framework below backdates to 1998, nothing has really changed as most companies within the ZHII still use the traditional medical aid concept. This is whereby members contribute their monthly subscriptions and during an unforeseen circumstance, they can acquire health care service at no cost or at a core payment or shortfall whilst the Insurer pays the greater part of the amount to the healthcare service provider. The Zimbabwe Health Insurance Industry is gradually growing as it now has more than ten players offering medical aid services countrywide. These companies include PSMAS, CIMAS, FMH, Cellmed Health Medical Fund, Bonvie Medical Aid Scheme, Fidelity Life Medical Aid Society, Agrimed, Generation Health, Corporate 24 Medical Aid, Alliance Health, Investmed Health fund etc. among others.



Source: Adapted from Conn & Walford (1998)

Fig 2.1. The health Insurance Process

2.2 Business Continuity (BC)

Business continuity efforts have existed historically, referring to organization's efforts to ensure the continuity of their service or product delivery in the face of disruptions (Schmid, et al., 2021). According to (Kiniger-Passigli, et al., 2011), “Business continuity is about keeping key business activities on-going after an adverse event, with the human, material and resources available at the time.” It is defined by (Schmid, et al., 2021) as, “the capability of an organization to continue the delivery of products and services within acceptable time frames at predefined capacity during a disruption.” (İrkey & Tüfekci, 2021), defined business continuity as the process of creating prevention and recovery systems to deal with potential threats to an organization. These threats can be manmade or natural, from simple power outages to fluctuations within economies, as well as pandemics and natural disasters (Schmid, et al., 2021). These authors have different views towards business continuity as (Kiniger-Passigli, et al., 2011) focused on reactive measures whilst (Schmid, et al., 2021) and (İrkey & Tüfekci, 2021) concentrated on proactive measures. However, both being reactive and proactive to unforeseen risk forms the basis of business continuity. According to Herbane, (2010) as cited by (Heikkila, et al., 2018), early literature on business continuity were mainly about disaster recovery. This meant that companies mainly focused on reactive measures after an unforeseen business challenge, however due to environmental changes, business continuity also focuses on preventive and preparedness measures.

2.3 How disruptive market challenges affect business continuity

Disasters and pandemics are inevitable and they adversely affect quality, quantity and availability of resources within a company among other things (Schmid, et al., 2021). For example, during the Cyclone Idai of 2019 most companies and schools in the Chimanimani District in Zimbabwe lost their buildings, key employees and students to the violent storms. This affected business continuity as business operations had to close down since infrastructure were destroyed; schools had to start rebuilding classroom blocks etc (Chatiza, 2019;IFRC, 2019). Global epidemic crises, such as the coronavirus (COVID-19), usually expose small and medium enterprises (SMEs) to various kinds of challenges and may put their lives at risk (Adam & Alarifi, 2021). However, with the case of the COVID-19 pandemic, even huge companies especially in Africa also suffered from the effects of the pandemic.

Disruptive market challenges also result in operational losses which disruptions do not only create immediate loss but also, when prolonged, hinder the attainment of company strategic goals (Heikkila, et al., 2018). According to (Kiniger-Passigli, et al., 2011), these disasters results in loss of both hard and soft assets. Hard assets are the tangible assets such as property, plant and equipment whilst soft assets are the intangible assets that include skills, intellectual capital, and even the brand reputation of a company. Damages to both hard and soft assets eventually result in financial losses for organisations (Kiniger-Passigli, et al., 2011). Business Continuity therefore seeks to ensure that resources and processes are resilient to enable them to continue even in the wake of adverse events, and restore promptly when disrupted (Heikkila, et al., 2018;Heinonen & Strandvik, 2020). Threats and disruptions result in revenue losses and higher costs, which leads to a decline in profitability (Kenton, 2021).

Organizations faced major financial and operational challenges to continue their business, requiring them to downsize or shut down their operations or workforce. (Schmid, et al., 2021). During this fast-developing period, companies that do not have a business continuity plan suffered business and financial losses, as they had to close operations until further notice (İrkey & Tüfekci, 2021). Only essential services, which were mainly healthcare service providers and retail outlets, operated with limited operating times. These events showed the importance of business continuity planning and knowledge management (İrkey & Tüfekci, 2021). Companies should therefore employ business continuity strategies to enhance continued operations during these unforeseen market disruptions, thus business continuity management is crucial.

2.4 Business Continuity Management (BCM)

“BCM is a management process which is practiced to counteract the negative impacts of possible threats on the continuity of organisational activities.” (Kiniger-Passigli, et al., 2011). According to (Schmid, et al., 2021) , it is a set of risk management strategies and process aimed at counteracting the various effects of disruptive marketing challenges towards companies. It focuses mainly on those risks that threaten the continuity of critical business activities. In this case, of the COVID-19 pandemic within the ZHII, critical business activities include service delivery, that is, regardless of the situation within the country, members should still have access to their medical aid services, and timeous processing of claims. Members should also be able to pay their subscriptions on time. With a futuristic and preparedness perspective, effective lessons from the COVID-19 pandemic should be implemented (Schmid, et al., 2021).

The ultimate goal of BCM is to create an organisation’s resilience, ensure service delivery regardless of an external shock having damaged assets, and prohibit access to essential resources as posited by (Kiniger-Passigli, et al., 2011). Business Continuity Management therefore reduces direct and indirect economic losses that may arise from a disruptive market challenge and the consequent business disruption (Schmid, et al., 2021). Fig 2 below shows the business continuity management framework by (Kiniger-Passigli, et al., 2011).

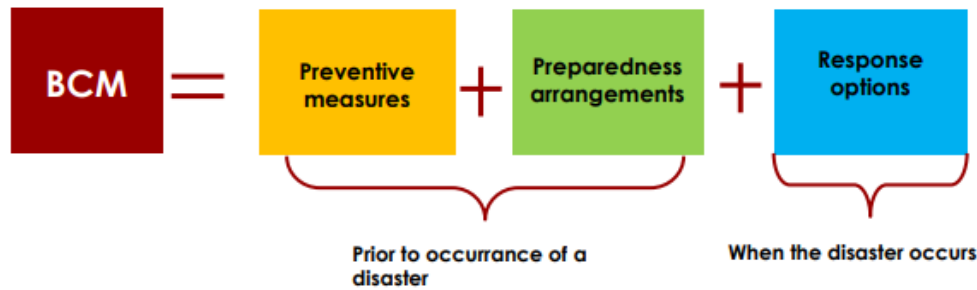


Fig 2: Business Continuity Management Framework.
Source. Adapted from Kiniger-Passigli et al (2011)

As shown on fig 2 above, BCM comprise of preventive measures as well as preparedness arrangements and response options (Kiniger-Passigli, et al., 2011). This is in line with this study as the study aims at deriving a business continuity plan, which enhances service delivery during disruptive market challenges. Preventive measures reduce the likelihood of a risk and preparedness arrangements enables a company to be pro-active in case the anticipated risks realise, hence damages or losses can be controlled or minimized. Response options are the reactive measures after the occurrence of disruptive market challenges (Kiniger-Passigli, et al., 2011), whilst preventive measures enable organisations to be proactive thus remaining resilient (Poto, 2019).

The key challenges of pandemic business continuity are the low perceived likelihood of its occurrence and the uncertainties in planning and response, especially for small and medium-sized enterprises (Schmid, et al., 2021). However, given how unexpected the COVID-19 pandemic shook economies globally and how it affected business operations, it is now of vital importance for companies to have contingent plans against such unforeseen incidents (Gustafsson, et al., 2020;Heinonen & Strandvik, 2020). Over the years from 2020, the virus is constantly changing its severity and new variants are being discovered e.g. the Delta Variant and the Omicron Variant. These variants are frequently causing global shocks as evidenced by the discovery of the Omicron variant in December 2021, which caused the UK to close its borders, and the whole globe followed suit. It is upon this background that the Industry should be prepared for such incidents. The question is, “what if another strong variant comes or a different pandemic hits the world, what are we going to do?” thus business continuity planning.

2.5 Business Continuity Planning (BCP)

‘Historic disruptions and the current impacts of the COVID-19 pandemic have driven organizations to seek tools to maintain their operations and ensure their resilience’ (Schmid, et al., 2021). Thus, business continuity planning is essential in dealing with such disruptions. According to (Schmid, et al., 2021) traditionally, business continuity developments on pandemic scenarios were not considered except for the healthcare sector (Hospitals, Labs etc.) and essential service providers. Limited guidance existed for businesses before the COVID-19 pandemic, thus this study is of great significance as it will assist companies in all sectors in having proactive measures against all risks both anticipated and unanticipated.

Poto (2019) defined a business continuity plan (BCP) as a document consisting of crucial data of the company to continue functioning through an unexpected incident. According to www.kyndryl.com (2022) and www.ibm.com (2020), it is a document outlining how a business will continue operating during an unplanned disruption in service. (TechTarget, 2021) posits that the BCP takes into consideration various unpredictable events such as natural disasters , fires, disease outbreaks and other external threats. Thus pandemics should not be spared in business continuity planning. According to

Capgemini Consulting (2016) as cited by (Poto, 2019), “furthermore, a business continuity plan is a pre-emptive blueprint that avoids and lessens disaster risk linked to an interruption of the business’s functions.” This is therefore a significant pillar of business continuity management. “Businesses are prone to a host of disasters that vary in degree from minor to catastrophic, thus BCP help companies to continue operating in the event of major disasters.” (Kenton, 2021). BCP enables companies to identify and address resiliency synchronization between processes, applications and infrastructure, thus enabling them to withstand and thrive during many threats www.ibm.com (2020)

Fig 2.3 below adopted from Allianz Global Corporate and Specialty (AGCS, 2021) shows the steps in business continuity planning.



Fig 3: Steps in business continuity planning.

Source. (AGCS, 2021)

According to the AGCS on fig 3 above, a BCP should comprise of the following key steps:

- Steering a business impact analysis (BIA) that forecasts the consequences of disruptions to business operations.
- Risk assessments, by describing possible disasters or exposures and their business impacts.
- Launching recovery point objectives (RPOs) which entail up to what point in time the business process' recovery can proceed.
- Establishing recovery time objectives (RTOs) which define the amount of time taken to recover after the warning of the business process disturbance and the exercising and maintenance time required to test the plan against different scenarios and adjust.

2.6 Strategies to deal with the effects of disruptive market challenges for business continuity.

According to various authors, technological innovations and business continuity management are the main strategies to deal with challenges brought by disruptive market challenges. (Heinonen & Strandvik, 2020), posited that to ensure survival during disruptive market challenges, public and private organizations need to have business collaborations, implement marketing research to understand the changing customer contexts and develop the agility of the organizations' capabilities and network of partners.

The emergence of the COVID-19 pandemic was an opportunity for companies to embrace innovation and digital technologies (Ali, et al., 2020; Gorzelany-Dziadkowiec, 2021). According to Schumpeter 1960 as cited by (Gorzelany-Dziadkowiec, 2021), innovation is defined as, “the introduction of a new

product, production method, opening a new market, access to a new source of materials, and reorganisation of an industry.” The pandemic prompted companies to adopt to remote working models, online service delivery became rampant for business continuity (Heinonen & Strandvik, 2020; Schmid, et al., 2021). Thus, it was an opportunity for companies to shift from the brick and mortar business model to the brick and click business model. Pandemics inspires new directions and approaches to innovation, which might actually be beneficial even after the disruptive market challenges as posted by (Heinonen & Strandvik, 2020). Innovation has become a necessity for all contemporary enterprises that want to survive in a world characterized by competition, technological change, and recurring crises (Adam & Alarifi, 2021). Management therefore need to embrace the changes brought by the COVID-19 pandemic as an opportunity to become more innovative and creative while remaining resilient amidst disruptive market challenges. According to (Baregheh, et al., 2009), organisations had to innovate in response to evolving customer expectations, lifestyles, changing technologies, markets and structures. The emergence of the COVID-19 triggered lifestyle changes and adaptations to technologies thus innovation and business continuity planning are the only solutions to enhance business continuity. COVID-19 has forced countries into lockdown while imposing inconvenience in the corporate and medical sectors, the tourism sector, and almost all industries (Ali, et al., 2020).

Significant technological changes were driven by disasters and outbreaks of infectious diseases hence the tremendous technological changes today (Gorzelany-Dziadkowiec, 2021). The COVID-19 emergency has urged companies to operate in new ways to face supply chain interruptions, shifts in customer demand, and risks to workforce health (Margherita & Heikkila, 2021). For example, due to the frequent lockdowns, companies adopted the remote working model hence they had to purchase laptops and other tools of trade for their employees. Companies now use computer-based application tools like teams, zoom and google meet among others, which were not popular before the pandemic. From 2020, most companies have reduced rental and travelling costs as employees are still working from home thus benefiting the companies. (Heinonen & Strandvik, 2020), introduced the concept of imposed service innovations which they defined as actions for resilience and renewal, rather than differentiation and growth during severe disruptions. According to (Gorzelany-Dziadkowiec, 2021), as a response to a crisis, innovation can significantly contribute to adaptability as she posited that; “in the time of the COVID-19 pandemic, stronger innovation can be a success driver after the crisis. Although her focus was on the aftermath of the crisis, innovation is still a success driver even during the peak of the crisis as it enables critical business operations to function amidst the pandemic or disaster.

The organizational ability to respond to critical contingencies is crucial for business leaders in the perspective of continuing business (Margherita & Heikkila, 2021). The COVID-19 pandemic revealed flaws in corporate business continuity and disaster recovery plans, as well as specific pandemic plans (TechTarget, 2021). BCM addresses the effects of disruptive market challenges by reducing the identified weaknesses, mitigating their impact, and bringing the situation back to normal as soon as possible after an adverse event (Kiniger-Passigli, et al., 2011). The Covid-19 global pandemic highlights the importance of business continuity planning for current and future operational disruptions (AGCS, 2021). Effective continuity management, robust planning and risk assessments assist organizations in adapting to unforeseen circumstances. Furthermore, handling a crisis in a successful manner with minimized losses and delivery delays will certainly contribute to enhance the reputation of the firm and the confidence of its customers as posited by (Kiniger-Passigli, et al., 2011).

2.7 Conceptual Framework

The study is based on the effects of pandemics towards business continuity. It focuses on the analysis of the impact of disruptive market challenges towards business continuity. The study will determine innovative ways that pose as a solution to the business challenges brought by pandemics with the COVID-19 pandemic as a case. A business/ Innovation Continuity Plan framework has been developed that will assist companies within the Zimbabwe Health Insurance Industry to deal with the effects of the COVID-19 pandemic and other future unforeseen market disruptions which will affect business

performance. The variables under study are pandemics and business continuity. There is a relationship between these variables. The COVID-19 pandemic is the independent variable, which has an impact on business continuity that is the dependent variable. The effects of pandemics trigger companies to become innovative and creative thus enhancing business continuity. The effects of pandemics negatively affect business continuity whilst service innovations pose as a solution to enhance business continuity during disruptive market challenges.

The objective of this study is to produce a business continuity plan, which incorporates service innovations (mainly imposed service innovations) as ways of being proactive and reactive to disruptive market challenges. The COVID-19 pandemic and more disasters to come pose as opportunities for companies to continuously innovate in a bid to adapt to the changes brought by the disruptive market challenges (Gorzalany-Dziadkowiec, 2021) hence Innovation Continuity Planning.

Schmid, et al (2021) below provides a framework for business continuity management that integrates the various steps in BCM and BCP. Therefore, a comprehensive framework will form the basis of this study.



Fig 4 Conceptual Framework

Source: Adapted from Schmid, et al (2021)

Schmid, et al (2021), split the BCM components into three levels namely the strategic responsibilities, tactical responsibilities and operational responsibilities. Strategic responsibilities are managed at executive level and these include leadership, policy, and scope, tactical responsibilities are addressed at director level and these include governance, performance evaluations etc. and lastly the operational responsibilities, which are implemented by risk or business continuity managers. This implies that business continuity planning entails involvement of all organisational levels as posited by (AGCS, 2021).

Since the study aimed at developing a BC innovation plan, the focus was mainly on the operational level responsibilities. These operational level responsibilities by (Schmid, et al., 2021) are actually business continuity planning steps according to (AGCS, 2021). Schmid, et al (2021), also included the Koonin’s 4C pandemic business continuity framework, which are continuity, customer, crew and community. Continuity are the measures, which prioritises critical services during a pandemic and backups of essential supportive resources. Customer referred to alternative service delivery apart from the existing service delivery hence agreeing with (Heinonen & Strandvik, 2020) on the need for imposed service innovations during pandemics, this is in relation to reduction of physical contact and potential communication channels. Crew includes all hygiene and distancing measures to keep both staff and members safe, dealing with sick employees or internal cases, encouragement of protective behaviours and communication plans. Lastly, community includes availability of resources, business collaborations, and identifying and following guidance from credible local and international health

authorities (Schmid, et al., 2021). This study will incorporate the 4C’s into the business continuity plan, as they are the elements, which pose as solutions to the effects of the pandemic and enhances preparedness.

The steps in continuity planning will be supported by (Rise, 2021) who provided a framework for Innovation Continuity Planning below. An innovation continuity plan is “The process of developing and executing strategies to address potential business opportunities that occur during a disaster (Rise, 2021). This does not only ensure company survival, but also continues to create new values during and after the disaster. Hence, it is important to incorporate innovation continuity planning in business continuity planning as both focuses on enhancing business continuity whilst the latter emphasises on innovation and creativity in enhancing business continuity.

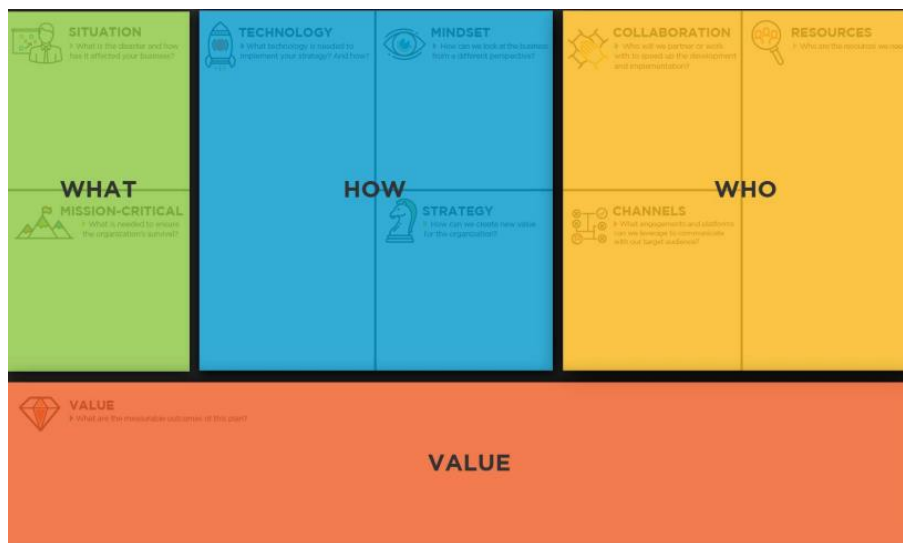


Fig 5 Innovation Continuity Plan framework.

Source. Adapted from Rise (2021)

2.8 Proposed study Framework

Below is the proposed conceptual framework developed for this study. It is a summary of the business continuity management framework by (Schmid, et al., 2021) and the innovation continuity planning framework by (Rise, 2021) explained above. According to the Author, in todays world where technology and innovation takes the lead, Business Continuity Management should also constitute of Innovation Continuity Planning.

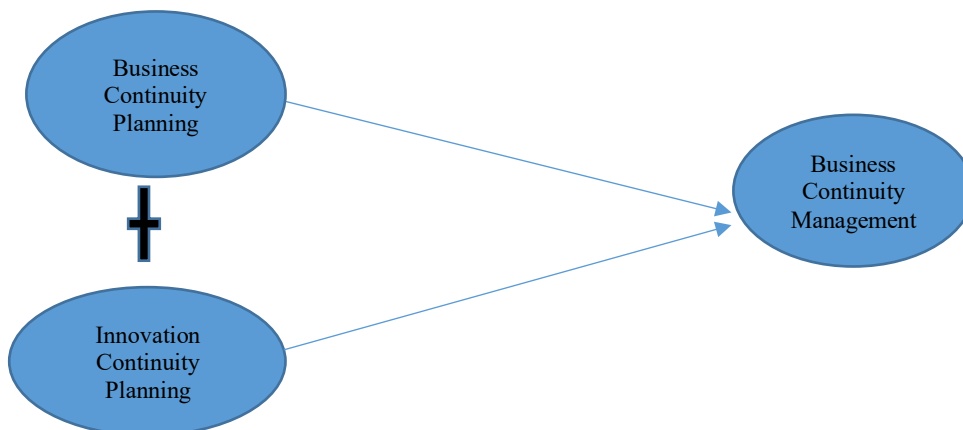


Fig. 6 Conceptual framework

3.0 Methodology

The study adopted a pragmatism philosophy, which makes use of both quantitative and qualitative methods. A mixed method approach was used. As part of qualitative research, structured interviews and document analysis were conducted; a descriptive survey was used for quantitative data collection. Document analysis as part of secondary research were print and electronic documents forms part of literature. In this study, these included journals, newspapers and company newsletters. It is a qualitative research method as according to (Saunders, et al., 2019), as it required data to be examined and interpreted to gain understanding, elicit meaning and develop empirical evidence. A review of prior literature in relation to the study was undertaken and data obtained was incorporated into the study. As part of quantitative data collection, online questionnaires were distributed to respondents and each respondent had an equal chance of clicking the link. A sample population of 65 respondents within the ZHII was used for the study. Structured interviews were conducted to management while questionnaires were send to employees and members. Closed ended questionnaires were asked to allow respondents to indicate their views on the impact of COVID-19 towards business continuity.

3.1 Discussions of results and conclusions

This study produced a business continuity-planning framework for the ZHII. The industry can adopt the framework to remain resilient during disruptive market challenges such as the COVID-19 pandemic. According to research findings from both literature review and data collection, disruptive market challenges result in service delivery disruptions, financial and operational losses (Schmid, et al., 2021; Irkey & Tüfekci, 2021). Accordign to study findings from management 88% of the employees within the ZHII attested that their respective companies suffered financial losses due to non payment of subcritptions due by individual members during the peak of the pandemic. This resulted in the lapsing of memberships hence the membership growth and revenue generation was adversely affected. Service delivery was disrupted as 100% of employees within the ZHII agreed that their respective companies did not have online platforms were members could submit their calims and invoices for refunds and advance payments respectively. This was also supported by 48% of members who attested that they were not able to submit their claims online whilst the rest of the members were neutral, implying that they were unaware given they did not have any claims to submit. Although these companies adopted the remote working model and shift working, claims processing and payments were delayed as staff members were overwhelmed as evidenced by 89% of employees and 52% of members who agreed that the timeous processing and payment of claims was affected by the COVID-19 pandemic. The research findings shows that business continuity planning and innovation plays an important role in ensuring company survival during disruptive market challenges as posited by (Kiniger-Passigli, et al., 2011)and (Gorzelany-Dziadkowiec, 2021). According to the research findings, on average, 89% of employees who responded to questionnaires agreed that business continuity planning and innovation are the best strategies to enhance business continuity during disruptive market challenges.

In summary, most companies within the Zimbabwe Health Insurance Industry did not have proper business continuity plans when the pandemic struck, thus most of their business activities were adversely affected. 50% of employees within various companies were not even aware of business continuity management processes within their respective organisations depicting that these companies did not involve employees in business continuity management and they failed to communicate their business continuity plans.

Basing on research findings, staff training and development and business collaborations are important elements to ensure success of business continuity and innovation plans within organisations. The developed business continuity-planning framework will assist companies within the ZHII to be proactive against disruptive market challenges as they have proper guidelines to follow through. During the course of the research study, the researcher discovered that some companies within the ZHII had business continuity plans in place, but they failed to implement them, thus they suffered from the effects of the pandemic. For future studies, the author therefore recommends a study on the implementation of business plans during disruptive market challenges.

Proposed Business Continuity planning framework

BCP ELEMENT	RESPONSIBLE UNIT	TIMELINES	PROCEDURE
Business Impact Analysis	All functional Units	Yearly basis	<ul style="list-style-type: none"> ✓ Defining company core business ✓ Identification of company critical business functions. ✓ Customer journey mapping ✓ Mapping departmental interdependencies ✓ Assessing potential business continuity events ✓ Identification of key recovery priorities ✓ Identifying key resources needed to enhance business continuity
Risk Assessment	All functional units in liaison with Risk Management	Yearly basis	<ul style="list-style-type: none"> ✓ Identification of potential threats that are likely to disrupt continued business operations within the organisations ✓ Identification of sources of disruption risk e.g. internal or external, local, regional or global. ✓ Defining the threats and vulnerabilities ✓ Establishing the likelihood and impacts of the threats ✓ Scenario Analysis which forms the basis of strategies that enhances business continuity and innovation
Business Continuity and recovery plans	All functional Units	Yearly basis	<ul style="list-style-type: none"> ✓ Establishment of continuity steps ✓ Establishment of downtime procedures and recovery time objectives ✓ Provision of a service delivery recovery guide during a disruptive market challenge this includes preventive measures, preparedness arrangements and response actions ✓ Provision of a standardised procedure manual for managing disruptive market challenges both at departmental level and at corporate level ✓ Development of continuity solutions incorporating service and technological Innovations
Resilience Strategy	All functional Units	Yearly basis	<ul style="list-style-type: none"> ✓ Identification of strategies to recover key business functions. ✓ Determining how the situation can be stabilized and ensuring continual of core business operations ✓ Identification of innovations that ensure continued business operations regardless of the nature of disruptive market challenge
Awareness, Training and Development	Human Capital Department	Yearly basis	<ul style="list-style-type: none"> ✓ Identification of potential business collaborations to facilitate staff training to maintain an all level awareness, understanding and involvement of employees in business continuity preparations and execution of plans. ✓ Identification of employee training needs ✓ Ensuring culture transformation trainings are executed.
Testing and Exercising	BCM committee (Representatives various functional units), ICT	Yearly basis	<ul style="list-style-type: none"> ✓ Testing reliability and sustainability of recovery strategies ✓ Continuous improvement of identified recovery strategies ✓ Resource auditing, ensuring available resources and infrastructure meet the recovery needs
Monitoring and Evaluation	Executive Team, Risk anagement, BCM committee	Yearly basis or during and after a potential threat/risk	<ul style="list-style-type: none"> ✓ Facilitating of response actions when a non-conformity arises ✓ Ensuring all business continuity programs are fully executed ✓ Ensuring BCP remains the most effective strategy for managing disruptive market challenges. ✓ Measuring the planned recovery strategies versus the executed

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Digital Technologies and Sustainability – identified synergies, challenges and anticipated impact on the transportation business segment

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Abstract. Under increasing pressure to decarbonize, in order to stay compliant and competitive, transportation industry is actively looking for the right next steps and actions. The main challenge is to become greener in an effective way that ensures the business performance. Technology and digital solutions, from electrification to artificial intelligence, help to accelerate the transition towards sustainability. However, they currently come with a significant share of risks mainly due to the still weak infrastructure and the unprepared workforce which could generate an inefficient usage of digital technologies. In this complex environment and lacking reliable data and benchmark to guide their next moves, the fleets have to make their decisions concerning suppliers, partners or tools. While the direction is clear, it's critical now for the transportation players to speed up into the execution of decarbonization. This will allow them to take business advantages as early movers, and to deal on the way with operational aspects in order to secure their productivity. Starting from the today's landscape of the industry, this article highlights the outputs of existing researches, aiming to provide a structured frame of the key inquiries and to identify possible paths for fleets, on their journey towards sustainability.

Keywords: *transportation, fleet, decarbonization, technology, digital, solutions, electrification*

Introduction

In the current context, when pursuing sustainability became a real need for preserving planet and life for the future generations, it started to be very clear that mobility will play one of the key roles in this process. Actively pushing in that direction, European Commission is seeking to have at least 30 million electric vehicles on the roads by the end of this decade, seeing electrification as one of the main ways to reach a more sustainable mobility. Referring to the transportation segment, the truck and bus category is also under heavy scrutiny, as the European Union established as target a reduction of average CO₂ emissions from new heavy-duty trucks by 15% in 2025 and by 30% in 2030. The plan is to stimulate zero and low carbon emissions vehicles and to request extra fees for the polluting ones. There is clear evidence of the increasing pressure to have more sustainable options when we talk about transportation, no matter that is for business or for personal travelling. This evolution towards new solutions for a more sustainable mobility is linked to the digital transformation and technology. The question is how digitalization can accelerate the transformation of various transportation categories (for goods and people) under the urge of a very tight timeline. Society, businesses and policy-makers need to put together various types of resources such as human and financial ones, technical tools, and supporting regulations. The objective is to enhance so called *twin transition* (green and digital), to obtain a positive impact of the transportation industry, a key player in mobility.

Synopsis of the main latest digital technologies to boost sustainability

Linked to the Electric Vehicles (EV) predicted switch, the transportation industry is actively seeking for complementary solutions to reduce its carbon emissions, such as fast-charging infrastructure and hydrogen fuel cells. A future eco-friendly transportation would require an adapted infrastructure to reduce the downtime and meet customer's needs. Fuel Cell Electric Vehicles (FCEV) are seen as the next big thing in the whole transportation market. Especially when talking about the trucks, the experts anticipate a significant growth of FCEV in the second half of this decade. On top of reducing carbonization, Fuel Cell (Hydrogen) technology announces also business advantages such as longer distances without recharging, more weight load on the trucks as hydrogen tanks are lighter and a reduction of the Total Cost of Ownership (TCO). Mobility sector (and especially the commercial segments like goods and people transportation) uses already the latest technologies such as artificial intelligence (AI), Internet of Things (IoT), cloud and edge computing or 5G networks. Applied for the trucks, vans or buses, these technologies offer an integrated view for fleet managers in terms of road optimization, fuel consumption, drivers behaviors, and also they enable the data collection for smart cities projects for a cleaner and safer mobility.

Vehicles are more and more connected to the digital environment. Connected tires represent another example, no matter they are integrated in fleet management systems or analyzed as unique features. The vehicle manufacturers and also the fleets started to test, pilot and apply systematically the intelligent sensors that permit to get information from the tire and to translate it in efficiency and environmental metrics and insights. Thanks to these intelligent sensors, the tire pressure real time monitoring tool gives data about the impact that the wrong pressure has on the fuel consumption. This is analyzed not only from the costs perspective, but also from the sustainability angle, the fuel savings being translated in the equivalent of CO₂ emissions reduction. Developments are ongoing to collect more data from transportation's assets impacting sustainability, such as tire wear, vehicle load or particles emissions.

Challenges in scaling technologies for a more sustainable transportation

Even though this type of technologies as Fuel Cell (Hydrogen) are already existing, scaling them is a challenging process, as they require high investments in the infrastructure and also the hydrogen production costs remain significantly high. Moreover, for some critical raw materials such as lithium, nickel, and cobalt needed to produce this newer types of technologies, it is very challenging to assure a lean supply chain, at the right capacity. On top of the vehicle features, telematics represent a set of technologies used today at quite a large scale by commercial fleets. Telematics allow to track fleets' assets in real time, to optimize the workflow and the whole fleet management, better leveraging costs versus profitability. At a higher level, when referring to the public transportation and the ambitions to have smart cities, lots of data are already transmitted thanks to technologies such as machine learning and artificial intelligence. All these technologies mentioned above aim to enable sustainable mobility, for smart cities and tomorrow's logistics operations. While transportation industry started to make progress based on data and actionable insights about how to save fuel, there is still a gap between the stated objective to contribute to a greener transportation and the reality on the roads. Even though the technologies exist today, the challenge is to integrate them, from transporter, to connected assets and data providers. Fleets and data providers need to better articulate and align on their objectives for sustainability. It's critical to clearly define the sustainability's key performance indicators (KPIs) and to have one commonly agreed framework to measure them. The observations on fleets reveal that most of them started to look closely at the CO₂ emissions reductions and safety improvement as key indicators, but without having much understanding about how to define and measure them.

From purely digital technologies perspective, there is still important progress to be done, starting with the creation of an environment that could allow optimal usage of the newest technologies such as cloud-edge computing processing huge amounts of data in real time, 5G connectivity ensuring high speed and reliable data transfer, AI and robotics, chips for smart vehicles, and new kinds of automotive operating systems. Next to the financial investments required to create and maintain these platforms, there is also the human resources preparation needed for an efficient usage of all these insights and data.

Only a well trained staff can track sustainable KPIs in a consistent way over time, extract the value from all these new technologies and put them at the service of sustainability and business growth.

Moving borders for the transportation industry

Known rather as a moderate pace transformation industry, transportation is today more dynamic than ever, under the pressure of both total cost of ownership reduction but also of sustainability's targets and regulations. New players try to aggressively enter in the market, especially in the electric vehicles field. In parallel, the traditional vehicles makers started to develop new technologies driven by innovation and sustainability. Regardless of the areas, vehicles or fleet management, we assist to the raise of new players everywhere, the border between tech and automotive overlapping constantly.

New entrants compete mainly in the EV vehicles area, while the incumbents put significant investments in technology or venturing with tech companies to cover their existing gap. Technological and digital innovations bring already value to the fleets in many aspects, such as road optimization which translates in mileage efficiency, costs reduction, increased uptime. However, when referring to sustainability there are still significant challenges. Figure 1 below shows the main aspects considered and evaluated by fleets in their decarbonization journey. From the type of vehicle (the main asset of a fleet) to the energy efficiency or infrastructure development, all the elements are correlated and should converge towards the central interest of the fleet: the performance. The daily reality of transportation industry shows that sustainability is often addressed in its relationship to costs and business results. Consequently, it's important to treat them in conjunction and consider their consolidated impact.

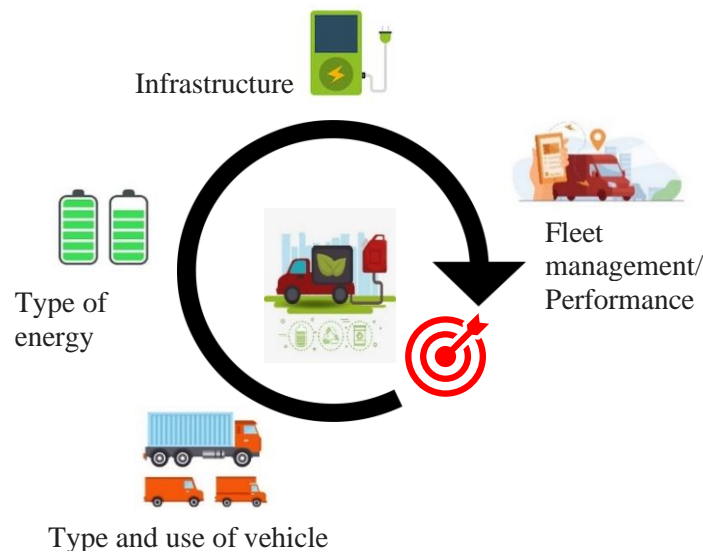


Figure 1. Key interest elements for fleets in the decarbonization journey

Under the time's and regulations' increasing pressure to switch towards more sustainable operations, the fleets managers still have to secure the assets and to reduce their costs for more productivity. These two factors are critical for ensuring the business continuity and they remain very important for the fleets also during their decarbonization journey. Those technologies that will succeed to enable the business performance together with more sustainable operations will be the winning ones. The implementation of the new technologies will have an in-depth impact on the fleets, as they will need to adapt or to completely build new ways of operating, from systems to well-trained human resources, able to manage and optimize these tools. On top, the path towards electrification hides also significant risks for the fleets business, in terms of choosing the right suppliers and secure profitable partnerships, among all the new and traditional vehicles makers. Fleet managers are tested now on their ability to make the right decisions in an uncertain context and based on a reduced amount of accurate information.

Conclusions and future insights

Many key players in the transportation industry are already on the road towards sustainability, aware that it's the right direction for the future. However, this is not a straight paved line. The journey to become sustainable is an winding road, that authorities, business and society need to consolidate now in order to preserve the world as it is, for the future generations.

Transportation industry, recognized as having a significant impact on the environment, is actually responsible as a whole of around 20% of the global CO₂ emissions, according to a research realized by Shell in collaboration with Deloitte. On one hand, the fleet management remains more than ever focused on the costs reduction, especially in the current economic environment, still recovering after Covid-19 impact and under historic inflation increase rate. However, on the other hand, it's crucial for fleets to adopt and use the new technologies in an effective way, to make significant steps towards a green business. Decarbonization represents a top priority for most of the fleets but many progresses are still to be done, one of the main challenges being the data accuracy in measuring and benchmarking the results. Fleets' employees driving this transition, such as purchasing staff, technical engineers and fleet managers work to understand the exhaustive direct and indirect impact of their fleets on the environment, following the scope 1, 2 and 3 of the carbon emissions frame. The pace of decarbonization process is fluctuant, by country and business maturity, but the transportation business moves into this direction, whether it is switching already to the electric vehicles or using transitional fuel. While the path forward is clear, the biggest question mark now is about the rapidity of finding a viable business model in the new context. Based on my direct observations of fleets actions and statements, there is a strong willingness to become greener, but also a lot of uncertainty about how to get there in an effective way for the business.

Most of the big players in the transportation industry have already defined their sustainability's goals and they are fine-tuning now the strategies to reach them. At this stage of the decarbonization journey, as revealed by the current researches on the topic, the fleets need solid and trustful partners, to work together on the sustainability's road map. Establishing strong partnerships will be a key condition to take advantage of the main technologies that would bring value to the transportation businesses, while also supporting them to become greener. Today, players from various industries such as spare parts suppliers, EV constructors, high tech companies, incumbents and start-ups, as well as private, public and even NGOs sectors join their know-how and resources to implement effective solutions on the net-zero carbon emissions roadmap. These partnerships are critical to advance and differentiate, especially in the transportation industry, in the context of strict regulations, time pressure and strong competition. The fleets and their partners work both to the strategic framework and to the in-depth operational aspects. They look to identify any feature or component of mobility that impacts sustainability. Then, using fine-tuned technological tools and methods, the objective is to have a positive impact on various sustainability's aspects such as: reducing the CO₂ emissions, improving the road safety, cutting the waste especially in production phase and ensuring recyclability, to build the circular economy.

Digitalization and sustainability are no longer just some trends, they clearly are a mandatory part of our daily lives and also of business models. They should go hand in hand and reinforce each other to innovate, for preserving the world and life for the future generations, the end-purpose of sustainability.

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An analysis on the impact of digital marketing strategies in enhancing market performance

A Case of Medical Aid Companies in Zimbabwe

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Abstract. Changes in the past few years has seen digital marketing becoming very active in communication, online advertising and sales growth. Customers value brands that provide convenience, dependability and personalisation at all times and everywhere. Medical aid companies have not been spared from these changes. These companies need to keep an eye on the paradigms of digital marketing as the fastest growing marketplace, so that they design robust strategies that leverage on the opportunities available in the digital space. A cross-sectional survey was carried out on 30 medical aid companies in the capital city Harare, Zimbabwe. An expert sampling strategy was used with a sample of 30 managers selected being experts in area under study. Data was collected using a closed-ended questionnaire. Statistical Package for the Social Sciences (SPSS) was used to analyse data and regression model indicate a significant contribution of each digital marketing strategy on market performance of medical aid companies in Zimbabwe. Significantly, the findings indicated that only Search Engine Optimisation (SEO) has a strong positive relationship with market performance. This suggests that medical aid companies should leverage on SEO and find ways to optimise the other digital marketing strategies so that they contribute more to their market performance.

Keywords: *digital marketing strategies, market performance, medical aid companies*

1.0 Introduction and background

Digital marketing is reshaping the way customers and organisations interact in the marketplace (Dash & Chakraborty, 2021). Margulies (2011) supports that changes in the past few years has seen digital marketing becoming very active in communication, web advertising and online sales. Customers value brands that provide convenience, dependability, and personalisation at all times and

everywhere. According to Lee and Kim (2009) as cited by Kalei (2020), websites, influencer marketing, search engine optimisation (SEO) and mobile marketing are examples of trending digital marketing strategies that organisations are using in an effort to generate sales of products and services. In most developing countries, Zimbabwe being one of them, the medical aid industry is a risk pooling business model for reducing out-of-pocket (OOP) health financing. Risk sharing mechanism of medical costs requires medical aid companies to continuously acquire new customers, retain existing ones resulting in the subscribers getting access to quality healthcare services. Driven by the objective to sustain a high pool of customers, medical aid companies need to keep an eye on the paradigms of digital marketing as the fastest growing marketplace and design robust strategies to leverage on the opportunities that lies in the digital space. It is important to note that medical aid societies play a pivotal role in financing healthcare service in Zimbabwe. Premier Service Medical Aid Society and CIMAS enjoys 87% market share of the industry as shown in table 1 below:

Table 1: Medical aid companies market share in 2021.

Base: Medical aid users	Total	Harare	Bulawayo	Manicaland	Masvingo	Midlands	Mash East	Mash West	Mash Central	Mat South	Mat North
OVERALL	668789	76547	31192	153112	113262	142471	68587	49362	21430	42890	69938
PSMAS	64%	30%	43%	82%	61%	90%	66%	61%	83%	70%	40%
CIMAS	23%	57%	21%	14%	20%	7%	16%	29%	8%	18%	42%
First Mutual Medical Benefit Fund	4%	3%	21%	9%	-	-	13%	-	-	6%	6%
Corporate 24	2%	-	-	-	-	-	-	-	-	6%	19%
ProHealth	2%	-	-	-	10%	-	-	-	-	-	-
Steward Health Fund	2%	-	-	-	10%	-	-	-	-	-	-
MASCA	1%	-	14%	-	-	-	-	-	-	6%	-
Cellmed	1%	-	-	-	-	2%	-	-	-	-	6%
Old Mutual	1%	3%	-	-	2%	-	-	-	-	-	-
Generation Health	1%	-	-	-	2%	2%	-	-	-	-	-

Source: (*Zimbabwe All Media & Products Survey 2021 First Half Report, 2021*)

Medical aid societies in Zimbabwe contribute an estimate of 80% of income to the private healthcare providers and 20% to the country total health expenditure (Equinet, 2010). According to PWC (2012) report on insurance as cited by (Yoder et al., 2012), 50 percent of the respondents to a study agreed that digital marketing had transformed the choice and purchase of insurance plans. According to a report by KPMG (2020) the digitization of the insurance industry is accelerating more rapidly than, perhaps, any other sector. In response to the impact of Covid-19 the use of digital marketing is expected to exponentially grow in adapting to the new normal of doing business which has resulted in the change of customer needs and attitudes towards brands. Insurance companies are looking to innovate and rethink strategies in response to the new business playfield that will exist post-pandemic. Medical aid companies as health insurers can leverage on digital marketing to adapt to the changing environment, target the untapped market and increase the survival of the industry. This study focuses on the contribution of digital marketing strategies and their influence on the market performance of medical aid companies in Zimbabwe.

Despite adopting the disruptive digital marketing strategies brought by the internet, medical aid companies face the challenge of selecting the appropriate strategies that optimise their market performance. The impact of digital marketing strategies in different industries like telecommunications industry (Tichafa & Nyoni, 2018), fuel industry (Manyumba, 2015) and Agro-food processors (Chinakidzwa & Phiri, 2020) has been interrogated in Zimbabwe. However, industries like health insurance has little research findings in the context of Zimbabwe health insurance sector. The proliferation of digital channels raises the question on which tactics these companies should adopt (Beukes & Wyk, 2016).

2.0 Literature Review

2.1 Digital Marketing definition

According to Chaffey (2016) digital marketing is the use of internet-based technologies in conjunction with offline communications to achieve marketing goals. Internet based channels are not the only form of digital marketing (Al-Afifi *et al.*, 2015). Besides the internet based channels such as social media, search engines, display advertising short messaging services (SMS) and multimedia messaging services (MMS) are also forms of digital media that do not require the internet. Companies use social media, search engines, email and websites to interact with existing and prospective customers. Digital marketing is an ever-evolving concept filled with regular innovations, valuable insights and constantly shifting parameters around personal data and audience targeting. Incorporating digital strategies can also have a powerful influence on offline marketing, ecommerce and in-store purchases.

2.2 Digital Marketing Strategies

According to Jalang'o (2015) as cited by Kalei (2020) digital marketing strategies refers to the approaches that companies use to promote products and services through digital platforms. The digital platforms include social media, websites, display adverts, mobile phone applications, email and search engine optimisation. Previous research done by Shariff *et al.*, (2020) and KPMG (2020) indicates that the existing insurance consumers prefer personalised service on multiple channels and digital channels are important for their researching engaging and purchasing activities. Digital technologies with the right strategies can potentially unlock the opportunities that will result in increase of medical aid companies surplus (Kayyali *et al.*, 2016). Johnson *et al.*, (2020) notes the increase in digital platforms used in Africa to perform business transactions. In 2019, there was an increase in the use of digital platforms by 18% as compared to 2018 (Digital Economy Report, 20221). The increased use of digital marketing is attributed to increased internet access enabling more individuals to transact on digital platforms (Digital Economy Report, 2021). Internet penetration enables the implementation of the various digital marketing strategies. A Hootsuite (2021) report indicates a significant internet penetration increase in Zimbabwe by above 200 thousand in the period between 2020 and 2021.

2.3 The shift towards online purchase of health insurance

The world is increasingly becoming more digital creating a virtual marketplace. Nowadays, people are buying insurance online. Many health insurance companies have occupied the digital space to increase their brand visibility as well as engage their potential and existing customers. Getting insurance is very complex, making it difficult for people to understand, and people go online to know about it. However, due to digital marketing, answers to the questions and doubts of the customers can be addressed online. They can represent your brand and make people aware of it online. This will help the insurance companies to gain more customers. The main aim of digital marketing is to reach the right audience for their business when the information of the insurance is provided to the right people with the help of email and social marketing. In the present era, digital marketing is increasing with time. It is changing the procedure of insurance policies.

2.4 A framework for marketing measurement

Input-output models have traditionally been recognised as the first cut performance measurement, a more sophisticated perspective of marketing is usually considered to involve it in some form of "chain of effects." As noted by Neely (2007) Marketing activities elicit a response from customers, either in terms of attitude or behavior, which leads to sales and earnings, which in turn influences shareholder wealth.

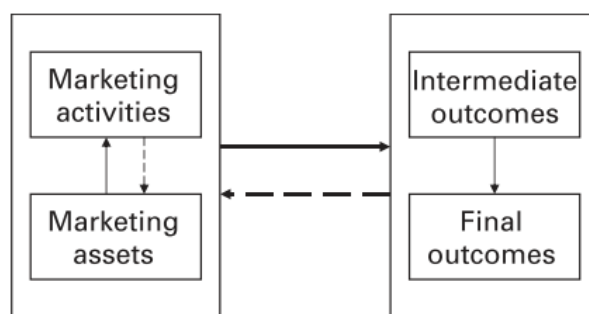


Figure 1: A framework for marketing measurement

Source: Clark (1999)

The “marketing mix” has typically guided the organization's marketing activities. New marketing performance measurements have been more popular in recent years, since post-sale support has become more crucial in many businesses. According to Norvapalo (2016) measurement of activities is, in some ways, a documentation exercise taking account of how much has been spent on the strategic marketing activities in the stipulated time and the return on investment as the final outcomes. In this study, focus is on the final outcomes of the digital marketing strategies as the medical aid companies are finding ways to sustain their business models that requires more subscribers and more monetary resources. Therefore, sales volume, profitability, market share and return investment are key measures that address the objective of the research.

2.5 Measuring the impact of digital marketing strategies on market performance

Market performance has become an important component in the field of measuring business success (Dess *et al.*, 2018). Likewise, Saura *et al.*, (2017) assume that digital marketing and Key Performance Indicators (KPIs) can and should play a significant part in strategy formulation. In this study, key performance indicators are key in determining the success and justification of adopting digital marketing strategies in the health insurance industry. Porter (2008) as cited by Beukes & Wyk (2016) indicates that the market performance can be established by measuring each digital marketing activity rather than holistically analysing the company. Many organisations face a challenge of separating the impact of digital marketing campaign or activity from other marketing activities. For instance, an increase in sales after a social media ad campaign makes it difficult for a company to proportionately attribute the exact sales increase to the social media campaign and explain the sales contributed by other activities. According to Amar (2022) due to the need of covid-19 health cover and customised health insurance by individuals due to the rising medical costs and out-of-pocket costs, there was an exponential increase in demand for health insurance. In this case, organisations face challenges in separating the sales from the digital marketing strategies and unexpected pandemic. There are a plethora of possible indicators and each meant to measure a different aspect of a digital marketing strategy, but it is still up to business managers to choose an indication that delivers insightful and valuable data.

2.6 Conceptual Framework

A conceptual framework is a guide to a research (Ravitch & Carl, 2020). The framework for the study has been developed from Epstein *et al.*, (2007) internet marketing payoff model. The model show the independent variables as internet strategies and financial returns as the dependent variables. The model is useful to this study as it gives a linkage between internet marketing and return on the investment. This in line with this study since it focusing on the relationship between digital marketing strategies and market performance.

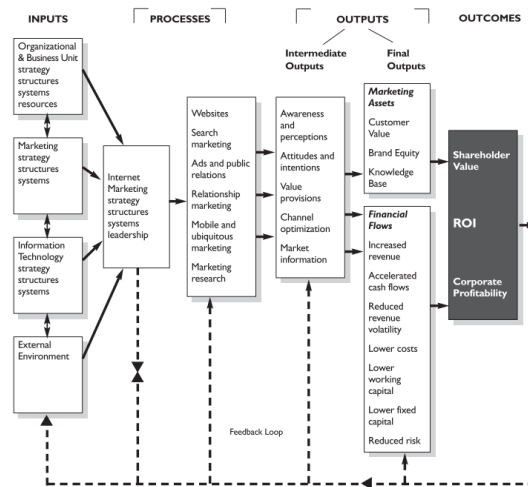


Figure 2: Internet marketing payoff model

The model starts by showing the impact of each digital marketing strategy on market performance and secondly each digital marketing strategy on sales or surplus.

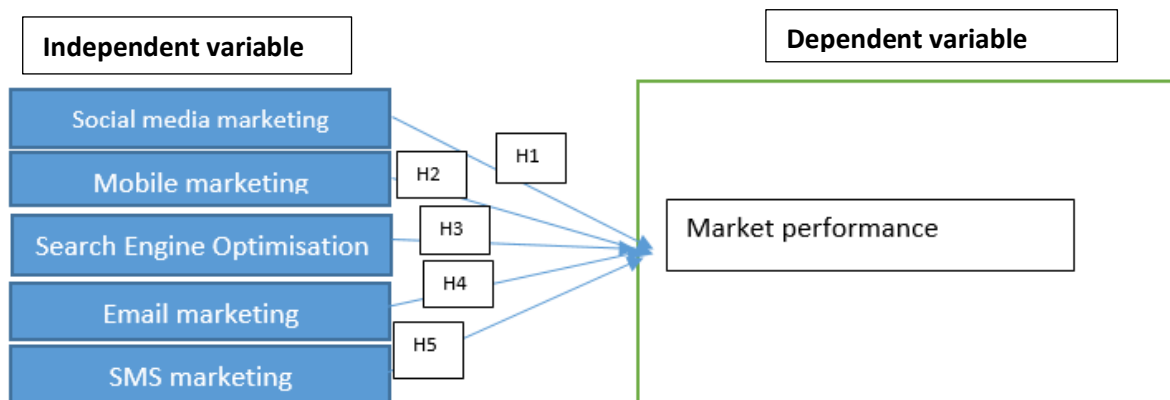


Figure 3: Proposed Conceptual framework. Adapted from (Epstein et al., 2007)

2.7 Hypothesis (H)

H1: Social media marketing positively affect market performance of medical aid societies in Zimbabwe

H2: Mobile marketing positively affects market performance of medical aid societies in Zimbabwe

H3: Email marketing positively affects market performance of medical aid societies in Zimbabwe

H4: SMS marketing positively affect market performance of medical aid societies in Zimbabwe

H5: Search engine optimisation positively affects market performance of medical aid societies in Zimbabwe

3.0 Research Methodology

The study adopted a positivist research philosophy and a cross-sectional survey was conducted on 30 medical aid companies in the capital city Harare, Zimbabwe. An expert sampling strategy was used with a sample of 30 managers selected being experts in area under study. Prior to the survey, the researchers made initial call to request to conduct a survey in the respective medical aid companies. A closed-ended questionnaire was developed as the research instrument collecting data. The questionnaire was distributed to marketing executives or marketing specialists and management from other functional departments that the researchers envisaged to have an appreciation of the organizations' digital marketing strategies. The marketing executives were selected to respond to the research questions because they were more knowledgeable on the relationship of the adopted digital marketing strategies and market performance within their organisation. An online platform google forms was used to develop the closed-ended questionnaire as well as conducting the survey. The developed questionnaire was sent to the emails of the selected sample and made a follow up call. The uses of digital marketing strategies were measured on a five point Likert scale. The scoring scale of the research instrument was 5= Strongly Agree, 4=Agree, 3=Neutral, 2=Disagree and, 1=Strongly Disagree. In this paper, on the analysis impact of adopting digital marketing strategies with respect to market performance in health insurance sector, dummy variables such as gender, age, qualification, position in organisation and company background information was taken into consideration. In this study, 100 questionnaires have been administrated. Market performance variable were also measured on a five point Likert scale and respondents were required to give their judgement using previous year performance in their various organisations. The measures of the constructs were adapted from previous studies of Chinakidzwa & Phiri (2020) and Kansal et al (2020). Microsoft Excel was used to sort the data downloaded in google forms and it was analysed on SPSS. The first analysis conducted was descriptive, followed by a regression analysis to test the hypothesis. The findings and analysis are shown in the following section.

3.1 Questionnaire validity

Validity explains how well the collected data covers the actual area of investigation (Taherdoost, 2018). Validity test of the questionnaire was important in analysing survey questions for their dependability. The tests for validity was done using several approaches to ensure the research instrument measure what it is intended to measure. A pilot testing was conducted to test the validity by administering a questionnaire to a number of the target respondents. Literature review was essential to define the constructs that should be included in the questionnaire. Expert contribution was sought to ensure face and content validity. In addition, we used the market performance constructs from O'Sullivan and Abel (2007), Hooley et al. (2005), Neely (2007) and Moorman and Day (2016) as cited by Chinakidzwa & Phiri, (2020). This contributed to the validity of constructs, as the validity of constructs is undoubtedly related to theory and hypothesis (Carmines & Zeller, 1979). The validity of the construct was also measured using Spearman's correlation coefficient. Prior to implementation, the questionnaire was piloted with a colleague at a selected medical supply store. Colleagues working in the marketing field contributed to the clarity, flow, and general design of the questionnaire. This is part of the validity of the face and was designed to assess whether the questionnaire makes sense. Pilot testing contributes significantly to validity and reliability (Saunders et al., 2016).

3.2 Questionnaire Reliability

The consistency of the survey results can be judged by checking the survey's dependability. Internal consistency is a measure of question cross-correlation and so is consistent in determining the desired composition. Calculating Cronbach's alpha coefficient is a widely used method for measuring internal consistency (Aithal & Aithal, 2020). The internal integrity of the data is measured with confidence that the depression measurements are reliable. A reliability analysis was performed by SPSS to test the

reliability of the collected data. Cronbach's alpha simply indicates the overall reliability factor for a set of variables. The Cronbach's alpha value for the five questions (items) related to the answer to the impact on digital marketing is calculated to be 0.91. Since Cronbach's alpha value is greater than 0.9, the data has strong internal consistency and the scale is considered very reliable. The researchers also checked the validity of the contents of the research equipment. An instrument is said to have content validity if it covers all possible aspects of a research topic. Researchers have confirmed the validity of the content of the research tools by obtaining the opinions of experts. Researchers have also conducted pilot surveys, which helped researchers readjust some of the items that represent irregularities.

3.3 Research findings

Overall results from descriptive statistics and hypothesis testing of the research variables show that the adoption of digital marketing strategies has an impact on the market performance of medical aid companies in Zimbabwe. The results collected throughout the research process and from medical aid companies were discussed.

3.4 Descriptive statistics

The aim of the research was to analyse if social media, mobile marketing, email marketing, sms marketing and search engine optimisation contributes to market performance of Medical aid companies in Zimbabwe. The findings indicate that 36.6% agreed that social media marketing positively contribute to their market share, 9.8% strongly agreed, 22% were neutral and 9.8% strongly disagreed. The study findings also show that 34.1 % agreed that mobile marketing contributes to their profitability, 14.6% strongly agreed, 22% neither agreed or disagreed while 7.3% disagreed. 31.7% agreed that email marketing contributes to revenue growth of the company, 14.6% strongly agreed, 24.4% were neutral while 7.3% disagreed. The findings also indicated that 26.8% agreed that sms marketing contribute to the return on investment, 14.6% strongly agreed, 24.4% neither agreed or disagreed, 7.3% disagreed while 4.9% strongly disagreed. The findings further indicated that 31.7% strongly believe that search engine optimisation(seo) contributes to sales growth, 24.4% agreed, 14.6% were neutral while 7.3% disagreed.

3.5 Hypothesis testing using regression

The study conducted a regression analysis to test if the independent variable predicts the changes in the dependent variable. The independent variables of this study were social media marketing, email marketing, mobile marketing, SMS marketing, search engine optimization, and the dependent variable was market performance.

The results of this study show that social media marketing, mobile marketing, email marketing, SMS marketing, and search engine optimization can predict the value of m

arket performance.

Hypothesis 1

The p-values were all below 0.05 which depicts that all the independent variable (social media) explain the dependent variable. In this study, $R^2 = 0.176$ shows that the regression model explains 17.6% of the variance in market performance. A summary of the results is shown in the table 2 below.

Table 2: hypothesis 1 showing a relationship between social media and market performance

Hypothesis	Regression	R	R ²	F	p-value	Hypothesis supported
H1	SM MF	.420	.176	6.413	.017	Yes

The above test indicates a significant relationship between social media and market performance.

Hypothesis 2

The hypothesis investigates whether mobile marketing has a substantial impact on the market performance of Zimbabwean medical aid organisations. The dependent variable profitability (PRO) was regressed on the mobile marketing as a measure of market performance (MM). The findings show that social media marketing has a direct positive impact on market share. The model explains 12.9 percent of the variance with an R2 of .129. The findings are summarized in the table below.

Table 3: hypothesis 2 showing a relationship between mobile marketing and market performance

Hypothesis	Regression Weights	Beta Coefficient	R2	F	p-value	Hypothesis supported
H2	MM → MP	.359	.129	4.432	.044	Yes

There is a significant relationship between mobile marketing and market performance.

Hypothesis 3

The hypothesis investigates whether email marketing has a substantial impact on medical aid companies' market success in Zimbabwe. The email marketing was regressed on the dependent variable revenue growth (R) as one indicator of market performance (EM). The findings reveal that email marketing has a direct positive impact on revenue growth. The model explains 21.2 percent of the variance of the regressed dependent variable, as indicated by R2=.212. A summary of the findings is shown in the table below.

Table 4: hypothesis 3 showing a relationship between email marketing and market performance

Hypothesis	Regression Weights	Beta Coefficient	R2	F	p-value	Hypothesis supported
H3	EM → MP	.460	.212	8.070	.008	Yes

The above test indicates a significant relationship between email marketing and market performance.

Hypothesis 4

The hypothesis investigates whether SMS marketing has a substantial impact on medical aid providers' market performance in Zimbabwe. The sms marketing variable was regressed on the dependent variable return on investment (ROI), which is a measure of market performance. The findings show that email marketing has a direct and positive impact on ROI. The model explains 45.8% of the variance, as indicated by R2=.458. A summary of the findings is shown in the table below.

Table 5: hypothesis 4 showing a relationship between sms marketing and market performance

Hypothesis	Regression Weights	Beta Coefficient	R2	F	p-value	Hypothesis supported
H4	SMS → MP	.477	.458	25.372	.000	Yes

There is a significant relationship between sms marketing and market performance.

Hypothesis 5

According to hypothesis tests, search engine optimisation (SEO) has a substantial impact on the market performance of medical aid organizations in Zimbabwe. The dependent variable sales growth was regressed on the search engine optimisation as a measure of market performance (SEO). The findings show that search engine optimisation has a direct impact on revenue growth. The model

explains 69.3% of the variance of the regressed variable with an R2 of.693. The results are summarized in the table 6 below.

Table 6: hypothesis 5 showing a relationship between search engine optimisation and market performance

Hypothesis	Regression Weights	Beta Coefficient	R2	F	p-value	Hypothesis supported
H5	SEO MP	.832	.693	67.596	.000	Yes

The above test indicates a significant relationship between search engine optimisation (seo) and market performance.

4.0 Discussion and conclusion

This study focused on the impact of digital marketing strategies on the market performance of Zimbabwean health insurance providers. The main purpose was to determine if social media marketing, mobile marketing, email marketing, SMS marketing, or search engine optimisation contribute to the market performance of the organisations. All the results of the regression model show the significant contribution of each digital marketing strategy to the market performance of Zimbabwean healthcare companies. However, the results show that only search engine optimisation has a strong positive relationship with market performance, and medical aid companies have further correlated market performance with the other four digital marketing strategies. It suggests that medical aid companies need to optimise their digital marketing strategies in order to increase their market performance. More research is required on identifying the best use of each specific digital marketing strategy in order to achieve the objectives of an organisation.

5.0 Acknowledgements

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6.0 Author contributions

The three authors contributed equally to the successful completion of this study research.

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Roma people and their road to cultural identity.

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Abstract: The paper “Roma people and their road to cultural identity” aims to present how the cultural identity of the Roma people has evolved through time and how it managed to preserve itself through history. Furthermore, it is important to see how the cultural identity of the Roma people is a key component in forming any kind of public policies and also in better understanding the differences between different groups.

Keywords: *cultural identity, roma people, cultural values, historical content*

1. Introduction

The identity of the Roma people is a complicated concept to fully define. Cultural, social and historical content is found in it, and the task of the researcher is to define how these elements are connected to each other at a given time and in a certain group, and how the hierarchy of elements appears and changes over time.

We can see that in literature, when it comes to defining the identity (or identities of the Roma – because the plural form seems to be more appropriate here) we can distinguish two main approaches: the essentialism of the traditional approach and the relationism of the so-called constructivist perspective. In the first approach, Roma identity is perceived as a reproduction of a cultural essence or substance: the idiom of 'being Roma' which is a transposition of the fundamental values of Roma culture into the behaviour of Roma individuals and into the life of a group. Culture here is an independent variable: to explain social life we have to refer to the culture that offers certain patterns that are activated in particular situations.

2. The different approaches on the Roma people’s cultural identity

In this approach, characterizing ethnography and traditional history, the Roma were considered an ethnic group with a stable, strong and practically unchanged identity. Such an identity can be understood as a synthesis of a common origin and cultural immunity. Thus, a Roma was someone whose ancestors came from India and arrived in Southern Europe in the fourteenth century and who was born a Roma – that is, someone was of Roma ethnicity.

In a cultural sense, a Roma was a person who spoke the Romani language and whose daily life was marked by the concept of a world divided into "pure" and "impure" spheres, who expressed solidarity with other Roma who showed respect for the hierarchy within the group, who accepted the obligations arising from the structure of the Roma community, and someone who, through nomadism or the adoption of specific forms of professional activity, he tried to lead to a normal life to minimize the extensive control of the non-Roma environment. This set of values makes up a special code of behaviour, with an associated way of seeing the world that together constitutes the essence of being a Roma, the "true Belonging" defined by some Roma groups such as romanipen, romipen, romanija, ciganija, etc. [1]

The second approach to Roma identity can be defined as a relational one. From this point of view, the set of cultural values (Romanipen) is treated as the historical result of concrete relations between Roma and the non-Roma environment, between certain Groups of Roma and between different categories of people in the context of these groups. It is precisely these relationships, within this point of view, that define the Roma identity and its many variations. In other words, in order to understand who the Roma are, it is necessary, above all, to return to the fundamental opposition between the Roma world and the world of non-Roma. It is precisely the impact of the non-Roma world, rather than any "natural difference", "ethnicity" or distinct cultural values, that, in the opinion of some researchers, played a crucial role in the construction of the Roma as a separate group.

This approach is based on the idea of Fredrik Barth[2] who argues that it is not cultural substitution that determines the identity of a group, but the social boundaries that shape the cultural content they contain. The identity of the Roma is therefore perceived here as a maintenance of the social border that protects the Roma "the social space composed according to their own ethics of kinship[3]". In this approach, culture is dependent: we can explain it as a result of the processes in which the Roma strengthen their relations with the environment.

Thus, the "Roma identity" is a whole complex consisting of a vision of the world based on cultural values, the image of one's own social space and the borders that separate it from others, as well as the way of perceiving one's own history. In other words, competing approaches to Roma identification constitute a fluid configuration of cultural social and intellectual values and conceptions in a state of constant transformation.

Max Weber gives a definition of ethnic groups as being + "those human groups that maintain a belief in a common descendant due to physical, customary or both similarities, ultimately because of the collective memory of colonization or migration[4]. From this definition we can delineate three important aspects: 1) the fact that the common lineage forming ethnic solidarity is based on a presumption or a real faith; 2) belief in a common descendant is more important than common lineage, and 3) that there is a basis that ranges from physical similarities to common history or cultural practices.

Over time, the belief in a common history and a common descendant turned into a culture shared by these members. Cornell & Hartmann gives a definition of this: "an ethnic group has become a group of people who are distinguished by common culture, typically including language, religion or other patterns of behaviour or belief[5].

Another important definition, one that marked the situation of the Roma in Eastern and Central Europe in a significant way, is offered by Joseph Stalin: "A nation is a stable community of people, historically constituted, formed on the basis of a common language, territory, economic life and psychological characteristics manifested in a common culture of its own" [6]. Due to this definition, the Roma were not considered to be a national minority during the communist period because they did not meet one or more criteria.

3. Influences on the construction of cultural identity

Antony Smith tries to combine the Weberian approach to ethnicity with the cultural sphere. It defines an ethnic group as "a type of cultural group, one that emphasizes the role of the myths of lineage and historical memory, and which is recognized by one or more cultural differences such as religion, customs, language or institutions"[7].

Thus, the concept of identity is presented by Brubkaer as one that generates confusion and ambiguity when used as an analytical term. The author proposes the subsumption of the concept of identity to pairs of terms that cover the various meanings of the term: self-understanding and social localization as terms that consider subjectivity and the disposition to act, categorization and identification as a procedural term and similarities, grouping and connectivity. Similarities relate to shared attributes, connectivity to relationships that connects people and grouping refers to the feeling of belonging to a distinct, delimited and cohesive group. [8]

The construction of ethnicity is primarily about the situations in which people self-identify, the way they perceive others, their daily experiences, the way they manage the problems they encounter and the ethnic or other terms used to describe the causality of problems.

Going further and addressing the types of identity construction, Castells [9] offers a definition of this and states that in the contemporary context there are three main types of identity construction that are based on their origin: resistance identity, project identity and legitimation identity.

Also, another perspective of approaching the Roma identity is through the prism of the approach to the issue regarding the sub-groups and gentiles, some sociologists pointing to the existence of 40 sub-groups or gentiles. Burtea shows the limits of this approach due to the fact that in the contemporary era "the traditional nation no longer seems to constitute a very vivid fact of conscience for a large part of the Roma population"[10]. There are even certain people who declare themselves to be Roma, but without having specific physical characteristics.

Stephane Laederich and Lev Tcherenkov concept the identity of the Roma as a primordial, immutable given, based on laws, traditions and customs that they systematically analyze. The authors classify certain groups as Roma fiid and treat the issue in a unitary way what they call to be Roma. [11]

Vermeersch⁵⁰, in an attempt to analyse how Roma are defined, divides the discourse on how Roma are defined in academia into three categories: (1) a historical diaspora with historical roots in northern India; (2) a group or race in which the members are related; and (3) a group with a culture and still of its own life, nomadism, common cultural practices and a conception of the world inspired by Romanipen[12].

An objective definition of Roma and their identity is tried by Szelenyi and Ladanyi, which shows that in research and censuses, the number of Roma depends on who identifies the subjects. They analyse three types of potential classifications of Roma: the classification made by experts who come into contact with Roma, the classification made by interviewers in scientific or commercial research, and the self-identification of subjects, showing that all three classifications are "real"[13].

History is a defining element when we talk about Roma identity. Thus, the shared memoirs on elements or events of the past, such as the Holocaust and the deportation to Transnistria, deeply marked not only the Roma who participated directly in these facts, but also the subsequent generations. Thus, the collective mentality of the Roma was one that changed in order to protect themselves. Proof of this is still the fear of some Roma people to self-destruct during the censuses for fear of being sent to sea by "paper boat"[14]. Another negative factor derived from this nefarious history is unfortunately also preserved among the majority, especially those with extremist discourse, who appeal to the period during Antonescu's time as a good way to deal with the Roma population.

Some may think that it is easy to identify someone who is Roma by breed traits, for example: Roma have darker skin. But not all Roma correspond to this taxonomy and, on the other hand, Sicilians or Turks are not Roma. Obviously, they have a common language, which would make this comparison perceptible, despite the fact that there are a lot of people who claim to be Roma, but who do not speak Roma, the Roma language is nothing more than a huge collection of dialects that would make it almost impossible to understand between, a Turkish Rum and a Spanish Roma.

Also, cultural identity characteristics - from religion, clothing or music belong to a similar trend towards an extreme variety (from traditional Balkan Roma music to Spanish flamenco, for example), to which we must also add the majority ethnic group's preconceptions about them. The message of such a fragmentary community can be neither coherent nor unintelligible for the institutions of the majority state.

Another important factor in defining Roma identity is the fact that the Roma population has not gone through a process of cultural unification and identity reconstruction, as europeans have done, therefore lacking a specific identity capable of manifesting itself politically, as in the case of other European minorities.

4. Conclusions

In conclusion, the Roma identity can be viewed from multiple perspectives, each offering a certain explanation of how both Roma and non-Roma people have built the image of the Roma cultural identity. In principle, the Roma identity is a construct formed predominantly (at least at first) by non-Roma. This construction was carried out through certain centres of power, from social institutions in particular and those of the state, to academic writings and behaviours towards Roma in everyday life.

Of course, the promotion of stereotypes and sayings with a negative character towards the Roma had a huge impact on the contemporary collective mentality and thus promoted false things about the Roma identity. The most eloquent and representative example of this is the use of the term gypsy by the majority person, a term that assigns many negative connotations to the person in question.

Thus, the Roma identity is a hybrid model. It is made up of the gypsy identity, built by the non-Roma, along with the identity formed by the Roma activists, along with certain specific elements such as language, religion, nation, etc. It is also formed and built in relation to other groups, being a reference to others and what others say about you. The Roma are the subjects of external categorizations that have greatly affected their understanding and perception of their own identity. Another important factor is also the way in which the Roma identity is communicated in the public space, which is separated into two categories - the academic environment that has a constructivist perspective on the identity of the Roma and the primordialist vision that is found in the media, but also in the public opinion, which transforms certain limited thoughts and knowledge into truths generally valid for the entire ethnic group.

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Assessment of Transformational and Autocratic Leadership on employee engagement in the South African Education Sector

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Abstract. Leadership plays a significant role in an organisation. Leadership style centred on the behaviour the leader exhibit when dealing with members of the team. The study examined the impact of transformational and autocratic leadership style on employee engagement at higher education in South Africa. Evidence from the existing literature suggests that motivating employees, elevating their desire for achievement and providing support, have advocated transformational leadership style as employee engagement enhancer. However, an autocratic leadership style dictates procedures and policies while ignoring communication, resulting in disengaged employees. Fewer studies focus on transformational and autocratic leadership style in a higher education in South Africa. The study provided useful insights into the two types of leadership styles in higher education and their effect on employee engagement level, as well as the importance of employee engagement in achieving the organisation's mission and vision. The study adopted a quantitative approach and used survey design. A structured questionnaire was distributed online to 210 universities staff and 131 responses were received. The findings of this study indicated that transformational leadership styles have a significant positive relationship with employee engagement, whereas autocratic leadership styles have a negative relationship with employee engagement. Furthermore, the results show that the autocratic leadership style and employee engagement relationship is insignificant. The study has made a recommendation that organisation use an appropriate leadership style that will enhance employee engagement in order to achieve organisational mandate.

Keywords: Leadership, transformational leadership, autocratic leadership, employee engagement.

1. Introduction

Leadership plays a significant role in an organisation. Leadership is the key to achieving a high performing education system (Veldsman, Johnson & Madonsela, 2016:189). As social architects, leaders play a crucial role in an organization by defining vision, strategic direction, and developing a relationship (Nel & Werner 2014:291). Veldsman, Johnson and Madonsela (2016:206) pointed out that leadership can positively change organisational effectiveness. A leader's leadership style is how he or she directs and motivates others to achieve organizational goals (Khajeh, 2018:2). Nel and Werner

(2014:290) said that organisations require strong leadership for optimal effectiveness. According to Shuck and Herd (2012), a leader can either create an environment that encourages or discourages engagement. Shuck and Herd (2012) posited that leaders who engage their followers make a significant difference in their workplace.

Leadership need to be used as a tool to implement strategies to manage employee engagement to retain employees' high level of commitment. Today's leaders confront the difficult task of rebuilding and regaining employee trust (Robbins & Coulter, 2016:538) because leaders often make the unintended mistake of mapping out solutions too swiftly (Kriemer 2019:26). The changing aspects of the higher education system, mergers, restructuring, and employee engagement become lesser and lesser due to the uncertainty of staff. Veldsman, Johnson and Madonsela (2016:206, 338) stated that the South African higher education system has been significantly remodelled through a process of mergers and realignment and this shift created leadership implications as a result there is a need for appropriate engagement model that includes organisational strategic intent, culture, growth and development of the organisation's leadership. Nel and Werner (2014:281) state that, "employee engagement was a positive predictor of task performance and further explains that poor leadership and insufficient employee engagement has a tremendous effect on organisational performance".

Today, the level of competition within the worldwide market is rapidly intensifying. Organisational leaders are forced to explore efficiency strategies that will enable them to compete successfully in the global market. This calls for leaders who will create and respond positively to change (Bass & Avolio, 1992:21). "Over the past several years, the development of high engagement workplaces has emerged as a strategic response to address the need to achieve results in a challenging environment" (Joyner, 2015:1131).

Higher education institutions leadership has found itself embroiled in sequence after sequence of new issues which students have put in front of them that they have had difficulty addressing (Veldsman, Johnson & Madonsela, 2016:217). Student enrolment has increased and that calls for more funding for higher education and more student accommodation. Every year students are financially and academically excluded which warrants for management to involve students in trying to resolve those issues. Some of the issues are difficult to resolve as they are governed by the state and leaders of the universities who are in no position to give solutions. The emphasis on employee engagement is becoming less priority as leaders' main focus remains on students' issues.

"Research around employee engagement is emerging and several models suggest leadership as a crucial element in the development of employee engagement, there remains a gap in understanding what leadership behaviours could affect engagement-encouraging cultures as well as the processes around which leader behaviours bring about higher levels of engagement" (Shuck & Herd, 2012:156).

Gallup (2013) reported that 6 percent of employees globally are disengaged. Furthermore, the state of global workplace report (Gallup, 2021) indicated that employee engagement has dropped by two percent globally from 22 percent in 2019 to 20 percent in 2020 and stated that leaders will need to address the decrease in employee engagement. The trend in global employee engagement reported that Africa is the second highest level of employee engagement globally at 67 percent. Even though the African continent well adapted when it comes to employee engagement, South Africa is still lagging (Vittee, 2015). Several studies have focused on transformational leadership style, and many have shown that transformational leadership style has a greater impact on employee engagement than autocratic leadership style (Kalsoom, Khan & Zubair, 2018:23). There is no enough evidence of the effect of transformational leadership style and autocratic leadership style in the South African higher education institutions.

The main objective of this research study is to determine the effect of transformational leadership style and autocratic leadership style in the South African higher education institutions. The researcher developed the following hypothesis in order to determine the impact of transformational and autocratic leadership styles on employee engagement.

H1: Transformational leadership style has a significant relationship on employee engagement.

H2: Autocratic leadership style has a significant relationship on employee engagement.

2. Literature review

2.1 Leadership

Robbins and Coulter (2016:541) defined leadership as a process of leading and persuading followers to attain a common purpose. Hughes, Ginnet and Curphy (2012:35) concurred with the definition stated above as the act of influencing a well-organised people toward achieving agreed goals. Nel and Werner (2014:91) posited that leadership is the process that involves a single person persuading others to direct their abilities and efforts willingly towards achieving organisational goals

2.2 Transformational leadership style

Bass and Avolio (1990:22) explained that “transformational leaders elevate the desires of followers for achievement and self-development, while also promoting the development of groups and organisation”. Bass and Avolio (1990:22) identified four basic components that a transformational leader exhibit to influence followers, namely; idealised influence, individually considerate, intellectually stimulating and inspirational motivation.

- **Idealised influence**

Leaders with idealised influence are visionary and mission-driven; they earn followers' trust, confidence, and trust; and they achieve strong individual identification. They make a great effort to develop individuals to achieve optimum performance (Bass & Avolio, 1990:22). Northouse (2016:167) contended that these people are highly recognised and trusted by their followers, and they have high moral and ethical standards.

- **Individually considerate**

Northouse (2016:169) described individualized consideration as “a representative of leaders who provide a supportive climate in which they listen carefully to the individual needs of followers”. Leaders focus on identifying the capabilities and the needs of followers and address them individually. They delegate, coach, advice and provide feedback to the subordinates. Furthermore, they uplift the confidence level of the subordinates and address their needs to take more responsibility. (Bass & Avolio, 1990:22).

- **Intellectually stimulating**

Leaders timeously acknowledge and encourage followers to deal with problems by applying different perspectives and they create an environment that fosters innovation and creativity. Followers become more innovative and effective in analysing and applying strategies in problem solving without supervision from the leader (Bass & Avolio, 1990:22).

- **Inspirational motivation**

Leaders optimistically and enthusiastically communicate with their followers the visions that need to be achieved with confidence. They motivate their followers by providing challenges and meaningful roles that will assist them in achieving their goals (Bass & Avolio, 1990:22). Northouse (2016:169) affirmed that this type of leadership enhanced team spirit and motivate followers to excel in their work through encouraging words.

Transformational leadership serves as a solid relationship between followers and leaders, allowing for a clear grasp of motivational levels, values, and interests (Khajeh, 2018:3). Rees and French (2015:92) affirmed that this type of leader highly motivates their followers and demonstrates devotion by articulating and conveying a clear vision, which frequently appeals to followers' higher concepts and values.

According to Nel and Werner (2014:302), a transformational leader serves as a role model, coach, and inspirational figure, encouraging employees and other stakeholders to joyfully contribute to the organisation's goals. Based on Khajeh (2018:3), transformational leaders develop personalised relationships with employees that create a climate in which people are satisfied and, as a result, perform better overall.

2.3 Autocratic leadership style

Robbins and Coulter (2016:525) defined autocratic leader as a leader who makes unilateral decisions, imposes work procedures and does not allow or limit employee participation. The autocratic leaders expect their subordinates to work based on their instructions. This type of leader promotes one-sided conversation and lacks creativity (Khajeh, 2018:5). Puni, Ofei, and Okoe, (2014) described autocratic leadership style as leaders who focus more on performance and less on people while keeping track of followers' mistakes. Edem (1998) as cited by Akor (2014:149) provide a summary of the characteristics of an autocratic leader;

- The leader dictates procedures and policies with no or little participation in decision-making from the subordinates.
- Tasks and methods are imposed on the subordinates
- There is a lack or no communication between the group and the leader
- The leader is always suspicious and nagging.

Autocratic leadership style is characterised by the leader centralising decision making power, and reluctance to share authority, position and power with the members of the team (Akor, 2014:149).

2.4 Employee engagement

Employee engagement is the most recent trend that is drawing attention to an organisation's succession in this competitive edge. Organisations with employees who are highly engaged generate more revenue than organisations with employees who are disengaged (Barik & Kochar, 2017:33). Shahid and Azhar (2013:252) added that employee engagement plays a major role to ensure that a business succeeds.

“Employee engagement is when employees are connected to, satisfied with and enthusiastic about their jobs” (Robbins & Coulter, 2016:466) and (Dessler, 2013:683) added that they show commitment and dedication. Leaders that are engaged proactively coach their employees and give them a room to develop and grow (Nel & Werner, 2014:281). Rees and French (2015:237) posited that engaged employees can lead to both organisational success and employee well-being. Dessler (2013:45) identified employees that engaged as those who invest both physically and mentally in their work and contribute to the success of the organisation. Shuck and Herd (2012:160) supported the view that when you develop a high level of employee engagement it will result in cost and benefit.

It is important to make sure that leadership exhibit actions that foster engagement and support activities that include ensuring that employees have a better understanding of how their department, contribute to the success of the organisation, have a clear picture of how their effort have an impact on achieving organisational goals and get a sense of accomplishment from working at the organisation (Dessler, 2013:352). “When engaged in their work, employees find meaning and excitement in the work they perform and go beyond role expectations and job descriptions, an antecedent of employee engagement” (Shuck & Herd, 2012:160). Kriemer (2019:28) stated that leaders need to foster an environment in which people feel valued regardless of their role.

Attridge (2009) contended that a high level of work engagement occurs when employees are involved in, committed to, and enthusiastic about their jobs. Das and Mishra (2014:75) added that most researchers describe employees who are engaged as those who are actively involved in their work, concentrated on what they are doing with full energy, they lose track of time as they are very focused. According to Robinson (2012:2), “Gallup researchers show that there are three types of employees:

A. Engaged

Employees work with passion and feel a profound connection to their company. They drive innovation and move the organisation forward. As depicted on figure 2.2.

B. Not-engaged

Employees are essentially ‘check out’. They are sleepwalking through their workday, putting time – but not energy or passion into work.

C. Actively disengaged

Employees are not just unhappy at work; they are busy acting out their unhappiness. Every day, these workers undermine what their engaged coworkers accomplish”.

3. Research methodology

The researcher adopted a quantitative approach to reach the study objectives. According to Bless, Higson-Smith and Sithole (2018:16), the quantitative approach depends intensively on statistics and numbers in the analysis and interpretation of findings from the population that can be generalised. The researcher chose a quantitative approach as the population was too large and the sample was drawn so that the findings can be generalised. Kumar (2014:14) reported that “the quantitative approach is rooted in the philosophy of rationalism; follows a rigid, structured and predetermined set of procedures to explore; aims to quantify the extent of variation in a phenomenon; emphasises the measurement of variables and the objectivity of the process; believes in substation based on a large sample size, gives importance to the validity and reliability of findings and communicates findings in an analytical and aggregate manner, drawing conclusions and inferences that can be generalised.” The data was collected using a survey questionnaire after adhering to all of the protocol and permission requirements. The respondents' responses were evaluated using a five-point Likert scale.

4. Findings and discussion

Reliability

Cronbach's Alpha coefficient was used as a measurement to determine the data's reliability. The Cronbach's Alpha values for transformational leadership and autocratic leadership were .712 and .726 respectively and the Cronbach's Alpha values for employee engagement was .971. An alpha of 0.70 or higher is considered acceptable in most social science research.

Table 1: Descriptive analysis of variables

	Autocratic	Transformational	Employee engagement
Means	2.55	3.47	2.93
Standard deviation	1.30	1.31	1.33

Table 1 shows that transformational leadership and employee engagement had the highest mean, while the standard deviations for all variables were nearly the same. This reflects that the majority of respondents believed their leaders exemplified a high level of transformational leadership, which increased employee engagement.

Table 2: Regression analysis

		B	Beta	t	Sig
1	(Constant)	1.339		2.668	.000
	Transformational	.571	.497	3.821	.000
	Autocratic	.072	.071	.617	.539
a. Dependent Variable: Employee engagement					

The beta values for transformational leadership styles was .571 as shown in table 2. This shows that there was a moderate positive relationship between transformational leadership and employee engagement, which is significant at a 5% level. The autocratic leadership beta value was .072 with a statistically insignificant value of .539 which was greater than 0.05. Although autocratic leadership can play a role in increasing employee engagement, the relationship has shown insignificant. This means that transformational. The findings indicate that transformational leadership style contribute highly to

employee engagement and the relationship is significant. Furthermore, the find no relationship between autocratic leadership style and employee engagement.

5. Conclusion and recommendation

The present study was designed to determine the effect of transformational and autocratic leadership style on employee engagement. The results of this investigation show that transformational was found to have a positive relationship with employee engagement. Furthermore, the findings indicated a negative and insignificant association between autocratic employee engagements. These findings reaffirm the low level of employee engagement that exists around the world. In conclusion, organisations that place a greater emphasis on selecting appropriate leadership styles are more likely to have a higher level of employee engagement and a motivated workforce eager to go beyond to achieve business objectives.

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Competitive survival and business model adaptability during Covid-19. A case of the microfinance sector in Zimbabwe

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Abstract. The study explored how adaptations to the business models of micro-finance institutions resulted in competitive survival during the covid-19 period. For the players in this sector to survive, some adaptations or innovations around the business model were made. This study was mainly interested in establishing the exact adaptations and the impact of those adaptations to the business model on the competitive advantage of the firms during this period. The population for this study included all the non-banking micro-finance institutions in Zimbabwe totalling 209. A sample of 132 was derived using Krejcie and Morgan 1970 sample size table. A questionnaire was used to gather data from the respondents and it was administered online due to travel restrictions. A response rate of 37% was garnered and this was deemed very reliable as the total acceptable response rate of online surveys is often ranging from as low as 20%. Data analysis was carried out using IBM's Statistical Package for Social Scientists (SPSS). The results revealed that there is a direct but weak correlation between business model and competitive survival and this was realised to be as a result of lack of unique resources and absence of dynamic capabilities. Only 18% change in competitive advantage was as a result of business model innovations carried out during this period. It is therefore the reason why the majority of these micro-finance institutions have been finding it very difficult to survive. It was recommended that for them to effectively innovate the business model so as to realise great changes in competitive advantage under hostile external environments, these institutions should acquire unique resources. These should include technological resources which would allow them to develop dynamic capabilities required for effective absorption, adaptation and innovation.

Keywords: *Competitive Advantage, Survival, Business Model Adaptations, Covid-19, Organisational Resources, Dynamic Capabilities*

Introduction

Nearly everyone was unprepared for the unanticipated Covid-19 outbreak, and organizations had to work swiftly to adjust their operations to the new situation. The lockout and other such measures disrupted every part of a company's operations, making it necessary for some business models to vanish overnight and for the necessity to survive to become a reality. Those that exhibited innovative dynamic abilities were the ones who immediately adjusted their business strategy to the new standard. The reality on the ground revealed, exactly one year after the epidemic began, that organizations must be able to innovate around their business model in order to foster competitive survival throughout all stages of value creation, value appropriation, and value capture.

In order to establish competitive survival during the COVID-19 epidemic, participants in the microfinance sector in Zimbabwe sought to change their business models in this study.

The Covid-19 pandemic and its associated measures such as total lockdown, working from home, social distancing and travel restrictions, among many others, have completely disrupted the operations of businesses globally (Ibarra, Bigdeli and Igartua, 2020). The impact of the pandemic's associated measures threatened the existence of businesses and almost all companies struggled to survive. This was even worse for the already struggling entities with the SMEs sector being the most affected due to the delicacy of their operational models. The pandemic came at the beginning of 2020 making it more difficult for most enterprises to cope with the sudden turn of events (ZAMFI, 2018).

The measures put by government and other officials to curb the spread of the disease disrupted the existing business models for most SMEs in the micro-finance sector in Zimbabwe. Traditionally, these were the brick and motor companies who would do most of their activities physically with all the business being done at the office. The imperative to find new ways of doing business become an urgent task for management. It became very much difficult for the business to continue with operations as they couldn't have access to the offices and their clients could not be reached as well.

Reaching out to customers was made impossible as the pre-covid-19 business models didn't have any means of interacting with the customers for the majority of the micro-finance sector. The revenue streams were cut, the companies couldn't create new business and the existing financial resources couldn't meet the company's overhead costs. Faced with six months of business closure, the majority of businesses closed shop and others downsized in order to minimise the damage to the business. As other companies took advantage of the pandemic to grow their business adapting their business model, others failed to survive due to the rigidity of their business models (Ibarra, Bigdeli and Igartua, 2020).

Literature review

In this section, the study reviews literature on business model innovation (BMI) and competitive survival (CS) in the context of Covid-19 in Zimbabwe's microfinance sector. Briefly, BMI adaptability depends much on two key issues namely dynamic capabilities and organisational resources (Clauss *et al.*, 2019). The study also looks into the role of technology in influencing business model adaptability. Technology plays both the role of a resource as well as that of an enabler (Chesbrough, 2007). As some organisations adapt their business models in anticipation to changes in the external environment, others fail to predict such changes due to the nature of their capabilities (Wirtz and Göttel, 2014).

Implications of Covid-19 measures on business operations

Micro-finance institutions fall within the SMEs category according to the classification by the government of Zimbabwe (SMEs Policy, 2010). Generally, SMEs are often hard-hit by various challenges with funding being one of the most common ones. Most SMEs in Africa are constrained by lack of financial support, poor management, corruption, knowledge limitations among many other challenges (Tembo, 2020). The emergence of Covid-19 and the associated measures aimed at curbing its spread has grossly disrupted the normal flow of businesses globally (ILO, 2020).

The disruption of global supply chain has not spared microfinance institutions in Zimbabwe as the majority of their services to the market depend much on the free movement of goods, services and people in the economy. Survival becomes a real challenge for the MFIs in Zimbabwe considering that they were already operating in a hostile macro-economic environment with hyper-inflation (ZAMFI, 2020a). There was a sharp decline in the aggregate number of customers in the second and third quarter of 2020 due to the total lockdown of the economy (ZAMFI Report, 2020b).

The sector witnessed a decline in its revenue streams by more than 50% between March 2020 and December 2020 mainly due to disruption of its usual customer base (RBZ, 2021). Micro-finance institutions normally thrive on the manufacturing sector, especially on SMEs who will be seeking to recapitalise their operations. The lockdown therefore indicates that there has been little or no borrowing from the manufacturing sector as there has been no production going on.

Globally, business volumes went down by over 30% with most industries operating below their usual levels. There has been over 300 million job losses in a space of 6 months in 2020 as a result of lockdown measures (ILO, 2020). The situation has been worse in developing countries such as Zimbabwe where declining GDP in 2020 meant the MFI sector had little to get from the market (Ministry of Finance and Economic Development, 2020). At global level, even large corporates found it very difficult to adjust their organisations to the demands of the pandemic (Furstenthal and Roth, 2020). According to Bar Am et al (2020), the majority of organisations indicated that they are having a difficult time adjusting their operations to the disruptions caused by covid-19.

Business model innovation

The ability of the organisation to respond to the changes in the external environment would give it an edge over its competitors and allows it to forge survival (Amit and Zott, 2012). Scholarly literature is laden with both theoretical and empirical evidence of organisations that have either folded as a result of a rigid business model or of others that have realised great success due to their ability to adapt their business model in response to disruptions from the external environment (Evans *et al.*, 2017). The collapse of global companies like Blockbuster and the rise of Netflix all reflect the implications of an organisation's ability to adapt its business model.

Organisations should have the right combination and configurations of resources and capabilities that can help them transform their business models when faced with operational challenges in order to create new opportunities and new value for its customers (Clauss *et al.*, 2019). Dynamic capabilities are central to the development of a new business model as they represent the means by which the business can sense, seize and transform new opportunities in the market (Latifi and Bouwman, 2018). Competitive survival is highly dependent on smooth adaptation to the forces of change in the industry and being proactive rather than reacting to situations (Peregrino de Brito and Artur Ledur Brito, 2019). As technology has brought about serious changes in the business world and leaving a lot of casualties due to failure to adapt to changes in the market environment, the Covid-19 pandemic has been too much a burden for most organisations, big or small.

Challenges facing the Micro-finance institutions in Zimbabwe

The underperforming Zimbabwean economy has made it difficult for the microfinance sector to survive for a number of years. As has been observed in numerous instances, the microfinance sector performs exceptionally well in struggling economies because most individuals and small enterprises would be looking for financial support to augment their incomes. Since 2000, the microfinance industry in Zimbabwe has faced significant difficulties that have forced many businesses to close and others to expand. Due to the usage of a stable currency like the dollar during the multicurrency period from 2009 to 2016, the sector was able to experience significant growth. The pandemic struck at a time when the majority of industry participants were dealing with significant difficulties in running their businesses in a climate of inflation.

On average, 20% of registered microfinance institutions often don't survive past their first five years of operation (ZAMFI, 2018). Different issues in the industry take diverse forms, but they always call for a comprehensive strategy from all interested parties (Mago, 2017). The pandemic presented most firms with an unprecedented challenge, and the majority of SMEs had to deal with the difficulties of functioning outside of their typical business surroundings. In order to restructure competitive survival during the COVID-19 pandemic, players in the microfinance sector in Zimbabwe modified their business models, which is the focus of this study. The study's initial goal is to measure the effects of Covid-19 on the functioning of Zimbabwe's microfinance industry. Second, the study aimed to identify the modifications made to the business model by SMEs in the microfinance industry in response to the influence of Covid-19 on their operations. Third, the study would assess the effects of such modifications on the business's ability to compete successfully.

The bulk of the business models that were in place before the pandemic may no longer be viable given how Covid-19 has impacted industries. Competition will undoubtedly take on a new dimension, therefore knowing how some organizations have changed their business models will be extremely helpful information that can aid others in establishing their own survival through business model innovation.

Objectives

The study is guided by the following objectives:

- To establish the adaptations made to the business model over the years
- To evaluate the implications of such changes to the business model on the competitive survival of the business.

Methods

The study employed a quantitative research design that employed structured close-ended questionnaires in data collection. The population for the study was 209 micro-finance institutions and a sample of 232 was derived using Krejcie and Morgan 1970 sample size table. Participants were selected into the study using random sampling. The data collection was done online and a 37% response rate was attained.

Results

The study looked into competitive survival through business model adaptability in Zimbabwe's Micro-finance sector. The response rate was 37% for the online questionnaire that was distributed via email. According to Morton, Robinson and Carr (2012), some studies with a response rate of as low as 20% would possibly yield more accurate results than those with 80% response rate (Genroe,2019). This depends much on the nature of the study and the technicality and complexity of the subject under study. The majority of the respondents indicated their willingness to participate in the study but could not as they cited the complexity of the subject that was under study. Online surveys are known for producing response rates that are often below 50% and this was even made more difficult due to Covid-19 restrictions which included a partial lockdown and travel restrictions. The acceptable online response rate should be between 30% and 40% which is different from the response for those distributed physically which should be between 60% and 80% (SurveyAnyplace,2018).

Reliability analysis

The study carried out a reliability analysis of the questionnaire that was used in data collection. The Cronbach's Alpha was used to determine the reliability score of the questionnaire.

Table 1.1 Reliability analysis using Cronbach's Alpha

Reliability Statistics	
Cronbach's Alpha	N of Items
.974	60

Source: Study Results (2021)

The reliability score for the study was .974 which is very much acceptable as it is above the lowest acceptable threshold of .600. This indicates that the questionnaire had the desired level of internal consistency and the results could be used as they are accurate measures of what was intended to be measured.

Normality test

The normality test is a measure of whether the data is normally distributed or not so that the right kind of test could be run. It's a requirement for running a regression analysis and if the data is normally distributed, then a linear regression analysis is carried and a Pearson correlation is done. However, if

the data is not normally distributed, then an Ordinal regression analysis is carried out together with the Spearman Rank correlation. So the normality test is a precondition for running a regression analysis.

Tests of Normality						
	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
R	.184	50	.000	.850	50	.000
C	.141	50	.014	.915	50	.002
BM1	.145	50	.010	.932	50	.007
CA	.259	50	.000	.738	50	.000

a. Lilliefors Significance Correction

From the results above, we are mainly interested in the Shapiro-Wilk results and they significance levels are indicating that the score are statistically significant and below .05 which indicates that the data not normally distributed. As a result, the study would do an Ordinal regression and a Spearman correlation analysis to establish the relationship between the variables.

Business model adaptations

The study provides data on the business model adaptations that were carried out by the microfinance institutions over time.

	SD	D	NA/D	A	SA
<i>We regularly utilize new technical opportunities in order to extend our product and service portfolio.</i>	2	22	10	36	30
<i>We are constantly searching for new collaboration partners.</i>	4	20	4	32	40
<i>New collaboration partners regularly help us to further develop our business model.</i>	6	20	8	32	34
<i>We regularly utilize new distribution channels for our products and services</i>	6	22	10	30	32
<i>Constant changes of our channels have led to improved efficiency of our channel functions.</i>	6	20	22	24	28
<i>We consistently change our portfolio of distribution channels.</i>	6	24	12	32	26
<i>We try to increase customer retention by new service offerings.</i>	6	10	10	42	32
<i>We emphasize innovative/modern actions to increase customer retention</i>	8	12	10	34	36
<i>We recently took many actions in order to strengthen customer relationships.</i>	8	12	14	30	36
<i>We recently developed new revenue opportunities (e.g. additional sales, cross-selling).</i>	6	16	14	26	36
<i>We increasingly offer integrated services (e.g. maintenance contracts) in order to realize long-term financial returns.</i>	6	18	18	32	26
<i>We do not rely on the durability of our existing revenue sources</i>	20	10	16	24	30
<i>We regularly reflect on our price-quantity strategy</i>	4	14	10	42	30
<i>We regularly utilize opportunities which arise through price differentiation.</i>	2	16	16	32	34

The table shows that the majority the respondents changed almost all aspects of their business model with creation of new products and services being the most. A total of 40% of the respondents strongly agreed that they sought new collaboration partners whilst 42% said they sought to retain customers by offering new products to the market. Price adjustments was also a very important adaptations made in order to remain competitive in the market. Technology was also harnessed over the years to adapt the business model in the micro-finance sector.

Correlating business model adaptations and competitive survival

The study ran the Spearman correlation since the data was not normally distributed and the competitive survival was the dependent variable whilst business model adaptations were the independent variable. So this was a non-parametric analysis of how BM adaptations influenced competitive survival.

Correlations				
			BM1	CA
Spearman's rho	BM1	Correlation Coefficient	1.000	.422**
		Sig. (2-tailed)	.	.002
		N	50	50
	CA	Correlation Coefficient	.422**	1.000
		Sig. (2-tailed)	.002	.
		N	50	50

** . Correlation is significant at the 0.01 level (2-tailed).

The correlation coefficient in the table shows a score of .422 which is a direct yet moderate correlation between Business model adaptations and competitive survival in Zimbabwe’s microfinance sector. There is a statistically significant relationship between BMI and competitive survival as shown by the *P* value of .002. This basically translates to say that there is a 42% change in competitive advantage as a result of any adaptations made to the business model.

Regression analysis: BMI on Competitive survival

The analysis was mainly concerned with the Pseudo R-Square as shown below of which in this case, the Nagelkerke was considered for the analysis.

Pseudo R-Square	
Cox and Snell	.175
Nagelkerke	.181
McFadden	.058
Link function: Logit.	

The Nagelkerke score was .181 which means that there is an 18% change in competitive advantage of the organisation due to variations or adaptations of the business model. This confirms that business model adaptations were not able to yield much on competitive advantage.

Discussion

The Zimbabwean micro-finance institutions have been faced with a number of problems mostly emanating from the macro-economic environment during the period under study (2016-2020) until 2020. These include a move from the multi-currency regime that was in operation since February 2009 back to the Zimbabwean dollar that was called the RTGS\$. Such changes were so abrupt which disturbed the flow of business in the sector (ZAMFI, 2020). All prices, interest rates, loan repayments and other charges which were pegged in US\$ were now being settled in RTGS\$. This destroyed business in a greater way as it would then become very difficult for the business to underwrite all those losses.

To make matters worse, the newly introduced RTGS\$ was not a reliable currency as it continued to lose its value due to inflation. The business community was called to take drastic measures in order to survive. Accordingly there has been many casualties as majority of the companies were under during the period following the introduction of the RTGS\$ (CZI, 2020). For organisations to survive under such hostile conditions, major adjustments to the business model should be put into place (Clauss *et al.*, 2019). Adaptations to the business model under these conditions don’t normally yield the best results due to lack of preparedness.

Successful adaptations of the business model can only be more effective in yielding competitive advantage for the organisations if the organisation possesses adequate resources and dynamic capabilities (Minatogawa *et al.*, 2020). Possession of unique resources, chief among them, technological resources, are a pillar for successful business model adaptations. Most micro-finance institutions do not possess any special resources which can help them forge capabilities required to quickly transform in response to abrupt market changes (Cull, Demirgüç-Kunt and Morduch, 2018). In a study by the World Bank, possession of technological resources has been seen as an advantage for quick business model adaptations and firms that possess unique technological resources have been found to respond quicker than those without (Cull, Demirgüç-Kunt and Morduch, 2018). Micro-finance institutions in Zimbabwe are found to lack unique resources as indicated by the dominant business model in the industry. The majority of them possess ordinary technological resources but very few have exclusive technology in use in their operations.

Such realisations are the reason why there is only 18% change in competitive advantage as a result of any adaptations in the business model over the years in questions. Organisations that possess unique resources, will always be able to forge dynamic capabilities of sensing, seizing and transformation of market opportunities that are brought by a change in the external environment (Clauss *et al.*, 2019). Competing on superior business model advantage through BMI during hostile market environments was found not to be very common among the micro-finance players mainly because they possess no unique resources or any dynamic capabilities that enable them to anticipate changes in the market. A market that sells homogenous products normally competes on service delivery and this is common of the micro-finance sector in Zimbabwe where their major product is micro-credit (Mago, 2017). The need to be distinct through BMI become more imperative especially when the core value of the homogeneous product is being threatened by rapid changes in external market forces (Mpofu *et al.*, 2013). Micro-credit as a product was under siege due to market volatilities which were being perpetuated by hyper-inflation that got associated with the introduction of the RTGS\$ in 2018 and the re-introduction of the Zimbabwean dollar around 2016.

For business model adaptations to quickly yield results, there is need for the organisations to possess dynamic capabilities which are categorised in three groups namely adaptive capabilities, absorptive capabilities and innovative capabilities and these are fundamental to the development of a competitive advantage for the organisation. Adaptive capabilities are more central to the business model adaptations especially during times of abrupt market changes such as those experienced between 2016 and 2020 in Zimbabwe. These are moulded around the ability to anticipate change and magnitude of its impact on the business's existing model. Such capabilities will always allow the organisation to set some contingency responses to any situation.

The study asked a number of questions on technology as technology were considered more important in business model adaptations due to its double role as resource and as an enabler for business model adaptations. In certain scenarios, business model innovation is allowed to happen through technology as an enabler whilst in certain circumstances, it is a resource that is central to building of capabilities. Lack of technological resources is seen as the key limitations to the extent to which an organisation can adapt to any changes in the marketplace. These are not just ordinary technological resources but rather exclusive technological resources that allow the organisation to compete above the average firm in the industry. The low implication of BM adaptations on competitive advantage in the Zimbabwean micro-finance sector was mainly due to the lack of unique capabilities that are backed by rare technological resources. The major changes in the macro-economic environment between 2016 and 2020 coupled by the disruptions caused by Covid-19 and its associated measures require great dynamism and agility of organisation had to survive.

Limitations

The study explored the impact of business model adaptations on competitive survival of micro-finance institutions in Zimbabwe during Covid-19. It didn't explore the factors that determine the magnitude of BMI adaptations such as organisational resources and dynamic capabilities though these issues are referenced greatly in the article. Future studies should focus on how dynamic capabilities

and organisational resource help shape the magnitude of business model innovation. This would then inform the interested stakeholders on the implications of resources and capabilities on competitive advantage directly. The period under study was chosen mainly because it represents significant changes in the external environment such as currency changes, Covid-19 among others. Future studies should focus on each specific change so that its impact could be quantified in exact terms.

Managerial implications

This study comes at a time when managers and leaders both in business and society are cracking their heads as to how best they can prepare their institutions to remain competitive in the face of harsh external environments. The study is therefore expected to provide some useful insight into how adaptations to the business model of an organisation could bring more impact on its competitive advantage when faced with life-threatening situations. This becomes more important especially in industries that offer homogeneous products as both comparative and differential advantage will not yield much differences. The study tackles issues associated with the possession of unique resources and dynamic capabilities which are essential in promoting realisation of a competitive advantage for the business.

Conclusion

The study reveals that there was a direct but insignificant correlation between the business model adaptations made by micro-finance institutions and competitive survival in the sector between 2016 and 2020. This was mainly due to limited the lack of unique resources and dynamic capabilities as the sector on average offered a homogeneous product using a similar business model. The adaptations to the business model made during this period couldn't result in any significant changes in competitive advantage due to lack of the requisite resources and capabilities that would give the organisations either a differential or a comparative advantage. For the micro-finance players to significantly attain competitive advantage, they need to acquire and be in possession of unique resources that are valuable, rare, imperfectly imitable and non-substitutable (VRIN). These resources should then help them to develop dynamic capabilities which would allow them to absorb, adapt and innovate around any changes in the external environment.

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Impact of covid-19 on sustainable entrepreneurship in Zimbabwe. Case study of green SME's.

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Abstract. The advent of the Covid-19 pandemic has crippled 60% of Green Small and Medium Enterprises (SME's) and some have discontinued operations because they failed to adapt. The study evaluated the effects of the Covid-19 pandemic on Sustainable Entrepreneurship so as to encourage nascent and existing Green SME's to become sustainable enterprises. The study adopted mixed-method approach that includes both qualitative and quantitative components. Using purposive sampling, nine managers of Green sustainable enterprises participated in the qualitative study and data was analysed using content analysis. In the quantitative section, 176 managers and employees were selected using simple random sampling. Quantitative data was collected using a structured questionnaire and analysed using SPSS21. The study findings shows that the effects of COVID-19 has brought on new ways of conducting business, however it has also negatively affected growth of business by reducing sales and reduction in production in most enterprises. Furthermore, lack of funding and formalization has caused some SMEs to close operations. The study recommends SMEs to examine their core strengths, and redefine sustainable business models in a more intensive and timely manner as well as adopt to new technologies. Furthermore, government should consider subsidising Green SMEs in order to fund their operations and also support them through flexible policies in case of pandemics. Furthermore, future studies could focus on factors that influence the growth of small and medium-sized enterprises (SMEs) in other sectors and their sustainability.

Keywords: *Sustainable entrepreneurship, Green SME's, Marginalized communities, Innovations, enterprise*

1. Introduction

The Zimbabwean entrepreneurial sector has been hit hardest by the Covid-19 as most of the players have informal operations. Since the first Covid-19 case was recorded in Zimbabwe on 20 March 2020, the informal sector was the last to get a green light to resume operations. The once were sustainable entrepreneurs had to resort to buying and selling basic goods so as to keep afloat, which disrupted the sustainable enterprise's initiatives as most informal enterprises had resorted to the survival mode

Due to the Covid-19 pandemic, Green SMEs are highly exposed to the negative effects. This study evaluated the impact of Covid-19 on sustainable entrepreneurship efforts by Green SMEs. The results are critical in supporting the survival of these enterprises as this will aid in mitigating the economic systemic impact in Zimbabwe. In addition, the results will stimulate innovations leads to sustainable employment and creation of conditions needed for future growth and resistance to any future global crisis (COMESA Monetary Institute, 2020). Small and Medium Enterprises (SMEs) play pivotal roles in the economic growth and sustainable development of every country (Moore et al., 2008). SMEs are said to contribute more to the economy if they adopt green or -sustainable initiatives. Contrary to conventional entrepreneurship, which primarily focuses on economic profit maximisation, sustainable entrepreneurship's existence builds on the key premise that entrepreneurs are probable to create economic, social, and ecological value by means of their commercial activity (Rank-Martin and Binder, 2015). Based on Rank-Martin and Binder (2015) research, the study will empower the SMEs to be more thoughtful, preserve societal values, protect the environment as well as contribute to the economy.

Covid-19 posed a lot of challenges for the SMEs which put sustainable practices on hold. The public sector was the first to resume operations during the first Covid 19 lockdown. During the first phase of the Covid-19 lockdown, SMEs had less information than before, and the information that they do possess become less and less valuable as unpredictability increases dramatically due to the lockdown measure (Maritz et al., 2020).

The advent of the Covid-19 pandemic has crippled most SMEs including Green SMEs and some have discontinued operations because they failed to adapt. Some of the SMEs lack training on how to adapt in a pandemic to maintain sustainability due to the declining access to education evidenced by the research carried out by Societe Generale (2020). This study focuses on the opportunities and challenges that affected the sustainability of SMEs.

2. Literature Review

2.1. Definition of SMEs

The Ministry of Small and Medium Enterprises and Cooperative Development (2014) defined small business as all registered business enterprises or entities with at most 50 employees and medium enterprises as those business entities with number of employees that range between 75 and 100. Furthermore, the European Union (EU) (2016) defined SMEs as enterprises that employ less than 250 workers, with a turnover of EUR 50 million or less and the total assets not worth greater than EUR 43 million.

2.2. Definition of Green SMEs

Krylova (2021) defined Green SMEs as those small and business enterprises that are dedicated to the environmental sustainability principles in its activities by striving to use renewable resources so as to reduce hazardous environmental consequences emanating from its operations. The above definition meets the guidelines for environmental performance that include production and distribution of new goods and services or traditional products that reduces negative impact of the environment.

FORA (2010) define green business models as “business models which support the development of products and services (systems) with environmental benefits, reduce resource use or waste and which are economically viable. These business models have a lower environmental impact than traditional business models.”

2.3. What is Green Entrepreneurship?

Dubey (2020) stated that Green Entrepreneurship is when a business entity or an individual is involved in business activities that nurtures the adoption of environmental sustainability practices. These include,

among other things, the adoption of a “green strategy” that enhances its business prospects. The business in most cases is aimed at offering a green product or service.

2.4. Justification for focusing on Green SMEs

According to the Eurostat (2014), Green SMES (GSMEs) signifies a win-win opportunity and they are key drivers of green revolution. The GSMEs have a significant impact on both developed and developed economies and the environment. The enterprises are committed to environmental sustainability through innovative green business models that more firms can adopt.

All over the world, SMEs play a crucial role and they are the most common business enterprises. The OECD (2017) report highlighted that in OECD member countries, SMEs are approximately 99 % of all companies and create around 70 % of total employment. The report further stated that in developing economies, SMEs account for 45% of employment and GDP of 33%. In addition, when the unregistered businesses are incorporated, small business provide above 50% contribution to employment and GDP. Similarly, Eurostat (2014) states that in the EU, SMEs contribute to 58.6% value added.

EU/OECD (2016) states that SMEs assists in reducing poverty and at the same time ensures inclusion by providing jobs to the low skilled workers from diverse segments. Some of the inexperienced workers have opportunities for upgrading their skills and some GSMEs provide access to social services and improved access to health care thereby closing the gap in service delivery.

In addition, it is vital to study GSMEs because the Santa Cruz Declaration on Local Green Enterprises (2020) acknowledges the important role that small enterprises perform in solving the global sustainability challenges. The Delhi Declaration on Local Green Enterprises also mentioned that there is now increase attention to focus on entrepreneurial ecosystems in support of green enterprises.

In June 2020, the international policy position with regards to a fair, green and transformative recovery prioritise SMEs, including those operating in the shadow economy, to speed up the private sector switch to greener practices. Likewise, the GEC and SEED organised a global policy roundtable in January 2021 that was centred on COVID-19 recovery & SMEs.

GEC/SEED Policy Roundtable concluded that SMEs are fundamental in driving green innovation, employment creation, green growth, social inclusion and transition to green practices. ILO (2020) reported that COVID-19 has hit Micro, Small and Medium Enterprises (MSMEs) resulting in over 75% suffering a decrease in incomes. The GEC/SEED Policy Roundtable also states that government stimulus packages and public spending is being made accessible to MSMEs and they are receiving minimum support.

In recent years, studies on sustainable entrepreneurship and sustainability have sparked wide interest from various global writers touching on different areas of the issues. According to Shane and Venkataraman (2010), “opportunities identification, evaluation, and exploitation are some of the entrepreneurship is activities entrepreneurs embark on, however, some entrepreneurial activities are a threat to the environment, pose risk to human and animal health, and may cause pollution to the ozone layer and may eventually lead to a global warming effect.”

Studies conducted by the Global debates on Global warming reveal global effects that include climate change, ozone layer depletion, and disruption of aquatic life which have proved that some industrial activities do affect the globe in various ways (York and Venkataraman, 2010). Zimbabwe requires entrepreneurs who are conscious about the environment, society as well as economic contributions, given that the globe is still in a Covid-19 pandemic the enterprises have to acquire the ability to adapt and be sustainable in a pandemic. Southern Africa has experienced some environmental and economic degradation through some entrepreneurial activities which have resulted in soil erosion, pollution, and disease. In Sub-Saharan Africa, climate change, global warming, and rainfall deficit impacted negatively on crop production and food security and reduce national welfare as highlighted by Arndt et al., (2015) and Thompson et al., (2010). A further review of literature exposed sustainable entrepreneurship as a response to social and environmental issues. Sustainable entrepreneurial activities have been known to preserve ecosystems, counter climate changes, improve fresh air supply and agriculture practices, maintain biodiversity and improve economic development in Africa.

2.6. Effects of the Covid-19 on Green SMEs in Zimbabwe

The COMESA Monetary Institute (2020) conducted their first comprehensive report since the Covid-19 pandemic outbreak. The study seeks to dive into the insights on African businesses reactions and outlook to Covid-19. It is one of the first comprehensive survey on the Coronavirus disease (Covid-19) pandemic and its economic impacts across Africa. The study analysed the enterprises reactions and responses made by businesses, and the impact of the Covid-19 pandemic on their businesses. The survey was a product of the African Trade Policy Centre (ATPC) of the United Nations Economic Commission for Africa (UNECA) and International Economics Consulting Ltd and it was administered online for one week in April 2020. The table below shows some of the challenges faced by organisations during the Covid-19 pandemic.

Table 1: Top Challenges faced from highest (1) to lowest (10) by companies by main business sector

Ranking	Goods	Services
1.	Business closed	Lack of operational cash
2.	Lack of operational cash flow	Drop in demand for production/services
3.	Drop in demand for production	Reduction of opportunities to meet new customers
4.	Issues with changing business strategies and offering alternatives product/services.	Business closed
5.	Many workers cannot return to work	Issues with changing business strategies and offering alternatives product/services.
6.	Challenges in logistics and shipping of products	Many workers cannot return to work
7.	Difficulties in obtaining supply of raw materials essential for production.	Decline in workers productivity from working at home
8.	Reduction of opportunities to meet new customers	Challenges in logistics and shipping of products
9.	Decline in workers productivity from working at home.	Difficulties in obtaining supply of raw materials essential for production.

Table 2. Challenges Faced by Company size ranked from 1(highest) to 3 (lowest) by company size

Ranking	Micro	Small	Medium	Large
1	Lack of operational cash flow	Lack of operational cash flow	Business closed	Reduction of opportunity to meet new customers
2	Business closed	Drop in demand for products/ services	Drop in demand for products/ services	Issues with changing business strategies and offering alternatives product/services
3	Reduction of opportunity to meet new customers	Reduction of opportunity to meet new customers	Reduction of opportunity to meet new customers	Drop in demand for products/services

Table 2.1 Source, COMESA Monetary Institute (2020)

The World Bank (2020) report highlighted that the corona virus pandemic caused world-wide health emergency and slowed down economic activities. Zimbabwe was not an exception as the GSMES sustainability was heavily affected. The achievement of some of the United Nations Sustainable Development Goals were also affected by Covid-19 as investment, trade and job creation were disturbed. The impact was worse in third world countries where the growth rate of MSMEs was

threatened significantly. Although there is no well documented number of GSMEs that closed operations in Zimbabwe, a substantial number were forced to close thereby causing high unemployment and economic stagnation. The report suggest that governments, in collaboration with private stakeholders should offer support to ensure sustainability of MSMEs.

The distribution channels used by the GMSEs were affected and this has a negative effect on both the demand and supply sides. Consumers lose their disposable income and the great uncertainty reduced consumption. The OECD (2020) report states that the higher levels of susceptibility and lower resistance levels linked to their size, SMEs were the most affected compared to larger firms.

3.0 Methods

This study adopted a mixed-method approach to data collection. The mixed methods research design allowed collection of both quantitative and qualitative data, integrating the two types of data, and applying unique designs to solve the problem at hand (Creswell and Guetterman, 2021). A survey was done using structured questionnaires on a sample of 176 SMEs randomly selected in the manufacturing sector within Harare, Zimbabwe. Furthermore, purposive sampling method was used to select 9 participants for interviews.

To address reliability and consistency, Cronbach's Alpha was used to show how well items in a set are positively correlated to one another. Cronbach's Alpha that is less than 0.6 are generally considered to be poor, those in the 0.7 range to be acceptable, and those over 0.8 to be good; the closer the reliability coefficient gets to 1.0, the better. Cronbach's Alpha for independent variables and the dependent variable were above 0.70. Data collected was considered to be internally stable and consistent. Tables, graphs, pie charts, line graphs, and frequency tables were used to present the data. Analysis of data was carried out with the help of the SPSS statistical software in order to generate more general notions from the interpretation of raw textual information.

4. Results

4.1 Effects of Covid-19 on Sustainable Green SMEs

From the discussions made by interviews, some cited that COVID-19 has had a good impact on their business's growth because the demand for online services has skyrocketed. The positive effects are also due to some businesses are introducing a click and collect service and partnering with other service providers. What are the effects of COVID 19 on sustainable entrepreneurship? This question looks at the effects of COVID 19 on sustainable entrepreneurship in maintaining and running their businesses. In this question, the study looked at the effects on business that the participants faced during the current settings.

Participant 1: *"The effects of COVID-19 and the changes it has brought on ways of conducting business has negatively affected growth of business by reducing sales and reduction in production in our company. For example, we used to generate USD\$5000 from our small business but now due to limited operating hours we have reduced to close nothing. However, this situation has positively influenced our innovativeness in operations as we have looked at ways of making sells through digital marketing. This is a key issue on sustainability and for that we say the effects of COVID are 50 50 to my business."*

Participant 2: *"Being a manger of a small company that was operating here in Kaguvi recycling bottles COVID 19 has hit hard on us. We have stopped our processes and we cannot embrace technology of having robots pick plastic bottles from the streets it can't. We have lots our customers we supply and since reduced employees to just two people from fifteen workers. We have lost business."*

Participant 3: *"At the beginning of my business I had borrowed money from the bank, now all that capital has been locked in raw materials and equipment. We can't operate, I will not be able to raise funds again in future."*

Participant 4: *“Poverty and lack of funding were barriers that have challenged our operation in Zimbabwe. Covid has since been a problem but for me it has hit hard where economic challenges had already affected so I don’t think either way COVID-19 has affected our businesses maybe just worsened.”*

Participant 5: *“Poverty has made it difficult for me to run a successful business because I cannot sit by and watch my people go hungry and without a home. I had anything I could hand over to them. Finally, I used money and items from my company to help them. It was difficult for me to distinguish between business and non-business expenses, especially in the first and second years. Kids were starting secondary school and needed money to pay their tuition. I took the money from the business and paid the fees. This has affected our sustainability not COVID.”*

Participant 6: *“Government policies have been unstable even before COVID so remove it under COVID it’s a problem on its own. “We have lost our international markets, the customers in Europe has since closed, this is so bad we have lost our links and business.”*

All the participants answered that they had challenges and threats to business sustainability however, some said they have experienced positive effects. The participants had to find threats of business not due to COVID 19 but economic hardships. The table below shows codes to show the effects both negative and positive businesses are facing due to COVID 19.

Code	No. of effects faced by participants	% of the type of effects faced by participant
Poverty and lack of funding	2	30
Government policies	1	15
Lost international markets	2	30
Lost our links and business”	2	30
Personal finance problems	2	30
Capital has been locked	2	30
Limited operating hours	1	15
Lost employees	1	15
Digital marketing	2	30
Innovativeness	2	30
Reducing sales and reduction in production	2	30

Quantitative data was collected using an online structured questionnaire using a 5-point Likert scale and captured using Statistical Package for Social Science (SPSS) version 22 for analysing quantitative data. One hundred and fifteen (115) participants responded to the study. Major components of the research findings were analysed and discussed. The descriptive statistics were prepared by the researcher using frequency tables, graphs and tables for clearer and understanding data presentation (Brink et al, 2018).

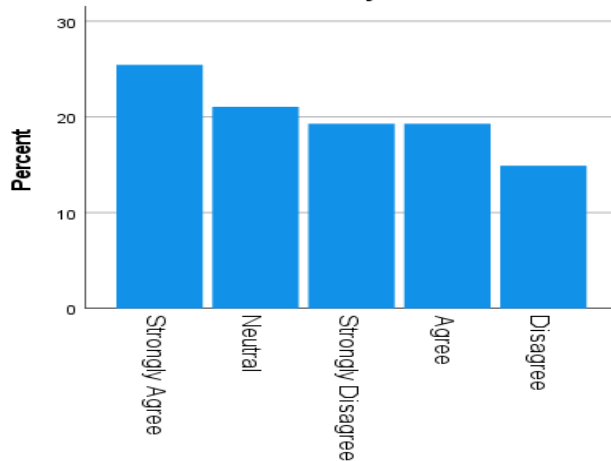
4.2. Assess the effects of Covid-19 on sustainable entrepreneurship.

In order to assess the impact of COVID-19 on sustainable entrepreneurship, through the quantitative data collection instruments, respondents were asked whether COVID-19 has negatively affected their sustainability. As shown on Table below, majority of respondents strongly Agree 25.4% (n=29), followed by those who were neutral (n=24) 21.1%, strongly disagree 19.3% (n=22), Agree 19.3% (n=22), Disagree 14.9% (n=17). This means that there is a statistically significant agreement COVID 19 has negatively affected businesses since $n(114) = 9.12$, $M = 1.457$, 3.17 SD and $p > 0.0005$. The results are presented in Table 4.6 below.

COVID-19 has negatively affected your business sustainability?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Agree	29	25.4	25.4	25.4
	Neutral	24	21.1	21.1	46.5
	Strongly Disagree	22	19.3	19.3	65.8
	Agree	22	19.3	19.3	85.1
	Disagree	17	14.9	14.9	100.0
Total		114	100.0	100.0	

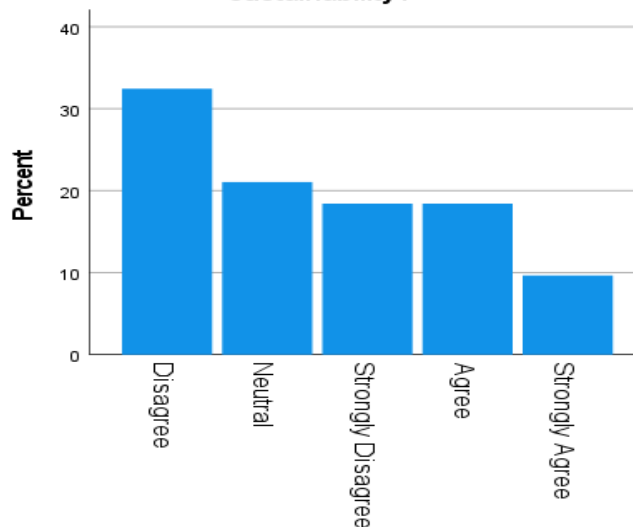
COVID-19 has negatively affected your business sustainability?



COVID-19 has negatively affected your business sustainability?

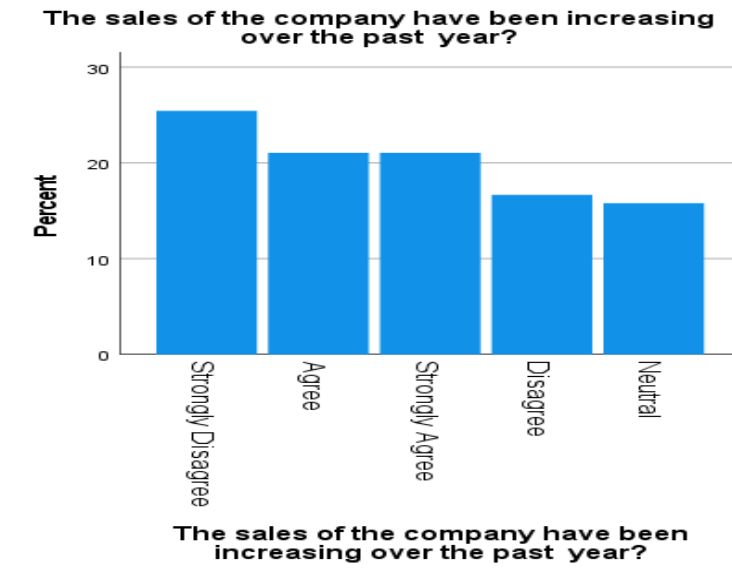
Respondents were also asked to assess whether COVID-19 has negatively affected their business. As shown on Table below, majority of respondents strongly Agree 25.4% (n=29), followed by those who were neutral (n=24) 21.1%, strongly disagree 19.3% (n=22), Agree 19.3% (n=22), Disagree 14.9% (n=17). This means that there is a statistically significant agreement COVID 19 has negatively affected businesses since $n(114) = 9.12$, $M = 1.457$, 3.17 SD and $p > 0.0005$. The results are presented below.

COVID-19 has positively affected your business sustainability?



COVID-19 has positively affected your business sustainability?

From the interviews, one respondent stated that, “COVID-19 has had a good impact on my business's growth because the demand for online services has skyrocketed. We are introducing a click and collect service and partnering with other service providers, despite the fact that we still face logistical challenges due to poor road networks.”



4.3. Effects of Covid-19 on sustainable entrepreneurship efforts by Green SMEs.

4.3.1 Legal context and policy consistency

With regards to the challenges to sustainable entrepreneurship frameworks by Green SMEs during the Covid-19 pandemic, participants were asked to assess legal context and policy consistency as one of the challenges. The majority of participants were neutral with their response as large extent 28.1% (n=32) followed by those who answered not at all 21.1% (n=24) and moderate extent at 19.3% (n=22), very large extent with 16.7% (n=19) and lastly those who answered little extent were 14.9% (n=17). This means that there is a statistically significant agreement that is legal context and policy consistency a significant factors in determining the sustainability of SMEs during a pandemic since $n(115) = 11.01$, $M = 2.35$, $SD = 0.77$, and $p > 0.0005$. The results are presented in Table 4.6 below

		Legal context			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Large extent	32	28.1	28.1	28.1
	Not at all	24	21.1	21.1	49.1
	Moderate extent	22	19.3	19.3	68.4
	Very large extent	19	16.7	16.7	85.1
	Little Extent	17	14.9	14.9	100.0
Total		114	100.0	100.0	

4.3.2. Management’s personal values

With regards to the challenges to sustainable entrepreneurship frameworks by SMEs during Covid-19 pandemic, participants were asked to assess Management’s personal values as one of the challenges. The majority of participants were neutral with their response as little extent and large extent 22.8% (n=26) followed by those who answered moderate extent 21.9% (n=25) and very large extent at 16.7%

(n=19), and lastly those who answered not at all were 15.8% (n=18). This means that there is a statistically significant agreement that management’s personal values contribution is a significant factor in determining the sustainability of SMEs during a pandemic since $n(115) = 11.01$, $M = 2.65$, $SD = 0.967$ and $p > 0.0005$. The results are presented Table 4.6 below

Management’s personal values

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Little Extent	26	22.8	22.8	22.8
	Large extent	26	22.8	22.8	45.6
	Moderate extent	25	21.9	21.9	67.5
	Very large extent	19	16.7	16.7	84.2
	Not at all	18	15.8	15.8	100.0
	Total	114	100.0	100.0	

4.3.3. Socio-cultural context

With regards to the challenges to sustainable entrepreneurship frameworks by SMEs during the Covid-19 pandemic, participants were asked to assess challenges due to the Socio-cultural context. The majority of participants were neutral with their response as moderate and very large extent 23.7% (n=27) followed by those who answered large extent 18.4% (n=21) and not at all 17.5% (n=20), and lastly, those who answered little extent was 16.7% (n=19). This means that there is a statistically significant agreement that there are socio-cultural context challenges contributing to the sustainability of SMEs during a pandemic since $n(115) = 9.01$, $M = 2.15$, $SD = 1.967$, and $p > 0.0005$. The results are presented in Table 4.6 below

Socio-cultural context

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderate extent	27	23.7	23.7	23.7
	Very large extent	27	23.7	23.7	47.4
	Large extent	21	18.4	18.4	65.8
	Not at all	20	17.5	17.5	83.3
	Little Extent	19	16.7	16.7	100.0
	Total	114	100.0	100.0	

4.3.4. Market forces

With regards to the challenges to sustainable entrepreneurship frameworks by SMEs during the Covid-19 pandemic, participants were asked to assess challenges associated with market forces. The majority of participants response was not all, 25.4% (n=29) followed by those who answered very large extent 23.7% (n=27), and little extent at 20.3% (n=23), moderate extent 19.3% (n=22) and lastly those who answered not at all were 11.4% (n=13). This means that there is a statistically significant agreement that there are challenges associated with market forces in determining the sustainability of SMEs during a pandemic since $n(115) = 9.01$, $M = 2.23$, $SD = 1.3967$, and $p > 0.0005$. The results are presented in Table 4.6 below.

Market forces

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all	29	25.4	25.4	25.4
	Very large extent	27	23.7	23.7	49.1
	Little Extent	23	20.2	20.2	69.3
	Moderate extent	22	19.3	19.3	88.6
	Large extent	13	11.4	11.4	100.0
	Total	114	100.0	100.0	

4.3.5. Ownership management structure

With regards to the challenges to sustainable entrepreneurship frameworks by SMEs during the Covid-19 pandemic, participants were asked to assess challenges associated with the Ownership management structure of the firms. The majority of participants response moderate extent, 29.84% (n=34) followed by those who answered very large extent 21.9% (n=25), and not at all 17.5% (n=20), large extent 16.7% (n=19) and lastly those who answered little extent were 14% (n=16). This means that there is a statistically significant agreement that there are challenges associated with the ownership management structure of the firms in determining their sustainability during a pandemic since $n(115) = 8.01$, $M = 3.23$, $SD = 1.67$, and $p > 0.0005$. The results are presented in Table 4.6 below;

Ownership management structure

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Moderate extent	34	29.8	29.8	29.8
	Very large extent	25	21.9	21.9	51.8
	Not at all	20	17.5	17.5	69.3
	Large extent	19	16.7	16.7	86.0
	Little Extent	16	14.0	14.0	100.0
	Total	114	100.0	100.0	

4.3.6. Industry-sector characteristics

With regards to the challenges to sustainable entrepreneurship frameworks by SMEs during Covid-19 pandemic, participants were asked to assess challenges associated with Industry-sector characteristics. The majority of participants response was not all, 27.2% (n=31) followed by those who answered little extent 22.8% (n=26), large extent and very large extent at 17.5% (n=20) and lastly those who answered moderate extent 14.9% (n=17). This means that there is a statistically significant agreement that there are challenges associated with Industry-sector characteristics in determining the sustainability of SMEs during a pandemic since $n(115) = 9.21$, $M = 2.33$, $SD = 1.4967$ and $p > 0.0005$. The results are presented Table 4.6 below.

Industry-sector characteristics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not at all	31	27.2	27.2	27.2
	Little Extent	26	22.8	22.8	50.0
	Large extent	20	17.5	17.5	67.5
	Very large extent	20	17.5	17.5	85.1
	Moderate extent	17	14.9	14.9	100.0
	Total	114	100.0	100.0	

4.3.7. Financing

With regards to the challenges to sustainable entrepreneurship frameworks by SMEs during the Covid-19 pandemic, participants were asked to assess challenges associated with financing. The majority of participants response was not all, 25.4% (n=29) followed by those who answered very large extent 22.8% (n=26), and little extent at 20.2% (n=23), large extent 17.5% (n=20) and lastly those who answered moderate extent were 14% (n=16). This means that there is a statistically significant agreement that there are challenges associated with market forces in determining the sustainability of SMEs during a pandemic since $n(115) = 11.11$, $M = 3.24$, $SD = 1.367$, and $p > 0.0005$. The results are presented in Table 4.6 below.

		Financing			Cumulative
		Frequency	Percent	Valid Percent	Percent
Valid	Not at all	29	25.4	25.4	25.4
	Very large extent	26	22.8	22.8	48.2
	Little Extent	23	20.2	20.2	68.4
	Large extent	20	17.5	17.5	86.0
	Moderate extent	16	14.0	14.0	100.0
	Total	114	100.0	100.0	

4.3.8. Firm size

With regards to the challenges to sustainable entrepreneurship frameworks by SMEs during the Covid-19 pandemic, participants were asked to assess challenges associated with Firm size. More than half of participants response was the little extent, 44.7% (n=51) followed by those who answered not at all 33.3% (n=38), and moderate extent at 21.9% (n=25). This means that there is a statistically insignificant agreement that there are challenges associated with Firm size in determining the sustainability of SMEs during a pandemic since $n(115) = 11.01$, $M = 3.93$, $SD = 1.667$, and $p < 0.0005$. The results are presented in Table 4.6 below;

		Firm size			Cumulative
		Frequency	Percent	Valid Percent	Percent
Valid	Little Extent	51	44.7	44.7	44.7
	Not at all	38	33.3	33.3	78.1
	Moderate extent	25	21.9	21.9	100.0
	Total	114	100.0	100.0	

4.3.9. Adequacy and sufficiency of economic infrastructure

With regards to the challenges to sustainable entrepreneurship frameworks by SMEs during the Covid-19 pandemic, participants were asked to assess challenges associated with the Adequacy and sufficiency of economic infrastructure. The majority of participants' responses was moderate extent 35.1% (n=40) followed by those who answered not at all and little extent at 32.5% (n=37). This means that there is a statistically insignificant agreement that there are challenges associated with adequacy and sufficiency of economic infrastructure in influencing the sustainability of SMEs during a pandemic since $n(115) = 9.1$, $M = 3.83$, $SD = 1.97$, and $p < 0.0005$. The results are presented in Table 4.6 below;

		Adequacy and sufficiency of economic infrastructure			Cumulative
		Frequency	Percent	Valid Percent	Percent
Valid	Moderate extent	40	35.1	35.1	35.1
	Not at all	37	32.5	32.5	67.5
	Little Extent	37	32.5	32.5	100.0
	Total	114	100.0	100.0	

4.3.10. Government intervention

With regards to the challenges to sustainable entrepreneurship frameworks by SMEs during the Covid-19 pandemic, participants were asked to assess challenges associated with Government intervention. The majority of participant’s responses were large extent 35.1% (n=40) followed by those who answered moderate extent 25.4% (n=29), and little extent at 21.1% (n=24), and lastly those who answered not at all were 18.4% (n=21). This means that there is a statistically significant agreement that there are challenges associated with market forces in determining the sustainability of SMEs during a pandemic since $n(115) = 9.12$, $M = 2.43$, $SD = 1.37$, and $p > 0.0005$. The results are presented in Table 4.6 below.

Government intervention

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Large extent	40	35.1	35.1	35.1
	Moderate extent	29	25.4	25.4	60.5
	Little Extent	24	21.1	21.1	81.6
	Not at all	21	18.4	18.4	100.0
	Total	114	100.0	100.0	

5. Discussion

The findings of this study found that the green SMEs were negatively impacted by the Covid-19 pandemic through restricted access to financial capital and markets. The majority of the respondents’ for the survey highlighted that the pandemic negatively impacted on the sustainability of their business. The pandemic impoverished many green business entrepreneurs in Zimbabwe and they find it difficult to sustain their families.

The results of this study confirm with the finding of other researches carried out on similar subject. The COMESA Monetary Institute (2020) found that SMEs were negatively affected by the pandemic through reduced access to operational capital, reduction of opportunities to meet new customers and challenges in obtaining supplies of raw materials essential for business operation. In addition the same study found that SMEs world-wide experienced reduction in the demand for their production as customers’ disposable income was reduced. Workers productivity was also negatively affected. The World Bank (2020) concluded that the corona virus pandemic caused world-wide health emergency and slowed down economic activities of many companies including SMEs.

6.0 Recommendations

(a) Government policy

The government policies should take into consideration introducing incentive that encourages green innovations. Funding initiatives and capacity building in partnership with the trade associations should be put in place for GSMEs. Funding through the private sector should be encouraged through policy and there is need to equip the private financial institution with knowledge about GSMEs and their significance to sustainable development. Public financing institutions should offer soft loan facilities to the green enterprises at favourable interest rates.

They owners and employees of the green enterprises should be equipped with relevant business skills. The Zimbabwe government should invest in training programmes through the line ministry that deals with SMEs. The GSMEs lacks management skills and they also require financial literacy. The government should also provide incubation facilities to the small green businesses so that they grow their businesses. This will help motivating them to invest more in research and development so that more environmentally friendly products can be manufactured for the domestic and international markets.

There should be regulations that support green practices and they should address the needs of the small enterprises. The compliance by SMEs to environmental issues should be very supportive through

making everything clear. In other words, compliance processes should be accessible to green businesses with less amount of documentation and easy to follow information.

(b) Green SMEs collaboration with local authorities

The role that local authorities play in green business innovation cannot be underestimated. They should develop a clear environmental sustainability approach that aids GSMEs to access domestic and international markets, resources and human capital development. Local authorities should create new departments that work the green SMEs. This makes it easy for them to quickly respond to the needs of the SMEs especially during times of the pandemic.

7.0 Future research

Future research can focus on the significance of incubation programmes for developing a conducive environment for green business sustainability. Academic researchers can also look into the skill that the green SMEs are lacking and as such inhibiting their success and sustainability. Furthermore, it is vital to study the policy initiatives that can help reduce the different forms of pollution for existing SMES by promoting green activities.

8.0 Conclusion

In conclusion, as highlighted by results of the study the Covid-19 did not just present challenges to Green SMEs it also presented great opportunities for the enterprises that were quick to adapt to the new normal. Sustainable Entrepreneurship offers a well-rounded approach for organizational strategic development. Functional sustainable entrepreneurship contributes to the Zimbabwean economy and will add value to humanity, communities, and the environment as well as contribute significantly to economic development. The current efforts by most informal businesses are not sustainable for the Zimbabwean economy which is still recovering from the recession. The Covid-19 lockdown will inevitably pose a disruption of economic activity at a point when the Zimbabwean economy is already experiencing a significant slowdown. In responses from Green SMEs highlighted that enterprises responsiveness can determine the impacts of the Covid-19 pandemic and each organisation experienced the pandemic differently.

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Business Model Innovations (BMI) by Small and Medium Enterprises (SMEs) during Covid 19 Pandemic. Case of Harare, Zimbabwe

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Abstract. The Business Model Innovation (BMI) concept has gained increased attention in recent years and has been seen as essential for company's growth and survival. Since Covid 19 (CV-19) pandemic, SMEs have been the most vulnerable because of restrictions and regulations by which have affected company's income. This study explores empirically the BMI by SMEs during the CV-19 pandemic. A quantitative descriptive approach was used to carry out the study. It was discovered through the study that the CV-19 pandemic had dire impact on SME operations and also that has led most SMEs to carry out adaptive BMI in order to survive the effects of the pandemic. Findings from research allow understanding the nature of business model innovations by SMEs in Zimbabwe during CV-19 pandemic. Therefore, this research helps to further advance BMI theory through exploring the concept in a practical and disruptive situation like CV-19.

Keywords: *business model, business model innovation, Covid 19 pandemic, small to medium enterprises*

1. Introduction

The outbreak of Covid-19 (then after CV-19) pandemic in various parts of the globe has given serious impact on health and economy in terms of trade, investment and tourism. However, since the covid-19 pandemic started, SMEs have been more vulnerable compared to large business. The crisis caused by the covid-19 pandemic has become the proper moment for SMEs to enhance the standard of their products or services and to develop various strategies for offering goods or services supported by their business' concern. This study seeks to appraise Business Model Innovations by SMEs during the Covid 19 pandemic. Specifically, the study focused on SMEs in Harare, Workington area and deliberately excluded other SMEs in other parts of the country. Furthermore, the study covers the period from March 2020 to current prevailing CV-19 environment. This research study makes contributions towards empirical knowledge and understanding on business model innovations that SMEs have engaged in to survive in this turbulent business environment.

According to Magaisa and Matipira (2017), "The SMEs of the Ministry of Micro, Small and Medium Enterprises in Zimbabwe represent between 80 and 90% of the country's workforce, while contributing at least 60% of Zimbabwe's GDP". Despite this contribution, Zimbabwe has one of the

largest informal economies in the world, surpassed by Bolivia (Medina & Shneider, 2018). Therefore, a great deal of effort is needed to manage the survival and growth of small businesses, especially in the CV-19 pandemic. Musvanhiri (2020) in an article titled Coronavirus: Zimbabwean companies count the cost of economic impact; It notes that the coronavirus outbreak has affected small businesses in Zimbabwe and that Zimbabwean entrepreneurs were struggling to get supplies from China. The closure of factories in China has had a serious impact on their profits. SMEs are expected to get worse if they don't adopt new strategies. Kraus et al. (2020) identified temporary business model innovation (BMI) as a possible solution to recover from the crisis. If a BM innovates through substantial changes within the elements and / or their configuration (Foss and Saebi, 2017), new opportunities are faced that increase the company's performance and should help SMEs recover.

There is an incessant debate on the differences between business models and strategy concepts (Frijs et al., 2015) as most researchers use these two terms interchangeably (Magretta, 2002). However, the business models and strategy have distinctive characteristics. The business model refers to the logic of the company, its operations and how it generates value for shareholders. The strategy refers to the selection of the business model that the company uses to compete in the market and describes how the company manages its competitors and its external environment (Magretta, 2002; Casadesus-Masanell & Ricart, 2010). Zott and Amit, (2008) and Frijs et al., (2015) agree that the concepts of business model and business strategy are complementary rather than the same.

The BMIs were classified according to the origin of the innovation, the degree of innovation or its novelty. Environmental forces such as a generally increasing rate of development, globalization, technological developments, deregulation and growing interest in sustainability issues have sparked interest in business model innovation, Wirtz et al. (2010). Various definitions by the authors refer to business model innovation as a change in the structure of the entire business model or individual elements of it, either as a reaction to opportunities or challenges in the organization's environment or as a vehicle for diversification. and innovation, (Geissdoefer et al, 2018). Spieth and Schneider (2016) conceptualize business model innovation as a "new to the company" change that affects at least one of the three dimensions of the business model: value offering, value creation architecture, and model logic. According to Fossi and Saebi, (2016) highlight that there are four lines of research on BMI, namely, the conceptualization and classification of BMI; IMC as a process; BMI accordingly; BMI and organizational implications. Overall, the BMI literature includes notable differences in the definition and conceptualization of the key construct which can be seen as a feature of emerging research. The available literature recognizes that BMIs can differ in terms of at least two dimensions. The first dimension sought in the literature is the degree of novelty of the BMI. Some academics highlight BMIs that are new to a company (although not necessarily new to an industry), for example Bock et al., (2012); Johnson, Christensen and Kagermann, (2008). Another relevant dimension researched in the literature is the scope of BMI, i.e. how much of a BM is affected by a BMI. At one extreme, BMI can only affect one component, such as the value proposition; at the other extreme, it can involve all the components of the BM and the architecture that unites those components (Amit & Zott, 2012; Schneider & Spieth, 2013).

Foss and Saebi (2016) evaluate BMI in terms of "scope" and "novelty". They distinguished four types of BMI which are evolutionary BMI, adaptive BMI, focused BMI and complex BMI. Although the core elements of BMI - the steps presented in most of the articles - are somewhat different, it was noted that they could be grouped into six main steps which can be traced back to the general literature on business model innovation. These steps are: conception, feasibility, prototyping, decision making, implementation and sustainability (Wirtz and Daiser, 2018).

There are three generally agreed components of BMI which are: value creation, value delivery and value acquisition. The value creation dimension of the business model describes what is offered to the customer (Parida, Sodan & Reim, 2018). Value delivery describes how activities and processes are used to deliver the promised value. Revised business models may often require the development and application of new capabilities (Raichinger et al.). New business models require the review of operational processes and activities for global delivery. Value capture is the third component of the

BMI and refers to the income model and its financial viability, with particular attention to possible sources of income and cost structure, Parida et. al, (2018).

According to Foss and Saebi (2016), the BMI literature includes significant differences in the definition and conceptualization of the key construct, which is the first gap in the literature. Many authors agree with this effect, as the various definitions of BMI given also demonstrate. The second gap is in the matching and identification of background and BMI results. The BMI theorization must clearly identify the antecedents and consequences of the focal phenomenon. Andreini and Bettinelli, (2017) agree that future explorations related to skills, cognition and context emerge as areas where potentially interesting developments are found. Huang et al. (2012), for example, point out that BMI occurs when the company observes and responds to environmental and customer-related changes. Contingency and moderation variables are another gap that needs to be addressed in future research. Numerous contributions to the BMI literature indicate the role of organizational skills, leadership actions and learning processes in achieving BMI, leaving out other organizational literature. This gap also includes examining the role of organizational skills and leadership, the role of learning and experimentation, the role of cognition (eg Aspara et al. (2013). Finally, most studies on BMI examined are qualitative in nature; offering a rich understanding of the phenomena in question. However, the use of additional methods will advance the investigation considerably. Furthermore, with the information obtained, researchers must continue to recognize the importance of translating the practical information (Daspit, 2017).

The COVID-19 pandemic has severely affected small and medium-sized businesses around the world due to government-mandated and recommended closures and working time cuts in an effort to slow the spread of the virus. It has been found in various studies, for example (Mazikana, 2020; Chaora, 2020) that maintaining business operations has been difficult for SMEs around the world, especially in developing countries such as Zimbabwe. Syriopolous, (2020) stressed that most SMEs should also close their businesses after CV-19, provided they have limited financial capacity and a high level of operational risk due to their small size. Shortages of goods or supply disruptions were a major challenge highlighted in most of the studies. There have been supply chain disruptions, especially for those relying on imported products. Brown and Rocha, (2020) said the blockade caused an exponential decline in global economic activity, as evidenced by a rapid decline in production, supply chain challenges, and a decline in global trade. Another challenge faced by SMEs is that of operational challenges and the risk of business closure in order not to stay afloat due to the restrictive measures imposed by the government as a way to reduce the spread of the coronavirus. Fairlie, (2020) documented that the CV-19 pandemic crisis caused long-term economic challenges related to lower start-up rates, a sharp rise in unemployment rates and a drop in demand that reduced SME growth prospects.

However, the CV-19 pandemic has been a catalyst for digital marketing. Most SMEs have moved from traditional marketing to digital marketing platforms, for example WhatsApp and Facebook, Mazikana (2020). Baldwin & Di-Mauro, (2020) stressed that SMEs using digital technologies such as e-commerce are strategically positioned to adapt to the CV-19 pandemic crisis. Some SMEs have seen opportunities in other industries and have diversified their operations ever since. For example, there has been a sharp increase in demand for reusable masks, hygiene products such as soaps, disinfectants, towels and other hygiene products, Chaora, (2020).The objectives of this study are:

- i. To assess how CV-19 has affected survival and growth of SMEs.
- ii. To investigate the nature of business model innovativeness in SMEs in Zimbabwe during CV-19.

2. Research Design and Methodology

This study took a philosophical view of pragmatism. This is because it emphasizes functional knowledge and understanding. Furthermore, this research philosophy allows the researcher to use any combination of methods necessary to find answers to research questions. This study adopted the quantitative descriptive research design that (Creswell, 2014). The descriptive design was chosen

because its aim is to describe the current situation and innovations of the SME business model during the CV-19 pandemic. This design was used because it allowed the researcher to access sufficient data of the appropriate richness and depth from a manageable size of the population of employees and owners of SMEs.

According to Boyle (2016), a total population comprises of all individuals in a group from which the sample might be drawn. The population of this research study was made up of management and owners of SMEs in Harare specifically operating in Workington area.

Variable		Frequency (n= 131)	Percentage (%)
Gender	Male	86	65.6
	Female	45	34.4
Position	Owner	38	29.0
	Director	34	26.0
	Manager	34	26.0
	Supervisor	25	19.1
Sector	Manufacturing	31	23.7
	Retail	35	26.7
	Food and agriculture	26	19.8
	Minning	8	6.1
	Clothing and textile	3	2.3
	Hospitality	4	3.1
	Hardware & Construction	20	15.3
	Transport	4	3.1
Years in operation	1-3 years	51	38.9
	4-6 years	35	26.7
	7-10 years	22	16.8
	over 10 years	22	16.8

The research study used the method of non-probabilistic sampling, which implies that the possibility that each representative is selected from the entire population is unknown and offers a variety of possible techniques for defining the samples, based on the judgment of the researcher (Saunders , Lewis and Thornhil, 2016). The non-probabilistic sampling techniques used in this study are convenience sampling and intentional sampling. Intentional sampling allows the researcher to identify, select and collect various cases of information related to the phenomenon of interest (Palinkas et al., 2015). Convenience sampling is defined as a method adopted by researchers in which they collect market research data from a conveniently available group of respondents (Palinkas et al., 2015).

In this study, a sample size of 150 participants who are in SMEs were studied and the sample size was derived using the Cochran formula. Boddy (2016) concluded that the larger information power the sample holds, the lower number of participants is needed, and vice versa. The major research instrument used for data collection in this study were questionnaires segmented in three sections focusing on demographic information and business profile information, quantitative questions and open-ended questions respectively. The questionnaires were targeted to both the owners and employees of SMEs in strategic positions, and where these are were not available, supervisors or second in command participated. Also the questionnaires were self-administered.

The researcher carried out a pre-test with the respondents who are in the SME sector through a convenience sampling. The pre-test method used was interviewee questioning. This allowed the researcher to clarify any doubts to the participants. The Cronbach alpha test and the Kaiser-Meyer-Olkin (KMO) test and the Barlett test were performed on the questionnaire to ensure the validity and reliability of the research. The data was analyzed using IBM SPSS version 25 and content analysis. Examples of tests performed include the paired Pearson correlation analysis which was performed to determine the degree of correlation between variables, regression, and ANOVA testing.

The research was approved by the ethics committee of a highly recognised tertiary institution in Harare, Zimbabwe. A number of ethical considerations were employed in this study which include free and informed consent; autonomy and voluntariness; integrity and confidentiality.

3. Results

Table 1.1: Response rate *Source: Survey Data 2020*

Respondents	Sample Size	Number of Responses	Response Rate
Total	150	131	87%

Source: Survey Data 2021

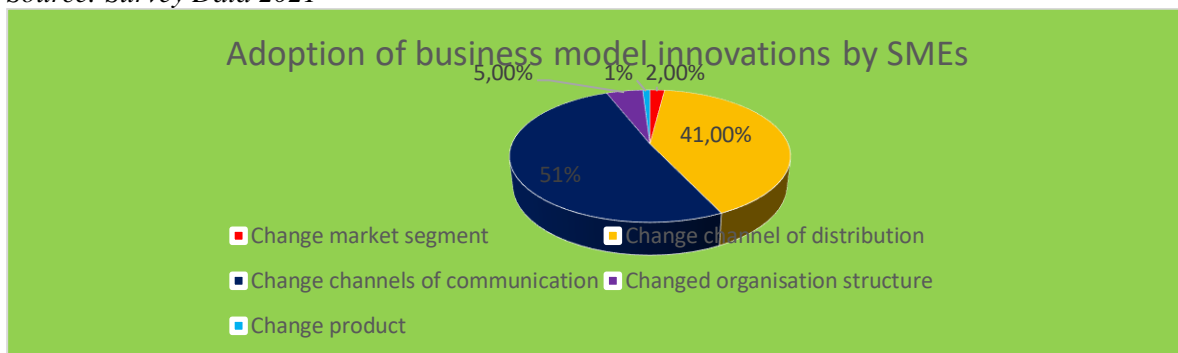


Figure 1.1: Adoption of Business model innovations by SMEs *Survey Data (2021)*

Analysis of responses on Impact of CV-19 on Revenues and Impact of CV-19 on Cashflows

Impact of CV-19 on Revenues and Impact of CV-19 on Cashflows was tested using the regression analysis where the coefficient value of 0.774 was generated showing that Impact of CV-19 on Revenues had an influence of 77.4% on affecting the outcome on the dependent variable Impact of CV-19 on Cashflows This finding shows that 22.6% influence on impact of Covid 19 on cashflows can be explained by other factors which can be the basis for future studies. The results from the questionnaire are also consistent with the views expressed in interviews where most interviewees expressed the view that Covid-19 has seriously impacted and their revenues and consequently, their cash flows have also suffered. The findings are supported by literature that states that, organizations across the globe have either completely shut-off or partially closed significantly impacting on the revenue generation of the firms and cashflows according to Washington, (2020) as cited in literature review.

Regression Analysis of responses on impact of CV-19 on profits and impact of CV-19 on operation costs

Furthermore, the study aimed at investigating the influence impact of CV-19 on profits and impact of CV-19 on operation costs. Responses gathered are presented on figure 4.4 as seen on the output diagram from the SPSS version 25. The coefficient value of .416 was generated showing that the impact of Covid 19 on profits influence operation costs of SMEs by 41.6% with 58.4% influence being accounted for by other factors not covered in the present study thus presenting an opportunity for other researchers to investigate on these factors. The findings entails that in as much as SMEs improve on profitability in light Covid 19, this will result in a positive improvement of operation costs by 41.6% coefficient level. The findings are supported by literature where several scholars including Askdin (2020) and Washington (2020) Covid 19 significantly affected profitability of organizations which also had a direct effect on operation costs as most firms were either operating at below capacity or not at all. Fixed costs however still required to be paid which seriously dampened the future of

SMEs. To reduce the burden of Covid 19 on operations costs, SMEs have to improve on their profitability so that operation costs can be effectively covered.

Analysis of responses on Impact of CV-19 on Customer base and Workforce

Analysis of responses on Impact of CV-19 on Customer base and Workforce generated a coefficient value of .526 showing that the role played by Covid 19 on Customer base has an influence of 52.6% in affecting workforce leaving 47.4% influence to be explained by others factors not covered in this study. On this basis this lays a foundation for future studies to investigate on the other factors accounting for 47.4% influence. Impact of CV-19 on Customer base is positively related to workforce availability this was supported by Kumar (2021) who states that Covid 19 completely shut off the customer base for most organizations, consequently the workforce that is needed on several organizations has also declined.

Table 1.3: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.062 ^a	.004	-.026	1.651

a. Predictors: (Constant), Adopt any of the following BMI

ANOVA^a

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.352	1	.352	.129	.721 ^b
	Residual	89.933	33	2.725		
	Total	90.286	34			

a. Dependent Variable: Stopped Operations; b. Predictors: (Constant), Adopt any of the following BMI

Coefficients^a

Model		Unstandardized Coefficients		Standardized	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.367	1.445		2.330	.026
	Adopt any of the following BMI	-.145	.403	-.062	-.360	.721

a. Dependent Variable: Stopped Operations

Regression analysis conducted on the stoppage of operations and adoption of Business Model Innovations generated an F- Value of 0.129 on ANOVA given that all the values ranging from 0.000 to 0.5 show existence of the relationship. The researcher found out that there is a significant relationship that exists between stoppage of operations and the adoption of BMI. Acceptance of the relationship was shown by the F-value of 0.129 that was significant at 5%. The findings entail that in as much as SMEs improves on their operations, the adoption of BMI will also increase.

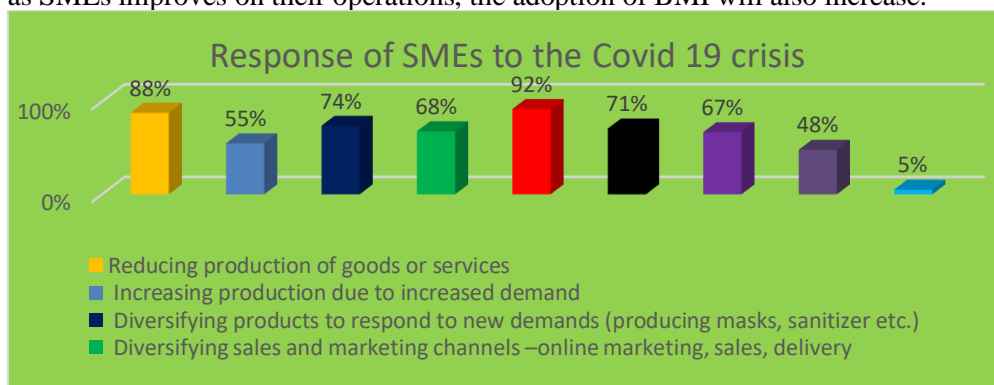


Figure 1.2: Response of SMEs to the Covid 19 crisis
Source; Primary Data 2021

How CV-19 affects survival and growth of SMEs.

Impact of CV-19 on Revenues and Impact of CV-19 on cashflows was tested using the regression analysis where the coefficient value of 0.774 was generated showing that Impact of CV-19 on Revenues had an influence of 77.4% on affecting the outcome on the dependent variable Impact of CV-19 on cashflows. This finding shows that 22.6% influence on impact of Covid 19 on cashflows can be explained by other factors which can be the basis for future studies. The results from the questionnaire are also consistent with the views expressed in interviews where most interviewees expressed the view that Covid-19 has seriously impacted and their revenues and consequently, their cash flows have also suffered. The findings are supported by literature that states that, organizations across the globe have either completely shut-off or partially closed significantly impacting on the revenue generation of the firms and cashflows according to Washington, (2020) as cited in literature review.

Furthermore, the investigation on the influence impact of CV-19 on profits and impact of CV-19 on operation costs. Responses gathered show a coefficient value of .416 was generated showing that the impact of Covid 19 on profits influence operation costs of SMEs by 41.6% with 58.4% influence being accounted for by other factors not covered in the present study thus presenting an opportunity for other researchers to investigate on these factors. The findings entails that in as much as SMEs improve on profitability in light Covid 19, this will result in a positive improvement of operation costs by 41.6% coefficient level. The findings are supported by literature where several scholars including Askdin (2020) and Washington (2020) Covid 19 significantly affected profitability of organizations which also had a direct effect on operation costs as most firms were either operating at below capacity or not at all. Fixed costs however still required to be paid which seriously dampened the future of SMEs. To reduce the burden of Covid 19 on operations costs, SMEs have to improve on their profitability so that operation costs can be effectively covered.

Responses on Impact of CV-19 on Customer base and Workforce generated a coefficient value of .526 showing that the role played by Covid 19 on Customer base has an influence of 52.6% in affecting workforce leaving 47.4% influence to be explained by others factors not covered in this study. On this basis this lays a foundation for future studies to investigate on the other factors accounting for 47.4% influence. Impact of CV-19 on Customer base is positively related to workforce availability this was supported by Kumar (2021) who states that Covid 19 completely shut off the customer base for most organizations, consequently the workforce that is needed on several organizations has also declined.

Nature of business model innovations in SMEs in Zimbabwe during CV-19.

The study sought to find out the current state of operations in light of the Covid 19 crisis, whether SMEs have had to stop their operations due to the Covid 19 crisis and the results of the study show that a majority of the respondents once stopped their operations but have since resumed operations. These findings also echoed the same sentiments shared by the World Health Organisation (2021) who found out that a majority of organizations came to a standstill in their operations at some point in their operations due the Covid 19 pandemic. They further state that only a few businesses that offered essential service remained opened during this period. Regression analysis conducted on the stoppage of operations and adoption of Business Model Innovations generated an F- Value of 0.129 on ANOVA. The researcher found out that there is a significant relationship that exists between stoppage of operations and the adoption of BMI. Acceptance of the relationship was shown by the F-value of 0.129 that was significant at 5%. The findings entail that in as much as SMEs improves on their operations, the adoption of BMI will also increase.

The respondents were pondered about their response to the CV-19 crisis. The results of the study show that the majority of respondents responded to the CV-19 crisis adjusting operational processes. The findings are in line with the findings of Smith, (2020) who stated that a majority of business organizations has had to alter their business models in a bid to cope up with the Covid 19 crisis. In a bid to analyze the level of adoption of BMI by SMEs, the respondents were asked about the adoption of BMI and the results of the study show that a majority of the respondents have changed their

channels of communication and also changed their channel of distribution a way dealing with the business environment in light of the Covid 19 crisis. These findings are in line with the findings of Mhizha, (2021) who found out that a majority firms have had to adopt new business models as the Covid 19 pandemic has significant altered the market conditions of any business either for the best or mostly, the worst. Also, Mauro, (2020) underscored that SMEs employing digital technologies such as e-commerce are strategically positioned to adapt to the CV-19 pandemic crisis.

The results then show that the nature of Business Model Innovativeness by SMEs in Zimbabwe has been mainly in channels of communication with customers and changing their distribution channels with a number of respondents mentioning use of online marketing, online payments and home delivery of products. This agrees with Chahal, (2021) who further stated that most companies have been forced to engage in online presents so as to cope with the restrictions imposed by CV-19. This also goes on to display that most of the BMI adopted by SMEs in Zimbabwe has been adaptive BMI. As stated by Saebi et al., (2016) adaptive BMI involves changes in the business model that are new to the firm but not necessarily new to the industry. Teece, (2010) highlight that this is when the firm adapts the design of its BM in response to changes in the external environment, and in this case the CV-19 pandemic.

Conclusion

This study was aimed at appraising Business Model Innovations by SMEs during the Covid 19 pandemic. Specifically, the study focused on SMEs in Harare, Workington area and deliberately excluded other SMEs in other parts of the country. Furthermore, the study covers the period from March 2020 to July 2021.

It was discovered in the study that CV-19 had an impact on revenues, cash flows, profit, operation costs, customer base, workforce and supplies. The results from the questionnaire were also consistent with the views expressed in interviews where most interviewees expressed the view that Covid-19 has seriously impacted and their revenues and consequently, their cash flows have also suffered. Some of the respondents highlighted that they have been negatively affected by the closing of borders as they relied on imports from countries like China and South Africa among others. To add on, others have indicated high operating costs in a difficulty economy with fixed costs still to be met despite everything. Respondents to the survey and interviews also highlighted challenges of slow deliveries by suppliers and airlines with other respondents emphasized challenges of samples and products taking longer to reach destinations which have since resulted in delays in getting orders.

It was also revealed in the study that there is a significant relationship that exists between stoppage of operations and the adoption of BMI. The results of the study show that the majority of respondents responded to the CV-19 crisis by adjusting operational processes thus showing that they adjusted their BM. A majority of the respondents changed their channels of communication and also changed their channel of distribution as a way of dealing with the business environment in light of the Covid 19 crisis. It is also of great importance to note that the nature of Business Model Innovations by SMEs in Zimbabwe has been mainly in channels of communication with customers and changing their distribution channels with a number of respondents mentioning use of online marketing, online payments and home delivery of products. This also goes on to display that most of the BMI adopted by SMEs in Zimbabwe has been adaptive BMI.

Limitations of the study are that the researcher could not fully access financial records for most of the SMEs as they did not consent with that. Time was also a restricting factor for this study as it was carried during the pandemic with restrictions that were also in place. Also the study only focused on management thus limiting information that could have been obtained from other employees for example clerks and cashiers who do the daily recordings. Lastly, there was limited past researches on the topic as BMI had been previously examined in different circumstances to Covid 19 pandemic.

It is therefore recommended from this study that future research may focus on other factors which also influenced a drop in revenues, cash flows, profit and supplies other than issues directly linked to the pandemic. Another area of research could be studies on how the SMEs went through the BMI process

and also how it has affected leadership, culture and other important elements of the enterprise. Also, it is recommended to do a future study on the role played by culture in BMI success. How effective the BMI have been in promoting growth and survival of the SMEs during the pandemic is also another area to be explored. Lastly, the sustainability aspect of the BMI by SMEs during the pandemic is an important area of future research.

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Antioxidant capacities of propolis - therapeutic effects and possible applications

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Abstract. Propolis is considered to be one of the most useful products of apitherapy, as the active principles are transmitted directly from the plant to humans, so its use has attracted quite a lot of supporters in human medicine. Due to its complex composition, which includes waxes, resins, balsams, volatile oils, vitamins, minerals, phenolic acids and flavonoids, the therapeutic benefits of propolis and its uses in various diseases are well known. In this paper aspects of the chemical composition of propolis, analysis methods of propolis and the way it can be used as a result of its therapeutic effects are presented.

Keywords: *propolis, antioxidant, therapeutic benefit, applications*

1. Introduction

The protective properties of the bioactives present in propolis make it a potential preventive and therapeutic agent, and it is considered a kind of natural antibiotic. The protective immune defence and antioxidant properties come from the constituents of the bioactive phytochemicals. The compounds in propolis also include, but are not limited to, phenolic acids, flavonoids, esters, aromatic aldehydes, amino acids, fatty acids, vitamins and minerals. Over time, both the efficacy and therapeutic properties of propolis have been demonstrated in more than 200 conditions, and propolis is already considered a powerful weapon in natural therapy. The therapeutic relevance of propolis is based on the discovery that propolis can successfully treat 30 types of viruses, nine species of parasitic fungi and 21 species of bacteria, following modern studies that refer to its therapeutic properties, being considered one of the most powerful natural anti-infectious drugs. [1]

Due to the presence of various phytochemicals, this bee product exhibits numerous biological activities, including antibacterial, antiviral, anti-inflammatory, antioxidant, immunostimulatory and antitumor benefits. Raw propolis of good quality will be recognisable by its lack of sheen, a good sign because if it is shiny then its properties will be diminished because there is too much wax in its composition, its strong specific smell will be bitter and sweet. Propolis is recognised as an aromatic resin-like substance, which is collected by bees from more than 20 species of trees from poplar bark, poplar buds, willows, poplar leaves, maple buds, conifers and plums. [2]

The therapeutic properties of propolis have been recognized since ancient times, these being: antifungal, anaesthetic, regenerative, bactericidal, analgesic, strong bioactive, antiviral, antitoxic and anti-inflammatory properties. Propolis has retained its position as a therapeutic adjuvant to date precisely because of its efficacy, only 0,2% of those who have used propolis have developed an allergy to the pollen found in its composition.

2. Chemical composition of propolis. Estimates of the antioxidant potential

The therapeutic action of different types of propolis is correlated with the presence of certain chemical compounds in their composition. An important clarification regarding the composition and

therapeutic effects of propolis is that there are differences in its composition, depending on the production technique, the plants supplying the resins, the evolutionary cycles, the flora of the area where the hives will be grown or climatic factors.

Regardless of area or climatic factors, the chemical composition of a raw propolis will include, but is not limited to, the following main components: amino acids, carbohydrates, vitamins, resins, waxes, volatile oils, enzymes, mineral salts and impurities.

Propolis is a complex nutrient with broad and varied physiological effects, which is why it has become the focus of much research due to its numerous biological and pharmacological properties.

The major groups of substances contained in propolis are as follows: [3,4]

- waxes are found in a percentage of 7,5 - 35%;
- impurities will be found in the range 4,4 - 19%;
- resins and balsams in 55%.

According to literature data, more than 300 compounds belonging to polyphenols, terpenoids, steroids, sugars, amino acids and others have been identified in propolis.

Balsams are in fact natural substances obtained by special methods from the bark of the aboriginal tree and are semi-liquid or liquid. There is no concrete expert data on how the resins in propolis were isolated, but their presence has never been questioned.

Among the constituents that are commonly found in resin and can also be identified in propolis are: cinnamic acid, ferulic acid, pentacyclic triterpenoids, benzoic acid - in concentrations ranging from 1,33 to 20%, coumarins and caffeic acid.

- volatile oils are found in a percentage of 10% in the composition of propolis, these compounds having as specific flavour characteristics.

- fatty acids are found in 5%;
- terpenes;

- free amino acids may be present in a number of 16 to 24, significant representatives of which are pyroglutamic acid, proline and arginine. The source of amino acids is the salivary secretions of bees and pollen.

- pollen in 5%;
- vitamins (pantothenic acid, A, B1, B2, B6, C, E, nicotinic acid);
- tannins.

The most important constituents of propolis, in addition to various aromatic and phenolic compounds are flavonoids (flavonols, flavonones, flavones).

The examples of flavonoids found in propolis are presented in Figure 1. [5]

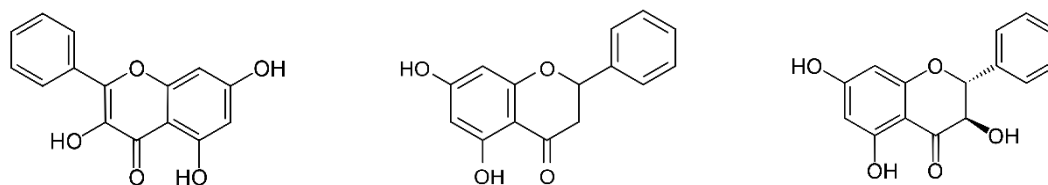


Fig.1. Structural formulas of galangin, pinocembrin and pinobanksin.

The mineral elements are found in different samples from different regions, such as Australia (0,68%), France (0,51-0,86%), USA (0,67%), China (0,55%).

The main representatives of mineral elements are vanadium, zinc, sodium, cadmium, magnesium, boron, barium, iron, strontium, aluminium, calcium, selenium, silver, silicon, lead, manganese, titanium, chromium, copper, nickel, molybdenum, cobalt and potassium.

Chemical composition - biological activity relationship

The multiple effects of propolis, such as antibacterial, antiviral, anti-inflammatory, antioxidant, immunostimulatory and anti-tumour effects are closely linked to its composition rich in beneficial substances such as flavonoids, phenolic acids, terpenoids, steroids and amino acids.

Thus, the antioxidant action is given by phenolic acids and their esters in the case of European propolis, respectively prenylated p-coumaric acids and flavonoids in the case of Brazilian propolis. Prenylated benzophenones are responsible for the antioxidant and antitumour action of Cuban propolis, and compounds such as prenylated flavanones have similar biological action in the case of Taiwanese propolis.

The examples of phenolic acids found in propolis are presented in Figure 2. [5]

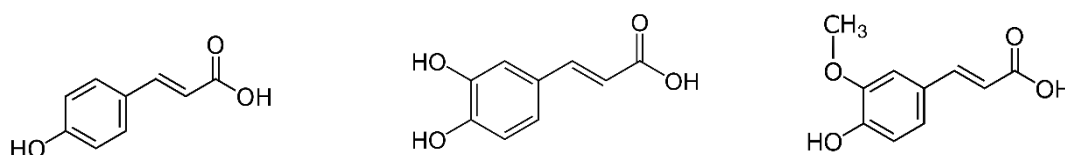


Fig.2. Structural formulas of p - coumaric acid, caffeic acid and ferulic acid.

The anti-tumour action of Brazilian propolis, considered one of the best bee products in the world, is due to benzofurans, prenylated p-coumaric acids and clerodane diterpenoids. This product also has hepatoprotective action given by flavonoids, prenylated p-coumaric acids, caffeoyl quinic acids and lignans.

With hepatoprotective action in European propolis are the compounds: caffeic acid and its esters and ferulic acid, while in Cuban and Taiwanese propolis no compounds with such biological action have been identified.

The anti-inflammatory and antibacterial action of European propolis is given by flavanones, flavones, esters of phenolic acids and phenolic acids.

Compounds such as prenylated p-coumaric acids, diterpenes and labdan are responsible for the antibacterial action of Brazilian propolis, and prenylated benzophenones confer antibacterial action to Cuban propolis. [6]

The chemical composition and biological activity of propolis depend on its botanical and geographical origin. The search for new bioactive substances, possible new constituents not yet identified in different types of propolis, is of great importance and is the subject of numerous specialist studies.

Analytical methods used for the identification and assay of biologically active constituents in propolis

The therapeutic qualities of propolis have been seriously highlighted over time, and depending on how propolis is standardised, purified and studied in the research, toxicological, technological, clinical and preclinical stages, it will be possible to make the transition from an empirical remedy to a medicine. The advertising of propolis must, however, be accompanied by clinical trials, in vivo or in vitro studies in order to be able to accurately determine its efficacy and pharmacovigilance, especially as its composition may differ depending on the area from which it is harvested, the species of bee that will be harvesting it and the season in which it is harvested.

Research on the chemical profile of propolis aims to propose a standard requiring quality parameters of propolis before its use in the pharmaceutical and cosmetic industry.

The measurement of parameters such as: wax content, polyphenol content, analysis of the flavonoid component of propolis, evaluation of the antioxidant and antimicrobial capacity are necessary to assess the quality of propolis and its use for therapeutic purposes being directly or indirectly responsible for the effects manifested by propolis.

The methods used in the qualitative and quantitative analysis of propolis extracts for the determination of biologically active compounds (polyphenols, flavonoids) are rapid, low-cost spectrophotometric methods for the determination of the main groups of bioactive substances in different types of propolis. An example is the quantification from poplar propolis of components such as flavones, flavonols, flavanones, dihydroflavonols and total phenolic compounds. [7]

Chromatographic techniques are also successfully used in the analysis of the polyphenolic profile of propolis and the determination of the contents of biologically active compounds such as the flavonoid component. A recent study analysed propolis samples from Bulgaria, Italy and Switzerland by gas chromatography-mass spectrometry (GC-MS), the results of which established a composition similar to the typical chemical pattern of aspen propolis. Compounds such as pinocembrin, pinobanksin -3-O-acetate, chrysin, galangin, prenyl esters of caffeic and ferulic acids were identified. In the mentioned study there were also two samples that differed significantly: one from an Alpine region of Switzerland, which was rich in phenolic glycerides, and one from Sicily, which contained only a limited number of phenolic substances and was rich in diterpene acids. [8]

This shows that there are major differences in the composition of propolis, depending on the plants supplying the resins, the evolutionary cycles, the flora of the area or climatic factors, which makes it difficult to standardise so that propolis extract for medicinal use can correspond to an optimal ratio between the quantity administered and the effect obtained.

Another chromatographic technique mentioned in the literature as being used with good results in determining the chemical profile of propolis is high-performance liquid chromatography coupled with mass spectrometry. [9,10]

Studies show that various chemical constituents of Brazilian propolis, including chroman, diterpenes and phenolic compounds, could be isolated and analysed by LC-MS using standardised methods. Dicafeoylquinic acids were detected in aqueous extracts of propolis, while diterpenes, flavonoids and prenylated phenolic compounds were found in their methanolic extracts. Based on the identified chemical constituents and their biological activities, the quality of the analyzed propolis can be evaluated and a direct link between the quality of Brazilian propolis and its phenolic constituents can be established. [11]

Analyzes of the mineral chemical composition of propolis can also be performed by near-infrared spectroscopy (NIR). In the literature mentioned is a study of propolis samples collected from Chile and Spain, in which the measured minerals were aluminum, calcium, iron, potassium, magnesium, phosphorus, and some potentially toxic trace elements such as zinc, chromium, nickel, copper and lead. The results obtained indicated that the NIR method is comparable to chemical methods. Another conclusion of the study was that the method is of interest in the rapid prediction of potentially toxic elements in propolis before consumption. There are also studies that prove the antioxidant capacity of propolis through near-infrared spectroscopy. [12, 13]

3. The uses of propolis in various pathologies

With the help of pharmacodynamic and chemical progress and pharmaceutical technology, it has been possible to develop rules for the preformulation and formulation of medicines, the most important rule, in fact, is that which refers to the relationship that the product in question and the effects have on a human organism, thus resulting in the term therapeutic dose. This term can also be used for products or medicines that are composed of a natural mixture of active substances with the help of a standardisation of the tincture and extract.

This standardisation term represents, in fact, a standardisation of the concentration of the active ingredient in the finished product and can be achieved by biological control or physico-chemical methods. Any experiment, whether clinical or laboratory, should be carried out only on standardised extracts so that the propolis extract for medicinal use can correspond to a ratio between the quantity administered and the effect obtained.

In the case of a standardised extract, the following possibilities may arise: individualisation of the treatment, lack of toxicity, administration of quantities containing controlled concentrations of active substances and maximum therapeutic efficacy.

The standardised propolis extract, although it may have side effects if the doses are exceeded, is not a toxic product.

Propolis tincture (propolis-based alcoholic solution) is the most widely used form of propolis and can be prepared as follows: 30 g of propolis, which is previously hardened in the refrigerator, should be added to every 100 g of 60° or 90° alcohol. It can be used to normalize blood pressure,

cure stomach pains, intestinal parasitosis, gastroduodenal ulcers, enteritis, cure internal infectious diseases, treat alcoholism, treat gynaecological, pulmonary, digestive, glandular or nervous system problems.

Locally, burns could also be treated, either with propolis tincture or with propolis-containing spray, which is used as an anaesthetic, antibacterial and stimulator of the regenerative process, covering the burned surface with a protective film and thus allowing the healing process to begin.

Propolis is very often used in food additives, beverages, medicines, supplements, the aim being to improve health and try to prevent conditions such as diabetes, cancer, inflammatory diseases, heart disease, liver disease.

Many studies and researches on propolis have been carried out over time, highlighting its beneficial effects with therapeutic action: antifungal, analgesic, epithelializing, immune system stimulator, diuretic, antioxidant, antimicrobial, antibiotic, antiparasitic, antitumor, anti-inflammatory and antiviral. [14,15]

The application of propolis in cosmetics and dermatology

In the cosmetic and dermatological industry, propolis is often used for its anti-inflammatory properties, and is exploited in products that will have a protective action against sunburn. In addition to sunburn it also protects the body against Roentgen and other types of radiation.

The ability to stimulate the healing process has been the therapeutic property that has been most noted of all the therapeutic properties of all bee products, most of which result in the regeneration of injured epithelium and tissue.

Both honey and the combination of honey and propolis have proven to have very effective healing effects, working on both over-infected and normal wounds.

Propolis can be the treatment that will have beneficial and broad-spectrum results on some dermatological infections, successfully manifesting itself also on pathogenic staphylococcus through a bactericidal action, regardless of the sensitivity that this staphylococcus will have to antibiotics.

A notable advantage of propolis is the rapidity with which it exerts its effect when compared with other conventional medicines, thus reducing the healing period, and the best example to support this advantage is that of a scab or skin wound which are quite common in patients who are bedridden.

The proliferation of the epithelium will be enhanced when propolis-rich sprays or ointments are applied directly to the open sore or burn, while managing to limit their infection with viral, bactericidal, bacteriostatic and antifungal properties. These products also work successfully on *Pseudomonas aeruginosa*, a pathogen that is often resistant to common antibiotics and is a major pathogen in people with major burns. A number of studies have shown that propolis not only accelerates the healing process but also provides mechanical protection to the wound with a protective film. [16]

The benefits of propolis for oral hygiene and oral cavity diseases

Propolis can also be used for the oral cavity in the form of mouthwash or toothpaste containing propolis which, if used regularly, eliminates mouth ulcers, lesions and periodontitis. It is very important that oral hygiene is carried out correctly, propolis in tincture form can have an important haemostatic, antiseptic and oral bactericidal role. In the case of canker sores it is recommended to apply undiluted tincture, puncturing the canker sore before it ulcerates, allowing it to dry and thus avoiding its painful form.

According to studies propolis in mouthwash will significantly reduce the formation of insoluble polysaccharides, insoluble supragingival plaque. Tooth decay will be prevented and its occurrence will be slowed down by an inhibition of bacterial growth due to the antibacterial role of propolis. Chronic recurrent aphthous ulcers can also be removed or prevented by using propolis, which has four times the anaesthetic effect of procaine and thus succeeds in reducing pain and forming a protective film on the surface of the ulcerated lesion. [17]

The benefits of propolis as a natural remedy for respiratory affections

Due to its anti-inflammatory and antibacterial effects, apitherapy will be of particular importance for bronchopulmonary disorders, as the combination of propolis and honey has reliable results on chronic bronchitis, especially if eucalyptus or lime honey is used.

If used alone, propolis may not have the desired effects, but it can be an adjuvant to classical treatment of the respiratory system. Both Romania and Eastern European countries have conducted multiple clinical trials and have identified many propolis-based medicines that have had a good result on respiratory disorders, thus increasing the interest of Asian countries, South America and the United States in apitherapy. The biggest stumbling block to these studies has always been determining the therapeutic dose.

Propolis can be used to decrease the frequency and alleviate asthma attacks, as the immunoprotective properties of propolis help to increase the body's defence capacity. Propolis, used as an adjuvant, leads to an inhibition of tuberculosis bacillus development due to its support of the body against the Koch's bacillus and its ability to reabsorb infectious foci. Propolis often has stronger properties on respiratory conditions than medicinal substances that have been targeted at these conditions. [18, 19]

The role of propolis is to stimulate immunological factors, both non-specific and specific, so that imbalances in the bacterial flora will be avoided, and this will lead to an increase in the general resistance of the whole body to disease.

Although it is widely used, with therapeutic properties recognised worldwide, there have been cases where allergic reactions have occurred in people with known sensitivities. There is also a strong possibility that people who are hypersensitive to bee stings, have eczema or bronchial asthma may have allergic reactions to propolis, the cause of which is not yet known, and which may be due to some protein residue left in the propolis by bees or even small traces of bee venom. [20]

4. Conclusions

Thanks to the active ingredients transmitted to humans, propolis is considered to be a very effective product, with good results even where some natural or medicinal preparations have not led to the desired result. The positive effects of propolis have been highlighted by a series of research and studies carried out on it, and it is considered a surprising natural product with therapeutic effects such as anti-tumour, anti-inflammatory, anti-fungal, antibiotic, analgesic, antioxidant and antimicrobial. The beneficial effect of propolis can also be harnessed through the use of its volatile fraction, which includes aromatic substances, terpenes and flavones, which are essential oils, as active ingredients.

The analysis of the chemical profile of propolis, the analysis by appropriate instrumental techniques of the polyphenol content, the spectrophotometric or chromatographic determination of the flavonoid component allow the assessment of its antioxidant capacity. The determination of parameters related to the chemical composition is a necessity before using propolis in the pharmaceutical and cosmetic industry, especially as this can differ depending on the area where it is harvested, the species of bee that will harvest it, the season in which it is harvested and climatic factors. The evaluation of the antioxidant capacity is a necessary part of the assessment of the quality of propolis and offers the possibility of standardisation and therapeutic use, being responsible for the effects manifested by it.

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Relationship Between Internet Usage, E-Skills, Personal Data Protection and Demographics Variables with Preference of E-Commerce

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Abstract. According to statistics, approximately 46% of the world's population, in other words 3.4 billion people, have become internet users. While the world population has increased by an average of 1.1% per year since 2000, the total number of internet users, which we call the internet population, has increased by approximately 13.2% every year and the spread of the internet has continued rapidly. E-commerce stands out as an attractive channel for many companies that want to start a business or increase their sales, because it can be implemented quickly and does not bear the costs of conventional retail. As a matter of fact, this study was conducted to investigate the relationship between various individual internet usage and electronic skills, personal data protection sensitivity, and some demographic characteristics and e-commerce preferences of individuals. For this purpose, the MNP model was used to investigate the determinants of e-commerce (internet place to buy goods) preferences. According to the findings obtained from the MNP model, regional differences, gender, internet usage skills (e-mail, reading news online, searching for information about health, web site sharing, job search, selling goods and services) in e-commerce preference, computer-mobile skills (banking, file transfer, application installation, photo editing), and personal data security (preventing the use of personal information and reading privacy text) have been determined to have significant effects.

Keywords: E-Commerce Preference, Internet Usage, E-Skills, Personal Data Protection, Qualitative Choice Models

Introduction

Individuals need to have a set of skills that can be called 21st-century skills beyond their basic skills. While pure knowledge was valuable and valid in the past centuries, only individual knowledge is not sufficient today [1]. The 21st century necessitates the individual to be an individual who can think creatively and critically, cooperate with others, have problem-solving and high communication skills, know how to reach the necessary information, and use technology while reaching the information, in order to be successful both in education and business life. At the same time, it is necessary to be an individual who is open to new ideas, flexible and adaptable, knows his responsibilities, has self-management and initiative, has developed social and cultural skills, is productive, and has leadership skills [2].

Although 21st-century skills are conceptually subject to different classifications in different disciplines, technology literacy is accepted as a basic necessity of life for many people, as are the

common features of all definitions, such as reading/writing skills, mathematical literacy, and social communication skills. In other words, the degree of affinity established with information technologies facilitates individuals' access to employment, social networks, and international borders.

Diversity in information technologies is also reflected in the shopping preferences of individuals at certain points. Electronic commerce (e-commerce) is defined as the activities of selling products produced through computer networks, advertising, providing technical support after sales and making payments [3]. E-commerce, which has grown rapidly in recent years, is reshaping the shopping habits of consumers and the business models of companies, especially retailers [4]. Because in today's globalizing world, other geographies have become more visible and instantly accessible than at any other time in history [5]. Although it provides individuals with conveniences such as time savings and instant access to goods and services in their daily lives, meeting even the smallest daily needs through electronic commerce enables individuals or institutions that are parties to commercial contracts to obtain and store large amounts of personal data [6].

Especially in recent times, the violation of personal data has brought along various legal discussions. It can be said that the collection of data belonging to real persons by recording began with the emergence of the state organization. Because the state needs to know its human resources in order to protect itself and provide public service. Although it seems that the data belonging to real persons are kept by private sector organizations and individuals other than the state, it seems as a result of the consumption economy, the development of information and communication technologies also has an effect [7]. Today, public and private organizations collect a lot of data. Personal databases, which are created from the collected data and have many variables, enable the establishment of relationships for various purposes. As a matter of fact, while living in a world where consumer data is becoming increasingly important, consumers become both producers and consumers of their own individual information. This horizontal plane from individual skills to consumption habits means new data, new technology, new market, new competitors and new strategies for businesses [8,9]. In other words, while the subject is related to individual skills and preferences on one side, there are e-commerce strategies of companies on the other side of the coin.

Because the development and diversification of behavioral science, business activities and economic models have followed each other for centuries [10]. As a matter of fact, this study was conducted to investigate the relationship between various individual and electronic skills, personal data protection sensitivity and some demographic characteristics, and the electronic commerce (e-commerce) preference of individuals.

Literature Review

While the world population continues to increase, all economies continue their digital change and transformation. The acceleration of digital transformation in every sector increases the interest and inclination of users toward digital. In addition, the increase in the level of digital maturity of users of all ages and genders actually accelerates and directs digitalization. In other words, this situation mutually affects each other and supports each other's development day by day [11]. As a matter of fact, while approximately 22 percent of the world's population was Internet users in the 2000s [12], when it comes to the 2020s, the population aged 14-64 spends an average of 6 hours a day using the Internet, and about half of this time is spent using the Internet from mobile devices [13].

In this sense, the Internet, as an information technology, is a "super highway" that connects people and data via other computers (or other information technology devices). This journey creates certain

effects according to the user profile. So much so that the way people belonging to different social groups perceive and classify social life also differs. For example, gender is one of the most important factors affecting individuals' participation in leisure activities [14]. Similarly, [15] found in a survey of households in Thailand, a developing country, that the main impulse of Internet usage is access to the Internet. Access to the Internet can create diversity in various social groups (age, gender, region of residence, etc.).

The study is important in that it has been determined that access to the Internet is a more priority parameter than access to a computer in Internet usage. In addition, [16] conducted a survey on 200 company employees in Turkey by categorizing Internet usage according to user profile and usage pattern.

The results show that while gender has a positive effect on Internet usage, factors such as age and income level do not have a significant effect on daily Internet usage (e-commerce, e-banking, e-government). On the other hand, [17] found that variables such as gender, educational status, and household income seriously affect consumers' e-commerce preferences, as a result of their survey at two large universities in the southeastern United States.

Of course, in addition to demographic variables, individual e-skills, and Internet usage preferences, there is also the personal data side of e-commerce preference. Because the protection of personal data has been important in the past, but the global information age production style we are going through has increased the value of data and led it to become a large market [9].

What is important at this point is that certain transactions made consciously or unconsciously on the Internet may harm personal rights and freedoms. The protection of personal data is a tool, the purpose is the protection of the person himself [18]. In this sense, for example, General Data Protection (2016) has been put into practice in order to control personal data management among member states and stakeholders within the scope of the European Digital Single Market Strategy, which is thought to contribute to the economic integration of the European Union through an online competition [19]. [20] found that the EU has more comprehensive and singular legislation in their research on personal data protection regulations between the European Union and China. On the other hand, they found that in China and many other Asian countries, they tried to operate things with more than one regulation instead of a single regulation. Although the awareness of personal data may vary from person to person, the fact that personal data is legally secured in the digitalized world at least has a deterrent and punitive feature against possible violations.

Data, Methodology and Findings

Research Questions and Model

In light of the aforementioned explanations, the research seeks answers to the stated research questions. (1) Do demographic variables (gender and region of residence) affect e-commerce preference?, (2) Do individual Internet usage skills (communication skills, access to information skills, social and political participation levels, professional life skills and skills to use some online services) affect e-commerce preference?, (3) Do individual e-skills (filing, software, processor usage, tabulation, data and photo editing skills) affect e-commerce choice?, (4) Does personal data management affect the choice of e-commerce?

The research model of the study is shown in Figure 1.

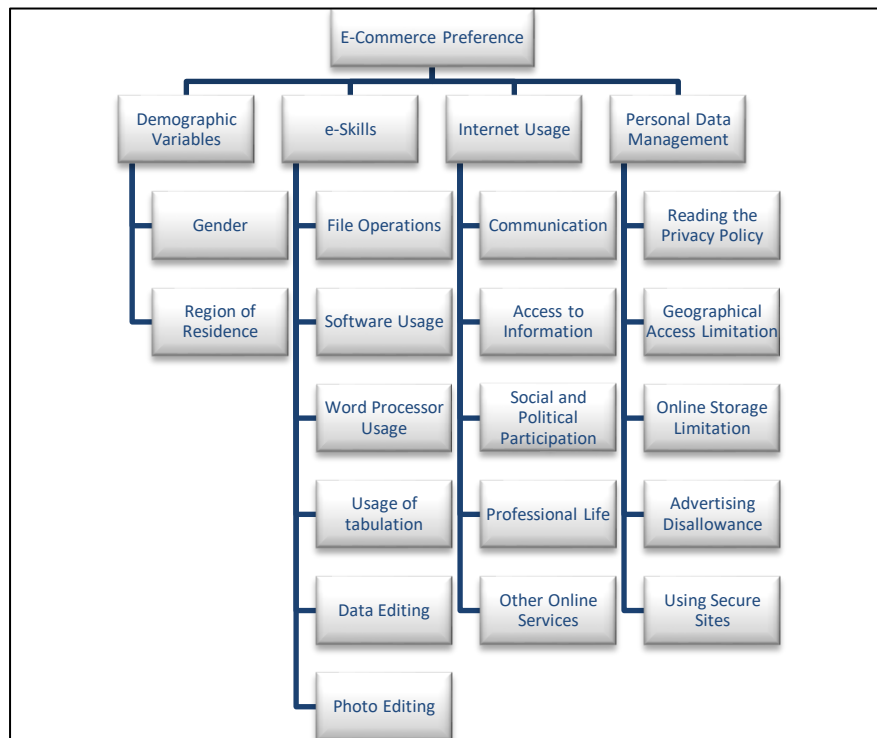


Figure 1: The Research Model

Data

In this study, the data of the Household Information Technologies Usage Statistics Micro Data Set carried out by the Turkish Statistical Institute in 2021 were used. In the Household Information Technologies Usage Research, it was aimed to determine the information society criteria and to produce related statistics. All Turkish households were included in the sample selection. The total sample size includes 9438 people [21]. The variables used in this study were selected from the questions in the Household Information Technologies Usage Statistics microdata set. Definitions of the variables to be used in the analysis are given in Table 1.

Table 1. Definitions of the Variables to be Used in the Analysis

Variable	Categories
Dependent Variable	
Which of the following goods have you purchased online in the last three months?	1:Domestic Sellers 2:Overseas Sellers 3:Both Domestic and Overseas Sellers
Independent Variable	
Gender	1:Male, 0:Female
Area of Residence (Level 1 Statistical Territory Units Classification)	
	TR1 1:Yes, 0:No
	TR2 1:Yes, 0:No
	TR3 1:Yes, 0:No
	TR4 1:Yes, 0:No
	TR5 1:Yes, 0:No
	TR6 1:Yes, 0:No
	TR7 1:Yes, 0:No
	TR8 1:Yes, 0:No
	TR9 1:Yes, 0:No

	TRA	1:Yes, 0:No
	TRB	1:Yes, 0:No
	TRC	1:Yes, 0:No
Which of the following activities have you used the Internet (including mobile applications) for a specific purpose in the last three months?		
Communication	Sending/receiving e-mail	1:Yes, 0:No
	Making voice or video calls via the Internet (using WhatsApp, Facetime, Viber, Messenger, Skype, Snapchat, etc.)	1:Yes, 0:No
	Creating a profile on social media (Facebook, Twitter, Instagram, Snapchat, etc.), sending messages or photos, and sharing content.	1:Yes, 0:No
	Messaging (WhatsApp, Messenger, Skype, BIP, Viber, Snapchat etc.)	1:Yes, 0:No
Access to Information	Reading online news sites/newspapers / news magazines	1:Yes, 0:No
	Searching health-related information (such as injuries, illnesses, nutrition, and improving health)	1:Yes, 0:No
Social and Political Participation	Searching for information about goods and services	1:Yes, 0:No
	Sharing opinions on social or political issues via websites or social media (blogs, Facebook, Twitter, Instagram, YouTube, etc.).	1:Yes, 0:No
Professional Life	Participating in an online discussion/vote on a social or political issue	1:Yes, 0:No
Other Online Services	Looking for or applying for a job	1:Yes, 0:No
	Sale of goods or services (Facebook Marketplace, Gittigidiyor, Sahibinden, Letgo, Sahaf, Dolap, BebeCruz, Tarz2 etc.)	1:Yes, 0:No
	Internet banking (website or mobile banking applications)	1:Yes, 0:No
Which of the following activities have you done in the last three months?		
	Copying or moving files (document, data, image, video), folders, between devices (email, Messenger, WhatsApp, USB, cable) or in the cloud	1:Yes, 0:No
	Downloading or installing software or mobile apps	1:Yes, 0:No
	Changing software, application or device settings (adjusting language, colors, contrast, text size, toolbars / menu)	1:Yes, 0:No
	Using word processing software	1:Yes, 0:No
	Creating presentations or documents by adding text, documents, images, videos, animations, tables or graphics	1:Yes, 0:No
	Using tabulation software	1:Yes, 0:No
	Using the advanced features of the tabulation program (functions, formulas, macros, Visual Basic, etc.) to edit, analyze, configure or manipulate data.	1:Yes, 0:No
	Editing photo, video or audio files	1:Yes, 0:No
	Coding in a programming language	1:Yes, 0:No
Which of the following methods have you used in the last three months to manage access to your personal data over the Internet?		
	Reading the privacy policy of the website or applications before giving your personal data	1:Yes, 0:No
	Restricting or blocking access to your geolocation	1:Yes, 0:No
	Limiting access to your profile, content information on social networking sites, or shared online storage	1:Yes, 0:No
	Not allowing your personal data to be shared for advertising purposes	1:Yes, 0:No
	Checking the features of websites to ensure the security of your personal data (https sites, sites with a secure logo or certificate)	1:Yes, 0:No
	Requesting update or deletion of personal data from websites, search engines administrator, or provider	1:Yes, 0:No

Multinomial Choice Models

Choice models are used to determine the decision maker's behavior. Multinomial logit (MNL) and probit models (MNP) are used to determine the factors affecting the preferences of categorical variables where the ordering is unimportant. Multinomial models are used when there are more than two alternatives to the dependent variable and are classified as ordered and non-ordered models according to the characteristics of the dependent variable [22]. Ordinal models are used when the categories of the dependent variable have an order, while non-order models are used when there is no ordering between

the categories of the dependent variable. In multinomial models, the aim is to model the probability values of situations as a function of covariates and to explain the results in terms of probability values for the preferences of different situations [23].

The most important assumption of multinomial logit (MNL) models is the assumption of independence of unrelated alternatives (IIA). This assumption assumes that one individual's choice of alternative over another will not change when a third viable alternative is added or subtracted. In practice, an individual may switch between alternatives based on their unique assessment of the benefits derived from each alternative. When the IIA is violated, the MNL is an incorrectly determined model and the estimated coefficients are biased and inconsistent [24]. [25] noted that MNP estimates show more accurate results than MNL estimates because they do not assume IIA.

MNL and MNP models are nonlinear models that can be used for the same purposes. The difference between these models is due to the assumptions about the error term. Due to the limitations of the IIA body required in the MNL model, the more flexible MNP model is preferred [26]. The error terms are assumed to have a normal distribution in the MNP model, which removes the IIA constraint. The advantage of this model is that it allows errors between choices to be correlated, which removes the IIA constraint [27]. Multinomial models are based on the random utility theory, that is, on the assumption that consumers will choose the alternative that will provide them with the highest utility among specific options. The utility function in the MNP model is given in Equation 1.

$$U_{ij} = x'_{ij}\beta + \varepsilon_{ij} \quad j = 1, \dots, J \quad (1)$$

The log-likelihood term corresponding to choosing option 1 in Equation 1 for the MNP model, assuming that the individual will maximise her utility, is given in Equation 2.

$$\begin{aligned} Prob[Y_i = 1] &= Prob[U_1 > U_j, j = 1, \dots, J, j \neq 1] \\ Prob[Y_i = 1] &= P(\varepsilon_2 - \varepsilon_1 > (x_1 - x_2)' \beta, \dots, \varepsilon_j - \varepsilon_1 > (x_1 - x_j)' \beta) \end{aligned} \quad (2)$$

Equation 2 is represented as in Equation 3 with the help of integral and is treated as $\eta_{kj} = \varepsilon_{ik} - \varepsilon_{ij}$ here.

$$Prob[Y_i = 1] = \int_{-\infty}^{x'_i \beta_1 - x'_i \beta_2} \dots \int_{-\infty}^{x'_i \beta_1 - x'_i \beta_j} f(\eta_{21}, \dots, \eta_{j1}) d_{\eta_{21}, \dots, \eta_{j1}} \quad (3)$$

Error terms in utility equations are correlated with each other. The increase in the number of binary correlations complicates the solution of integrals. Some simulation methods are used in the estimation of the MNP model [28]. The MNP model, in which the probabilities are independent of each other and show a multivariate normal distribution, is shown in Equation 4.

$$Y_i^* = \beta_0 + \beta_1 X_i + \varepsilon_i \quad (4)$$

For observable alternatives,

$$\begin{aligned} Y_i^* &< 0 \text{ for } Y_i = 1 \\ 0 &\leq Y_i^* < A_1 \text{ for } Y_i = 2 \\ A_1 &\leq Y_i^* < A_2 \text{ for } Y_i = 3 \end{aligned} \quad (5)$$

⋮

$$A_{M-2} \leq Y_i^* \text{ for } Y_i = M.$$

Under all these assumptions, probabilities are calculated as follows.

$$\begin{aligned} Prob(Y_i^* = 1) &= \pm(-\beta_0 - \beta_1 X_i) \\ Prob(Y_i^* = 2) &= \pm(A_1 - \beta_0 X_i) - \pm(-\beta_0 - \beta_1 X_i) \\ &\vdots \\ Prob(Y_i^* = M) &= 1 - F(A_{m-2} - \beta_0 - \beta_1 X_i) \end{aligned} \quad (6)$$

In Equation 6, $F(\cdot)$ represents the cumulative distribution function of the standard normal variable. Estimates of $\beta_0, \beta_1, A_1, A_2, \dots, A_{m-2}$ are obtained from log-likelihood functions. In the MNP model, the maximum likelihood method is used to calculate the preference probabilities. Since the integral calculations of the dependent variable for more than four alternatives are very difficult, it is preferred to keep the number of categories as low as possible [29]. The interpretation of explanatory variables in the MNP model is performed by marginal effects by choosing a comparison group.

Findings

In this study, the factors affecting the e-commerce preferences of individuals are investigated with the MNP model, which is one of the unordered qualitative preference models, specific to the unordered variables given in Table 1. The MNP model to be estimated is given below.

ecommerce_{preference}

$$\begin{aligned}
 &= \beta_0 + \beta_1 \textit{WestMarmara} + \beta_2 \textit{Aegean} + \beta_3 \textit{EastMarmara} + \beta_4 \textit{Westanatolia} \\
 &+ \beta_5 \textit{Mediterranean} + \beta_6 \textit{Middle anatolia} + \beta_7 \textit{West Blacksea} \\
 &+ \beta_8 \textit{East Blacksea} + \beta_9 \textit{NortheastAnatolia} + \beta_{10} \textit{Middle EastAnatolia} \\
 &+ \beta_{11} \textit{Southeastern Anatolia} + \beta_{12} \textit{Gender} + \beta_{13} \textit{Email Send} \\
 &+ \beta_{14} \textit{SocialMedia Engagement} + \beta_{15} \textit{Making a VideoCall} \\
 &+ \beta_{16} \textit{Sending a Message from the Internet} \\
 &+ \beta_{17} \textit{OnlineNewsReading from the Internet} \\
 &+ \beta_{18} \textit{Searching for Health Information on the Internet} \\
 &+ \beta_{19} \textit{GettingGoodsandServicesInformationfromtheInternet} \\
 &+ \beta_{20} \textit{Website Sharing} + \beta_{21} \textit{job search on the Internet} \\
 &+ \beta_{22} \textit{Goods and Services Sales} \\
 &+ \beta_{23} \textit{Performing Bank Transactions on the Internet} \\
 &+ \beta_{24} \textit{Making a File Transfer} + \beta_{25} \textit{Ability to Install Application} \\
 &+ \beta_{26} \textit{Making Device Setting Changes} + \beta_{27} \textit{Creating Documents} \\
 &+ \beta_{28} \textit{Ability to Use Spreadsheet Software} \\
 &+ \beta_{29} \textit{Ability to Perform Data Editing} + \beta_{30} \textit{Photo, video, audio file editing} \\
 &+ \beta_{31} \textit{Writing Code in Program Language} + \beta_{32} \textit{Reading privacy text} \\
 &+ \beta_{33} \textit{Limit geolocation} + \beta_{34} \textit{Dlimit storage} \\
 &+ \beta_{35} \textit{Blocking the use of personal information} + \beta_{36} \textit{Prefer safe websites} \\
 &+ \beta_{37} \textit{Personal data update and request deletion} + u_i
 \end{aligned}$$

The descriptive statistics and percentages of the variables used in the study according to their distribution within the preferred place of online shopping are shown in Table 2.

17% of individuals who only shop domestically, 13% of individuals who only shop overseas, and 27% of individuals who shop online both domestically and overseas live in Istanbul. 6.2% of individuals living in the West Marmara do domestic shopping, 3.4% overseas, and 4.8% do online shopping both domestically and overseas. 12.2% of individuals living in the Aegean region do domestic shopping, 6.9% do overseas shopping, and 7.7% do online shopping both domestically and overseas. 10.9% of individuals living in the East Marmara region do domestic shopping, 10.3% do overseas shopping and 11.6% do online shopping both domestically and overseas. 11.5% of individuals living in the Western Anatolia region do domestic shopping, 17.1% do overseas shopping, and 11.9% do online shopping both domestically and overseas. While 49.9% of individuals who shop online only domestically are

men, 50.1% are women. While 52.6% of individuals who shop online only from overseas are men, 47.4% are women. 63.1% of individuals who shop online both domestically and overseas are men and 36.9% are women. Also 70% of individuals who shop only domestically, 59% of individuals who only shop from abroad, and 81% of individuals who shop both at home and abroad can send e-mail.

95.3% of individuals who only shop online domestically, 96% of individuals who shop online only from overseas, and 96.9% of individuals who shop online both domestically and overseas make voice or video calls via the Internet. 86.5% of individuals who only shop online domestically, 87.4% of individuals who shop online only from overseas, and 89.4% of individuals who shop online both domestically and overseas share content on social media. 95.5% of individuals who only shop online domestically, 97.1% of individuals who shop online only from overseas, and 99.1% of individuals who shop online both domestically and overseas are texting. 81.1% of individuals only shop online domestically, 82.3% of individuals who shop online only from overseas, and 85.9% of individuals who shop online both domestically and overseas online read the news sites/newspapers/news magazines.

Table 2. Descriptive Statistics on Variables

Variable	Category	ONLINE SHOPPING			
		Only Domestic	Only Overseas	Both Domestic and Overseas	Total
Region	Istanbul	1543 (17.7)	24 (13.7)	147 (27)	1714 (18.2)
	West Marmara	543 (6.2)	6(3.4)	26 (4.8)	575 (6.1)
	Aegean	1060 (12.2)	12 (6.9)	42 (7.7)	1114 (11.8)
	East Marmara	947 (10.9)	18 (10.3)	63 (11.6)	1028 (10.9)
	West Anatolia	1002 (11.5)	30 (17.1)	65 (11.9)	1097 (11.6)
	Mediterranean	801 (9.2)	4 (2.3)	59 (10.8)	864 (9.2)
	Central anatolia	515 (5.9)	22 (12.6)	33 (6.1)	570 (6.0)
	West Blacksea	509 (5.8)	5 (2.9)	42 (7.7)	556 (5.9)
	East Blacksea	481 (5.5)	1 (0.6)	5 (0.9)	487 (5.2)
	Northeast Anatolia	287 (3.3)	22 (12.6)	25 (4.6)	334 (3.5)
	Central East Anatolia	457 (5.2)	2 (1.1)	21 (3.9)	480 (5.1)
	Southeastern Anatolia	573 (6.6)	29 (16.6)	17 (3.1)	619 (6.6)
Gender	Male	4353 (49.9)	92 (52.6)	344 (63.1)	4789 (50.7)
	Female	4365 (50.1)	83 (47.4)	201 (36.9)	4649 (49.3)
Sending e-mail	No	2580 (26.9)	71 (40.6)	99 (18.2)	2750 (29.1)
	Yes	6138 (70.4)	104 (59.4)	446 (81.8)	6688 (70.9)
Making a Video Call	No	410 (4.7)	7 (4.0)	17 (3.1)	434 (4.6)
	Yes	8308 (95.3)	168 (96.0)	528 (96.9)	9004 (95.4)
Social Media Participation	No	1173 (13.5)	22 (12.6)	58 (10.6)	1253 (13.3)
	Yes	7545 (86.5)	153 (87.4)	487 (89.4)	8185 (86.7)
Sending Messages via the Internet	No	134 (1.5)	5 (2.9)	5 (0.9)	144 (1.5)
	Yes	8584 (98.5)	170 (97.1)	540 (99.1)	9294 (98.5)
Reading Online News from the Internet	No	1649 (18.9)	31 (17.7)	76 (13.9)	1756 (18.6)
	Yes	7069 (81.1)	144 (82.3)	469 (86.1)	7682 (81.4)
Searching for Health Information on the Internet	No	1198 (13.7)	32 (18.3)	78 (14.3)	1308 (13.9)
	Yes	7520 (86.3)	143 (81.7)	467 (85.7)	8130 (86.1)
Goods and Services Information Retrieval	No	1412 (16.2)	31 (17.7)	77 (14.1)	1520 (16.1)
	Yes	7306 (83.8)	144 (82.3)	468 (85.9)	7918 (83.9)
Website Sharing	No	7323 (84.0)	122 (69.7)	433 (79.4)	7878 (83.5)
	Yes	1395 (16.0)	53 (30.3)	112 (20.6)	1560 (16.5)
Job Search	No	7443 (85.4)	140 (80.0)	443 (81.3)	8026 (85.0)
	Yes	1275 (14.6)	35 (20.0)	102 (18.7)	1412 (15.0)
Goods and Services Sales	No	7027 (80.6)	128 (73.1)	399 (73.2)	7554 (80.0)
	Yes	1691 (19.4)	47 (26.9)	146 (26.8)	1884 (20.0)
Performing Bank Transactions	No	1714 (19.7)	52 (29.7)	74 (13.6)	1840 (19.5)
	Yes	7004 (80.3)	123 (70.3)	471 (86.4)	7598 (80.5)
Making a File Transfer	No	3559 (40.8)	113 (64.6)	185 (33.9)	3857 (40.9)
	Yes	5159 (59.2)	62 (35.4)	360 (66.1)	5581 (59.1)

Installing Application	No	4940 (59.7)	118 (67.4)	250 (45.9)	5308 (56.2)
	Yes	3778 (43.3)	57 (32.6)	295 (54.1)	4130 (43.8)
Making Device Setting Changes	No	5946 (68.2)	149 (85.1)	325 (59.6)	6420 (68.0)
	Yes	2772 (31.8)	26 (14.9)	220 (40.4)	3018 (32.0)
Creating Documents	No	5697 (65.3)	137 (78.3)	289 (53.0)	6123 (64.9)
	Yes	3021 (34.7)	38 (21.7)	256 (47.0)	3315 (35.1)
Using Tabulation Software	No	5964 (68.4)	146 (83.4)	306 (56.1)	6416 (68.0)
	Yes	2754 (31.6)	29 (16.6)	239 (43.9)	3022 (32.0)
Performing Data Editing	No	7023 (80.6)	154 (88.0)	381 (69.9)	7558 (80.1)
	Yes	1695 (19.4)	21 (12.0)	164 (30.1)	1880 (19.9)
Photo, Video, Audio File Editing	No	4755 (54.5)	135 (77.1)	238 (43.7)	5128 (54.3)
	Yes	3963 (45.5)	40 (22.9)	307 (56.3)	4310 (45.7)
Coding in Program Language	No	8244 (94.6)	166 (9.4)	489 (89.7)	8899 (94.3)
	Yes	474 (5.4)	9 (5.1)	56 (10.3)	539 (5.7)
Reading Privacy Text	No	4388 (50.3)	127 (72.6)	253 (46.4)	4768 (50.5)
	Yes	4330 (49.7)	48 (27.4)	292 (53.6)	4670 (49.5)
Limiting the Geolocation	No	5142 (59.0)	137 (78.3)	288 (52.8)	5567 (59.0)
	Yes	3576 (41.0)	38 (21.7)	257 (47.2)	3871 (41.0)
Limiting the Storage	No	4945 (56.7)	131 (74.9)	268 (49.2)	5344 (56.6)
	Yes	3773 (43.3)	44 (25.1)	277 (50.8)	4094 (43.4)
Blocking the Usage of Personal Information	No	4310 (49.4)	130 (74.3)	220 (40.4)	4660 (49.4)
	Yes	4408 (50.6)	45 (25.7)	325 (59.6)	4778 (50.6)
Preferring the Safe Websites	No	4808 (55.2)	135 (77.1)	245 (45.0)	5188 (55.0)
	Yes	3910 (44.8)	40 (22.9)	300 (55.0)	4250 (45.0)
Updating Personal Data and Requesting Deletion	No	7219 (82.8)	157 (89.7)	427 (78.3)	7803 (82.7)
	Yes	1499 (17.2)	18 (10.3)	118 (21.7)	1635 (17.3)

Note: Values in parentheses indicate percentages.

86.3% of individuals who only shop online domestically, 81.7% of individuals who shop online only from abroad, and 85.7% of individuals who shop online from both domestically and overseas search health-related information. 83.8% of individuals who only shop online domestically, 82.3% of individuals who shop online only from overseas, and 85.9% of individuals who shop online both domestically and overseas search for information about goods and services. 16% of individuals who only shop online domestically, 30.3% of individuals who shop online only from overseas, and 20.6% of individuals who shop online both domestically and overseas share their views on social or political issues via websites or social media. 14.6% of individuals who only shop online domestically, 20% of individuals who shop online only from overseas, and 18.7% of individuals who shop online both domestically and overseas are looking for a job or applying for a job via the Internet. 19.4% of individuals who only shop online domestically, 26.9% of individuals who shop online only from overseas, and 26.8% of individuals who shop online from both domestically and overseas sell goods or services via the internet.

80.3% of individuals who only shop online domestically, 70.3% of individuals who shop online only from overseas, and 86.4% of individuals who shop online both domestically and overseas use internet banking (website or mobile banking applications). 59.2% of individuals who only shop online domestically, 35.4% of individuals who shop online only from overseas, and 66.1% of individuals who shop online both domestically and overseas perform the operations of copying or moving files (document, data, image, video) between folders and devices (email, Messenger, WhatsApp, USB, cable) or on the cloud. 43.3% of individuals who only shop online domestically, 32.6% of individuals who shop online only from overseas, and 54.1% of individuals who shop online both domestically and overseas download or install software or mobile applications. 34.7% of individuals who only shop online domestically, 21.7% of individuals who shop online only from overseas, and 47% of individuals who

shop online from both domestically and overseas perform presentation or document creation operations by adding text, document, image, video, animation, table or graphics.

31.6% of individuals who only shop online domestically, 16.6% of individuals who shop online only from overseas, and 43.9% of individuals who shop online from both domestically and overseas use tabulation software. 19.4% of individuals who only shop online domestically, 12% of individuals who shop online only from overseas, and 30.1% of individuals who shop online both domestically and overseas use the advanced features of the tabulation program to edit, analyze, configure, or modify data (functions, formulas, macros, Visual Basic, etc.). 45.5% of individuals who only shop online domestically, 22.9% of individuals who shop online only from overseas, and 56.3% of individuals who shop online from both domestically and overseas organize photo, video, or audio files. 49.7% of individuals who only shop online domestically, 27.4% of individuals who shop online only from overseas, and 53.6% of individuals who shop online both domestically and overseas read the privacy policy of the website or applications before providing personal data. 41% of individuals who only shop online domestically, 21.7% of individuals who shop online only from overseas, and 47.2% of individuals who shop online from both domestically and overseas restrict or block access to geographical location. 43.3% of individuals who only shop online domestically, 25.1% of individuals who shop online only from overseas, and 50.8% of individuals who shop online both domestically and overseas limit access to profiles, content information on social networking sites, or shared online storage spaces. 50.6% of individuals who only shop online domestically, 25.7% of individuals who shop online only from overseas, and 59.6% of individuals who shop online both domestically and overseas do not allow the sharing of personal data for advertising purposes. 44.8% of individuals who only shop online domestically, 22.9% of individuals who shop online only from overseas, and 55% of individuals who shop online both domestically and overseas prefer secure websites. They control the features of websites to ensure the security of personal data (https sites, sites with a secure logo or certification). 17.2% of individuals who only shop online domestically, 10.3% of individuals who shop online only from overseas, and 21.7% of individuals who shop online from both domestically and overseas request the updating or deletion of personal data from the websites, search engines administrator or provider.

In the study, firstly, the multinomial logit model was estimated. As a result of the Hausman test, it was determined that the assumption of this model, the independence of irrelevant alternatives, could not be met, that is, the change in the coefficients was systematic ($X^2=-1205,20$; $p=0,000$). As a result of this result, the multinomial probit model was used, which does not require the assumption of irrelevant alternative independence. In the study, Stata 15.0 and IBM SPSS Statistics 25.0 programs was used in the analysis of the econometric model.

According to the marginal effect results of the multinominal probit model shown in Table 3, individuals living in the Western Marmara region are 3.5% more likely to shop only domestically compared to those living in Istanbul, while they are 3.4% less likely to shop both domestically and overseas. Individuals living in the Aegean region are 4.6% more likely to shop only domestically compared to those living in Istanbul, while they are 4.3% less likely to shop both domestically and overseas. Individuals living in the East Marmara region are 1.9% less likely to shop both domestically and overseas than those living in Istanbul. Individuals living in the Western Anatolia region are only 1.1% more likely to shop overseas than those living in Istanbul, while the probability of shopping both domestically and overseas is 2.4% lower. Individuals living in the Mediterranean region are only 1.9% more likely to shop domestically than those living in Istanbul, while the probability of shopping only overseas is 1.1% lower. Individuals living in the Central Anatolian region are 2% more likely to only

shop overseas than those living in Istanbul, while the probability of shopping both domestically and overseas is 1.9% lower. Individuals living in the Eastern Black Sea region are 8.3% more likely to do only domestic shopping, while the probability of shopping only overseas is 1.5%, and the probability of shopping both domestically and overseas is 4.1% lower than those living in Istanbul.

Table 3. Marginal Effects on the Multinomial Probit Model

Variable	Category	dy/dx	Std.Err.	z	P> z
Area of Residence (Reference Category: İstanbul)					
West Marmara	1	0,035***	0,013	2,780	0,005
	2	0,000	0,007	0,030	0,980
	3	-0,034***	0,011	-3,250	0,001
Aegean	1	0,046	0,010	4,780	0,000
	2	-0,004	0,005	-0,790	0,428
	3	-0,043	0,009	-4,930	0,000
East Marmara	1	0,017	0,011	1,530	0,127
	2	0,002	0,005	0,410	0,678
	3	-0,019*	0,010	-1,920	0,055
West Anatolia	1	0,012	0,011	1,160	0,245
	2	0,011**	0,006	2,020	0,044
	3	-0,024**	0,009	-2,550	0,011
Mediterranean	1	0,019*	0,012	1,680	0,094
	2	-0,011***	0,004	-2,770	0,006
	3	-0,008	0,011	-0,750	0,452
Central Anatolia	1	-0,001	0,014	-0,080	0,935
	2	0,020**	0,008	2,470	0,014
	3	-0,019	0,012	-1,540	0,124
West Blacksea	1	0,007	0,014	0,490	0,625
	2	-0,005	0,006	-0,970	0,330
	3	-0,002	0,013	-0,120	0,908
East Blacksea	1	0,083***	0,009	9,410	0,000
	2	-0,015***	0,004	-4,110	0,000
	3	-0,069***	0,008	-8,400	0,000
Northeast Anatolia	1	-0,037*	0,020	-1,880	0,060
	2	0,035***	0,011	3,030	0,002
	3	0,003	0,017	0,170	0,865
Central East Anatolia	1	0,053***	0,011	4,690	0,000
	2	-0,013***	0,004	-3,160	0,002
	3	-0,041***	0,011	-3,790	0,000
Southeastern Anatolia	1	0,031***	0,012	2,590	0,010
	2	0,019***	0,007	2,710	0,007
	3	-0,050***	0,010	-5,170	0,000
Gender (Reference Category: Male)	1	0,027***	0,006	4,750	0,000
	2	-0,002	0,003	-0,740	0,459
	3	-0,025***	0,005	-5,000	0,000
Sending e-mail (Reference Category: No)	1	0,012*	0,007	1,770	0,076
	2	0,004	0,003	1,240	0,216
	3	-0,016**	0,006	-2,590	0,010
Social Media Participation (Ref. Category: No)	1	0,020	0,015	1,320	0,188
	2	-0,008	0,007	-1,150	0,250
	3	-0,011	0,013	-0,850	0,393
Making a Video Call (Ref. Category: No)	1	0,010	0,009	1,220	0,224
	2	0,000	0,004	-0,110	0,911
	3	-0,010	0,008	-1,300	0,192
Sending Messages via the Internet (Ref. Cat: No)	1	0,000	0,025	-0,010	0,995
	2	0,005	0,009	0,550	0,584
	3	-0,005	0,023	-0,210	0,837
Reading Online News via the Internet (Ref. Cat :No)	1	0,016**	0,008	2,100	0,035
	2	-0,005	0,004	-1,340	0,182
	3	-0,011	0,007	-1,620	0,106

Searching for Health Information on the Internet (Ref.Cat: No)	1	-0,018**	0,008	-2,170	0,030
	2	0,006	0,004	1,600	0,109
	3	0,012	0,007	1,590	0,111
Goods and Services Information Retrieval (Ref.Cat: No)	1	-0,004	0,008	-0,520	0,606
	2	-0,003	0,004	-0,740	0,462
	3	0,007	0,007	0,990	0,324
Website Sharing (Ref.Cat:No)	1	0,021***	0,007	3,060	0,002
	2	-0,015***	0,003	-4,590	0,000
	3	-0,006	0,006	-1,010	0,311
Job Search (Ref. Cat: No)	1	0,016**	0,007	2,220	0,026
	2	-0,008**	0,004	-2,120	0,034
	3	-0,008	0,006	-1,330	0,184
Goods and Services Sales (Ref.Cat:No)	1	0,020***	0,006	3,060	0,002
	2	-0,006*	0,003	-1,810	0,070
	3	-0,014**	0,006	-2,470	0,014
Performing Bank Transactions (Ref.Cat.:No)	1	-0,006	0,008	-0,720	0,471
	2	0,005	0,003	1,390	0,166
	3	0,001	0,007	0,140	0,891
File Transfer (Ref.Cat.:No)	1	-0,018***	0,007	-2,670	0,008
	2	0,011***	0,003	3,150	0,002
	3	0,007	0,006	1,220	0,222
Installing the Application (Ref.Cat.:No)	1	0,012*	0,007	1,880	0,060
	2	-0,006*	0,003	-1,790	0,073
	3	-0,006	0,006	-1,100	0,272
Making Device Settings Change (Ref.Cat.:No)	1	-0,016**	0,008	-2,050	0,040
	2	0,010***	0,004	2,480	0,013
	3	0,006	0,007	0,910	0,362
Creating Documents (Ref.Cat.:No)	1	0,012	0,008	1,520	0,129
	2	-0,003	0,004	-0,660	0,512
	3	-0,009	0,007	-1,350	0,176
Using the Tabulation Software (Ref.Cat.:No)	1	0,003	0,009	0,380	0,703
	2	0,003	0,005	0,720	0,472
	3	-0,007	0,008	-0,870	0,384
Performing Data Editing (Ref.Cat.:No)	1	0,011	0,009	1,290	0,196
	2	-0,006	0,005	-1,040	0,300
	3	-0,006	0,007	-0,810	0,420
Photo, Video, Audio File Editing (Ref.Cat.:No)	1	-0,002	0,006	-0,360	0,719
	2	0,012***	0,003	3,430	0,001
	3	-0,009	0,005	-1,740	0,082
Coding in Program Language (Ref.Cat.:No)	1	0,018	0,011	1,580	0,113
	2	-0,009	0,007	-1,400	0,162
	3	-0,008	0,009	-0,920	0,356
Reading the Privacy Text (Ref.Cat.:No)	1	-0,008	0,006	-1,360	0,174
	2	0,008***	0,003	2,770	0,006
	3	0,000	0,005	-0,020	0,985
Limiting the Geolocation (Ref.Cat.:No)	1	-0,002	0,007	-0,330	0,739
	2	0,004	0,003	1,150	0,249
	3	-0,002	0,006	-0,330	0,744
Limiting Storage (Ref.Cat.:No)	1	0,005	0,007	0,660	0,511
	2	-0,003	0,004	-0,710	0,480
	3	-0,002	0,006	-0,320	0,749
Preventing the Usage of Personal Information (Ref.Cat.:No)	1	-0,002	0,007	-0,260	0,797
	2	0,007**	0,003	2,120	0,034
	3	-0,006	0,006	-0,930	0,354
Preferring Secure Websites (Ref.Cat.:No)	1	0,000	0,007	0,040	0,970
	2	0,004	0,004	1,140	0,254
	3	-0,004	0,006	-0,760	0,446
Requesting Personal Data Update and Deletion (Ref.Cat.:No)	1	0,000	0,008	0,000	1,000
	2	0,000	0,004	0,110	0,913
	3	0,000	0,006	-0,070	0,942

Note: *10%, **5%, ***1% show statistical significance at the significance level.

Category: 1: Domestic, 2: Overseas, and 3: It refers to individuals who shop both domestically and overseas.

Individuals living in the Northeast Anatolia region are 3.7% less likely to shop only domestically than those living in Istanbul, while the probability of shopping only overseas is 3.5% lower. Individuals living in the Central East Anatolia region are 5.3% more likely to do only domestic shopping, while the probability of shopping only overseas is 1.3%, and the probability of shopping both domestically and overseas is 4.1% lower than those living in Istanbul. Individuals living in the Southeastern Anatolia region are 3.1% more likely to do only domestic shopping and 1.9% more likely to shop only overseas, compared to those living in Istanbul, while the probability of shopping both domestically and overseas is 5% lower.

It has been determined that while female individuals are 2.7% more likely to do only domestic shopping than male individuals, the probability of shopping both domestically and overseas is 1.6% lower. It has been determined that individuals who follow online news via the Internet are 1.6% more likely to only shop domestically than those who do not. It has been determined that individuals who search for information about health on the Internet are 1.8% less likely to do only domestic shopping than those who do not. Individuals who share websites on the Internet are 2.1% more likely to make only domestic shopping, while the probability of shopping overseas is 1.5% less than those who do not. Individuals who are looking for a job on the Internet are 1.6% more likely to only shop domestically than those who are not, and 0.8% less likely to shop overseas. Individuals who sell online are 2% more likely to shop only domestically compared to those who do not sell, while they are only 0.6% less likely to shop overseas and 1.4% less likely to shop both domestically and overseas. Individuals who know how to transfer files on a computer are 1.8% less likely to make purchases only from domestic compared to individuals who do not know, while they are 1.1% more likely to make purchases only from overseas.

Individuals who know how to install computer and mobile applications are 1.2% more likely to shop only domestically, while the probability of shopping only from overseas is 0.6% lower than those who do not. Individuals who know about the system change are 1.6% less likely to shop only domestically than those who do not, while the probability of shopping only from overseas is 1% higher. Individuals who share photos and videos are 1.2% less likely to shop only from overseas than those who do not.

Individuals who read the privacy policy of the website or applications before giving their personal data are 0.8% more likely to shop only from overseas abroad than those who do not. It has been determined that individuals who do not allow the sharing of their personal data for advertising purposes are 0.7% more likely to make purchases only from overseas, compared to individuals who do.

Conclusions and Discussion

According to statistics, approximately 46% of the world's population, in other words 3.4 billion people, have become internet users. While the world population has increased by an average of 1.1% per year since 2000, the total number of internet users, which we call the internet population, has increased by approximately 13.2% every year and the spread of the internet has continued rapidly. Although almost half of the world's population has become internet users today, the internet population will continue to grow rapidly in the coming period [11]. The dizzying change in technology has found its way in the field of e-commerce, as in all trade formats, and trends that were not in our lives a few years ago have reshaped e-commerce today. E-commerce stands out as an attractive channel for many companies that want to start a business or increase their sales, because it can be implemented quickly and does not bear the costs of conventional retail. As a matter of fact, this study was conducted to investigate the relationship between various individual internet usage and electronic skills, personal data

protection sensitivity, and some demographic characteristics and e-commerce preferences of individuals. For this purpose, the MNP model was used to investigate the determinants of e-commerce (internet place to buy goods) preferences. According to the findings obtained from the MNP model, regional differences, gender, internet usage skills (e-mail, reading news online, searching for information about health, web site sharing, job search, selling goods and services) in e-commerce preference, computer-mobile skills (banking, file transfer, application installation, photo editing), and personal data security (preventing the use of personal information and reading privacy text) have been determined to have significant effects.

According to the findings, when examined in terms of the region, it was determined that the individuals living in Istanbul preferred to shop both domestically and abroad more than other regions. As a strategic priority in e-commerce, it is necessary to establish a website that will attract the attention of consumers, and after doing this, it is necessary to capture and maintain the necessary traffic. In this sense, in a national e-commerce strategy, it is important to choose a location that will increase the e-commerce traffic to a sustainable rate for the beginning. [30] stated that e-commerce activities in the United States started in the era of telemarketing, and they stated that the sales figures in population-dense regions were high in the internet era as they were in the telephone era. On the other hand, [31] is study on households in Italy concluded that although internet use is more common among urban consumers, the size of the city they live in does not affect e-commerce and e-banking transactions. According to the research, the use of e-commerce is mostly shaped by the preferences of participation in cultural and artistic activities, not residence in the city or in the countryside. These different results show us that although the consumer population value of the region is an important factor, it will not give a meaningful result on its own. As a matter of fact, [32] in his comparative research on e-commerce during the Covid-19 period examined the changes in the daily life practices of individuals living in three countries after the pandemic and found that people in Germany (30%), the United Kingdom (46%) and the United States of America. They found that they tend to do more online shopping in their states (52%). At this point, it would not be wrong to argue that the socio-cultural structures of countries are one of the determining factors in e-commerce preferences.

[33] stated that demographic characteristics such as gender affect the actions and decisions of individuals before they engage in a certain behavior. In this sense, the relationship between gender and the environment in which individuals spend their daily lives is important. Because this situation can differentiate the purpose and outputs of internet usage. First of all, it should be noted that although there are cultural differences in internet use, gender discrimination and inequality has decreased to zero in the last quarter century. It is possible to support this situation with studies conducted in the EU countries [34] and Turkey [16]. There are quite different results in online shopping-oriented internet use. In our study, it was found that men prefer to shop from abroad and women prefer to shop domestically. Similarly, the majority of individuals who shop online, both at home and abroad, are men. [35] in his study on students enrolled in e-commerce course in the USA found that women value the benefits of online shopping less than their male counterparts. [36] stated while emphasizing that male users prefer e-commerce more, found that male users prefer the online method more for computer, mobile phone and television shopping, and female users for clothes and perfume shopping. These results show that although e-commerce is the product needed on the basis of motivation, in general, men do not hesitate to buy durable consumer goods online, which have a relatively high price scale. At the same time, male internet users can act bravely and pragmatically compared to female internet users in e-commerce. The balance of usage equality, which emerged as a result of the widespread use of the Internet, especially in

the workplace, has deteriorated in favor of men when the use of e-commerce is considered. Of course, this situation has cultural characteristics as well as the fact that women are more sensitive and sensitive to the product they buy.

It would be useful to mention the use of social media, which has been rapidly increasing in e-commerce preferences, especially in recent years. Because a company's communication and interaction with its target audience through social media can increase brand awareness, website traffic and sales. Considering the time people spend on their social media accounts, the importance of the relationship between social media and strategic business management emerges. According to the results obtained in the research, a significant portion of individuals who only shop online at home, those who shop online only from abroad, and those who shop online both at home and abroad (over 80% in all three categories) share content on social media. The use and sharing of social media require a certain level of skill and can create various effects on the attitudes and behaviors of users. For example, [37] concluded in their research that customers consider the comments and suggestions of other customers on social media when purchasing products from e-commerce sites. In other words, in general, users can be both sellers and buyers of each other and references related to the product or service. On the other hand, according to the research results of [38], the use of social media significantly affects online shopping, but the more intensive use of social media also significantly affects distrust in social media, and as a result, distrust in social media has a significant impact on online shopping. creates a negative effect. In addition to the skill of the user in the relationship between social media and e-commerce, his trust in the social media platform he uses and his belief in the evaluations of other users are important factors.

When the results are evaluated within the scope of e-skills, individuals who know how to install computer and mobile applications are 1.2% more likely to shop only domestically, while the probability of shopping only from abroad is 0.6% less than those who do not. On the other hand, it has been found that individuals who can send e-mails, read news online, share websites, seek jobs, sell goods and services, and install applications are more likely to make domestic purchases. First of all, the issue that needs to be examined is for what purposes the computer and the internet are mostly used. Because the primary priority of people who have access to every computer or internet or can use it at a certain level is not online shopping. In fact, regardless of all other factors, online shopping starts with the customer feeling safe [39] On the other hand, as computer and internet usage skills progress, individuals' e-commerce motivation can increase. There are research results supporting this result [40, 41; 43]. Finally, in the research, it was found that individuals who prevent the use of personal information, read the privacy text, have the ability to transfer files, make photo, audio and video adjustments on a computer or phone, and change settings in electronic devices are more likely to shop from abroad. The sense of trust between the seller and the buyer in e-commerce can no longer be achieved by websites or sales methods that create a perception of trust alone; The main issue for customers is the need to protect online privacy [44]. In this sense, it is understandable that individuals who have a certain level of computer and internet usage skills and experience tend to shop from abroad due to price or quality advantage and consider this method reliable.

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Social financing and the sustainability of social enterprises in Zimbabwe

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Abstract. Social enterprises are important contributors in boosting economic growth, creating jobs, and improving the quality of life for both entrepreneurs and the communities where they operate. The challenge facing most social entrepreneurs is the access to finance. This research aimed at developing an innovative financing model that best suit social enterprises in Zimbabwe. This was achieved by looking at the factors affecting sustainability of social enterprises and the challenges and opportunities for sustainable social financing in Zimbabwe. Using quantitative methodology, data was collected through close ended questionnaires that were distributed to social entrepreneurship stakeholders in Harare, Zimbabwe. Analysis of the quantitative data used the SPPSS 22 statistical software package. The key study findings identified the following six factors that directly impact the sustainability of social enterprises, that is, social finance access, government support, community attitude and involvement, governance, strategy and management skills and ability of entrepreneurs to solve complex problems. The main conclusions were that the lack of financial resources had most significant impact on the demand and supply of social entrepreneurship funds. The study recommends that, a revolving social innovation fund should be established to provide funding for social enterprises. This acts as suitable product on the supply side which social enterprises require. As a result, policymakers and stakeholders can come together to ease the process for social enterprises to acquire financing.

Keywords: *Social financing, Social enterprise, Social entrepreneurship, Sustainability, Funding*

1. Introduction

Social enterprises play an important role in tackling the complex problems facing societies today (Frank & Muranda, 2016; Gumbe & Towera, 2016; Rawal, 2018). Countries like Zimbabwe face increasing poverty and unemployment levels, the emergence of multi-faceted social problems, government spending restrictions and the challenges of climate change all which require innovative approaches to addressing them (Ndiweni & Verhoeven, 2013). The development of social enterprises in Zimbabwe may provide or contribute towards a viable solution to address the scourge of the social problems faced (Frank & Muranda, 2016). Social enterprises, however, do face challenges and difficulties with some of these challenges being contextual while others are more common in nature and cut across different settings (Gumbe & Towera, 2016). However, the main factors affecting the

growth of social enterprises in Zimbabwe include risks and costs associated with their establishment and sustaining them, and the dearth in business skills required for setting up and managing viable enterprises. There is a lack of access to capital and credit markets (Gumbe & Towera, 2016).

Although it is an integral part of financial development the impact of financial innovation on the economic growth of developing countries has not been fully studied (Rizzi, et al., 2018). The lack of financial resources due to absence of willing funders is one of the obstacles in impacting the development of social entrepreneurship (OECD, 2013; Castellás, et al., 2018; Fergus & Robyn, 2019). The development of dynamic social enterprises is important because they generate social and economic value (Wanyoike & Maseno, 2021). To be able to deliver social value sustainably, the enterprises must gain access to reliable and predictable financing (Doherty et al., 2014; Frank & Muranda, 2016). This calls for attention to the need for financial innovation that can help develop these entities (Chibba, 2009). According to Chibba, financial innovation research in developing countries has mostly focused on welfare issues, particularly the implications for financial inclusion, but has not addressed social finance models (Akbulaev, et al., 2019). The economic climate in Zimbabwe has not been conducive to investment since 2000. This research investigates the significance of innovative finance towards the development of social enterprise in Zimbabwe. This study examines the factors affecting sustainability of social enterprises and the challenges and opportunities for sustainable social financing in Zimbabwe.

2. Literature review

2.1 Social Enterprise Concept: Definitions

The OECD (2017) defines entrepreneurship as: “The dynamic process of creating incremental wealth. This wealth is created by individuals who assume major risks in terms of equity, time, and/or career commitment of providing value for a product or service. The product or service itself may or may not be new or unique but the entrepreneur must somehow infuse value by securing and allocating the necessary skills and resources.” There is no consensus on the definition of social entrepreneurship (Santos, 2012). Despite the lack of both the definition and inconsistent usage of the term social enterprise in the international literature (Dart, 2004) a few perspectives in the literature are considered below. Firstly, social enterprise is thought to be something new and something distinct from classical business and traditional non-profit activity, combining at different extents elements of the social purpose, the market orientation, and financial-performance standards of business (Young, 2008). Social entrepreneurship has received little research attention in developing countries yet its impact in society cannot be ignored (Bote, et al., 2014; Chibba, 2009; Lourenço, 2013).

2.1.1 Funding Social Entrepreneurship

Social enterprises need financing at the various stages of their life cycle (Serrano, et al., 2019). Funds are needed to conduct research, start new ventures, purchase inventory and assets to grow and maintain the business (Gundry, Kickul, Griffiths & Bacq, 2011; Martin, 2013; Wanyoike & Maseno 2021). Most social enterprises have failed to raise initial capital (European Commission Communication, 2011; Serrano, et al., 2019) as most social entrepreneurs are individuals who find it difficult to raise enough funds at an early stage. However, governments, financial institutions and the general public in developed countries have embraced social entrepreneurship as evidenced by their willingness to fund social enterprise ventures (Frank & Muranda, 2016; Wanyoike & Maseno 2021). Lourenço, (2013) pointed out that countries that support sustainable development achieve social, economic and environmental positive impacts. While Roodman and Morduch, (2011) argue that: “Access to credit and deposit services potentially provide the poor with opportunities to take an active role in their respective economies through entrepreneurship, building income, bargaining power and social empowerment among poor women and men.”

Identifying the actors in the social enterprise finance ecosystem is important as it will be useful to come up with a suitable finance model. Bitektine and Haack (2015) state that: “Aside from supply and demand actors and intermediaries, the investment environment (atmosphere), which is distinctly

shaped by governments, policymakers, and regulatory authorities, can make or break public legitimization and thus contribute to society's validity judgement regarding impact investments.”

2.2 Funding Challenges Faced by Social Enterprises

Lyons & Kickul, (2013, p. 157) highlight that there is limited research evidence on social enterprise financing despite sentiments that the area is becoming "an exciting new frontier in a field that is already setting new standards". Cassar (2004) points out that while the necessity of money is undeniable and a critical driver of a business' ability to survive and grow, it is also a significant barrier for social entrepreneurs (Lehner, 2013). One of the major disadvantages of social enterprises in comparison to commercial enterprises is the lack of funding (Bugg-Levine et al., 2012). Lack of funding impedes the creation and growth of social enterprises which is reported as one of the most pressing issues facing social enterprises in the world (Calic & Mosakowski, 2016; Clarkin & Cangioni, 2016).

The primary goal of a social enterprise is not profit maximization (Martin, 2015). However social enterprises are not profitable enough to entice investors to invest in them (Bugg-Levine et al. 2012). While social enterprises can be successful in generating significant social and environmental impact, they continue to encounter difficulties in covering the costs associated with obtaining funding (Bugg-Levine et al., 2012). The risk associated with the start-up phase is particularly high due to their focus on social impact rather than wealth creation. As a result, meeting the requirements of investors for risk-adjusted returns can be difficult, especially given the high risk associated with the start-up phase (Lyons & Kickul, 2013). The reference to the so-called ‘valley of death’ which for social enterprises is typically defined as the period between initial grant funding and investment capital represents a significant barrier (Martin, 2015). Harding (2004) cited the importance of access to funding in the creation of jobs and economic growth.

Difficulties in monetizing social impact, that is, the ability to generate economic income from the creation of social value is one of the main reasons why some social enterprises are unable to generate sufficient income (Lyons & Kickul, 2013). Further stating that because value is created for the entire society rather than just a specific group of customers social enterprises face challenges in attracting individuals who will render free services (Lyons & Kickul, 2013). These difficulties present unique challenges for both investors and social entrepreneurs themselves, as well as for the general public (Lyons & Kickul, 2013). Occasionally, social enterprises are compelled to compromise their social mission in order to achieve profitability goals or to attract necessary funding sources (Dacin, Dacin & Matear, 2010). This may result in a trade-off between social mission and profits which may jeopardize the mission's ability to make a positive social impact (Lyons & Kickul, 2013).

Another issue related to financial problems is the difficulty in determining the social impact of a project (Kickul & Lyons, 2015). In other words, investors are not provided with an appropriate assessment of the social return on investment (Dacin et al., 2010). There is a need therefore for social impact assessments that are acceptable to investors (Kickul & Lyons, 2015). Lyons and Kickul (2013) noted that investors should recognize that social and financial value are inextricably linked and cannot be separated. The nature of this link was expressed by Jed Emerson, CEO of Blended Value who stated that: “There is a common misconception that values are divided between the financial and the societal, but this is a fundamentally incorrect way of thinking about how we create value. “Value is complete” (World Economic Forum, 2005).

Funding difficulties for social enterprises can be attributed to differences in time perspective as these enterprises are typically concerned with maximizing long-term value and establishing long-term effects, whereas investors are typically concerned with maximizing short-term value and establishing immediate effects (Lyons & Kickul, 2013).

2.3 Social Entrepreneurship and Long-Term Sustainability

Social enterprises primarily focus on improving social well-being and addressing social and environmental challenges. Griffiths and Tan (2007) highlighted that those traditional efforts to fight poverty, through charity programs have become unproductive hence the need to create a system in

which economic and social values are intertwined and developed simultaneously. This argument is supported by Porter and Kramer (2011) who stated that: “Businesses acting as businesses, not as charitable donors, are the most powerful force for addressing the pressing issues we face.” (Porter & Kramer, 2011).

Charitable organizations alone cannot deal with the social and environmental concerns encountered today and fail to innovate and respond effectively (Brandstetter & Lehner, 2015). Furthermore, focus falls too much on the act of charitable giving rather than on achieving social effects (Brandstetter & Lehner, 2015). Lack of effectiveness in optimizing the social results is one of the major reasons behind the inefficiency of aid programs (Griffiths & Tan, 2007). Thus, the need for a new approach that balances commercial and social objectives towards solving contemporary problems. Prieto (2011,) argues that underprivileged areas require social entrepreneurs with new solutions. Warwick and Polak (2013) pointed out the distinctive characteristics of social companies which makes them more adapted to generate innovative solutions which include pursuing a meaningful social mission. In turn, Porter and Kramer (2011) cited the dedication by these companies towards creating positive social effects which sets them apart from the typical corporate thinking thus enhancing their capacity to handle challenges in the social world (Porter & Kramer, 2011). Griffiths and Tan (2007) point out that social enterprises deploy their talents and resources towards tackling the social challenges.

The long-term viability of social enterprises is influenced by factors that include management, financial resources, project design, and community attitudes. The difficulty of re-securing management knowledge and assistance, as well as quality assurance, all limit their flexibility (Borzaga & Defourny, 2001). According to the Plunkett Foundation (2010) the variables that influence a social enterprise's long-term viability include lack of shared commitment, people-centeredness, unclear objectives, bad governance, weak leadership, a lack of flexibility and reactivity, a lack of continuity of purpose, credibility issues, membership attrition and limited entrepreneurial innovativeness.

2.4 Social Enterprises in Developing Countries

Social entrepreneurship has received little research attention in developing countries yet its impact in society cannot be ignored (Bote, et al., 2014; Chibba, 2009; Lourenço, 2013). There is limited financial support and general ignorance of social ventures by communities (Seda & Ismail, 2019). Limited resources and reluctance by banks and financial institutions to provide financial support to small and medium enterprises SMEs is high in developing countries, thus governments are expected to play an even greater role in providing funding for SME development (Wonglimpiyarat, 2015). Furthermore Assuncao, (2013) argues that financial access is a catalytic metric for socio-economic development. Thus, innovative financial services that take into account the rural conditions of developing countries and offer appropriate provision have the ability to overcome financial constraints thereby improving people's living and socio-economic conditions (Bote, et al., 2014).

THE UNICEF June 2020 Budget Brief examines how the Ministry of Public Service, Labour and Social Welfare budget for 2020 addressed the social protection requirements of Zimbabwe's vulnerable and marginalized households. Figure 1.1 below shows that the total funding for the Zimbabwe Social Protection sector in 2020 is US\$117 million, with ninety- three percent (93%) coming from local sources and seven percent (7%) from development partners (UNICEF, 2020).

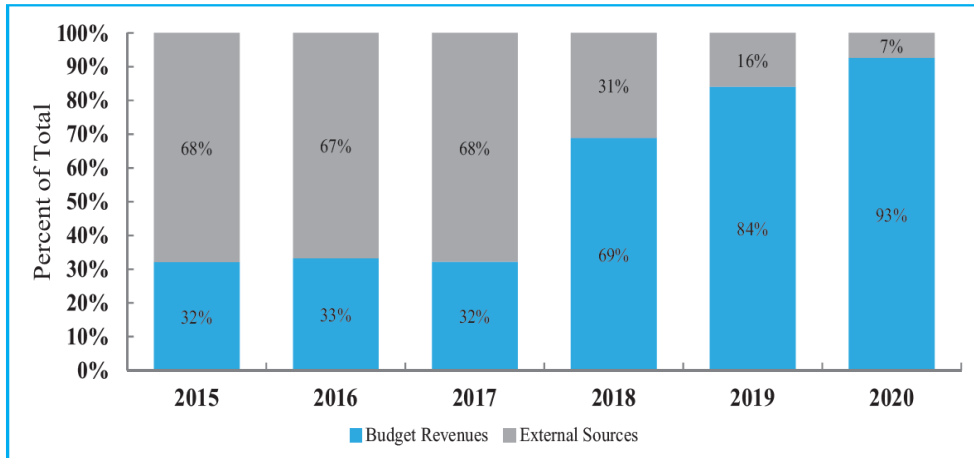


Figure1.1: Trend in Domestic and External Social Protection Sector Financing. **Source:** Various Budget Statements and UNICEF calculation (UNICEF, 2020).

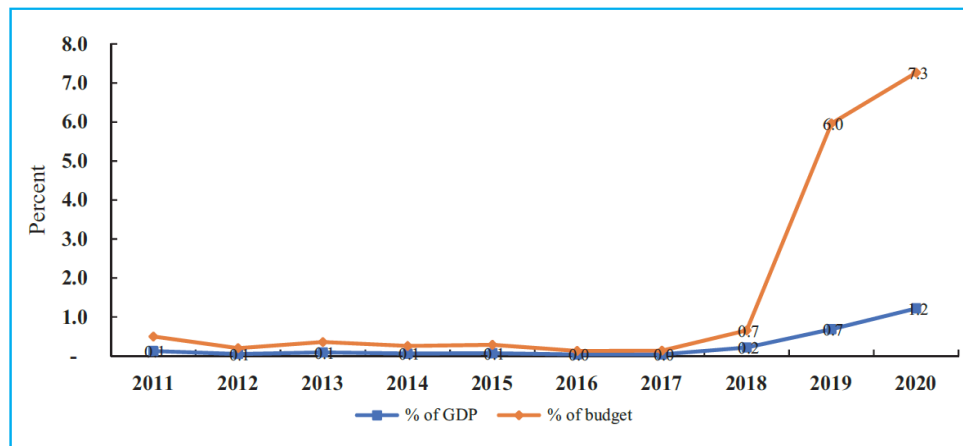


Figure1.2: Non-Contributory Social Spending: Percent of Total Budget and GDP. **Source:** Ministry of Finance and Economic Development and Author Calculations and UNICEF calculation (UNICEF, 2020).

Figure 1.2 above shows that Zimbabwe spends less than two percent (1.2%) of GDP on social assistance programs equivalent to 7.3% of the overall national budget which is insufficient in comparison to existing and future social protection needs (UNICEF, 2020). Zimbabwe should strive to catch up with its regional neighbours in terms of social spending (UNICEF, 2020). While the increase in public sector finance is encouraging, more domestic resource mobilization is needed to fill the gap created by declining donor support (UNICEF, 2020).

3. Methodology and Instruments

The study adopted a quantitative methodology in determining the factors affecting sustainability of social enterprises in Zimbabwe. The factors were discovered through literature and then evaluated among Harare's social enterprise stakeholders. A self-administered closed ended questionnaire survey was used to collect data. A sample of 125 respondents was drawn from employees as well as management personnel of social businesses, lenders, and financial regulators, as detailed in Table 3.1 below. Convenience sampling was utilized to gather data from social entrepreneurship stakeholders who were chosen for the study because they have worked for the company for more than a year and could aid in the objectives of the study. It is possible to fully comprehend the underlying phenomena of interest using this non-random selection strategy, which

targets individuals with specificity. Data was analysed using the Statistical Package for Social Sciences (SPSS) Version 22 software. The researcher summarised details about the participants for this study using descriptive statistics in the form of tables. To facilitate distribution and the ease of answering via electronic devices like computers and smartphones, the instrument was set up as an online form with a Google survey format. The employed data gathering techniques were entirely in accordance with Covid 19 standards. To obtain consent, remind the responders, and express gratitude, telephonic calls and social media messages were used.

Table 3.1. Social Entrepreneurship stakeholders in Harare, Zimbabwe

Company	Managerial/Owners	Employees	Total
Microfinance	8	12	20
Banking	12	27	39
Private Equity Fund	10	19	29
Social Enterprises ¹	25	12	37
Grant total			125

Source: Research survey 2021

4. Results and Findings

Quantitative data analysis findings are presented in order to answer the study's research questions. These are addressed by looking at the factors that are affecting sustainability of social enterprises.

4.1 Questionnaire response rate and demographics

Out of the 125 Questionnaires distributed to social entrepreneurship stakeholders, 87 of them were returned with enough data for analysis. This shows that a response rate of 0.696 was attained. Looking at the demographics of the respondent's majority which is 72.4% were male whilst only 27.6% were females. This shows that the sector is dominated by male and therefore the quantitative part of this study was biased more towards to what male respondents are likely to say.

Table 4.1 Response Rate and Demographics
Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	63	72.4	72.4	72.4
	Female	24	27.6	27.6	100.0
	Total	87	100.0	100.0	

As shown on the descriptive table below again the level of education for the respondents on average is a university degree since it's at 2.75. and as shown on Figure 4.1 below. This means that few respondents do have postgraduate degrees and at the same time those with college diplomas are also few. The mean Age of respondents is 3.30 meaning that most respondents are aged 35-44 years. This is necessary to ensure the solutions that are come out of the study through the respondents be of something to rely on as age also determines the level of innovativeness. Most people have stayed in the industry on average for about 6-7 years as shown on the descriptive table were the mean of years in the sector is 2.89.

Table 4.2 Response Rate and Demographics

	Descriptive Statistics				
	N	Minimum	Maximum	Mean	Std. Deviation
gender	87	1	2	1.28	.450
level_education	87	1	4	2.75	1.034

¹ These are organizations that are social enterprises but not microfinance institutions

age	87	1	6	3.30	1.069
years_in_the_sector	87	1	5	2.98	1.494
Valid N (listwise)	87				

The Figure 4.1 below shows the distribution of age of the respondents which has a mean of 2.75 and standard deviation of 0.6333. The distribution is skewed to the centre with many respondents holding an undergraduate degree.

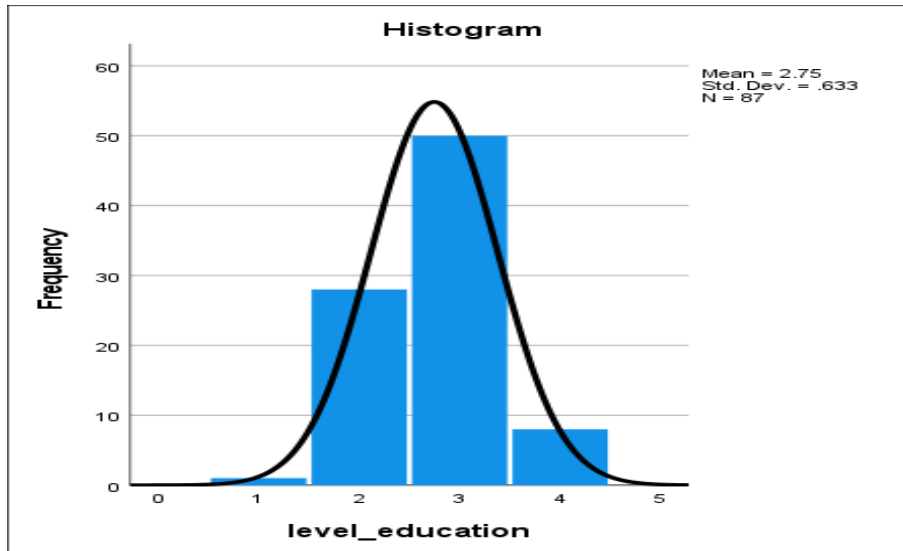


Figure 4.1 Histogram showing the distribution of level of education

4.2 Reliability statistics

Cronbach's alpha was used to determine the issue of reliability statistics underpinning the study. According to Fergus & Robyn (2019) the ability of a research instrument to replicate results under similar conditions is referred to as reliability. The Cronbach alpha coefficient value for all four construct variables of the study exceeded 0.7, as shown in Table above, which Fergus & Robyn (2019) considers to be the most acceptable threshold and confirmation of reliability. Given their Cronbach Alpha value, the study accepted all of the constructs.

4.3 Factors affecting sustainability of social enterprises in Zimbabwe

Respondents were asked what variables they believe are harming the sustainability of social enterprises in Zimbabwe in order to answer the study's first research question. A total of ten factors were considered. The mean and standard deviation of each of the factors are shown in the table below.

Table 4.3 Descriptive Statistics factors affecting sustainability of social enterprises

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Q1a	87	1	5	2.99	1.351
Q1b	87	1	5	1.98	1.418
Q1d	87	1	5	3.08	1.399
Q1c	87	1	5	2.84	1.328
Q1e	87	1	5	2.99	1.377

Q1f	87	1	5	3.20	1.437
Q1g	87	1	5	2.86	1.472
Q1h	87	1	5	3.26	1.426
Q1i	87	1	5	2.86	1.472
Q1j	87	1	5	3.00	1.494
Valid N (listwise)	87				

4.3.1 Access to social funding

There was a statistically significant agreement (n=87, Mean=2.99, SD=1.351) to support that to access to social funding is a major factor that determine whether a social enterprise can be sustainable from the beginning. Majority of the respondents, 31% agreed that this was a factor and therefore it means when social enterprise access social funding there are bound to sustain and make impact in the society.

Table 4.4 Access to social funding

Q1a

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	18	20.7	20.7	20.7
	Disagree	14	16.1	16.1	36.8
	Neutral	17	19.5	19.5	56.3
	Agree	27	31.0	31.0	87.4
	Strongly Agree	11	12.6	12.6	100.0
	Total	87	100.0	100.0	

4.3.2 Pursuit of dual missions

There was a statistically insignificant agreement (n=87, Mean=1.98, SD=1.418) to support that pursuit of dual missions is a major factor that determine whether a social enterprise can be successful or not. Majority of the respondents, 22% disagreed and also 21% strongly disagreed, whilst 21.8% agreed as shown on Table 4.5 below. There is no enough evidence from this study that no matter how many missions the social enterprise embarks on it does not affect its sustainability.

Table 4.5 Pursuit of dual missions

Q1b

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	21	24.1	24.1	24.1
	Disagree	22	25.3	25.3	49.4
	Neutral	12	13.8	13.8	63.2
	Agree	19	21.8	21.8	85.1
	Strongly Agree	13	14.9	14.9	100.0
	Total	87	100.0	100.0	

4.3.3 Competitiveness.

Competitiveness can be defined in the context of businesses as the ability of companies to offer goods or services in a favourable quality-price relationship which ensures high profits at the same time increasing or maintaining its market share gaining customer favour over other competitors. There was

a statistically insignificant agreement (n=87, Mean=2.84 SD=1.328) to support that competitiveness is a major factor that determine whether a social enterprise can be sustainable in Zimbabwe. Majority of the respondents, 24.1% disagreed as shown on Table 4.6 below, that this was a factor and therefore it means trying to have a competitive edge is not what can make a social enterprise in Zimbabwe succeed.

Table 4.6 Competitiveness.

		Q1c			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	17	19.5	19.5	19.5
	Disagree	21	24.1	24.1	43.7
	Neutral	20	23.0	23.0	66.7
	Agree	17	19.5	19.5	86.2
	Strongly Agree	12	13.8	13.8	100.0
	Total	87	100.0	100.0	

4.3.4 Community attitude and involvement

People in a community can be involved in projects to solve their own problems, which can be regarded as community engagement and this is especially vital in emergency sanitation programs, when individuals may be unfamiliar with their surroundings and unfamiliar with the new sanitation facilities. From the research findings, there was a statistically significant agreement (n=87, Mean=2.84 SD=1.328) to support this factor. Majority of the respondents, 26.4% agreed and also 19.5% were neutral and strongly disagreed, whilst 18.4% agreed as shown on Table 4.7 below. There is enough evidence from this study that community engagement is a factor that influence their sustainability.

Table 4.7 Community attitude and involvement

		Q1d			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	17	19.5	19.5	19.5
	Disagree	14	16.1	16.1	35.6
	Neutral	17	19.5	19.5	55.2
	Agree	23	26.4	26.4	81.6
	Strongly Agree	16	18.4	18.4	100.0
	Total	87	100.0	100.0	

4.3.5 Strategy and Management skills

There was a statistically significant agreement (n=87, Mean=2.99 SD=1.377) to support that Strategy and Management skills of a social enterprise play a role in determining direction of success of the organisation. There is enough evidence to support that it is a major factor that determine whether a social enterprise can be successful or not.

Majority of the respondents, 41% agreed and also 20% were neutral as shown on Table 4.8 below.

Table 4.8 Strategy and Management skills

		Q1e			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	12	13.8	13.8	13.8
	Disagree	8	9.2	9.2	23
	Neutral	17	20	20	43
	Agree	36	41	41	84
	Strongly Agree	14	16	16	100.0
	Total	87	100.0	100.0	

Strongly Disagree	12	16.1	0.138
Disagree	8	26.4	0.092
Neutral	17	19.5	0.195
Agree	36	18.4	0.414
Strongly Agree	14	19.5	0.161
Total	87	100	

4.3.6 Innovativeness of business ideas

The social enterprises operate not as profit making businesses but at the same time there are not non-profit organisations. This means their business idea and innovativeness would certainly be a major factor. There was a statistically significant agreement (n=87, Mean=3.20 SD=1.437) to support this hypothesis that a social enterprise can be successful depending on how innovative their business idea is. Majority of the respondents, 25.3% strongly agreed and also 20.7% agreed, whilst 19.5% were neutral as shown on Table 4.9 below. There is therefore enough evidence from this study that business idea and innovativeness of the social enterprise does affect its sustainability.

Table 4.9 Innovativeness of business ideas

		Q1f			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	15	17.2	17.2	17.2
	Disagree	15	17.2	17.2	34.5
	Neutral	17	19.5	19.5	54.0
	Agree	18	20.7	20.7	74.7
	Strongly Agree	22	25.3	25.3	100.0
	Total	87	100.0	100.0	

4.3.7 Government support

There was a statistically significant agreement (n=87, Mean=2.86 SD=1.472) to support that government support is also a major factor that determine whether a social enterprise can be successful or not. Majority of the respondents, 22% disagreed and also 21% strongly disagreed, whilst 31.8% agreed as shown on Table 4.10 below. There is enough evidence from this study that government support in terms of finance, subsidies or tax exemptions can affect its sustainability as discussed by Fergus & Robyn (2019).

Table 4.10 Government support

Q1g

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	21	24.1	24.1	24.1
	Disagree	18	20.7	20.7	44.8
	Neutral	9	11.8	11.8	66.7
	Agree	10	11.5	11.5	78.2
	Strongly Agree	29	31.8	31.8	100.0
	Total	87	100.0	100.0	

4.3.8 Governance

Governance is a factor that is usually associated with large corporates, however even SMEs and even smaller businesses like family-owned entities are affected by the way their internal controls are done. Respondents were asked to validate that this can affect viability of social enterprises. There was a statistically significant agreement (n=87, Mean=3.26 SD=1.426) to support that governance is also a factor that determines whether a social enterprise can be successful or not. Majority of the respondents, 27.6% strongly agreed and also 23% were neutral as shown on Table 4.11 below. Therefore, there is enough evidence from this study that governance is a factor that affect its sustainability.

Table 4.11 Governance

Q1h

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	14	16.1	16.1	16.1
	Disagree	13	14.9	14.9	31.0
	Neutral	20	23.0	23.0	54.0
	Agree	16	18.4	18.4	72.4
	Strongly Agree	24	27.6	27.6	100.0
	Total	87	100.0	100.0	

4.3.9 Entrepreneurial knowledge, experiences and capabilities

There was no statistically significant agreement (n=87, Mean=2.86 SD=1.472) to support that entrepreneurial knowledge, experiences and capabilities determines whether a social enterprise can be successful or not. Majority of the respondents, 25.3% strongly disagreed and also 20.7% disagreed as shown on Table 4.12 below. There is no enough evidence from this study that no entrepreneurial knowledge, experiences and capabilities affect its sustainability of a social enterprise.

Table 4.12 Entrepreneurial knowledge, experiences and capabilities

Q1i

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	22	25.3	25.3	25.3
	Disagree	18	20.7	20.7	46.0
	Neutral	13	14.9	14.9	60.9
	Agree	18	20.7	20.7	81.6
	Strongly Agree	16	18.4	18.4	100.0
	Total	87	100.0	100.0	

4.3.10 Complex problem solving

There was a statistically significant agreement (n=87, Mean=3.00 SD=1.494) to support that complex problem-solving characteristics of the entrepreneur is a major factor that determine whether a social enterprise can be successful or not. Majority of the respondents, 23% strongly agreed and also 19.5% agreed, as shown on Table 4.13 below. There is therefore enough evidence from this study that complex problem-solving characteristics of the entrepreneur affects its sustainability.

Table 4.13 Complex problem solving

Q1j

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	19	21.8	21.8	21.8
	Disagree	19	21.8	21.8	43.7
	Neutral	12	13.8	13.8	57.5
	Agree	17	19.5	19.5	77.0
	Strongly Agree	20	23.0	23.0	100.0
	Total	87	100.0	100.0	

4.4 One-tailed t test of Challenges and Opportunities of social entrepreneurship

In order to assess the validity of each challenge a one-tailed t test was done on the hypothesis of these challenges and below is the presentation of the results.

Table 4.14 One-tailed t test of Challenges and Opportunities of social entrepreneurship

	Challenges and opportunities	Mean	SD	p-value	Result
1	The challenges are associated with Credibility of social enterprises	1.92	.735	0.41	Statistically insignificant
2	The challenges are associated with Lack of flexibility and responsiveness	2.07	.832	0.042	Statistically significant
3	The challenges are associated with Lack of shared commitment	2.80	1.119	0.83	Statistically insignificant
4	The challenges are associated with Government policy inconsistency	2.86	1.296	0.0012	Statistically significant
5	The challenges are associated with Lack of access to social capital	2.87	1.379	0.0013	Statistically significant
6	The challenges are associated with Inconsistency of purpose	3.02	1.463	1.87	Statistically insignificant
7	The challenges are associated with Resistance within Communities	2.95	1.405	2.02	Statistically insignificant
8	There are vast opportunities in social entrepreneurship in Zimbabwe?	3.24	1.381	0.02	Statistically significant

9	The right match between social enterprise needs to a suitable financing model is key to solve existing funding gaps to achieve self-sustainability of these enterprises?	3.15	1.368	0.0034	Statistically significant
10	Hybrid finance offers opportunities for tailor-made financing solutions for social enterprises?	2.72	1.436	0.001	Statistically significant

From the results of p-values of the hypothesis challenges are associated with credibility of social enterprises, lack of shared commitment, resistance within communities and inconsistency of purpose were failed to be supported by the responses by the participants in the study. Government policy inconsistency, lack of access to social capital, lack of flexibility and responsiveness are the major challenges that social enterprises in Zimbabwe face.

5.0 Discussion

5.1 What are the factors affecting sustainability of social enterprises in Zimbabwe?

According to the findings, only six of the ten hypothesized factors were shown to be meaningful in affecting social enterprises in Zimbabwe. There was no enough evidence to support Pursuit of dual missions, Competitiveness, Innovativeness of business ideas and also entrepreneurial knowledge, experiences and capabilities. This means that whether a social entrepreneur is skilled and has knowledge with innovativeness it does not guarantee success. However, these findings contradict those of Akbulaev, et al., (2019), who stress the value of social entrepreneurship training. The main factors that were raised are social finance access and government support. These findings corroborated previous research, as discussed by Maseko, N. et al., (2011), Fergus & Robyn (2019), Serrano, et al., (2019) and Wanyoike & Maseno (2021). Other supporting factors as shown below are governance, management skills and ability of entrepreneur to solve complex problems.

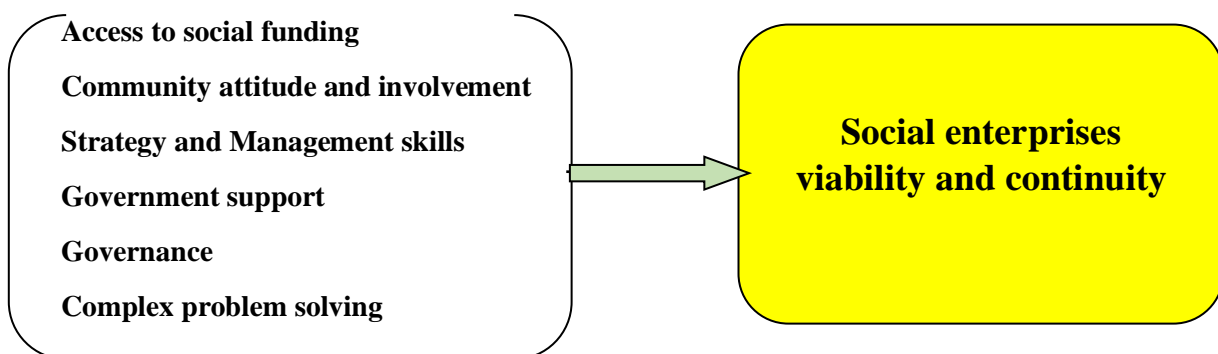


Figure 5.1 Factors that affect sustainability of social enterprises **Source:** Research data (2022)

These factors are interconnected in such a way that one factor boosts the other and ultimately viability of social enterprises as shown of Figure 5.2 below;

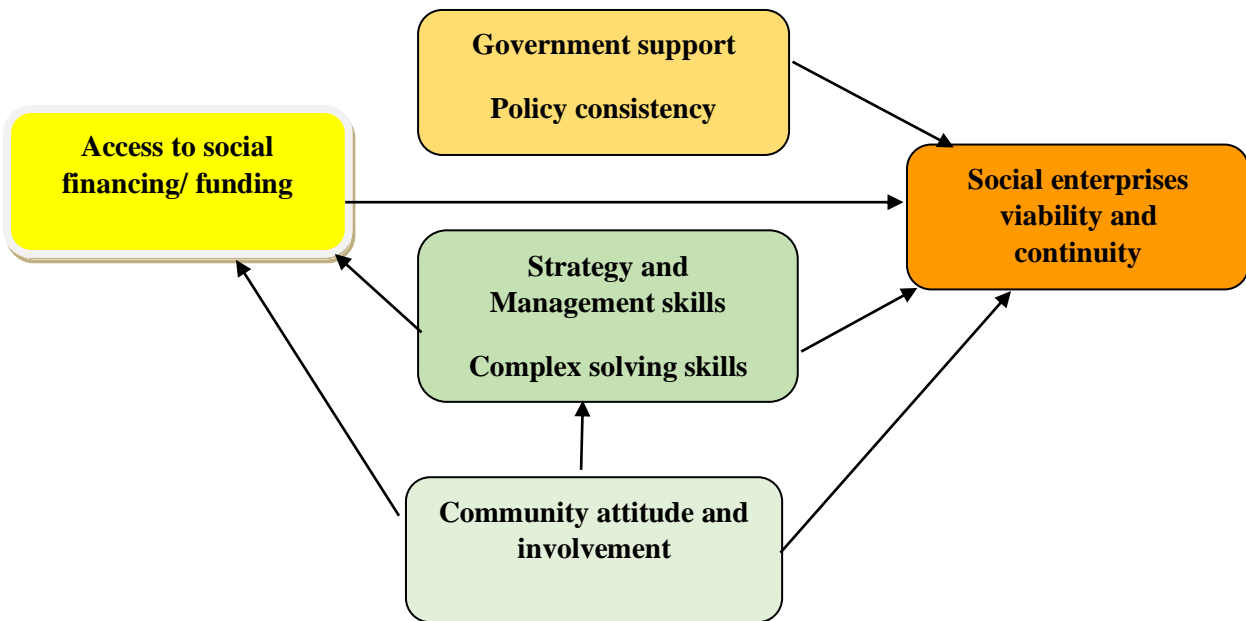


Figure 5.2 Factors that are connected and support the viability and continuity of social enterprises
Source: Research data (2022)

These findings supported literature as discussed by Frank and Muranda (2016) who discussed that, social enterprise organizations confront significant difficulties in mobilizing resources for the purpose of financing their enterprises. The cost of borrowing money in Zimbabwe is excessively high (Allen, H., 2006 and Nyarota, S., et al.,2015) to the point where it endangers the viability of businesses that borrow money in order to expand their operations and invest in new projects. Further, given the current Zimbabwean economic context, microfinance institutions that provide affordable or low-interest loans consider social enterprises as risk entities. Despite these constraints, the complexity of societal problems and the limited financial resources available for social service delivery can encourage social entrepreneurs to take additional risks by participating in social organizations. In the same way key factors like the management skills of the social entrepreneur were found to be also key determinants of success of these entities.

5.2 What are the challenges and opportunities for sustainable social financing models in Zimbabwe?

From the quantitative results, challenges with credibility of social enterprises, lack of shared commitment, resistance within communities and inconsistency of purpose were failed to be supported by the responses by the participants in the study. Seda and Ismail (2019) highlight the challenge of communities' general ignorance of social ventures. Therefore, it can conclude that challenges associate with these are negligible in the social entrepreneurship sector in Zimbabwe. The key obstacles that social businesses in Zimbabwe encounter include inconsistency in government policy as discussed by Fergus & Robyn (2019), a lack of access to social capital, and a lack of flexibility and responsiveness (Plunkett Foundation, 2010). Social enterprises are not self-contained firms in the traditional sense. They are a component of a value chain and compete with firms and they're part of a larger business ecosystem (Serrano, et al., 2019), that contains a large number of small and large enterprises that compete and collaborate with one another (vertical linkages). As a result of this procedure, they need further government protection.

These challenges are correlated as you have one source of challenge likely to cause the other for instance lack of government support may be through exemptions and also through encouraging the private sector it may result in lack of access to social capital. As discussed by the Plunkett Foundation

(2010), Brandstetter and Lehner, (2015) and Frank and Muranda (2016), social enterprises also need to be responsive to changes in the economy such that their business part that generates financial returns does that to support their social call.

6.0 Conclusions and Recommendations

The study findings indicate that, only six of the ten hypothesized elements were found to be important in effecting social enterprises in Zimbabwe, resulting in a total of six relevant factors. Neither the pursuit of dual objectives nor the competitiveness or innovativeness of company concepts, nor the entrepreneurial knowledge, experiences, and competencies were sufficiently supported by the available evidence. There are challenges associated in trying to start and operate a social enterprise in Zimbabwe. These are challenges inked to government policy inconsistency, lack of access to social capital, lack of flexibility and responsiveness are the most significant obstacles that social enterprises in Zimbabwe face. To address financing challenges faced by the social enterprises in Zimbabwe it is recommended that a tailored national revolving fund be set up by the government. This revolving fund is proposed to be contained at the national centre of social innovation that can be accessed by all stakeholders. This centre will allow for Social Innovation and social financing by furnishing a comprehensive offering of key service areas that assist in development of social enterprises that help solve social issues.

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