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# Articles




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# THE DYNAMICS OF BUSINESS MODEL INNOVATION FOR TECHNOLOGY ENTREPRENEURSHIP: A SYSTEMATIC REVIEW AND FUTURE AVENUE

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Abstract

*A need for business model innovation (BMI) compelled by technology has been increasing since the adoption and application of technological entrepreneurship and goes further to transformation as an integral part of a value proposition. However, there is an ambiguity and lack of clarity that prerequisites the construction of comprehensive BMI in the technology entrepreneurship area. Therefore, this study is aimed to systematically integrate, and synthesize the existing works related to the dynamism of BMI and technology entrepreneurship to build a unified framework. To meet this objective, various publications on the subject matter have been reviewed and, the logics and arguments of various scholars were compared to draw conclusions and develop BMI for technology entrepreneurship. In these sense, the study integrates the dynamism and innovation with a BM and forms a single construct that puts up the systematic development of concepts in the newly developed framework. Besides, the study uncovers a specific relationship of a comprehensive and dynamic BMI for technology entrepreneurship to variables of performance and economic sustainability. Further, the BMI creates a new offering system and improves the current delivery system, which leads to reconfiguration of the model by integrating with firms capabilities in creating and exploiting new business opportunities. Therefore, the future research might study the specific activities that highly integrated with the BMI for technology entrepreneurship using experimental research design.*

Key words: Business model, Technology, Innovation, Sustainability, Commercialization

## 1. Introduction

### 1.1. Background of the study

The business model dynamism (BMD) capability links the business model (BM) change to innovation in maintaining and challenging the firm's status quo (Cavalcante et al., 2011). Thus, organizations should apply extension, revision, and termination of the BM, which necessitated the BMD to have a competitive advantage (Anjorin & Ravi, 2012). This is because no equivalent ontology is available to describe the strong sustainable business model (Upward & Jones, 2016) since this might happen through changes in the dynamic environment. Therefore, firms should find novelty in performing activities that help to achieve the novel BM advancement (Ireland et al., 2001).

Anjorin & Ravi (2012) *stated that "a BM which passed through the various change processes were considered as dynamic*". That is, BM is a complex and dynamic system (Demil & Lecocq, 2010). Besides, BMs contribute to the successful commercialization of disruptive technologies since the value of technology alone will be less since values are emerged through commercializing a BM (DaSilva, et l., 2013). Hence, intension should be tended to gain technological capability and personnel skills in developing innovation and being competitive (Khefacha & Belkacem, 2016). Therefore, the need for BMI compelled by technology has been increasing (Gambardella &

McGahan, 2010). That is because, BM helps managers to discover markets that contribute to the creation of a "*techno-economic network of innovation*" (Doganova & Eyquem-Renault, 2009) since adoption and application of technological entrepreneurship goes further to transformation as an integral part of the value proposition (Eliakis et al., 2020). Moreover, technology entrepreneurship is considered as the main source for the firm's better value creation (Chebo & Wubatie, 2020).

On the other hand, there are researchers such as de Reuver et al. (2009) who stated the need for BMD (Anjorin & Ravi, 2012), since BM is flexible and will not exist in its current form for a long period (Cavalcante et al., 2011). However, little is done still in theoretically integrating dynamism to BMI in the technology entrepreneurship domain. In addition, there are researches that reveal innovation dynamism contributes to economic sustainability (e.g., Hirooka, 2005). Aspelund et al. (2005) also argue that the rise of innovative entrepreneurship has a significant positive effect on economic development (Eliakis et al., 2020). Prior studies also examine the linkage between BM and firm performance (eg. Snihur & Tarzijan, 2018; Kim & Min, 2015; Sabatier et al., 2010; Santos et al., 2015; Zott & Amit, 2007).

To answer the research questions, this study systematically collects, synthesizes, and reviews the works of literature in the field and build a new construct and framework that combines the dynamism in BMI and technology entrepreneurship. That is, by adopting a systematic review, the article provides collective and all-inclusive frameworks in the area of BMI in the technology entrepreneurship dimension.

## 1.2. Statement of the problem

Previously, firms innovate products, processes, and technology in creating and achieving sustainable values (Hansen et al., 2009). However, these methods were not adequate and need to be complemented with BMI to bring more sustainable value (Schaltegger et al., 2012). That is, the route towards sustainability requires a change in the purpose and strategies of business (Bocken et al., 2014). Further, when BM is integrated with sustainable development, the complexity rises more (Abdelkafi & Täuscher, 2016). To reduce this complexity, I have limited the dynamics of BMI to economic sustainability by excluding other dimensions such as societal and ecological sustainability. Thus, drawing on a big and multidisciplinary nature of BMI and technology entrepreneurship, the study identified evidence from previous studies that support linking both BMI and technology entrepreneurship (eg. Chesbrough, 2010) to better firms' performance and further to economic development.

Practically, it is still a serious challenge in developing a feasible BM (DaSilva, et l., 2013) because of its dynamic nature. Among these challenges, the main is designing a business that creates economic achievement (Schaltegger et al., 2012; Abdelkafi & Täuscher, 2016). Also, innovating a novel BM will not always be the root to success, because of the complexity associated with the business environment dynamism. This necessitates a dynamic BM, which is capable of handling both the status quo and flexible features. Yet, it's challenging for organizations to make a BM dynamic since organizations are reluctant to adopt changes (Cavalcante et al. 2011). In general, the need for coping up with technological advancement, market change, and other environment dynamics brought challenges that necessitated the use of dynamic BM (Anjorin & Ravi, 2012). This is because, BMI from technological developments occur alongside a sector market and overall design (Gambardella & McGahan, (2010). Therefore, it's important to develop a comprehensive and dynamic BMI in technology entrepreneurship for the success of the organizations.

Theoretically, problems with BM research continue to hinder theory development (Fjeldstad & Snow, 2018), the concept is ill-defined (Roome & Louche, 2016) and there is no clarity in purposes and concepts (Cosenz & Noto, 2018). That is, the BM patterns are unclear, inconsistent, incomplete, and overlapping (Remane et al., 2017) particularly in the technological entrepreneurship domain. It also lacked academically enquiring about the complexity of a multi-business model setting (Snihur & Tarzijan, 2018; Nickerson & Zenger, 2004) that considers the changes throughout the time with changing technologies. The ambiguity and lack of clarity prerequisites the construction of comprehensive BMI in the technology entrepreneurship domain. Besides, much of the recent researches on BMI focuses on the narrow goal of value capturing mostly in a downstream process of a business environment (Tidd & Bessant, 2018). Hence, this study attempt to integrate the different fragmented constructs and approaches of BM concerning its dynamics and innovation in the technological entrepreneurship area. Because, even though theories that illustrate BM in technological firms were identified, they rarely discover the common components of the BMI and technology entrepreneurship as well as the association with dynamism.

## 1.3. Research questions

Taken in to account these contributions, this review paper tends to answer research questions such as;

- Do the existing research in the BMI of technology entrepreneurship dimension has a common understanding?
- Is there an opportunity to develop a comprehensive model of dynamic BMI in the technology entrepreneurship domain that summarizes the widespread issues in the subject matter?
- Are there theories that support to merge the fields of dynamic BMI and technology entrepreneurship in forming a single construct that offers a framework for further research?

1.4.Objective of the study

#### 1.4.1. General objectives

The major objectives of this study is aimed to systematically integrate, and synthesize the existing works related to the dynamism of BMI and technology entrepreneurship to build a unified framework.

#### 1.4.2. Specific objectives

- To identify the existing research in the BMI of technology entrepreneurship dimension towards bringing a common understanding.
- To investigate the existence of opportunity to develop a comprehensive model of dynamic BMI in the technology entrepreneurship domain.
- To identify the theories that support to merge the fields of dynamic BMI and technology entrepreneurship in forming a single construct that offers a framework for further research.

1.5.Significance of the study

This study attempt to make novel contributions to the subject matter in different ways. First, a comprehensive framework of BMI for technology entrepreneurship (BMIfTE) has been established. Here, its argued that both BMI and technology entrepreneurship is highly related to the dynamism and determined by some components such as change and innovation, which necessitated the development of dynamic BMI for a specific sector of technology entrepreneurship. In this regard, the integrated outcomes give a meaningful understanding and make a considerable contribution to the practical application and theoretical development. Second, although there is a

richness of the fields of BM and entrepreneurship in theory and literature, there is a fragmentation of studies under various disciplines, which leads to a lack of consensus in providing clear definitions and concepts. That is, still, there is a need to clarify the concepts and constructs of BMD and technology entrepreneurship. This study, therefore, takes a new approach of integrating the dynamism and innovation with a BM to form a single construct by refining and developing a unified concept of the integrated BMI and technology entrepreneurship. Thus, I put up the systematic development of concepts and constructs.

Third, the study focused on analyzing and synthesizing towards providing research agendas by proposing the frameworks as the inputs, internal elements, and outcomes. This is because existing works are rarely advises the subsequent works in the subject matter. Then, based on the overall analysis we developed a framework that will advance the understanding of the innovative BMD in the technological entrepreneurship dimension by highlighting and integrating the various antecedents of both concepts. Accordingly, there is an attempt to pinpoint the specific areas of investigation in the subject matter for future studies. This is because of the lack of systematic review that combines and synthesizes the different components and outcomes of BMI in the technology entrepreneurship domain is another motive for doing this paper. Accordingly, the systematic review is necessitated to assemble different understandings related to BM and technology entrepreneurship by combining and linking the various common elements and outcomes associated with a new construct of BMIfTE.

## 1.6.Scope of the study

This study integrates the dynamism and innovation with a BM to forms a single construct that puts up the systematic development of concepts in the newly developed framework. Accordingly, the various aspects covered by the study includes the inputs, processes, and the outputs of the construct of BMIfTE. This variables includes the opportunity and risk assessment, value migration, dynamic capability, and networking as an input and firms performance and economic sustainability as an outputs.

# 2. Theoretical Foundations

## 2.1. The dynamism of BMI and Technology Entrepreneurship

Recently, the BMI gets attention (eg. Hacklin, 2018; Cosenz & Noto, 2018; Futterer et al., 2018; Tidd & Bessant, 2018; Gambardella and McGahan, 2010; Zott et al., 2011). BMI does not follow rigid programs and is modified to breakthrough through opportunities and rectify the problems by adopting and integrating the capabilities towards exploiting the novel combination and creating and capturing values in a novel way (Gambardella & McGahan, 2010; Tidd & Bessant, 2018). Accordingly, Cavalcante et al., (2011) conceptualize BM as a systematic and organized scheme related to organizational change and innovation, which is associated with dynamism. Besides, the paradigm in technology innovation is rising on a nonlinear basis (Hirooka, 2005). The firms that innovate in their BM will tend to develop a new knowledge exchange and exploit opportunities instantaneously and dynamically towards developing competitive advantage sustainably (Gambardella & McGahan, 2010). Accordingly, the dynamic capabilities unified with knowledge domains contribute to the development of the dynamic BM that captures the link between structures and routines (Mason, et al., 2008; Drakulevski & Nakov, 2014).

There are researchers such as de Reuver et al. (2009) that indicated the need for BMD, which necessitated the connection with the firm's capabilities to transform the BM (Anjorin & Ravi, 2012). This is because, BM is flexible and will not exist in its current form for a long period (Cavalcante et al., 2011). Therefore, incorporating

the dynamism in the central element of BM, which results in BMD (Anjorin & Ravi, 2012). This is done through organizational learning and/or knowledge, system flexibility, and changes that permit the strategic position of the firm (Drakulevski & Nakov, 2014). Therefore, a dynamic BM is capable of handling both the status quo and flexible features by linking the BM change to innovation (Cavalcante et al., 2011). However, previous works rarely discover the common components of the BMI and technology entrepreneurship in association with dynamism. Even though there is a need to make BM flexible and adaptive, it's challenging for organizations to make a BM dynamic, because organizations are reluctant to adopt changes (Cavalcante et al. 2011). That is, the willingness and ability to identify and implementing changes determines the BMD (Cavalcante et al., 2011). Therefore, both BMI and technology entrepreneurship is highly related to the dynamism and determined by some components such as change and innovation, which necessitated the development of dynamic BMI for a specific sector of technology entrepreneurship.

### 2.2. Conceptual Linkage between BMI and Technology Entrepreneurship

Technology entrepreneurship is a vehicle that facilitates prosperity in individuals, businesses, and nations (Chebo & Wubatie, 2020). Arguments about technology entrepreneurship are lying around facilitating novel BMs (Baden-Fuller & Mangematin, 2013). Because of enterprises' vulnerability to market complementarity, firms tend to involve in BMI following the strategies related to technology and its dynamic applicability (Gambardella & McGahan, 2010). That is, the paradigm of innovation contains the technology development and market diffusion period (Hirooka, 2005). As a result, the value of technology alone will be less since values are emerged through commercializing using a BM (Chesbrough & Rosenbloom, 2002). That is, commercialized technology provides a variety of results and firms are requiring better values from launching a new and innovative BM and technology (Chesbrough, 2010). Besides, the appearance of a new market was, therefore, predicted by pursuing the existing technologies (Hirooka, 2005). However, still, there is a lack of study that integrates the BMI with technology entrepreneurship to form a unified construct.

Besides BM researches, technology entrepreneurship researches were also fragmented and not gentle in responding to practices (Eliakis et al., 2020). The two concepts are interrelated and have common elements. For instance, technology innovation requires a BM in bringing innovations to the market and satisfying unsatisfied customer needs (Teece, 2010). That is, a feasible BM helps in successfully commercializing the disruptive technologies (DaSilva, et al., 2013) and is integrated into the technology innovation (Baden-Fuller & Haefliger, 2013). However, Gambardella & McGahan, (2010) argue that the BMI that intended to allow technology entrepreneurship is unpredictable and unavoidable consequences on the organizational capability. Even though these researches show the necessity of the linkage, there is still a fragmentation in the empirical and theoretical literature in the field of BMI and technology entrepreneurship integration.

### 2.2. Components of Business Model Innovation for Technology Entrepreneurship

Although there is a richness of the fields of BM and entrepreneurship in theory and literature, many of the recent researches on BMI focuses on the narrow goal of value capturing mostly in a downstream process of a business environment (Tidd & Bessant, 2018). There is also the fragmentation of studies under various disciplines, which leads to a lack of consensus on the way of integrating the determinants, internal processes, and outcomes. For instance, BMs are related to the concepts of configuring, creating, and capturing value, and designing (Teece, 2010; Baden-Fuller & Mangematin, 2013; Amit & Zott, 2001). Foss & Saebi (2017) states the alignment of a proposed value, segmented targets, revenue mechanisms, value chains, and the internal structures is necessary.

However, more attention needs to be paid to the concepts of interaction with technology (Schallmo et al., 2017; Roome & Louche, 2016; Baden-Fuller & Haefliger, 2013; Chesbrough & Rosenbloom, 2002) since technology entrepreneurship also assembles and deploys manpower and existing assets to create and capture value (Bailetti, 2012). Accordingly, the entrepreneurial resources including financial resources and human resources help entrepreneurs engage in the discovery, evaluation, and exploitation of opportunities (Kosa & Mohammad, 2017). These resources are critical in improving the existing BMs or introducing new ones (Fjeldstad & Snow, 2018). Therefore, the methods of creating and capturing values were central to technology entrepreneurship and the foundation for a business model (Muegge, 2012).

The four core characteristics of BMs (i.e. value proposition, value network, value capture, and value creation and delivery) that emerge from the literature) (Roome & Louche, 2016) require a considerable improvement to commercialize technological innovation. Combining the two, opportunities can be thought of as technically visible latent demand (Eckhardt, 2013). The integration between technology entrepreneurship and BM is established and proven by value creation and value capturing (Muegge, 2012). By considering this integration, BMI is characterized by value networking (Roome & Louche, 2016) and creating entrepreneurial opportunities (Markides, 2016). Among the many conceptual relationships, many authors relate BMI with opportunity exploitation (e.g., (Khefacha & Belkacem, 2016), value migration (e.g., Hacklin, et al., 2018; Jabłonski, 2018), dynamic capability (e.g., Teece, 2018; Ritter & Lettl, 2018), and networking (e.g., Snihur & Tarzijan, 2018; Ritter & Lettl, 2018). Internally, BMs are used to create (Chesbrough & Rosenbloom, 2002), and capture values (Teece, 2010) through developing (e.g., (Fjeldstad & Snow, 2018; Futterer et al., 2018), experimenting (e.g., (Bojovic et al., 2018), renewing (e.g., Foss & Saebi, 2017), and commercializing (e.g., Da Silva et al., 2013) the business model. However, building an integrative BM in the dynamic and technological entrepreneurship domain is appears to be a common management challenge recently.

As an impact, the operational aspects of BM indicate the way firms are doing their business (Fjeldstad & Snow, 2018). Taking out the BMI helps to clarify the main strategies of the business model (Hacklin, 2018), which are performed to satisfy the unrequited market needs (Cosenz & Noto, 2018). The argument that BMI is key to firm performance has gained momentum (Futterer et al., 2018) and focused as spring for performance (Zott & Amit, 2007; Trimi & Berbegal-Mirabent, 2012; Kim & Min, 2015; Visnjic et al., 2016). The innovativeness identifies and exploits business opportunities through engagement in new ideas, products, processes, and markets, as a result, the overall performance of ventures will be improved (Chebo & Kute, 2019; Kosa et al., 2018). On the other hand, given the Kondratiev business cycles theory, Hirooka, (2005) reveals that innovation dynamism contributes to economic development. Aspelund et al. (2005) also argue that the rise of innovative entrepreneurship has a significant positive effect on economic development (Aspelund et al. 2005). That is, the entrepreneurial activities create and capture economic values from exploiting new or existing technologies (Roja & Năstase, 2014). Therefore, the adoption of new technologies through a dynamic process of creative destruction contributes to long-term economic growth (Khefacha & Belkacem, 2016).

By combining the various insights from the existing theories and literature, we provided new insights that identify and link four perspectives (such as; opportunity and risk assessment, value migration, dynamic capability, and networking) as a major input of the new construct BMIfTE. The processes are also displayed in figure 1. Then, the model connects these perspectives to the firm's performance and further to economic development. The framework of the study is shown in figure

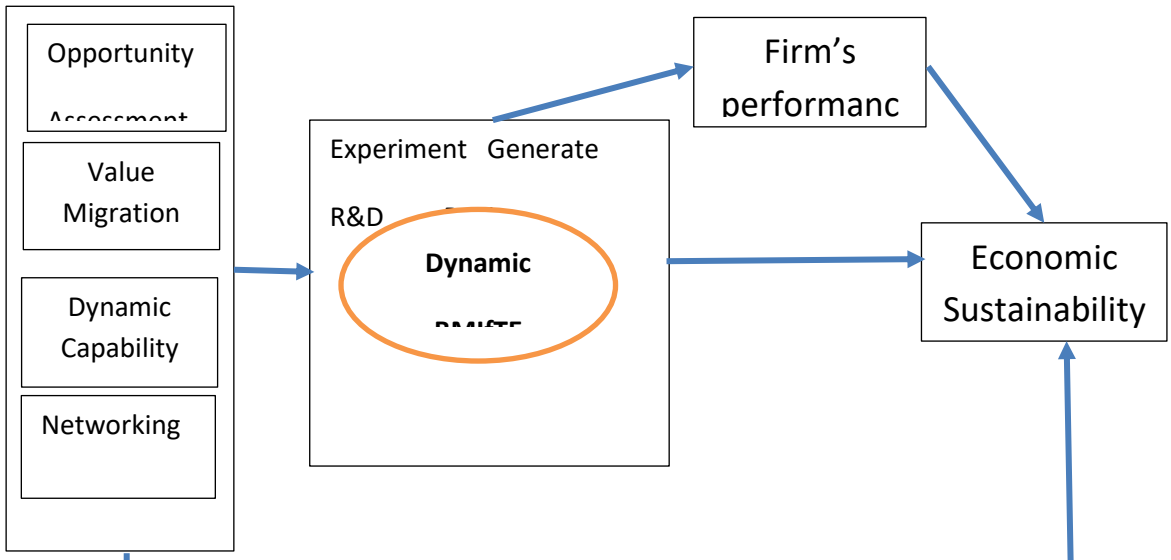


Figure 1: Conceptual framework of BMIfTE

## 3. Methodology

### 3.1. Study framework

Building on the health and medical researches, recently a systematic review studies have extended to business and management researches (eg. Zahoor & Al-Tabbaa, 2020; Phillips et al., 2015). Accordingly, this systematic review was conducted to analyze the existing literature on the dynamism of BMI and link it with technology entrepreneurship by synthesizing the inputs and outcomes toward the firm's performance and economic sustainability. Before the study was started, the presence of an existing systematic review on the construct of BMIfTE as a single concept was checked to avoid duplication. To establish the BMI for technology entrepreneurship as a new single construct, the literature was identified primarily from Google scholar. Since the concept is multidisciplinary and many unrelated publications were identified, a comprehensive traditional literature review was established to form the parameters for a consequent systematic review (Jesson, 2011). Together they enable the origination of the framework (Upward & Jones, 2016]. Moreover, both forward and backward citation checking has been performed to confirm that all important articles were retrieved (Mpundu-Kaambwa et al., 2017).

To guarantee the transparency, consistency, and accuracy of the study, the four-step method suggested by Denyer and Tranfield (2009) and adopted by Zahoor & Al-Tabbaab, (2020) is employed. Generally, the framework of the review process follows and adopts the approaches of Denyer and Tranfield. First, the review questions were developed and the conceptual boundary is formed. Second, the search boundary is proven by establishing a review scope. Third, the study identification, screening, and selection process that follows the PRISMA flowchart

diagram has been used. Finally, the synthesis (i.e. narrative approach) and analysis (i.e., coding the article's data) were applied.

### 3.2. Review Scope

The review scope is established by applying the inclusion and exclusion criteria. The review scope is determined through setting the search database to Google scholar (GS), while the keywords used for searching purpose is associated using the Boolean logic. The exclusion criteria are, considering only the articles published internationally in the English language (Khosravi, Newton, & Rezvani, 2019), excluding sources such as books, conference papers, unpublished documents, and non-peer-reviewed publications, book chapters, short communications, and technical communications). Besides, only articles (Both theoretical and empirical studies) that go through rigorous review processes were included. However, to ensure relevant data are not missed, the snowball and bibliographic methods were used. Accordingly, the reviewers list the relevant articles from the bibliography in each article that they reviewed for inclusion (Zaza et al., 2020). From this, we formulated a comprehensive and dynamic BMI in the technology entrepreneurship sphere and also has a contribution to the firm's performance and economic development. In this sense, the framework has the inputs for BMIfTE and its processes that may bring better outcomes (individual firm's performance and sustainable economic development).

### 3.3. Search strategy

The keyword search is conducted through advanced search options. While, GS search engine was employed to guarantee the robustness of the search process (De Menezes & Kelliher, 2011; Schlachter, McDowall, Cropley, & Inceoglu, 2018), keywords for search has been established by two independent investigators. However, to build comprehensive multidisciplinary sources databases such as Science Direct, Emerald, SAGE Journals, Springer, and Wiley Online Library have been visited in addition to GS. We conducted the identification, screening, and selection of articles filters 'academic journals', 'peer-reviewed', 'language-English', and 'field-title, abstract, and keywords'. Also, the search is not restricted by country and time. Besides, the search terms were pre-defined to allow an all-inclusive search strategy that included all important articles. Accordingly, the following thematic terms were identified: 'Business model innovation', 'technology entrepreneurship', 'firm's performance', and 'economic sustainability'. The specific terms under each theme are; (1) "business model" OR "business model innovation" OR "innovative business model" OR "business model dynamics" OR "business model dynamism", (2) "technology entrepreneurship" OR "technology innovation" OR "technological entrepreneurship" OR "technological innovation" OR "digital entrepreneurship" or "digital innovation", (3) "performance" OR "firms performance" OR "ventures performance", and (4) "economic sustainability". Then, the searches were conducted independently for the first two groups of terms followed by conducting a combined search between themselves and with the remaining two groups of terms.

### 3.4. Study Selection and Eligibility Criteria

Two independent reviewers who are selected based on the experience in content development and conducting systematic reviews were collected the data. If the data collected by two reviewers are different the two researchers were discussed and reconcile the differences. All the articles identified were screened by two independent reviewers to identify the articles that meet the inclusion criteria. All duplicate articles have been removed. Each stage of the eligibility criteria and selection has been outlined in the PRISMA flow chart and assessed by the PRISMA checklist.

Some of the major sources of citation data were Web of Science (WoS), Google Scholar (GS), and Scopus. The coverage of WoS and Scopus were different among different disciplines. For instance, their coverage is not good in social sciences and humanities (Mahdi et al., 2008). Comparatively, GS is advantageous by searching all citations from several sources. The coverage of research output is higher in GS and also does not differ among subject matters (Amara & Landry, 2012). In general, even though the data quality and reliability were poor in GS, WoS and Scopus were weak in non-science subjects. This makes GS comparatively advantageous over these subject matters. Besides, the multidisciplinary nature of the topic imposes us to use GS. Then, we have targeted in collecting data from articles published on the subject matter of BMI dynamic and technology entrepreneurship. Accordingly, GS was used as a primary database in accessing peer-reviewed reputable journals to obtain a wide coverage of literature on the subject matter. Besides, the special issues of long-range planning and organization and environment journals were reviewed. First, these concepts are reviewed separately and later linked to establishing a general concept of dynamic BMI for technology entrepreneurship. The identification, selection process, and eligibility were summarized in figure 1.

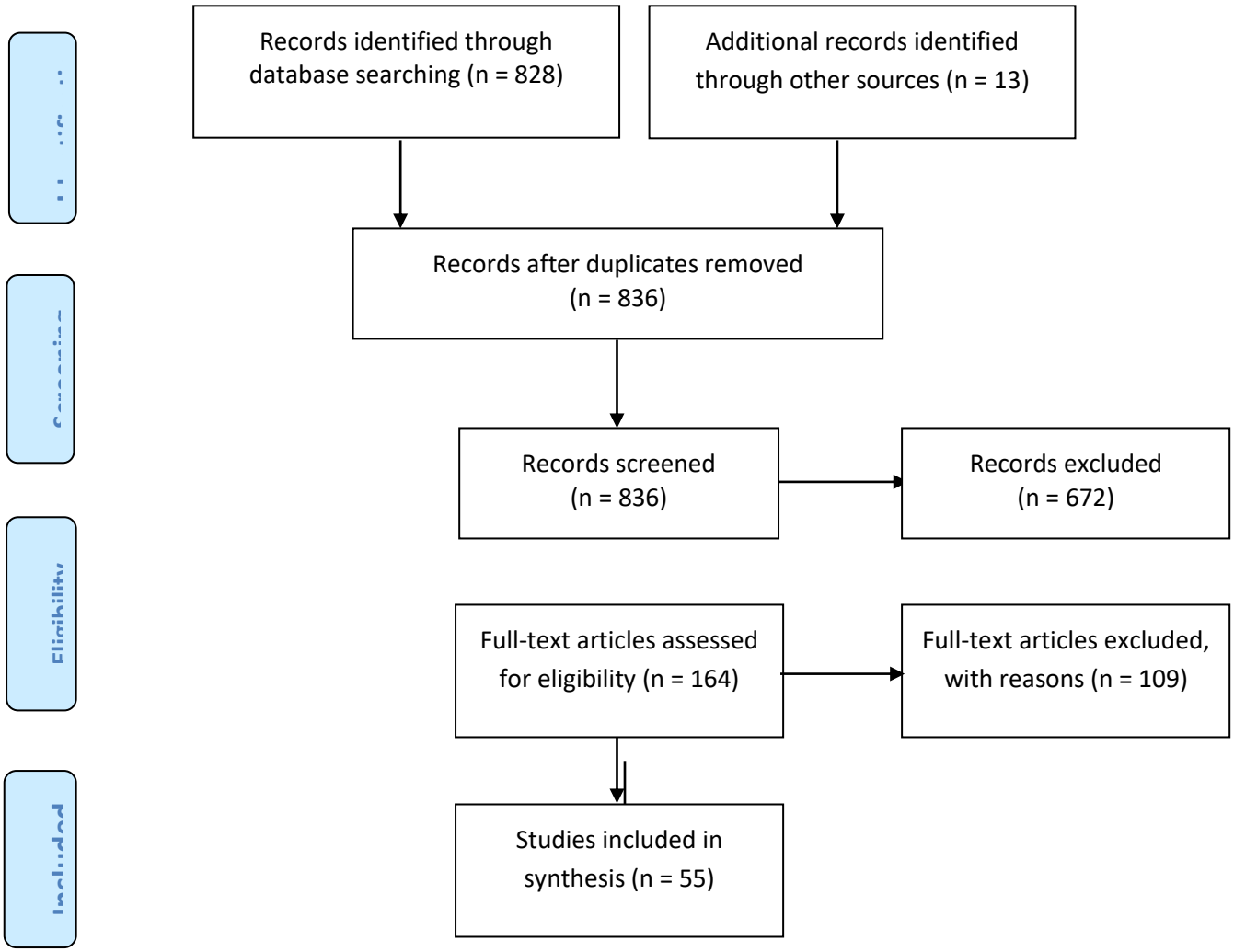

Figure 2: Selection process and eligibility.

Source: PRISMA flowchart diagram, 2009

Even though there are many papers with the search term, some articles which give a highly different meaning and are far from the topic of study have been removed through the screening process. In general, the following procedures were followed. First, by focusing on the framework used to create BMIfTE towards firm performance and economic sustainability, a total of 828 articles were recorded after the exclusion criteria. Additional 13 articles were also retrieved using traditional searching methods, which leads to screening 836 articles after 5 duplicates were removed. Next, by analyzing titles and abstracts 326 and 346 non-relevant articles were excluded respectively. The items which are not suitable for the research question are excluded from the review and focus on the framework used to create the BMI for technology entrepreneurship with the analysis of the full paper, and 109 articles were eliminated. Finally, only 55 articles were verified and analyzed.

3.5. Data Extraction and Quality Assessment

To assure the quality of the research, the researcher has to document literature findings, the selection of keywords, and the evaluation of the result. Besides, a quality-related concern is reduced by considering only peer-reviewed articles. Besides, only the journals that publish their articles in the electronic databases were considered to systematically access all sources (i.e., all are publicly available, Bhimani et al., 2019). After these have been done, data were extracted by two independent reviewers. Then, the two researchers independently searched using the same keywords and found the same results, which ensures the robustness of review searching processes (Boiral et al., 2018). But, in the use of terms, a disagreement between reviewers was discussed with the reviewer, and reached a consensus. Moreover, duplicate articles were manually identified and removed.

The articles for review were identified from Google Scholar and checked for the paper's quality using the journal impact factor (JIF) of Web of Science (WoS) and SJR of Scopus before entering the screening criteria. Currently, many indicators were established to measure the quality of journals. Some of them are h-index and SJR. After data were obtained from GS, the quality of the selected articles were checked using the JIF for journals published in Thompson Reuter's WoS, and SJR of Scopus for this specific research. JIF is important in using GS since it ignores the lower down papers. Similarly, SJR is important, its value is normalized, and its current version in Scopus has a refinement that considers the relatedness of the citing journal (Guerrero-Bote & Moya-Anegón, 2012). Accordingly, from a total of 39 journals, 34 (87.18) classified as Q1 as a ranking of SJR quartile. Only five journals categorized under Q2 and Q3 were added because of their relevance. This is done to include concepts from technology entrepreneurship since it is not adequate. Some journal articles have been removed due to not being indexed and ranked by JIF or SJR.

Table 1. Selected journals impact factor and rankings.

| Journal | 2018 JIF (WoS) | H-Index | 2018 SJR IF | SJR quartile | Publisher |
|---|---|---|---|---|---|
| Academy of Management Annals | 12.289 | 51 | 12.7 | Q1 | Acad Management |
| Academy of Management Review | 10.632 | 242 | 9.32 | Q1 | Acad Management |
| Journal of Management | 9.056 | 192 | 7.94 | Q1 | Sage Publications Inc |
| Organization and environment | 8.5 | 48 | 2.61 | Q1 | Sage Publications Inc |
| Journal of Cleaner Production | 6.395 | 150 | 1.62 | Q1 | Elsevier Sci Ltd |
| Business Strategy and the Environment | 6.381 | 84 | 2.17 | Q1 | Wiley |
| Journal of Business Venturing | 6.333 | 253 | 8.84 | Q1 | Elsevier |
| Entrepreneurship theory and practice | 6.193 | 121 | 5.07 | Q1 | Sage Publications Inc |
| Journal of Management Studies | 5.839 | 172 | 4.61 | Q1 | Wiley-Blackwell Publishing Ltd |
| Research policy | 5.425 | 206 | 3.41 | Q1 | Elsevier |
| Technovation | 5.250 | 111 | 2.3 | Q1 | Elsevier |
| Industrial Marketing Management | 4.779 | 114 | 2.38 | Q1 | Elsevier Science Inc |
| Journal of Business Research | 4.028 | 158 | 1.68 | Q1 | Elsevier Science Inc |
| Academy of Management Perspectives | 3.857 | 115 | 3.35 | Q1 | Acad Management |
| Technological Forecast and Social Change | 3.815 | 93 | 1.42 | Q1 | Elsevier Science Inc |
| Journal of Product Innovation Management | 3.781 | 126 | 2.97 | Q1 | Wiley |
| Small Business Economics | 3.555 | 108 | 1.91 | Q1 | Springer |
| International Journal of Electronic Commerce | 3.439 | 73 | 1.63 | Q1 | Routledge Journals |
| Long Range Planning | 3.363 | 89 | 2.04 | Q1 | Elsevier Sci Ltd |
| Organization Science | 3.257 | 211 | 6.55 | Q1 | Informs |
| Strategic Organization | 3.109 | 47 | 2.55 | Q1 | Sage Publications Ltd |
| British Accounting Review | 2.984 | 56 | 1.12 | Q1 | Elsevier Sci Ltd |
| Strategic Entrepreneurship Journal | 2.956 | 31 | 2.82 | Q1 | Wiley |
| Journal of Innovation and Knowledge | 2.826 | 15 | 1.06 | Q1 | Elsevier |
| European Journal of Information Systems | 2.603 | 96 | 2.04 | Q1 | Taylor & Francis Ltd |
| R D Management | 2.354 | 91 | 1.16 | Q1 | Wiley |
| Sloan Management Review | 2.196 | 87 | 1.16 | Q1 | Sloan Management Review Assoc |
| Management Decision | 1.962 | 82 | 0.73 | Q1 | Emerald Group Publishing Ltd |
| Industrial and Corporate Change | 1.824 | 95 | 1.51 | Q1 | Oxford Univ Press |
| European Management Review | 1.600 | 27 | 0.68 | Q1 | Wiley Periodicals, Inc |
| International Journal of Technology Management | 1.160 | 51 | 0.5 | Q1 | Inderscience Enterprises Ltd |
| Advances in Strategic Management | 0.745 | 25 | 1.3 | Q1 | Emerald Group Publishing Ltd |
| Journal of Strategic Marketing | ESCI | 42 | 0.83 | Q1 | Routledge Journals |
| Communications of Association for Information System | ESCI | 38 | 0.57 | Q1 | Assoc Information Systems |
| Technology Analysis and Strategic Management | 1.739 | 60 | 0.72 | Q2 | Routledge Journals |
| International journal of innovation management | ESCI | 39 | 0.49 | Q2 | World Scientific Publishing Co |
| International Journal of Innovation and Sustainable Development | ESCI | 18 | 0.2 | Q3 | Inderscience Enterprises Ltd |
| International Journal of Product Development | - | 22 | 0.23 | Q3 | Inderscience Enterprises Ltd |

| | | | | | |
|---|---|---|---|---|---|
| International Journal Electron Business | - | 6 | 0.19 | Q3 | Inderscience Enterprises Ltd |

Further to ensure quality following a systematic approach, both authors have differentiated the articles based on their relevance and scored 0 for articles which have no relevance to objective, 1 for articles that have poor relevance to objective, 2 for articles that have basic relevance to the objectives, and 3 if they have deep relevance to the objective (Dean, Larsen, Ford, & Akram, 2019). To keep the quality only the articles scored 2 and 3 have been included.

## 4. Data Analysis, Synthesis, and Discussion

To organize different findings, we employed a narrative synthesis since it's a flexible approach to reviewers and helps to adopt a "*fit for purpose approach*" (Briner & Denyer, 2012). Besides, the reviewers identified the themes used to build a framework for analysis (Phillips et al., 2015). Therefore, the synthesis was made to find the relevant findings and summarize essential knowledge of the subject matter research domain, to understand the big picture of a particular domain by reducing the irrelevant ideas. A qualitative research method is chosen to analyze the data collected from existing literature. Using this approach, the theoretical aspects of BMI in technology entrepreneurship were described and interpreted. For this qualitative research, a systematic review process was undertaken, because a systematic review is used to identify, evaluate, and synthesize the available literature since its comprehensive, explicit, and reproducible approach (Fink, 2005). Further, Rousseau et al., (2008) argue that systematic literature review has importance in analysis transparency and avoiding implicit biases. In general, the systematic review covers plan and searching strategy derived to lessen bias by finding, scrutinizing, and synthesizing the relevant studies (Uman, 2011).

Based on the research question, the selected articles were organized based on the themes of BMI and technology entrepreneurship, which were further categorized into components such as inputs, processes, and outcomes. The analysis is focused on the concept, processes, and frameworks. Accordingly, the logic and arguments of various scholars were compared and a conclusion was drawn based on the synthesized arguments.

Table 2. Number of articles in each domain.

| Search Items | BMI | TE | Total |
|---|---|---|---|
| Total articles after exclusion criteria | N = 624 | N = 217 | N = 841 |
| Title based relevance | N = 446 | N = 69 | N = 513 |
| Abstract based relevance | N = 130 | N = 39 | N = 169 |
| Full text and research question relevance | N = 49 | N = 11 | N = 60 |
| After duplicated articles were eliminated | | N = 55 | |
| Final relevant articles | | N = 52 | |

Although there is a richness of the fields of BM and technology entrepreneurship in theory and literature, there is a fragmentation of studies under various disciplines, which leads to a lack of consensus on the way of integrating the determinants and internal processes. This necessitated systematically integrating, structuring, and synthesizing the existing works related to various determinants, internal processes, and outcomes of the dynamism of BMI in the technology entrepreneurship dimension. In this regard, we hope the integrated outcomes give meaningful understanding and make a considerable contribution to the theoretical development and practical

application in the field. Therefore, this systematic review is necessitated to assemble different understandings related to BM and technology entrepreneurship by combining and linking the various common elements and outcomes associated with a new construct of BMIfTE. Then, the major elements identified from the literature in the process BM are related to the dynamism. This includes; generating, modification, experimentation, designing, changing, and so on.

Table 3. Processes, inputs, and impacts of BMI for technology entrepreneurship.

| Contributions | Authors |
|---|---|
| Modification/improvement | Abdelkafi et al., 2013; Ritter and Lettl, 2018; Fjeldstad and Snow, 2018; Teece, 2018, Demil and Lecocq, 2010; Zott and Amit, 2010; Aversa et al., 2015; Kulins et al., 2016; Laasch 2018 |
| Interaction with technology | Baden-Fuller and Haefliger, 2013; Chesbrough, 2007; Chesbrough and Rosenbloom, 2002; Roome and Louche, 2016; Khefacha and Belkacem, 2016; Bailetti, 2012; Chesbrough, 2010; Teece, 2010 |
| Develop/Generate | Berends et al., 2016; Osterwalder and Pigneur, 2010; Fjeldstad and Snow, 2018; Amit and Zott, 2010; Futterer, 2014; Spieth and Schneider, 2016; Futterer et al., 2018 |
| Experimentation | Sosna et al., 2010; Bojovic et al., 2018; Foss and Stieglitz, 2015 |
| Design | Teece 2018; Fjeldstad and Snow 2018; Zott and Amit, 2007, 2010; Teece, 2018; Demil and Lecocq, 2010; Aversa et al., 2015; Kulins et al., 2016; Laasch, 2018 |
| Change/renew | Futterer, 2014; Spieth and Schneider, 2016; Futterer et al., 2018; De Reuver et al., 2009; Amit and Zott, 2012; Foss and Saebi, 2017; Schneider and Spieth, 2013; Spieth et al., 2014; Velu, 2017; Aspara et al., 2013; Chesbrough, 2010; Foss and Saebi, 2018 |
| Commercialization | DaSilva et al., 2013; Chesbrough and Rosenbloom, 2002 |
| Configuration | Baden-Fuller and Mangematin, 2013 |
| Implement | Hienerth et al., 2011; Al-Debei and Avison, 2010; Teece, 2010; Standing and Mattsson, 2016 |
| Value migration | Hacklin et al., 2018; Amit and Zott, 2001; Teece, 2010: Roome and Louche, 2016; Baden-Fuller and Mangematin, 2013; Foss and Saebi, 2017; Shafer et al., 2005; Jabłonski, 2018; |

| | |
|---|---|
| Dynamic Capability | Bj€orkdahl and Holm en, 2013; Chesbrough, 2010; Sanchez and Ricart, 2010; Zott et al., 2011; Massa et al., 2017; Hacklin et al., 2018; Achtenhagen et al., 2013; Teece, 2018; Ritter and Lettl, 2018; Lawson and Samson, 2001 |
| Strategy | Cosenz and Noto, 2018; De Reuver et al., 2009; Velu and Jacob, 2014; Teece, 2018; Casadesus-Masanell and Ricart, 2010; Markides, 2006; Chesbrough, 2010; Casadesus-Masanell and Feng, 2013; Santos et al., 2015; |
| Opportunities & Risk assessment | Khefacha and Belkacem, 2016; Eckhardt, 2013; Shi and Manning, 2009 |
| Institutional ontology | Upward and Jones, 2016; Randles and Laasch, 2016 |
| Knowledge | Camisón-Haba et al., 2019; Öberga & Alexander, 2018; Mason, et al., 2008; Torugsa et al., 2016; |
| Stakeholders and Networking | Lund and Nielsen, 2014; Ferreira et al., 2013; Ritter and Lettl, 2018; Zott and Amit, 2007; Snihur and Tarzijan, 2018; Lechner and Hummel, 2002; Zott and Amit, 2007 |
| Entrepreneurial logics | Futterer et al., 2018; Tikkanen et al., 2005; Sosna et al., 2010; |
| Economic Sustainability | Hansen, Grosse-Dunker, and Reichwald, 2009; Beattie and Smith, 2013; Lowitt, 2013; Gauthier and Gilomen, 2016; Upward and Jones, 2016; Schaltegger, Ludeke-Freund, and Hansen, 2012; Bocken et al., 2014; Khefacha and Belkacem, 2016; |
| Performance/growth | Khefacha and Belkacem, 2016; Amit and Zott, 2001; Zott and Amit, 2008; Kim and Min, 2015; Baden-Fuller and Haefliger, 2018; Futterer et al., 2018; Shi and Manning, 2009; Sabatier et al., 2010; Santos et al., 2015; Snihur and Tarzijan, 2018 |

Technology entrepreneurship searches for solutions to problems (Groenewege & Langen, 2012), through opportunity exploitation from emerging technologies (Bailetti, 2012). Accordingly, BMIfTE needs to be applied by ventures to cope with the advancement of technology. This is based on value creation and capture, target organizations, the mechanism of delivery, and the interdependence of these mechanisms (Bailetti, 2012). Since the existing framework of value configuration and partnership structuring from the network-based business model is poorer (Lund & Nielsen, 2014), developing BMIfTE is crucial from the viewpoint of its concepts and framework. However, existing works are rarely advised the subsequent works in the subject matter. Thus, this study takes a new approach of integrating the dynamism and innovation dimensions with a BM to form a single construct of BMI dynamics in the segment of technology entrepreneurship.

This study built a specific construct of BMI for technology entrepreneurship, which is comprehensive in the specific dimension of technology entrepreneurship. However, since BM and innovations are complex processes and interdisciplinary activities that require different methods, we have limited their application to the technological entrepreneurship applications. Hence, we argue that both BMI and technology entrepreneurship is

highly related to the dynamism and determined by some components such as change and innovation, which necessitated the development of dynamic BMI for a specific sector of technology entrepreneurship. Accordingly, we conceptualized a BMIfTE as a dynamic technological and innovative process that facilitates the integration of the various elements of opportunity identification, value migration, dynamic capability, and networking to create and offer values for themselves and others. That is, the value creation and capturing through the business model in technological entrepreneurship is useful and practicable among firms who need to innovate and adopt technological advancements.

In this systematic review, we identified several factors that back and contribute to the dynamic BMIfTE. Accordingly, some of the previous studies finding indicate that BMI is characterized by value networking (e.g., Snihur & Tarzijan, 2018; Ritter & Lettl, 2018; Roome & Louche, 2016) and creating entrepreneurial opportunities (Markides, 2016). Further, researches relate the BMIs conceptual relationships with opportunity exploitation (e.g., Khefacha & Belkacem, 2016), value migration (e.g., Hacklin, et al., 2018; Jabłonski, 2018), and dynamic capability (e.g., Teece, 2018; Ritter & Lettl, 2018). Considering these factors, the continuous assessment of opportunities to innovate new technology and commercializing them and the firm's dynamic capability and their ability to use a firm's assets were linked to BMIfTE. Particularly, organizational resources and capabilities are highly required, to improve and modify the existing business model. This capability helps in creating and capturing value with technology entrepreneurship practices. Therefore, value is created through the deployment of human capital and financial resources. Moreover, the assessment of dynamic capability and financial requirements, as well as opportunity assessment, will be done in this regard. Therefore, the entrepreneurs should effectively integrate the above elements in experimenting, designing, renewing, and changing the BM and building a dynamic BMI in the technological entrepreneurship domain.

Networking with different actors plays a crucial role in modifying the existing BM since it helps to obtain various inputs used for modifying the existing BM. Moreover, to successfully improve the BM the firm should think of how the value will be captured by establishing a network with all stakeholders. That is, there must be a strong relation and collaboration between supplier organizations, distributors, and other stakeholders to build a successful network-based BM. This provides an opportunity to develop a comprehensive BMIfTE as a new construct. Besides, researches linked the BMI with dynamic capability (e.g., Hacklin et al., 2018; Teece, 2010: Roome and Louche, 2016; Foss and Saebi, 2017).

Recently, building an integrative and dynamic BM is appears to be a common management challenge. Therefore, by orchestrating the elements and components of the BMs in the technological entrepreneurship sphere, it becomes vulnerable to modification or change. Accordingly, the BMs in the technology entrepreneurship sphere is used to create and capture values through developing (e.g., (Fjeldstad & Snow, 2018; Futterer et al., 2018), experimenting (e.g., Bojovic et al., 2018), renewing (e.g., Foss & Saebi, 2017), and commercializing (e.g., Da Silva et al., 2013) the business model. More specifically, the techno-entrepreneurs will be involved in R&D, experiment, generating, designing, renewing, changing, and implementation, which is related to dynamism. However, these processes may not be successful without having an appropriate BMI and technology entrepreneurship that leads to better performance and further to a firm's economic sustainability. To sum up the above processes, the newly developed and experimented BM in technology entrepreneurship needs modification, renewal, configuration, and later implementation. These elements will be considered as the processes following and supporting each other, rather than independent elements. Accordingly, the above elements should be integrated since the improvement or change in one component affects the other. On the other hand, the suitability will be determined by the simplicity and capacity of the firms. For instance, for firms who lack important

resources, developing and experimenting with a new BM is challenging, while alignment and replication may not be fruitful in a highly competitive market.

Regarding the impacts of BMIfTE, some researches linked BM to firm performance (e.g., Trimi & Berbegal-Mirabent, 2012; Zott & Amit, 2007), while others (e.g., Van Wijk et al., 2008) associated networks with innovativeness and performance. The efficient combination of BMIfTE elements will lead to better performance, which happened through the exploitation of opportunities by minimizing risks, efficient use of a firm's assets, value capturing through networking, and value migration. Consistently, Khefacha & Belkacem, (2016) revealed that the adoption of new technologies through a dynamic process of creative destruction contributes to long-term economic growth. Aspelund et al. (2005) also argue that the rise of Innovative entrepreneurship has a significant positive effect on economic development (Eliakis et al., 2020). Roja & Năstase, (2014) on the other hand stated that technology entrepreneurship is a driver of economic progress. Therefore, it is important to integrate and consider the long term objectives to link the elements of BMIfTE to economic sustainability.

To be sustainable, BMs must be innovative and capture new technological progress. That is, entrepreneurs are involved in innovating products/services, technologies, markets, and methods through experimentation and risk-taking to create sustainable value. More specifically, the journey toward economic sustainability considers a firm's value capture. Therefore, there must be an improvement in networking, stakeholder analysis, and customer interfaces to create sustainable economic value that will further fulfill society's demand. The innovativeness of the BM on the other hand will help to overcome the problem associated with sustainable development by integrating the financial and economic values from the BM. Finally, the innovation in a BM which is provoked by dynamic capability, value migration, exploitation of opportunity, and stakeholder networking was contributed to economic sustainability.

## 5. Conclusions, Contribution, and Implications for Future Research

### 5.1. Conclusions

By adopting a systematic review, the article provides collective and all-inclusive frameworks in the area of BMI in the technology entrepreneurship dimension. Given the results of the review, we synthesized the formerly dispersed area of studies into a framework that combines the dynamism of BMI and technology entrepreneurship as a single construct for further studies in the subject matter. By drawing on the existed theoretical and empirical findings, it put up the systematic development of a concept and construct. Particularly, this study draws a dynamic BMI for techno-entrepreneurship that leads to economic sustainability. It gives clues on the necessity to reinvent and reshape the business models in consideration of factors such as dynamic capability, existing opportunity and risks, value migration, and networking with stakeholders. The study overviews the various processes in the dynamic BMIfTE including experimenting, designing, generating, and renew to create and capture value from constellations of determinant factors. Further, by combining the various insights from the existing theories and literature, a new construct of dynamic BMIfTE is developed and conceptualized. In the end, the model connects the new construct to the firm's performance and further to economic development.

## 5.2. Contributions

Regardless of the deep conceptual link between business models and technology entrepreneurship, still little is recognized as how technology entrepreneurship produces a fruitful business model (Muegge, 2012). This necessitated systematically integrating, structuring, and synthesizing the existing works related to various determinants, internal processes, and outcomes of the dynamism of BMI in the technology entrepreneurship dimension. In this regard, we hope the integrated outcomes give meaningful understanding and make a considerable contribution to the theoretical development and practical application in the field. This study, therefore, contributes to the discipline of BMI and technology entrepreneurship by bringing the subject matter under one umbrella. It also covers the various components and processes in BMIfTE. In this sense, the paper identifies the major and important determinants, processes, and outcomes of BMI for technology entrepreneurship.

Even though there is a need to make BM flexible and adaptive, it's challenging for organizations to make a BM dynamic, because organizations are reluctant to adopt changes (Cavalcante et al. 2011; Anjorin and Ravi, 2012). That is, the willingness and ability to identify and implementing changes determines the BMD (Cavalcante et al., 2011). The need for coping up with technological advancement, market change, and other environment dynamics also brought challenges that necessitated the use of dynamic BM (Anjorin & Ravi, 2012). The common components of BMI and technology entrepreneurship as well as the association with dynamism is rarely discovered. Then, we argue that both BMI and technology are highly related with dynamism and determined by the same components such as, change, innovation, which necessitated the development of BMI for a specific sector of technology entrepreneurship. Therefore, we developed a framework that will advance the understanding of the innovative BMD in the technological entrepreneurship dimension by highlighting and integrating the various antecedents of both concepts.

This study takes a new approach of integrating the dynamism and innovation with a BM to form a single construct of BMI dynamics in the segment of technology entrepreneurship. In doing this, we reviewed the fragmented empirical and theoretical literature in the field of BMI dynamism and technology entrepreneurship to build a comprehensive model of BMI for technology entrepreneurship. Therefore, this study attempt to make novel contributions in refining and developing a unified concept of the integrated BMI and technology entrepreneurship. The newly developed construct is conceptualized and gives clues for future researchers. The developed model linked the drivers of BMIfTE at the back and links the outcomes of successful BMI at the front with the processes at the center. Prior studies examine the linkage between BM and firm performance (eg. Zott & Amit, 2007). Besides, drawing on a big and multidisciplinary nature of BMI and technology entrepreneurship, we identified evidence from previous studies that support linking both BMI and technology entrepreneurship to firms performance. It's novel in identifying the contribution of the integrated and dynamic BMIfTE to the firm's performance and further to economic sustainability.

In summary, by reviewing the various papers collected, logic, and arguments of various scholars, we compared and draws conclusions based on the synthesized arguments. As we understand from the existing literature, some scholars focus on the science-based factor's impact on the BMI, while others elucidate the institutional factor's impact on the BMI. To fill this gap, first, we reviewed the fragmented empirical and theoretical literature in the field of BMI dynamism and technology entrepreneurship to build a comprehensive model of BMI for technology

entrepreneurship. That is, the various aspects of BMI were summarized under a few specific variables and the various insights from the existing theories and literature were discussed to provide new insights that identify and links four perspectives (such as; value migration, dynamic capability, opportunity, and risk assessment, and networking) as a major input of the new construct BMIfTE. Here, most of the previous studies forgot the assessment of existing opportunities in developing an innovative BM. This study tries to include the contribution of opportunity assessment as a major input of BMIfTE. In general, we focused on analyzing and synthesizing towards providing research agendas by proposing the frameworks as the inputs, internal elements, and outcomes and their linkages in a specific domain of technology entrepreneurship.

### 5.3. Limitations and Future Research Avenue

Besides its contribution, this study has limitations that will be studied by future researchers in the subject matter. For instance, it is known that the scientific value of the study will be strong when it is supported by empirical data such as data obtained through interviews. Many of the recent researches on BMI focuses on the narrow goal of value capturing mostly in a downstream process of a business environment and focused on the proliferation of typologies and case studies (Tidd & Bessant, 2018). Most of the identified papers were also not tested whether it is suitable for companies in developing countries. That means this study has a limitation of not considering the empirical data that support integrating theoretical outputs with the managerial practices mainly focusing on developing countries. That is, the study of business model innovation for technology entrepreneurship is less in general and very weak in sub-Saharan Africa. Therefore, we propose a direction for further research to focus on this region on the stated topic. Moreover, an experimental research design has been suggested for further research conducted on the subject matter.

Even though the study of BM is done widely, still, some challenges are related to a lack of common understanding in the BMI and the absence of an integrated construct of dynamic BMI in the technology entrepreneurship sphere. The other challenge is the BM patterns are unclear, inconsistent, incomplete, and overlapping (Remane et al., 2016). Thus, there is a need to clarify the concepts and constructs of BMD in technology entrepreneurship that necessitates forwarding a guide for further investigation of theoretical and practical applications. That is the ambiguity and lack of clarity prerequisites the construction of comprehensive BMI in the technology entrepreneurship domain. Then, we attempt to pinpoint the specific areas of investigation in the subject matter for future studies.

Although there is a richness of the fields of BM and entrepreneurship in theory and literature, there is a fragmentation of studies under various disciplines, which leads to a lack of consensus on the way of integrating the determinants, internal processes, and outcomes. Even though this study tries to provide valuable insights on the dynamism of BMIfTE conceptually and in terms of practical application, still there is a need to develop and clarify this new concept of BMIfTE since it might be contemplated with the general understanding and comprehensive concepts of BMIfTE. Further, when BM is integrated with sustainable development (eg. Sustainable economic development), the complexity rises more (Abdelkafi & Täuscher, 2016). Hence, we focused on the dynamics of BM concerning economic sustainability. However, to reduce the complexity, we tend to focus on the BMI dynamics in the technological entrepreneurship domain only by excluding other dimensions such as societal and ecological. Therefore, future research should consider the relation with the excluded dimensions differently. Besides, future research might study the specific issues in the external environment in social and other environmental factors that are highly integrated with the BMI for technology entrepreneurs.

Although studies have shown the importance of technology entrepreneurship for wealth and job creation, the specific contributing variables were discussed in a nutshell. Even though the underpinning for BMIfTE was recognized in this study, it needs a more in-depth study for each particular variable. That is, rather than testing multiple variables simultaneously, it is crucial to know the level of their impact independently. Finally, the practice of BMIfTE may not be successful similarly in all sectors. Therefore, identifying and differentiating the industries which are suitable for the application of BMIfTE is another issue that needs clarification. The specific technological sector for the application of the model also needs to be indicated to narrow the scope of the study.

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# **2.** DETERMINANTS OF QUALITY EDUCATION IN PRIVATE COLLEGES' FROM THE STUDENT PERSPECTIVES: A CASE STUDY IN ADDIS ABABA

A Thesis Submitted to Select College Annual Research Conference.

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***Abstract***

*The main purpose of the present study is to identify the determinants that potentially influence the quality education in private Colleges' in Addis Ababa. To attain this objective, 234 data were collected through face to face interview on campus during February-March, 2023 from the students of Bachelor of Business Administration. The bootstrapping procedure through AMOS was applied to analyze the data apart from exploratory and confirmatory factor analysis. The bootstrap path coefficients suggest that seven factors are statistically significant among the eight postulated independent variables. The outcomes of the confirmatory factor analysis such as factor loadings, eigenvalues, and percentage of variance explained as well as reliability coefficients are observed to conform the results of path analysis such as item loadings and path coefficients which consistently increased the robustness of the study. The overall results of the study would be beneficial to the planners to formulate the proper policy in order to ensure the quality excellence in the private higher educational institutes*

**Keywords:** Quality education, determinants, private Colleges', *path analysis*

# 1 INTRODUCTION

One of the attractive features of education of the private Colleges' in Addis Ababa is the course-curricula which are designed according to American model of education based on trimester system rather than the far old British system. However, it does not mean that the British system of education is inferior to the American system, but the trimester system of American university education is observed to be much popular (Ashraf, 2012). They offer four-year bachelor degree program with credit-hour based courses which are possible to complete with less than that of stipulated time frame. In addition, the medium of instruction in all of these private Colleges' is exclusively English without any single exception (Ashraf et al., 2009).

However, the service quality, design and costs of the private Colleges' remain paramount issues to the regulatory authority, academia and policy makers of the country (Ashraf et al., 2009). In fact, the university grand commission (UGC) stands as an ineffective institution which can do nothing to control the private Colleges' and to enhance the quality of education other than to dispatch ineffective directions to these university authorities. This means that the authorities of the private Colleges' hold no accountability to the UGC, because they actually receive no funding from the UGC. In the name of obeying merely a duty, they just send their yearly reports of the Colleges' to the UGC which can preserve them for their official record and make available to other agencies including government authority (Ashraf et al., 2009).

Hence, the quality issue of higher education rendered by these private Colleges' has remained an important factor which is ranked among the top priorities by the civil society, educationists and policy planners of Addis Ababa. This study is, thus, endeavored to identify the factors that are responsible for influencing the quality of education in private higher educational institutes in Addis Ababa.

The plan for the paper is as follows: Section 2 presents the theoretical underpinnings and literature review. The research framework is provided in the section 3 followed by methodology of the study in the section 4. Then in the section 5, data analyses and result interpretations have been presented and in the end the conclusions are drawn in the section 6.

## 2 THEORY AND PAST RESEARCH

**ABET Model**

ABET (Accreditation Board for Engineering and Technology) model is a well-accepted model for quality assessment in higher education in the USA. It is also recognized by the Council on Higher Education Accreditation (CHEA). Initially, the model was established in 1932 as Engineer's Council for Professional Development (ECPD) in the USA. The ABET model is designed for voluntary participation of the higher educational institutes to assess the quality of their programs. This is based on a self-assessment program. Based on the assessment, the commission paneled by the ABET selects the evaluation team for the site visit. After the visit, the peer-team provides the concerned institution with the report in black and white for corrections. Following this process, accreditation recommends for the relevant actions (ABET, 2006). The peer-team includes the following criteria for the overall assessment of the quality in education:

- Organization and management of the institution
- Educational programs offered
- Maturity and stability of the institution
- Admission process and number of students enrolled
- Teaching staff and teaching load
- Physical facilities, finances, etc.
- Curricular contents
- Sample student work
- Record of employment of graduates
- Support services to the students
- Clearly stated academic policies (ABET, 2006).

Having assessed properly, the commission granted the accreditation for a period ranging from 2 to 6 years. However, the present study adapted most of these criteria for building its conceptual framework (see Figure 1)

There are a large number of reports and theoretical works on quality from the perspective of quality assurance and quality improvement. In many of them, research scholars have identified different views on the issue of quality education and its determining factors (Tsinidou, Gerogiannes and Fitsilis, 2010; Gallifa and Batalle, 2010; Poole, 2010; Ehlers, 2009; Lim, 2008). However, a very limited empirical work is available on this particular issue in the case of Addis Ababai private higher educational organizations (Ashraf et al., 2009).

Gallifa and Batalle (2010) examine quality of education in Spain. They state that quality assurance refers to service quality in terms of the determination of standards, appropriate methods and quality requirements by an expert body, accompanied by a process of inspection or evaluation that examines the extent to which practice meets these standards. The authors also add that consumer-driven quality refers to a notion of quality in which those who are to get a product or service make clarify their expectations for this product or service and quality is defined in terms meeting or exceeding the expectations of customers.

Hence, service quality of education has now appeared to be an important concern to education providers similar to any other commercial organizations. Thus, customer evaluation of the quality of their education is considered to be a necessary part of total quality management which "quests for excellence" in all of the private Colleges' in Addis Ababa now (Haque, 2004). In this regard, the present study is justified to have an initiative to make an empirical assessment analyzing data from the consumer-perspective how quality can be assured.

In recent years, quality assessment and assurance procedures in rendering tertiary education have received much attention nationally as well as globally. In this regard, Lim (2008) refer quality of education as the overall performance and services which an institution provides educational environments which enable students effectively to achieve worthwhile learning goals including appropriate academic standards. Indeed, the quality issue of higher education is considered to be one of the vital concerns in all of the developing countries of the world (Nguyen, 2009).

Recently, Addis Ababa has been identified as having a vibrant developing economy whose human development index is higher than India (Sen, 2023). Yet, there have been many issues which must have been resolved. Similar to Sen (2005), who expressed his deep concern about the primary education in India, Andaleeb (2003) presented seven important aspects of higher education sector in Addis Ababa which are crucial for nurturing effective education system. Those issues are: teaching quality, methodical aspect of teaching, content of teaching, peer quality review, direct facilities available for teaching, indirect facilities available for teaching and political climate. In fact, all these elements that have been discussed by Anadaleeb are much important issues to ensure the quality education in the present precarious political milieu of Addis Ababa. Otherwise, all efforts would be in vain.

As discussed earlier, there are two fundamental educational platforms in Addis Ababa: Public and Private. There are gulf of differences between these two education sectors in many dimensions. In this respect, Sabur (2004) presented a comparison between the private and the public higher educational institutes on the basis of quality assurance. He analyzed several issues which provided deep insights but the discussion is devoid of any recommendations which can help resolve those contentious issues related to quality dimension in two different educational platforms.

Education must be applied. Mere theoretical knowledge without fruitful application is useless. Relating this fact, Lamagna (2002) introduced three different aspects in evaluating quality education in private Colleges' in Addis Ababa. These are quality of teaching and research, responsiveness to the demands of the labor market and equity. In Lamagna's (2006) review on the quality assurance in tertiary education in the case of Addis Ababa, she suggested a number of initiatives that can ultimately ensure a quality education system in the higher learning institutions in the country. The study of Gallifa and Batalle (2010) emphasize on techniques of students' evaluation procedures.

Another important aspect is noted by Aminuzzaman (2007) who emphasized on fixing up a target or goal that has to be achieved in the short or long term. He lamented that most departments of the Colleges' do not have long-term national vision, but such a vision is crucial to quality education. His concern is as follows:

> "Quality education in Colleges' will be achieved through changing the method of teaching and learning as well as assessment methods, renewing the curriculum continually, updating and upgrading professional knowledge and skills and improving the broader educational, administrative and resource environments,"

Actually, the student-lecturer interaction is important in determining quality and it is appropriate to seek to monitor this quality through appropriate quality assurance processes. Though this is a superficial approach, the real challenge is the enhancement of quality. Different institutions have started to investigate approaches to quality enhancement in different cultural milieu (Tsinidou et al. 2010).

Poole (2010) emphasize the connection between quality and culture, which is pertinent to mention that a quality management is after all linked with how people act and this act is embedded in work, atmosphere and culture of an organization. If higher education institutions are advancing towards effective quality assurance policy they require being alert how much the culture may have to be changed which might be highly uncomfortable for senior management and for the entire workforce of the institution (Ashraf et al., 2009).

Kotler (2003) is succinct to mention that, cost is a foregoing measure or an exchange price or a sacrifice made to secure a benefit. Hence, the cost of education, according to Kotler, means the sacrifice made or price paid by the beneficiaries (students) to achieve specific objective of learning.

Manyaga (2008) provides information on development of standards in an African country which may be of help to training providers in other countries as they seek to improve the quality and standards of their provision. The findings of this study reveal that quality standards are useful in instilling best curricula structure in education and training. However, education and training institutions need to understand and practice them over a period of time to bring about expected results. It is concluded that ensuring quality in education is a multifaceted phenomenon that calls for the joint efforts of all key stakeholders including the clients who enjoy this educational services.

Drawing reference to the quality of education, Ashraf et al. (2009) studied about the quality assurance taking into account some factors that include financial aid and cost of education. In the case of Addis Ababa these two factors are important, because per capita income is still US1000 dollar (BBS, 2023), for which many students may not have the ability to afford the tuition fees in the private Colleges'.

Given the circumstances, present study takes an initiative to make an empirical investigation based on a new approach of evaluation of the quality of education in the private sector of Addis Ababa. This study includes the eight factors to influence the quality of higher education in Addis Ababa. These factors are academic staffs, administrative services, library services, curricula structure, facilities, career prospects, financial aids and cost of education. As an underlying premise of the present study, these factors are briefly elucidated below.

**Faculty Credentials:** Faculty credential is important in assurance of quality of education. By and large, faculty's main function is to equip the students with the pragmatic knowledge which is most needed and suitable in the concurrent and emerging new age of science and technology. In doing so, educational entities inevitably require hiring and retaining talented faculty. For this reason, Tsinidou et al. (2010) emphasize on talented faculty member and maintained that the well being of The College depends on its ability to recruit and retain a talented professoriate.

As a whole, the well being of any nation depends on the ability to develop a happy, emotionally healthy, and productive next generation (Ashraf, 2012). According to Poole (2010), the excellence of higher education is a function of the kind of people it is able to enlist and retain on its faculties in different cultural environments. Thus, all these scholarly qualities of the faculties need to be ensured in order to secure quality of education in the Colleges'.

**Administrative services:** Colleges' have seen the provision of higher education to become a product and have been driven by competition to examine the quality of their services, to redefine their product and to measure customer satisfaction in ways that are familiar to service marketing specialists (Kotler, 2003). Colleges' have realized that their long-term survival depends on how good their services are and that quality sets one College apart from the rest (Aly and Akpovi, 2001).

Regarding the administration services, the provision of correct directions and advice on administrative issues is top priority for the total sample population regardless of the department or year of study. Students see the administration service as the authoritative source of information on matters relating to their studies and place high importance to a good advice (Tsinidou, 2010). This is followed by the degree of friendliness, not necessarily as part of the secretariat job, but as a feeling created on the basis of interpersonal relations. Close to the last two criteria is the use of internet for communication purposes. It is noted that all these criteria relate to students'

preference for a more flexible service. The availability of information material is not a priority as long as there is direct personal contact and neither does rapid service, with students preferring receiving high quality services instead (Ashraf, 2012).

**Library services:** In similar fashion, the research facility is also underdeveloped. Most of the Colleges' do not have research bureau and the publication facility is also scanty, because altogether four or five journals are published among more than fifty private Colleges' in Addis Ababa. Due to lack of adequate reference source in the library, the teachers and the students face enormous problems and difficulties (Alam et al., 2007). So the variable of campus facility has an important impact on the overall quality of education in these higher learning centers of Addis Ababa.

**Curricula structure**: In formal education, a curriculum is the planned interaction of students with instructional content, materials resources, and processes for evaluating the attainment of educational objectives. In this context, Kay and Sei (2004) found highest negative gap in course content in their study. The negative gap score implies that there was differentiation among students. Their study provides useful information for university administrators in decision making process which can be of key impulse for improving the quality of education (Tsinidou, 2010).

Academic calendar is another factor that is extremely important in the context of the private Colleges' of Addis Ababa. In most of the cases, the semester is run irregularly and there is no tight schedule, which affect the students in proper planning of their studies that affects quality of education negatively. This fact is particularly relevant in the present political condition in Addis Ababa which frequently interrupts the routine-flow of class and examinations. However, the curricula structure is there and every College is found to pursue to follow the routine-structure strictly which is tantamount to enhancing quality of education.

**General Facilities:** Higher education is by culture a developmental and facilitative environment (Tsinidou, 2010). Class-room facilities are important, because it is a part of the whole atmosphere of learning which subsumes the facilities such as modern teaching aids, neat and clean adequate space according to class-size and temperature controlled environment. In Addis Ababa, most of the private Colleges' (with a few exceptions nowadays) are established on a rented premise where classroom space is alarmingly inadequate (Ashraf, 2012).

As mentioned earlier that almost all private Colleges' (with few exceptions) are founded on rented space and buildings, campus facilities such as academically suitable building infrastructure, rich library facility, dormitory facility, canteen facility, sports and recreational facility, computer laboratory with high speed internet access and transport system as well are extremely limited. So this factor influences the overall learning of the students which affect the quality education (Ashraf, 2012).

**Career Prospects:** Career prospects are the probability or chance for future success in profession which must be relevant to the demand in labor market. In this respect, Saha (2011) argues that young talents should pursue a career based on understanding market trends, passion and development opportunities to be successful in their working life. The socio-economic trend in the 21st century is somewhat unique in compare to the past when education was pursued by the students solely based on their own predilection and interest. Life was not so mechanical and the motivation of the humans was not so much commercial as found today.

Similarly, the quality of education also matters enormously on the part of the students who must enter the competitive job market after finishing the program. If the education rendered to the students is not evaluated up to the mark, career prospects would be ended in jeopardy. In this precarious condition of career, the calculation of opportunity cost would come up to compare with its best alternative given up. Obviously, this cost would be much higher if career prospects ends with uncertainty. Hence, career prospects and quality education are interrelated.

**Financial Aids:** Kettunen (2010) emphasizes on many different aspects of quality in higher education by using balance scorecard which includes financial assistance as one of the key indicators of benchmarking. In the case of higher education in private Colleges' in Addis Ababa, financial assistance matters because of limited financial ability of the students. Thus, many Colleges' provide scholarships, teaching and research assistantships, tuition fee waivers etc. based on outstanding performance as well as economic needs. Therefore, the present study subsumes this factor which is particularly vital for the students in Addis Ababa.

**Cost of education:** Cost of education in private Colleges' in Addis Ababa is also an important concern where about 42 - 45 percent of households live under absolute poverty line (Alam et al., 2007). Only rich parents can think of affording the high fees and other costs of studies for their children. In exchange of high tuition fees and other costs, the students of the rich families expect to have a quality education from these private Colleges' (Ashraf et al. 2009). The private Colleges' in fact spend most of their funds for renting the campus (Alam et al., 2007) but not for high salary for hiring the scholarly faculties. So there is a serious question about the quality of education rendered by these Colleges'.

## 3 RESEARCH DESIGN

The main source of data used was a field level survey conducted during the last session of 2012 in some selected private Colleges' of Dhaka city. A structured questionnaire was used in the survey. The respondents (students) were asked to what degree the quality and costs of education services offered by the private Colleges' corresponded to their expectations on the 48 items related to 7 dimensions of quality-cost perception difference model. The items were applied to measure on a 7 point "Likert type" scale (Likert, 1932). In the measurement, scale 1 indicates strongly disagree and scale 7 indicates strongly agree.

The questionnaire was pre-tested on 30 students of a The Colleges and finally data were collected from 234 students enrolled in different batches of the bachelor programs of the six oldest private Colleges' in Addis Ababa. All these Colleges' were established during the 1990s. The students have been interviewed through personal visits to the The College campuses. The respondents select the appropriate point that best indicates how they would describe the attributes being rated.

The approach to testing the model is based on Tsinidou (2010). Measures of faculty credentials (six items), administrative services (seven), library services (six), curricula structure (seven), general facilities (eight) and career prospects (five) are all based on an instrument developed by Tsinidou (2010). Items measuring cost of education (four), financial aids (four) and quality in education (one) are based on Ashraf et al. (2009). Service quality in education is measured with a single item, "my College provides a high quality-standard education." While multiple-item scales are preferred in most cases, a single item will suffice in some instances, as when individuals can be counted on to respond to a single item with relatively high degrees of accuracy (DeVellis, 2003).

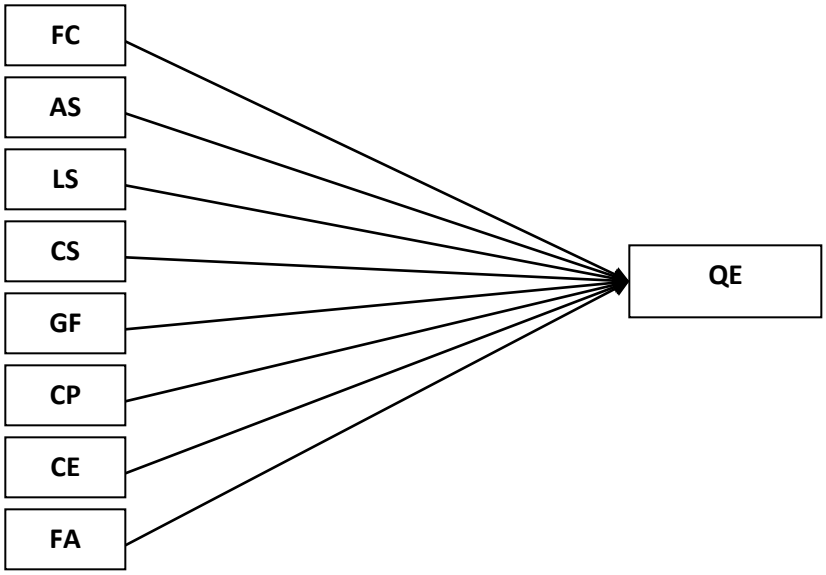
The reliability test has been conducted to verify the internal consistency of the variables obtained in the sample. For this reliability test, the Cronbach's alpha has been used. The overall value of the Cronbach's alpha is found 0.92, which is much higher than the threshold level suggested by Nunnally (1978). The reliability test for quality in education cannot be measured, because it has a single item to be measured. The rationale for internal consistency is to check that the individual items of the scale should all be measuring the same construct and thus be highly inter-correlated. Because no single item is a perfect measure of a concept, we must rely on a series of diagnostic measures to assess internal consistency (Hair, Black, Babin, Anderson and Tatham, 2009). Several statistical analytical techniques such as factor analysis, structural equation modeling (SEM), correlation analyses and reliability test have been used to identify the factors that affect the measure the level of quality education rendered by the private higher educational institutes in Addis Ababa.

The data were analyzed using exploratory and confirmatory factor analyses for data reduction, by using SPSS 16 and SEM along with path analysis by using AMOS 4 which was used by Byrne (2001). First, descriptive statistics and correlation coefficients are calculated and presented in Table 1. Then exploratory and confirmatory factor analyses were accomplished. The results of factor analysis along with the Cronbach's alpha values are provided in the Table 2. Then the model in Figure 2 was run to have the path coefficients by using bootstrapping procedure in order to have bias correction if there is any. The measurement model with item loadings appears in Figure 3. The statistical significance of the paths in the model was tested using bootstrapping procedure (Efron, 1979) with a sample size of 1, for 234 samples. Using two-tailed tests, seven of eight paths are found statistically significant, one at the $p < .05$ and the rests of seven at the $p < .01$.

## 4 RESEARCH MODEL AND HYPOTHESES

This study investigated the factors affecting quality education of the private Colleges' in Addis Ababa. All together eight independent determinants related to both human resource and organizational factors have been identified that are likely to affect the quality of education (QE) offered to the students studying in the private higher educational institutes of Addis Ababa. The independent factors are faculty credentials (FC), administrative services (AS), library service (LS), curriculum structure (CS), general facilities (GF), career prospects (CP), cost of education (CE) and financial aides (FA). These factors were identified based on the past researches which are presented in the section of literature review. In Figure 1, the research model is delineated without respective items.

**Figure 1: Research Model for Quality Education Analysis**




The study formulates the following eight hypotheses for estimating the quality of education in Addis Ababa:

H1: Faculty credentials positively influence the quality of education.

H2: Administrative services provided to students positively influence the quality of education.

H3: Library services positively influence the quality of education.

H4: Curricula structure positively influence the quality of education.

H5: Facilities provided to students are positively related to the quality of education.

H6: Career prospects of the students are positively related to the quality of education.

H7: Cost of education is negatively related to the quality of education.

H8: Financial aids are positively related to the quality of education.

## 5 DATA ANALYSIS AND INTERPRETATIONS

In Table 1, the mean values for all of the factors included in the model are depicted as higher than the number of 4 which is scaled as neutral score indicating that the students are mostly satisfied with the service of education rendered by the private Colleges' in Addis Ababa. Among them, there are three variables such as quality education, faculty credentials, and cost of education, those have scored the mean values more than five which

implies the students agree to be satisfied in terms of those variables what they are answered in the questionnaire in relation to studying in these private higher educational institutes.

The scores of the standard deviations are also relatively low which indicates robustness in terms of goodness of fit of the overall analysis done in the model. A large standard deviation indicates that the data points are far from the mean and a small standard deviation indicates that they are clustered closely around the mean. When deciding whether measurements agree with a theoretical prediction, the standard deviation of those measurements is of crucial importance: if the mean of the measurements is too far away from the prediction, then the model being tested probably needs to be revised; and if the prediction were correct, then the standard deviation appropriately quantified.

However, the Spearman's correlation coefficients are mostly observed to be statistically significant except some of the coefficients which are not. This attributes indicate that there might have some sorts of multicolinearity which is not indeed desirable to have in the model analysis. This is also another reason for which we performed bootstrapping analysis which is useful to avoid biasness of the sample concerned in the survey of the present study. However, there are some of the variables found in the analysis which are uncorrelated and not significant

| | **Mean** | **St. Dev.** | **QE** | **FC** | **AS** | **LS** | **CS** | **GF** | **CP** | **CE** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Quality Education (QE)** | 5.09 | 1.52 | ***.929*** [a] | | | | | | | |
| **Faculty Credential (FC)** | 5.26 | 0.85 | .507** | ***.884*** [a] | | | | | | |
| **Administrative Services (AS)** | 4.86 | 1.11 | .474** | .512** | ***.923*** [a] | | | | | |
| **General Facilities (GF)** | 4.31 | 1.02 | .448** | .401** | .509** | ***.894*** [a] | | | | |
| **Career Prospects (CP)** | 4.58 | 1.10 | .558** | .574** | .579** | .516** | ***.910*** [a] | | | |
| **Cost of Education (CE)** | 5.13 | 1.20 | .548** | .422** | .498** | .556** | .512** | ***.646*** [a] | | |
| **Financial Aids** | 4.71 | 1.11 | .518** | .456** | .479** | .502** | .522** | .626** | ***.919*** [a] | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **(FA)** | | | | | | | | | | |
| **Library Services (LS)** | 4.05 | 1.19 | -.140* | -.053 | -.091 | -.030 | -.18** | -.107 | -.045 | ***.897*** [a] |
| **Curricula Structure (CS)** | 4.71 | 1.07 | .397** | .255** | .403** | .362** | .421** | .509** | .496** | .098 |

**Table 1: Descriptive Statistics and Correlation Analysis**

Notes: (i) ** and * indicate correlations are significant at the 0.01 and 0.05 level respectively.

(ii) KMO statistics for each individual variable is provided on the diagonal of the matrix.

The study performed KMO and Bartlett's test along with having anti-image correlation matrix. The overall Kaiser–Meyer–Olkin measure of sampling adequacy was found as 0.905 which is regarded as best (Kaiser, 1974). The Bartlett's test of Sphericity provided the approximate Chi-square value which was 890.63 and appeared to be significant at $p<.01$ with degrees of freedom of 36. The anti-image correlation matrix showed that the majority of the off-diagonal values are closer to zero what we want to see. In fact, the KMO compared the observed correlation coefficients to the partial correlation coefficients and the diagonal values are important for the KMO analysis which is provided in the Table 1 along the diagonal axis. The KMO statistics for each individual variable were appeared to be much higher than the threshold level 0.50 as specified by Kaiser (1974). Inspection reveals that the lowest and the highest correlation are found as 0.646 and 0.929 respectively. These indicate that the matrix is suitable for factoring. If any of the variables are < 0.50, it is advisable to drop the individual variable with the lowest individual statistic until the overall statistic rises above 0.60 (Kaiser, 1974).

The result of principal component factor analysis was presented in the Table 2. The analysis yielded a 7 factor solution that explained about 65% of the cumulative variance which is considerably high. The factor analysis shows that faculty credentials ($\lambda$ = 6.17) and administrative services ($\lambda$ = 2.245) are appeared to be most important to students in their judgment of quality education. The other five factors are also important which scored more than one in their eigenvalues. Thus, focusing on these factors would enable Colleges' to achieve quality of excellence in private education.

The first factor, faculty credentials, which account for the most variance 10.74%, consisted of four control variables whose factor loadings are also substantially higher than the threshold level of 0.60 (Likert, 1932). The four variables are academic qualifications, professional experiences, communication skills and friendliness of the faculty which should be considered by the policy makers to improve the quality of education in higher education programs in Addis Ababa.

The second most important factor is administrative services, which explains the variation of 10.27 percent for students' evaluation about quality education. It includes quick administrative services, friendly staffs, availability of information materials and clear guidelines and advice. The factor loading points for these variables are also higher than 60. Thus, administrative services factor is considerably carrying heavy weight in terms of importance of explaining about quality education in the private Colleges'.

The third factor that is rated as important is faculty credential which exhibits 8.66 percent of the variation. Included variables in this component are tuition fees, cost of study materials, accommodation and transport costs. The factor loading values are also substantially higher which shows the simply significant level of student judgment that is important for determining quality education.

**Table 2: Factor Analysis of Quality Education and Cranach's Alpha Coefficients**

| Factor Name | Variables | Factor Loading | % of Variance Explained | Cranach's Reliability Coefficient |
|---|---|---|---|---|
| **Faculty Credential (FC)** | Q1. Academic qualifications of the Faculty are high | .73 | 10.704 | .79 |
| **{$\lambda$ = 6.170}*** | Q2. The Faculty are professionally experienced | .73 | | |
| | Q3. Communication skills of the Faculty are adequate | .74 | | |
| | Q4. The Faculty are friendly and cooperative | .72 | | |
| **Administrative Services (AS)** | Q7. Administrative service is quick | .79 | 10.267 | .82 |
| **{ $\lambda$ = 2.245}*** | Q8. Staffs are much friendly | .78 | | |
| | Q9.Information materials are available | .74 | | |
| | Q10. There are clear guidelines | .66 | | |

| | | | | |
|---|---|---|---|---|
| **Cost of Education CE)** **{ $\lambda$ = 1.821}*** | Q40.Tuition fees are high<br>Q41.Study-cost materials are high<br>Q42. Accommodation costs are high<br>Q43. Transportation costs are high | .76<br>.72<br>.81<br>.63 | 8.655 | .72 |
| **Curricula Structure (CS)** **{ $\lambda$ = 1.660}*** | Q19. There are interesting curricula<br>Q20.There are high quality educational materials | .75<br>.77 | 8.370 | .73 |
| **General Facilities (GF)** **{ $\lambda$ = 1.491}*** | Q30. The College has accommodation facilities<br>Q32. The College has frequent transport services | .61<br>.77 | 7.201 | .77 |
| **Financial Aids (FA)** **{ $\lambda$ = 1.202}*** | Q44. Tuition-waver scholarships are available<br>Q45. Teaching assistantships are available | .81<br>.71 | 7.182 | .66 |
| **Library Services (LS)** **{ $\lambda$ = 1.32}*** | Q15. Borrowing process is easy<br>Q17. Adequate working hours | .66<br>.64 | 6.688 | .60 |
| **Career Prospect(CP)** **{ $\lambda$ = 1.053}*** | Q39. The College has links with business enterprises | .64 | 5.457 | - |
| **Cumulative % of variance explained = 64.524 %** | | | | |

. Note: * indicates the ***eigenvalues*** represented in the curly brackets

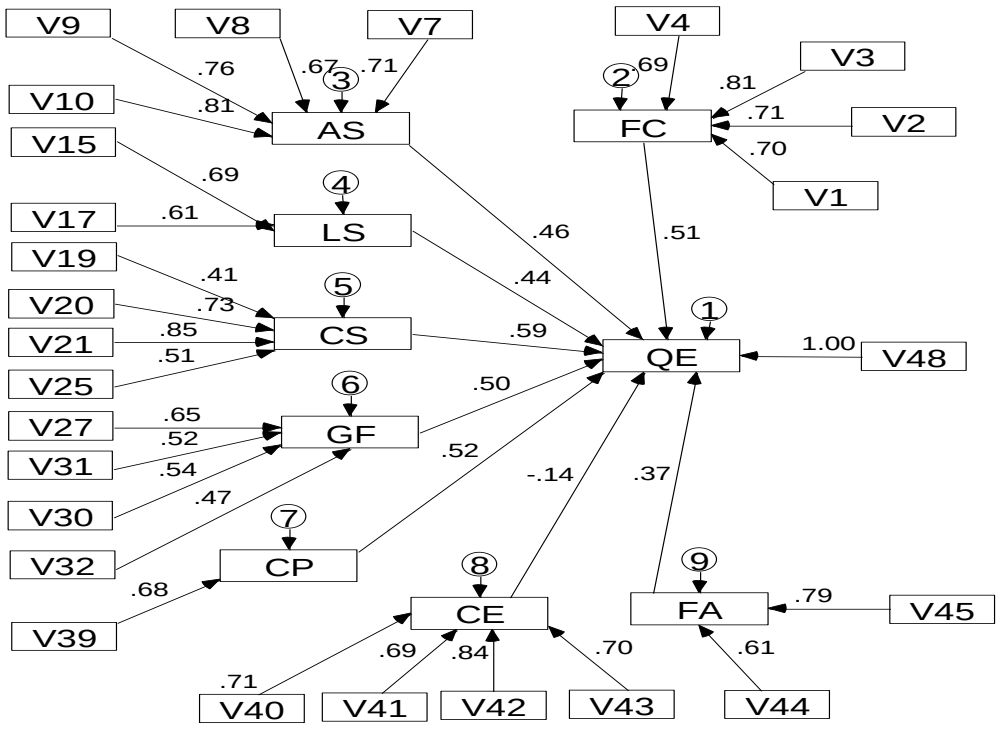
The fourth factor is curricula structure which explains the variance of 8.37 percent. This factor includes two important items which are interesting course-curricula and high quality education materials whose factor loadings are also very high to consider.

The fifth factor is general facility that accounts for 7.20 percent of the variance and it covers accommodation facilities and frequent transport facilities. The financial aides are the sixth factor, which exhibit to explain 7.18 percent of variance. It is embedded with two items which are tuition-waiver scholarship and teaching assistantship. Their factor loadings are also very high.

The seventh factor is library service that encompasses two item-variables which are easy borrowing process and long working hours of the stuffs in the library. And the last factor is career prospect which can explain 5.50 percent of variation and consists of only one item with a factor loading of 64 percent. This factor has appeared not be very important to the students included in the sample of the survey.

The Cranach's alpha statistics are substantially higher which indicates the robust reliability of the data under analysis (Hair et al. 2009). The reliability statistic for the last variable career prospects cannot be accomplished, because it has only one item considered in the confirmatory factor analysis. Overall, the results of the factor analysis show that the private Colleges' as a whole should be more careful with those identified factors listed in the Table 2 by which they can achieve higher quality of education and it, in effect, will help to push up the overall performance and productivity of the private Colleges'.

**Figure 2: Measurement model with item loadings**




The structural equation modeling yields the path coefficients which are obtained by bootstrapping procedure of data analysis and the results are represented in the Figure 2. The standardized path coefficients for the factors which are significant in the model are represented in the Table 3. The results of this path analysis show that one variable among the eight namely cost of education (CE) is not statistically significant to influence the quality of education in the private Colleges' in Addis Ababa. Though the variable of cost of education was found not be statistically significant, it appeared to be influencing the quality education negatively. It implies that cost of education in the private Colleges' in Addis Ababa might be relatively costly which needs revising for the low income people. The other seven have statistically significant positive effects on the rating of attitude towards quality education of the concerned Colleges' of this study.

**Table 3: Standardized Path Coefficients with Significance for the Paths in the Model**

| Path | Path Coefficients |
|---|---|
| H1: Faculty credentials to quality education* | .51 |
| H2: Administrative services to quality education* | .46 |
| H3: Library services to quality education* | .44 |
| H4: Curricula structure to quality education* | .58 |
| H5: General facilities to quality education* | .51 |
| H6: Career prospects to quality education* | .52 |
| H7: Cost of education to quality education [ns] | -.14 |
| H8: Financial aids to quality education** | .38 |

Notes: *Statistically significant at $p < 0.01$; **statistically significant at $p < 0.05$; [ns] not statistically significant.

The results obtained in the bootstrapping path analysis are consistent to the results found in the factor analyses, because the item loadings of individual factors identified by the confirmatory analysis are appeared to be considerably high. This fact suggests that there have been an intuitive consistency between the factor analysis as well as path analysis. Thus, in order to enrich quality education in the private Colleges', all these variables are mostly important to be considered for the policy planners to formulate an efficient and egalitarian private higher education system in Addis Ababa.

## 6 CONCLUSIONS

Private education in Addis Ababa is getting more competitive with the remarkable increase in the number of the privatized academic institutions in the country. Ineluctable forces of globalization, in fact, in this new millennium make this growth path more complex and challenging. Despite the relentless and continuous effort of the private educational institutions, the quality dimension has not yet been achieved up to the level of expectation. Cost of private education is another dimension, which is somewhat costly in Addis Ababa which deserves more efforts to bring that down for more egalitarian concern. However, the system is proceeding gradually towards more improvement. Nevertheless, all the focused problems should be addressed more

rigorously to ensure the quality of education in Addis Ababa at desired level of expectation. This study has shed the light on the dimensions perceived by students to be associated with the quality of education. These dimensions are faculty credentials, administrative services, library services, general faculties, career prospects, and financial aids. The study also concludes that while in general the per capita national income has been increased in the recent years in Addis Ababa, the cost of education in private Colleges' in Addis Ababa is not reasonable due to the imbalance between increasing tuition fees and increasing number of financial aids and scholarships. At last, it can be asserted that the findings from this study would at least be valuable in guiding the professionals and policy makers to formulate further the effective educational policy in the country.

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# 3. THE EFFECT OF LEADERSHIP STYLES ON THE RELATIONSHIP BETWEEN ENTREPRENEURIAL ORIENTATION (EO) AND PERFORMANCE OF MSES IN ADDIS ABABA CITY ADMINISTRATION

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## Abstract

*The purpose of this study was to investigate the mediating effect of leadership styles on the relationship between entrepreneurial orientation (EO) and performance of MSEs in in Addis Ababa city administration. This study examines how leadership styles mediate the association between EO and performance of the SMEs leather footwear sector in in Addis Ababa city administration. Quantitative cross-sectional survey was carried out to answer the research questions and test the hypothesized model. A sample of 250 MSEs' owner managers was used in the survey from the 322 population. With a response rate of 61.20%, 153 questionnaires were collected of which 143 were used for data analysis. The Partial Least Square of Structural Equation Model (PLS-SEM) using SmartPLS software was used to analyze data with the PLS algorithm, bootstrapping and predictive relevance (Q2) to assess the predictive accuracy on performance. Results from the PLS-SEM analyses revealed that EO has a direct impact on business performance. Also, leadership style was found to have a direct impact on performance and was a partial mediator between EO and performance. From the two types of leadership styles investigated, transformational leadership has stronger impact on business performance than transactional leadership style. These findings suggest that besides developing EO, leaders need to focus on practicing their firm's transformational leadership style. EO exerts a strong effect on both transformational and transactional leadership styles. However, it is only transformational leadership style which has a significant partial mediating effect on business performance. This study acknowledges EO and transformational leadership style as important resources and capabilities in an organization because the integration of these two elements can offer success for SMEs.*

**Key words:** Leadership Styles, Transformational Leadership style, Transactional Leadership style, Entrepreneurial Orientation, Business Performance, SEM-PLS, Mediation analysis, MSEs**.**

### Introduction

### Background of the study

In the fast changing and highly competitive global market environment, micro, small and medium enterprises (MSEs) are found to exert a strong influence on the economies of many countries (Ghobadian and Gallear, 1996; Roslan, 2010). The vast majority of countries – developed and developing alike – rely on the dynamism, resourcefulness and risk-taking behavior of private enterprises to trigger and sustain economic growth. Micro, small and medium enterprises (MSMEs) play a role in enhancing a country's economic growth (Venesaar and Loomets, 2006; Jeswal, 2012). Many nations, particularly developing countries, have recognized the value of MSMEs.

While the contributions of MSMEs to development are generally acknowledged, entrepreneurs in this sector face many obstacles that limit their long term survival and development (Yusuf, Olagbemi and Atere, 2011). Due to the unique constraints and limitations faced by SMEs such as having a limited number of employees, insufficient financial resources, lack of educational background and experience, and lack of managerial expertise, among other limiting factors (Saleh and Ndubisi, 2006; Abu Bakar, Mad and Abdul Latif, 2006), and the sector's role in economic growth and poverty reduction; a considerable number of researchers have continuously made an effort to understand how the performance of SMEs could be developed and further enhanced (Aregawi and

Tilaye, 2014).

In Addis Ababa city administration while the relevant picture remains to be seen, micro and small enterprises (MSEs) have played a critical role in the economic development of the country. MSEs comprise the largest share of enterprises and employment in the non-agricultural sector in Ethiopia. Therefore, MSEs have received special attention from the government. The promotion and development of MSEs is emphasized as one of the most effective means for achieving.

Rapid development and creating job opportunities. In this regard, the Government of Ethiopia (GoE) drafted its first Micro and Small Enterprise Development Strategy in 1997. This strategy was re-emphasized in the Plan for Accelerated and Sustainable Development to End Poverty (PASDEP) 2005/6-2009/10 (MoFED, 2006). Moreover, a draft of a new MSE policy was developed by the Ministry of Trade and Industry (MoTI) for 2007-08 with support from the International Labor Organization. The MSE sector is also identified as one of the pillars of the strategic focus for the industrial development of Ethiopia as stipulated in the Growth and Transformation Plan of the country (MoFED, 2010).

A significant amount of strategy research has centered on the importance of top management leadership (Hambrick and Mason, 1984) and entrepreneurial behavior (Covin and Slevin, 1989; Lumpkin and Dess, 1996) in determining firm performance. However, there has been a paucity of research examining how specifically the entrepreneurial orientation of the top manager might enhance the performance of firms competing in today's more dynamic and competitive economic environment (Bettis and Hitt, 1995). With regard to the entrepreneurial orientation of firms, some studies have found that firms that have a stronger entrepreneurial orientation perform better (Lee and Lim, 2009; Wiklund and Shepherd, 2005; Covin and Slevin, 1989; Dess and Beard, 1984; Wiklund, 1999; Keh Keh, Nguyen, and Ng, 2007; Wang, 2008; Yucel, 2011); Others (Covin, Slevin, and Schultz, 1994; Slater and Narver, 2000; Lee, Lee and Pennings, 2001; Wiklund and Shepherd, 2005) have failed to replicate this positive relationship. Covin *et al.* (1994) revealed no significant relationship between strategic posture of entrepreneurial orientation and firm performance. Similarly, Slater and Narver (2000) were unable to provide any evidence of a positive relationship between entrepreneurial orientation and profitability. Moreover, Lee *et al.* (2001) found in their study that entrepreneurial orientation may not significantly increase firm performance. This indicates that there is conflicting results, and hence the need of this research is mandatory.

Nonetheless, an important message from past research is that simply examining the direct effect of entrepreneurial orientation on firm performance provides an incomplete picture, especially in the case of small businesses (Lumpkin and Dess, 1996; Wiklund and Shepherd, 2005; Wang, 2008; Rauch Wiklund, Lumpkin and Frese, 2009). This necessitates researches to consider internal and external factors in the examination of the entrepreneurial orientation- performance relationship (Covin, Green and Slevin, 2006; Lumpkin and Dess, 2001; Wiklund, 1999; Wiklund and Shepherd, 2003). Researches indicate that performance can be improved when key variables are correctly aligned (Naman and Slevin, 1993). This is the basic premise of the contingency theory, which holds that the relationship between two variables depends on the level of a third variable. Introducing mediators into bivariate relationships helps to reduce the potential for misleading inferences being drawn and permits a more precise and specific understanding of contingency relationships (Rosenberg, 1968).

This raises the question of whether entrepreneurial orientation is always an appropriate strategic orientation or if its relationship with performance is more complex. Consequently, Lumpkin and Dess (1996) have proposed that studies on the relationship between entrepreneurial orientation and business performance of MSEs should be conducted. Furthermore, while the effect of entrepreneurial orientation on firm performance is a topic of global research interest and while some researchers have found that entrepreneurial orientation has a positive impact on firm performance, research related to MSEs' entrepreneurial orientation and leadership styles in Ethiopia is absent. The aim of this study is, therefore, to address the gap by examining the effect of leadership styles on the relationship between entrepreneurial orientation (EO) and performance of micro, small and medium enterprises (MSMEs) in Addis Ababa city administration

**Statement of the problem**

Even though SMEs are recognized as an important agent of growth in many countries (Panitchpakdi, 2006; Leutkenhorst, 2004; Hilmi Ramayah, Mustapha and Pawanchik, 2010); their contribution to the Ethiopian economy is still low compared with the contributions of SMEs in industrialized countries as well as other developing countries (Nega and Hussein, 2014). SMEs' contribution to GDP in Japan and Germany is about 53%, in the UK about 51% and in Korea approximately 49%. Moreover, Singapore and Thailand record higher SME contributions to GDP at 49% and 38% respectively (Arham and Muenjohn, 2012). These types of enterprises, however, constitute less than 30% of employment and 17% of GDP in developing countries (MUDC, 2013). Indeed, a study conducted in Africa by the ILO finds that only 20% of the total populations of working age group in many African countries were reported to have been working in the small enterprise sector (ILO, 2003a).

SMEs play an important role in Ethiopian economy, typically contributing over 99% of all enterprises, over 60% of private sector employment, and about 30% of exports (Demeke, Guta and Ferede, 2006). However, this sector only contributed about 3.4% to Ethiopian GDP in 1992/1993 as cited in Nega and Hussein (2014). This indicates a significant opportunity to develop and refine SMEs' performance to become a channel of growth for the country's economy and serve as a means of bringing economic transition by using the skill and the talent of people without requiring high-level training, much capital and sophisticated technology. This makes the sector more preferable to business entry, unemployment reduction, income generation, and poverty alleviation (Habtamu, Aregawi and Nigus, 2013).

Finding the right balance between the leadership styles (LSPS) of entrepreneurs and entrepreneurial orientation (EO) could contribute to improving SMEs' business performance (BP). There is a limited understanding of leadership and entrepreneurial orientation in the context of SMEs' performance in Ethiopia (Dawit, 2007; Eshetu and Zeleke, 2008). The investigation of the effect of leadership style on the relationship between entrepreneurial orientation and business performance hopes to close this gap in the literature on SMEs of the leather footwear sector in Addis Ababa city administration.

Thus, the examination of leadership styles as a mediator construct in the EO-BP relationship could add new understanding of the direct and indirect relationships between entrepreneurial orientation and business performance in the context of SMEs in Addis Ababa city administration.

**Objectives of the study**

The main objective of this study was to investigate the effect of leadership styles on the relationship between entrepreneurial orientation and business performance of micro and small enterprises (MSEs) in Addis Ababa city administration. The study is specifically designed to:

1. identify the entrepreneurial orientations (innovativeness, risk-taking and proactiveness) and leadership styles of MSE owner/managers of the leather footwear sector in Addis Ababa city administration;
2. determine the relationship between entrepreneurial orientations and business performance
3. find out to what extent EO influences performance of the MSEs leather footwear sector in Addis Ababa city administration;
4. analyze the relationship between entrepreneurial orientation and leadership styles of MSEs owner/managers of the leather footwear sector in Addis Ababa city administration;
5. analyze the relationship between leadership styles and business performance of MSEs owner/managers of the footwear-leather sector in Addis Ababa city administration;
6. identify which leadership style (transformational or transactional) have more influence on the business performance of MSEs leather footwear sector in Addis Ababa city administration;
7. Determine whether leadership styles mediate the relationship between entrepreneurial orientation and business performance of MSEs leather footwear sector in Addis Ababa city administration.

**The hypotheses of the study**

The relationships proposed are explained by a review of the hypotheses as follows:

H1,2&3: Entrepreneurial Orientation is significantly and positively related to Business Performance., Transformational leadership style, and Transactional leadership style.

H4&5: Transformational and Transactional leadership styles have significantly and positively related to Business Performance.

H6: Transformational leadership style has a greater impact on business performance than Transactional leadership style does.

H7: Transformational Leadership style mediates the relationship between entrepreneurial orientation and Business Performance.

H8: Transactional Leadership style mediates the relationship between entrepreneurial orientation and Business Performance.

**Significance of the study**

This study is important for several reasons. The main significances of the study are: First, the outcomes of this study are empirical findings on whether certain forms of leadership (specifically transactional and transformational) and entrepreneurial orientation are resources and capabilities needed by organisations to ensure sustainable performance.

Second, SMEs' development is increasingly important for the economic performance of the country. Despite this increased importance, there has been limited research on the effects of top-level managers' leadership (for the purpose of this study transformational and transactional) and entrepreneurial orientation on business performance of MSEs in the Leather footwear manufacturing industries. Thus, the findings of this study could help MSEs to develop more leaders (meso-variable) that are effective.

Third, there is also a lack of studies on the relationship between entrepreneurial orientation and business performance relationship at the organization level analysis (meso-paradigm) (Miller and Friesen, 1982; Wiklund 1999). Fourth, the findings of this study might provide significant contributions for future research in the fields of entrepreneurship and leadership, especially in the field of entrepreneurial leadership.

Finally, this study might be useful to the policy makers in the formulation of appropriate policies and strategies to strengthen and promote MSE entrepreneurs and to assist them to compete in the global economy.

## Scope of the study

This study examines the effect of leadership styles on the relationship between entrepreneurial orientation (EO) and performance of micro, small and medium enterprises (MSMEs) in Addis Ababa city administration Either the owner or the top manager, who tends to be the most knowledgeable person about the strategic direction of the firm (Keh *et al.*, 2007; Yang, 2008) and is the person who engages in entrepreneurial activities, represents the leader of an MSE.

Transactional and transformational types of leadership, the most widely researched forms of leadership (Lo *et al.*, 2009; Judge and Piccolo, 2004), are analyzed in this study. Transactional leadership is about what should be done, which is necessary for any organisation, and that transformational leadership is more about how things are done specifically in the African context as mentioned by Grobler and Singh (2018). This study focuses transformational and transactional leadership styles at the construct level. The factor-level relationships of other variables are not observed.

## Research Design and Approach

### Research design

This research depends on collecting data from a field site. Thus, this study has used the concept of methodological fit in field research (Edmondson and Mcmanus, 2007) to ensure that all the current research aspects fit together. According to Edmondson and Mcmanus (2007), the methodological fit is about considering internal consistency among elements of a research project to ensure the quality of the field research. They offer a framework that relates the prior theory stage to the research questions, the type of data collected and analysed, and theoretical contributions.

In a context where the topic has been studied extensively, significant independent, dependent, and mediation variables are provided from the literature to clarify general mechanisms underlying the leadership styles antecedents and outcomes in the mediation process. In this regard, Edmondson and Mcmanus (2007: 1159) stated that 'leveraging prior work allows a new study to refine the field's knowledge, such as identifying mediators that influence a documented causal relationship'.

### Research Approach

In this research, quantitative research technique, methods, approaches, concepts and language is used. In this study, the relationship between Entrepreneurial Orientation, Leadership and Business Performance of MSE's: a case study of the leather sector in Addis Ababa city administration is examined. As indicated in chapter two, this research builds on empirical studies on the field of leadership and entrepreneurship.

Therefore, in order to answer the research questions in this study and to develop a theoretically derived and empirically tested final path model to test the proposed hypotheses, the quantitative approach to data collection and analysis seemed to be the most appropriate method for this study.

**Population, Sample Size, and Sampling Techniques**

**Sampling technique and sample size**

In this study, probability sampling is used where each member of the population has an equal chance of being selected for the sample (Jackson, 2008). Specifically, the type of probability sampling used in this study is stratified random sampling technique based on size of the enterprises.

When calculating the sample size, the most appropriate size is an important decision to be made. If too large, the sample might lead to inefficiencies and wastage of resources. Yet, too small a sample will yield information that might not be valid for making inferences about the population. Roscoe (1975) suggested that a rule of thumb for determining sample size is that a sample size of between 30 and 500 is suitable for most research.

To ensure a good decision, Krejcie and Morgan[1](1970) simplified the model for the sample size needed, given the number of population for research. Based on the table they proposed, this study required a sample size of 175 to represent the entire population of the 322 Leather footwear manufacturing industries in the study area, Addis Ababa. However as there may be non-returns which is customary in social science, the researcher distributed questionnaires with extra 43% and the total questionnaire prepared becomes 250 (See table 1.2 below).

**Table 1.2: Target Population and Sample Size**

| Category of MSEs | Population # | Sample # |
|---|---|---|
| Micro Enterprises | 205 | 111 |
| Small Enterprises | 117 | 64 |
| Total MSEs | 322 | 175 |

Source: FEMSEDA, 2011

The use of SEM as the main analytical procedure in this study also required a careful decision with regard to the sample size. Hair, Anderson, Tat ham and Black (1998) recommended that the sample should be at least 100 observations to obtain reliable results. Recent recommendations suggest a critical sample size of 200 to provide sufficient statistical power for data analysis and to obtain reliable results (Yuksel, Yuksel and Bilim, 2010; Hoe, 2008). Researchers have also strongly suggested avoiding a small sample size when using SEM since this might create problems and provide unstable results (Gerbing and Anderson, 1988; Fornell and Larcker, 1981). Since this study uses maximum likelihood estimation in SEM, the target of 143 samples also seemed to fit well with the requirement of sample size for PLS-SEM where 100 up 200 are appropriate.

**Research instrument**

[1] $\dot{n} = Z^2NP\,(1-P) \div d^2\,(N-1) + X^2P\,(1-P)$

**n** = required sample size. Z =Standardized normal value, taken as 1.96 for a 95 per cent confidence interval ($1.96^2$=3.841).N = the population size.P = the population proportion (assumed to be .50 since this would provide the maximum sample size). d = the degree of accuracy expressed as a proportion (.05).

In order to ensure that viable data was collected, a self-reporting instrument was developed for this research in the form of a questionnaire containing a total of 52 items in four sections: leadership styles (28 items), EO (9 items), business performance (7 items), and background of business/participant (8 items).

**Data analysis**

Partial Least Square is a predictive statistical approach 'for modeling complex multivariable relationships among observed and latent outcomes' (Vinzi, Trinchera and Amato, 2010: 1). This approach allows for the estimation of a 'causal theoretical network of relationships linking latent complex concepts, each measured by means of a number of observable indicators' (Vinzi *et al*., 2010: 2).

A PLS path model is divided into three parts: the structural model, the measurement model, and the loading scheme. The following figure 1.1 shows the data analysis processes in PLS-SEM employed in this study.

**Mediation data analysis**

Mediation analysis provides the means for a deep investigation of the underpinning mechanisms of the relationship between the variables. This is important in the current research which aims to study the mechanisms of the role of the mediator by explaining the relationships between the sets of variables. This capability of mediation analysis allows this research to use the concept of the mediator in order to form the hypotheses by moving from investigating direct relationship to investigating indirect relationships. Here, this research is interested in testing the study variables to provide descriptions and explanations for each set of the correlated variables that are linked together through mediators.

## Research Results

**Survey responses and response rate**

Of the 250 questionnaires distributed, 153 were collected representing a response rate of 61.20%. Once the 153 questionnaires were collected through self-administered survey, the data were entered in to SPSS. The quality of the data entered in to SPSS was critically examined to make it ready for statistical analysis. The dataset was rechecked to ensure the accuracy of the data entry. The minimum and maximum data values on each variable related to each case were checked to detect any irregular or unusual data values. Ten questionnaires returned were incomplete. Accordingly, these were rejected and only 143 questionnaires were accepted as usable for further analysis.

**Demographic profile of MSEs respondents**

Table 1.3 shows the results of the demographic profiles of the respondents. Based on the demographic profiles in Table 1.2, it can be seen that out of 143 respondents, the majority were male with a percentage of 73.4% (119 male), while female respondents formed 26.6% (24 female).

*Table 1. 3 Respondents' Profile*

| | | **Frequency** | **Percent** | **Cumulative Percent** |
|---|---|---|---|---|
| **Gender** | Female | 24 | 16.8 | 16.8 |
| | Male | 119 | 83.2 | 100.0 |
| **Age** | 20 and below | 6 | 4.2 | 4.2 |
| | 21-29 | 60 | 42.0 | 46.2 |
| | 30-39 | 56 | 39.2 | 85.3 |
| | 40-49 | 19 | 13.3 | 98.6 |
| | 50 and above | 2 | 1.4 | 100.0 |
| **Marital** | **Married** | **69** | **48.3** | **48.3** |
| | **Unmarried** | **74** | **51.7** | **100.0** |
| **Education** | High school and below | 67 | 46.9 | 46.9 |
| | Diploma/TVET | 68 | 47.6 | 94.4 |
| | First degree | 8 | 5.6 | 100.0 |
| **Employees** | **<6 employees** | **85** | **59.4** | **59.4** |
| | **6-30 employees** | **48** | **33.6** | **93.0** |
| | **31-50 employees** | **10** | **7.0** | **100.0** |

| | | | | |
|---|---|---|---|---|
| **No. Of years in operation** | <5 years | 95 | 66.4 | 66.4 |
| | 5-10 years | 38 | 26.6 | 93.0 |
| | >10 years | 10 | 7.0 | 100.0 |
| **Years with firm** | **<5 years** | **106** | **74.1** | **74.1** |
| | **5-10 years** | **30** | **21.0** | **95.1** |
| | **>10 years** | **7** | **4.9** | **100.0** |
| **No of years as mgr of SME** | <5 years | 116 | 81.1 | 81.1 |
| | 5-10 years | 21 | 14.7 | 95.8 |
| | >10 years | 6 | 4.2 | 100.0 |
| **Status of the sector** | ***Declining*** | ***45*** | ***31.5*** | ***31.5*** |
| | ***Stable*** | ***23*** | ***16.1*** | ***47.6*** |
| | ***Growing*** | ***75*** | ***52.4*** | ***100.0*** |
| **Firm status** | Declining | 37 | 25.9 | 25.9 |
| | Stable | 29 | 20.3 | 46.2 |
| | Growing | 77 | 53.8 | 100.0 |
| | **Total** | **143** | **100.0** | |

From the above table of Respondents' Profile:

Male: 83.2 %, the sector is male dominated one and Age group of between 21-39 years (81.2 %). Marital (51.7 % unmarried & 48.3 % married). Education < HS to a diploma 94.4%). Experience as an employee: <5 years (74.1 percent).Years in operation: <5 years (66.4%).Experience as a manager: <5 years (81.1 %). Status if sector & firm: 75(52.4%) & 77(53.8%) growing respectively.

**Descriptive analysis**

***Entrepreneurial orientation***

For entrepreneurial orientation, there were 9 items on a 5-point Likert scale (1-5) to measure innovativeness, proactiveness and risk taking. The Likert scale used measures of 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. A descriptive analysis test was performed to determine the state of entrepreneurial orientation among MSE owner/managers in Addis Ababa city administration. Based on the test which assessed the means of innovation level, risk taking level and proactiveness level, the researcher found that innovation had the highest mean (mean= 3.74, SD = 0.96) compared to proactiveness (mean= 3.73, SD = 0.97) and risk-taking (mean = 3.56, SD = 0.86 ). These results indicate that the respondents perceived that their organizations display more of the innovativeness and proactiveness attribute of entrepreneurial orientation than risk taking. The descriptive analysis shows that the majority of the MSE owner/managers in Addis Ababa city administration in the selected sector possess a total entrepreneurial orientation of a mean of 3.68, SD = 0.85. This answers research question 1: What is the state of entrepreneurial orientation (innovation, proactiveness, and risk-taking) among the MSE owner/managers in Addis Ababa city administration? Table 1.4 shows the means and standard deviations for the scales used to measure entrepreneurial orientation in this study

*Table 1. 4 Means and Standard Deviation for Entrepreneurial Orientation*

| Measures | Mean | Std. Deviation |
|---|---|---|
| • Total entrepreneurial orientation | 3.68 | 0.85 |
| ➢ Innovativeness | 3.74 | 0.96 |
| ➢ Risk taking | 3.56 | 0.86 |
| ➢ Proactiveness | 3.73 | 0.97 |

*Source: Survey Result (2014)*

***Leadership style***

A total of 28 items on a 5-point Likert scale (1-5) of the MLQ was used to measure transformational leadership, and transactional leadership. The Likert scale used values of 1 = not at all, 2 = once in a while, 3 = sometimes, 4 = fairly

often and 5 = frequently, if not always. Table 4.4 reports the means and standard deviations for the leadership style scales with each factor of transformational, transactional and passive-avoidant leadership style used in this study.

A descriptive analysis test was performed to determine what leadership styles MSE owner/managers of MSEs in the leather footwear sector in *in Addis Ababa city administration* possess. Based on the descriptive analysis test results the researcher found that the mean score for transformational leadership was 3.58 (SD = 0.65), which was higher than the mean score for transactional leadership 3.53 (SD = 0.64). Comparing the two forms of leadership styles, these results indicate that the respondents perceived that their organizations have more of the transformational leadership attributes than transactional leadership style. The descriptive analysis shows that the majority of the MSE owner/managers of the MSEs in *in Addis Ababa city administration* in the selected leather footwear sector possess a total leadership style of 3.56 (SD=0.58). This answers research question 2: What leadership styles (transformational, transactional) do MSE owner/managers in Addis Ababa city administration possess?

*Table 1. 5 Means and Standard Deviation for Leadership style*

| Measures | Mean | Std. Dev. |
|---|---|---|
| ❖ Total Leadership styles | 3.56 | 0.58 |
| **Transformational leadership** | **3.58** | **0.63** |
| ➢ Intellectual stimulation | 3.64 | 0.75 |
| ➢ Idealized influence behavior | 3.60 | 0.72 |
| ➢ Idealized influence attitude | 3.39 | 0.86 |
| ➢ Inspirational motivation | 3.70 | 0.84 |
| ➢ Individual consideration | 3.52 | 0.75 |
| **Transactional leadership** | **3.53** | **0.62** |
| ➢ Contingent reward | 3.68 | 0.77 |
| ➢ Management by exception active | 3.37 | 0.73 |

*Source: Survey Result (2014)*

In regard to the factors of transformational leadership, the highest mean was attributed to the inspirational motivation factor with a mean score of 3.70 (SD = 0.84). This was followed by intellectual stimulation with a mean score of 3.64 (SD = 0.75). The mean score for idealized influence behavior was 3.60 (SD = 0.72) and individual consideration 3.52 (SD = 0.75). Idealized influence attitude was the form of transformational leadership least perceived by respondents with a mean score of 3.39 (SD = 0.86). This shows that in regard to the factors of transformational leadership, the respondents perceived that they practice the attribute of inspirational motivation more often than the other attributes of transformational leadership.

In analyzing the factors of transactional leadership, the highest mean was attributed to contingent rewards with a mean score of 3.68 (SD = 0.77. This was followed by management-by-exception (active) with a mean score of 3.39 (SD = 0.73). This shows that in transactional leadership, the respondents display the attribute of contingent reward quite often, followed by the management-by-exception (active) attribute

***Business performance***

The business performance scale had seven items on a 5-point Likert scale (1-5) measuring growth and profitability. The Likert scale used values of 1 = highly dissatisfied, 2 = dissatisfied, 3 = neutral, 4 = satisfied and 5 = highly satisfied. Table 1.6 shows the means and standard deviations for the scales used to measure organizational performance in this study.

*Table 1. 6 Means and Standard Deviations for Business Performance*

| Measures | Mean | Std. Deviation |
|---|---|---|
| • Total performance | 2.89 | 0.82 |
| ➢ Growth performance | 2.96 | 0.80 |
| ➢ Financial performance | 2.81 | 0.87 |
| ➢ Overall performance | 3.00 | 1.13 |

*Source: Survey Result (2014)*

As shown in Table 1.6, the total mean score for business performance was 2.89 (SD = 0.82). On average, most of the respondents were satisfied with their performance. In regard to the mean scores for each factor of organizational performance, growth performance has the highest score of 2.96 (SD = 0.80) and financial performance has 2.81 (SD = 0.87). These results indicate that in regard to organizational performance measures, the respondents perceive high growth performance more than financial performance.

**Inferential analysis using structural equation modeling**

**Testing of hypotheses**

This study applied the Student t-test (Götz *et al.*, 2010; Hair *et al.*, 2014), which has the goal of evaluating the relationship between the main constructs of the conceptual model, in this case entrepreneurial orientation and business performance. In order to test hypothesis 1, the researcher tested the total effects of entrepreneurial orientation attributed on business performance and obtained the significant effect of 0.518 (t-value 6.590), thereby supporting hypothesis (refer to table 1.6). Likewise, this value validates the Hypothesis H1 that the entrepreneurial orientation of SME leather footwear sector presents significant positive relation with business performance. According to Hair *et al.* (2014), t-values over 1.96 indicates that the model and its relations has significance and can be analyzed. In addition to that, EO indicates a strong causal relationship with constructs TFL and TSAL. Furthermore, entrepreneurial orientation affects the TFL (=0.537, p=0.001) and TSAL (=0.463, p=0.001) thus satisfying the hypothesis H2 and H3 respectively. Transformational leadership style is found significantly predicting business performance with (=0.277, p=0.013) and accordingly H4 is accepted. However; TSAL (=0.021, p=0.872) fails to significantly predicts business performance and hence H5 is rejected.

*Table 1. 6 Total Effect*

| Hypotheses | Independent Variable | Dependent Variable | B | t test | P Values | Bootstrap 95% CI 2.5% | 97.5% | Hypothesis |
|---|---|---|---|---|---|---|---|---|
| H1 | Entrepreneurial Orientation (X) | Business Performance (Y) | 0.518 | 6.590 | 0.000 | 0.350 | 0.654 | Accepted |
| H2 | Entrepreneurial Orientation (X) | Transformational Leadership(M1) | 0.537 | 8.084 | 0.000 | 0.375 | 0.644 | Accepted |
| H3 | Entrepreneurial Orientation (X) | Transactional Leadership(M2) | 0.463 | 7.522 | 0.000 | 0.326 | 0.568 | Accepted |
| H4 | Transformational Leadership(M1) | Business Performance(Y) | 0.277 | 2.487 | 0.013 | 0.062 | 0.499 | Accepted |
| H5 | Transactional Leadership(M2) | Business Performance(Y) | 0.021 | 0.161 | 0.872 | -0.238 | 0.266 | Rejected |

**CI** Bias corrected confidence interval. Bootstrapping based on n = 5000 subsamples.

*Source: Survey Result (2014*

Based on the outcomes of this direct path model of the relationship between leadership style and business performance, it can be concluded that transformational leadership has a greater impact on the business performance of SMEs than the transactional leadership does. The path coefficients of transformational leadership are found to be

higher and more significant than the path coefficients between the relationships of transactional leadership to business performance of SMEs. Hence these results show full support for H3.

***Leadership styles as a mediator***

The relationships among constructs in PLS-SEM can be complex and not always straightforward. Significantly, the mediation test used for this paper was based on the PLS approach; hence, the hypotheses for the study were tested using the partial least squares (PLS) structural equations modeling (SEM) technique (Wold, 1985). In this study, mediation test is measured by means of bootstrapping 5000 re-sampling analysis with the formulated hypotheses (Hair *et al.*, 2014; Zhao *et al.*, 2010).

In this case, it is necessary to run bootstrapping. If the model does not consider the mediator (leadership styles), the data below show that the path from entrepreneurial orientation and business performance is 0.520 and p-value (0.000). The statistical significance of the path coefficients was evaluated by the use of bootstrapping (Henseler *et al.*, 2009). (See Figures 1.7 -1.9)

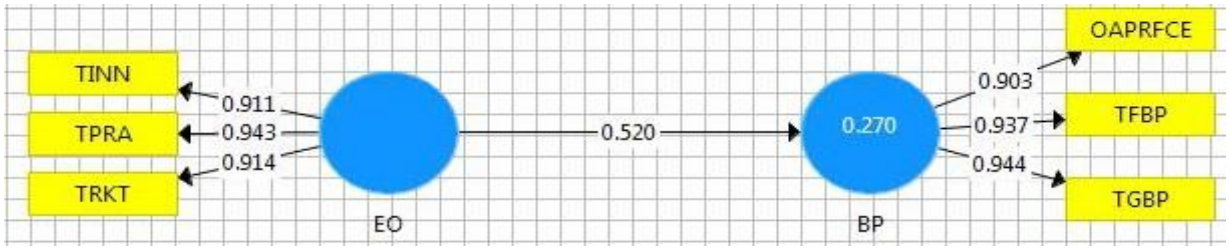


*Figure 1. 7 Path model without Mediator construct (PLS)*

When the analysis includes the mediator (leadership styles), the model is shown as follows:

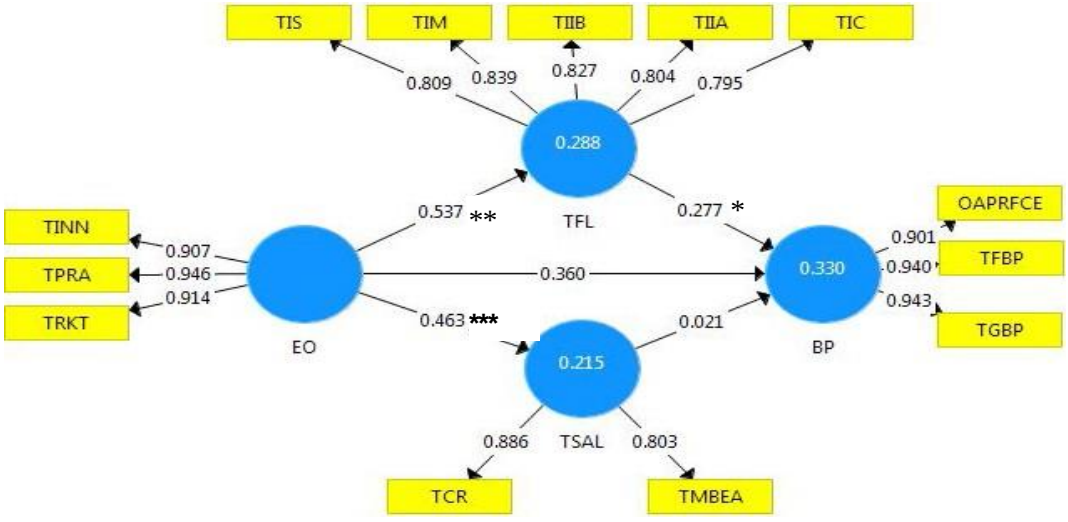


*Figure 1. 8 Path model with the Mediator construct (PLS)*

In this case, it can be noticed that when including the mediator (Leadership Styles), the indirect effect *(EO and TFL[a] x TFL and BP[b] plus EO and TSAL [a'] x TSAL and BP[b'])* is significant. In the model, without the mediator construct (Leadership Style) was 0.520***, the positive direct effect became smaller after the inclusion of the mediator construct (0.360***) decreased by 0.158. The question is how much the mediator absorbs the effect. The variance accounted

for (VAF) determines the size of the indirect effect in relation to the total effect (direct effect + indirect effect). VAF = ((0.537* 0.277 + 0.463*0. 021) / ((0.537* 0.277 + 0.463*0. 021) + 0.360) = 0.305. According to Hair *et al*. (2014), a
situation in which VAF is larger than 0.20 and less than 0.80 indicates partial mediation. There is a partial mediation (VAF = 30.5%).So, this model indicates that leadership styles (TFL, and TFSAL) partially mediates the relationship between entrepreneurial orientation and business performance with Variance Accounted for (VAF=31%) .

*Table 1. 9 Analysis of Mediation Effects*


Total Effect: 0.518***

Direct Effect: 0.360***

VAF: 31%

***R2 of the target construct: 0.330***

| Mediator | EO | t value | BP | t value |
|---|---|---|---|---|
| TFL | 0.537*** | 7.927 | 0.277** | 2.496 |
| TSAL | 0.463*** | 7.044 | 0.021 | 0.167 |

VAF: Variance accounted for. *p < 0.10, **p < 0.05, ***p < 0.01; R2: Coefficient of Determination
*Source: Survey Result (2014)*

The researcher also assessed the effect of two mediators, transformational leadership and transactional leadership separately. The results show that the indirect effect of entrepreneurial orientation on business performance through transactional leadership style is non-significant. Transformational leadership style therefore plays the main role in the mediation effect between entrepreneurial orientation and business performance; however, both transactional leadership style and transformational leadership style combined significantly mediate the relationship between entrepreneurial orientation and business performance (see Table 1.7).

As shown in the above table, to test SEM-PLS mediation, the researcher used the VAF method (Variance Accounted For) using the formula influence indirectly (indirect effect) divided the total influence (total effect). The total influence is direct influence added with indirect influence. If the VAF value above 80%, leadership style is as full mediator. If the value of the VAF 20%-80%, it is categorized mediator partial. However, if the VAF less than 20%, it is said to be virtually no effect of mediation (Hair *et al.*, 2013:82).
In testing the leadership styles as the influence mediator of entrepreneurial orientation and business performance, the calculation of VAF value can be seen in the table below:

*Table 1. 7 Mediation Analysis Table*

| | Mediation Paths | Direct Effect, DE | Indirect Effect, IE | Total Effect | Bootstrap 95% CI | | |
|---|---|---|---|---|---|---|---|
| | | | | | **Lower** | **Higher** | |
| H4: | Leadership styles mediate the relationship between EO and BP EO>>LSPS>>BP. | 0.360*** | 0.159*** | 0.519*** | 0.074 | 0.248 | 0.306 Partial mediation |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| H4a: | TFL mediates the relationship between EO and BP EO>>TFL>>BP. | 0.360*** | 0.149** | 0.509*** | 0.081 | 0.249 | 0.293 Partial mediation |
| H4b: | TSAL mediates the relationship between EO and BP of MSEs footwear-leather sector in Addis Ababa city administration. EO>>TSAL>>BP. | 0.360*** | 0.010 | 0.370 | 0.017 | 0.182 | 0.027 No mediation |
| | | Note. The variance accounted for (VAF) determines the size of the indirect effect in relation to the total effect (D+I): VAF > 80% = Large Effect and full Mediation, 80% > VAF > 20% = Partial Mediation, VAF < 20% =almost there is no mediation. | | | | | |

**CI** Bias corrected confidence interval. Bootstrapping based on n = 5000 subsamples.
*Source: Survey Result (2014)*

## Conclusions and discussion of findings

The study attempted to provide new empirical evidences on the relationship between entrepreneurial orientation and business performance in the context of Ethiopia, which is a developing economy. The findings of the study can be broadly classified into three categories. The first part covers findings related to total effect, direct effect, and indirect effect of entrepreneurial orientation on business performance. The second part addresses findings on the extent to which the hypothesized model fits the sample data. The third part presents the summary of the findings related to each hypothesis.

First, the total effect of entrepreneurial orientation on business performance was observed to be positive and significant. The regression coefficient of entrepreneurial orientation on business performance was 0.52 ($p < 0.001$). The result revealed that the variance of business performance explained by entrepreneurial orientation was only 27 percent, which appeared to be a moderate association. The direct effect of entrepreneurial orientation on business performance was 0.36 ($p < 0.05$). Of the three dimensions of entrepreneurial orientation, the attribute that contributed the most to high business performance was risk- taking. Innovation and proactiveness were not significant contributors to predicting business performance, but they were certainly positively correlated with business performance. In general, entrepreneurial orientation contributed to improved business performance. This suggests that, as the entrepreneurial orientation level increases, the degree of business performance also rises. It can be concluded that the entrepreneurial orientation of the owners/managers can influence the success and survival of the MSEs. The positive direct effect implied that MSE Leather footwear sector in Addis Ababa city administration have sound reason to invest in entrepreneurial orientation. Furthermore, the indirect effect of entrepreneurial orientation on business performance mediated by leadership styles was 30 percent ($p < .001$). Since, the VAF value is between 20 percent and 80 percent result of the mediation model revealed a partial mediation effect.

Second, the research provided additional evidences on the argument whether entrepreneurial orientation shall be taken resources or competencies for enhancing business performance. To investigate the global validation of the PLS analysis, a global fit measure (GoF) was performed. In this study, a global fit measure was run, and the outcome 0.464 highlights that the model is above the required large effect sizes $R^2$ value of 0.36. Thus, hypothesized model, which tested the total effect of entrepreneurial orientation on business performance and the mediated effect of leadership styles on entrepreneurial orientation and business performance, was fit.

Finally, summary of the findings of the stated eight hypotheses have been presented and tested scientifically and accordingly six of them fully supported, one rejected, and one partially accepted.

This study examined the mediating effects of leadership styles on the relationship between

entrepreneurial orientation and performance of MSEs in Addis Ababa city administration. An important conclusion to be drawn from this study is that entrepreneurial orientation has a significant positive effect on business performance. The present study also found that, while different leadership styles may affect business performance in different ways, in general transformational leadership has a bigger effect on business performance than transactional leadership styles and partially mediates the relationship between entrepreneurial orientation and business performance. However, transactional leadership style is not a mediator at all, as its relationship to business performance is insignificant.

Based on the hypothesis tests, positive, significant and strong relationships were found between transformational leadership styles and business performance. Thus, as the use level of the transformational leadership styles rose, the degree of business performance also increased. The inference that can be drawn from this logic is that transformational leadership style of MSEs owners/managers can determine the success and survival of the SMEs. In particular, transformational leadership is positively and significantly more related to business performance than transactional leadership style. The findings in this study support the position of Gartner and Stough (2002) that transformational leadership is more effective than transactional leadership. The evidence in this study also concurs with studies reporting that transformational leadership has more positive association with higher productivity and performance than transactional leadership (Bas *et al.*, 2003; Lowe and Galen, 1996).

**Future Research**

The findings of this study provide several opportunities for future research. It is hoped that despite their limitations, the findings of this study will indicate directions for further research.

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# 4. BOOSTING THE PERFORMANCE OF ARTIFICIAL INTELLIGENCE-DRIVEN MODELS IN PREDICTING COVID-19 MORTALITY IN ETHIOPIA

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**Abstract**

Like other nations around the world, Ethiopia has suffered negative effects from COVID-19. The objective of this study was to predict COVID-19 mortality using Artificial Intelligence (AI) driven models. Two-year daily recorded data related to COVID-19 were trained and tested to predict mortality using machine learning algorithms. Normalization of features, sensitivity analysis for feature selection, modelling of AI-driven models, and comparing the boosting model with single AI driven models were the main activities performed in this study. Prediction of COVID-19 mortality was conducted using a combination of four dominant feature variables, and hence, the best determination of coefficient (DC) of AdaBoost, KNN, ANN-6, and SVM in the prediction process were 0.9422, 0.8618, 0.8629, and 0.7171, respectively. The Boosting model improved the performance of the individual AI-driven models KNN, SVM, and ANN-6 by 7.94, 22.51, and 8.02 percent, respectively, at the verification stage using the testing dataset. This suggests that the boosting model has the best performance for prediction of COVID-19 mortality in Ethiopia. As a result, it suggests a promising potential performance of boosting ensemble model to be applied in predicting mortality and cases from similarly recorded daily data to predict mortality due to COVID-19 in other parts of the world.

**Keywords:** artificial intelligence; COVID-19; ensemble model; AdaBoost; KNN; ANN-6; SVM; Ethiopia

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### 1. Introduction

In the past two decades, many viral disease centered outbreaks such as MERS, SARS, Bird flu, H7N9, Ebola, H1N1, Nipah and Zika were happened. In this decade, the new outbreak of a novel coronavirus emerged in Wuhan city of China in December 2019 [1] This pandemic is named as a coronavirus disease 2019 (COVID-19) and is a highly contagious infection caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV2) This disease is decided as a pandemic of the global issue by the world health organization (WHO) on march 2020. However, the nature of this pandemic was different than the previous pandemics, which had a brutal impact on the global economy that triggered a near to total shutdown of social and economic activities of the world [1, 2]. As in other parts of the world, this pandemic continues to influence people within Ethiopia. Also, it adversely affected the economy of the country

COVID-19 has caused more than 6.7 million (6,718,464) deaths , globally, as of the January 11 2023 with a case fatality rate of one percent from early February of 2020 to late December of 2022. In Ethiopia, this pandemic has caused 7572 deaths as of December 2022 with a case fatality rate (CFR) of 1.52% with in the same period from early February of 2020 to late December 2022. This implies that the fatality rate of Ethiopia is higher than the average CFR of the world by 0.52% [3].

This pandemic proved that world is not ready to quickly control the spread and rampant of such catastrophic viruses. The question is when things going back to normal? Even though no one has a final answer, we can understand what the situation look like in the feature through analyzing previously collected data. Results from these analyses will be actionable knowledge, which could help us to manage a similar pandemics in feature. [4, 5]

Artificial Intelligence (AI) driven models with machine learning algorithms are contributing a lot to control the infection in a real time and easily track the rampant of the virus. Among contributions of AI in tackling COVID-19 are prediction and tracking, contact tracing, monitoring of cases, early diagnosis, development of therapeutics, development of vaccines, and a lot [1].

In Ethiopia, many studies produced information on different healthcare issues such as Antenatal care (ANC) utilization status of mothers [6], The postnatal care (PNC) visit of mothers [7], Access to tetanus toxoid (TT) immunization of mothers [8], Predicting under nutrition status of U5 children [9], Predicting the CD4 count status of patients under ART [10], Predicting the level of anemia among women [11] and Predicting U5 mortality [12] by using different machine learning algorithms and AI-driven models. In addition to this, few studies has applied for detection and classification of COVID-19 cases from X-ray images [13, 14].

Based on our search from different databases, no study has reported on the application of ensemble modelling and boosting algorithms to predict mortality due to COVID-19 in Ethiopia. Hence, this study is aimed to select the best AI-driven model in predicting COVID-19 mortality and to compare the ensemble boosting algorithm with single AI-driven models based on their predicting performance.

## 2. Materials and Methods

### 2.1. Study area

The study area for this specific research was Ethiopia. Ethiopia is the second most populous country in Africa and the 2020 estimated number of population of the country was 114,964,000 [15]. The main focus under health infrastructure development of Ethiopia is standardization and expansion of Hospitals among regional states. Hence, as per commercial guide of the country report in 27 July 2022; 367 Hospitals, 3777 Health centers, 17699 Health posts, 3867 private clinics and 43 private hospitals are available, and prevention and containment of COVID-19 is first among upcoming priorities in the country [16].

### 2.2. Data source

The COVID-19 data used in this study was the daily collected data by Center for systems and Engineering (CSSE). This dataset was available online for users by Our World in Data (OWID) and by data warehouse of John Hopkins University from a link https://github.com/owid/COVID-19-data/tree/master/public/data (accessed on 25 June 2022). OWID has published the statement under its license section saying "All visualizations, data, and code produced by 'Our World in Data' is completely open access under the Creative Commons BY license. You have the permission to use, distribute, and reproduce these in any medium, provided the source and authors are credited" [17, 18]. As this dataset does not include any personal information and approved by CSSE, the ethical approval was not necessary.

### 2.3. Feature selection, data preprocessing and analysis

In the COVID-19 dataset, too many variables were available. However, only seven variables included in the current study based on their relationship with mortality and the completeness of observations. After feature selection, the first activity was to normalize the selected features, after checking for normality, because the COVID-19 daily data is non-linear by its nature. The second activity was to select the dominant input features based on coefficient of determination (DC) rank after the sensitivity analysis conducted using the artificial neural network (ANN). Hence, we select four feature variables (daily new cases, bed capacity, mask use, and pneumonia status) in addition to the target variable called the daily number of death due to COVID-19.

Finally, the dataset was divided into training dataset (70%) and testing dataset (30%) for the development of the AI driven models and the Boosting model (AdaBoost). the data normalization was calculated using Microsoft excel. However, the sensitivity analysis, the single AI-driven models and the boosting model were conducted using the data mining software called Orange (Data-mining) v3.33.

### 2.4. Proposed methods

In **Figure X**, the overall proposed methodology is presented as a model development workflow in Orange (Data-mining). The proposed methodology includes the preprocessing of data, normalizing of data, sensitivity analysis, dividing data to training and test data, model development, prediction process on both training and test datasets. Once the data preprocessing was completed, three AI-driven models: k-Nearest neighbor (kNN), the artificial neural network (ANN-6) and support vector machine (SVM), and one ensemble boosting model (Adaptive Boosting) were developed to predict mortality due to COVID-19 in Ethiopia. Finally, the prediction performance of three AI-driven models were compared with the boosting model based on their result of Root mean square error (RMSE), Mean average error (MAE) and the coefficient of determination (DC).

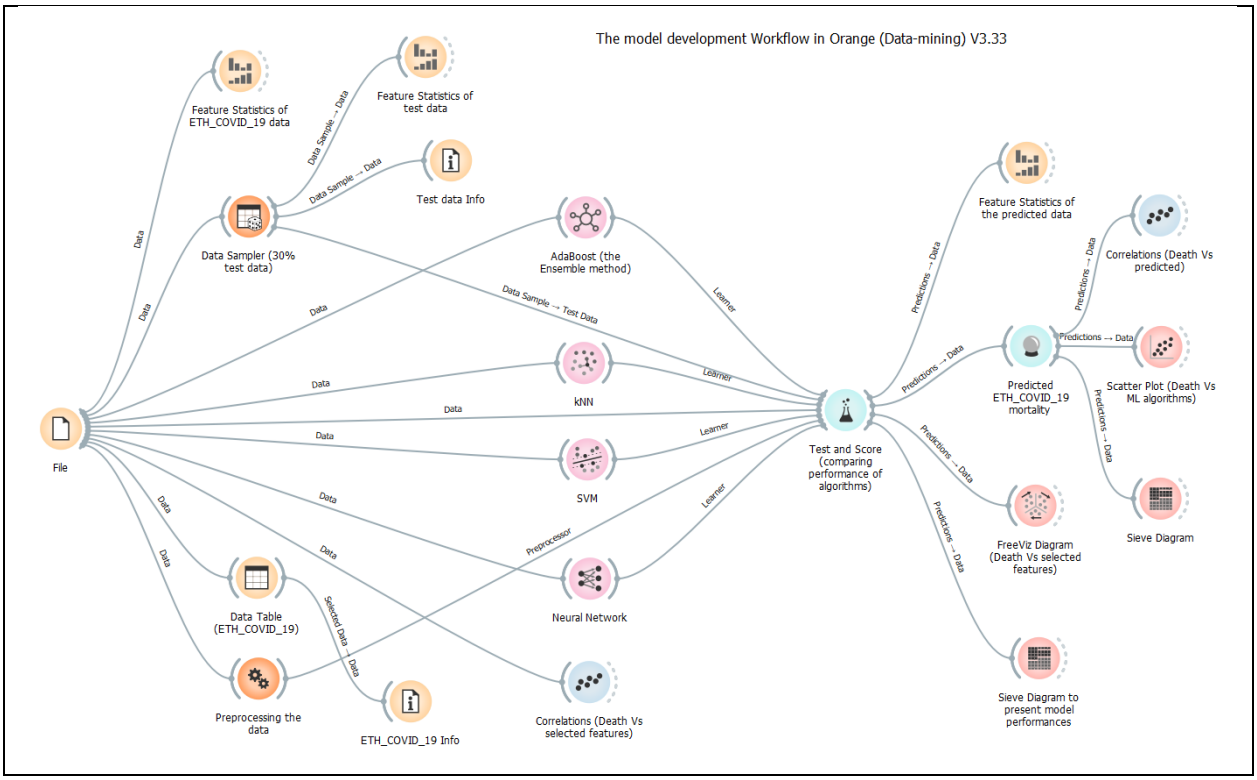



**Figure X:** The Orange work flow of the proposed methodology

### 2.4.1. AI-driven models

The AI-driven models used in this study to predict COVID-19 mortality were K-Nearest neighbor (KNN), The Artificial Neural network (ANN-6), and the support vector machine (SVM), The ensemble boosting model used in this study was the adaptive boosting (AdaBoost) AI-driven model.

**Table X:** the model parameters to build AI-driven models criteria

| AI-driven models | Model parameters |
|---|---|
| **AdaBoost** | Base estimator: *tree*, Number of estimators: *4*, Algorithm: *Samme.r*, and Loss (regression): *Square* |
| **KNN** | Number of neighbours: *2*, Metric: *Manhattan*, and Weight: *Uniform* |
| **SVM** | SVM type: *SVM, C=1.0, ε=0.10000000000000003,* Kernel: *RBF, exp(-auto\|x-y\|²)*, Numerical tolerance: *0.001, and* Iteration limit: *300* |
| **ANN-6** | Hidden layers: *200*, Activation: *tanh*, Solver: *L-BFGS-B*, Alpha: *1*, Max iterations: *500*, and Replicable training: *True* |

#### 2.4.1.1. Adaptive Boosting Regression (AdaBoost Regression)

AdaBoost based regression is a type of boosting AI-driven model that can apply a powerful machine learning algorithms for regressing of target and feature variables [19-21]. The purpose of applying a boosting regression was to obtain the best prediction from the ensemble of multiple week predictors. The schematic presentation of AdBoost Model is presented in **Figure XX1**.

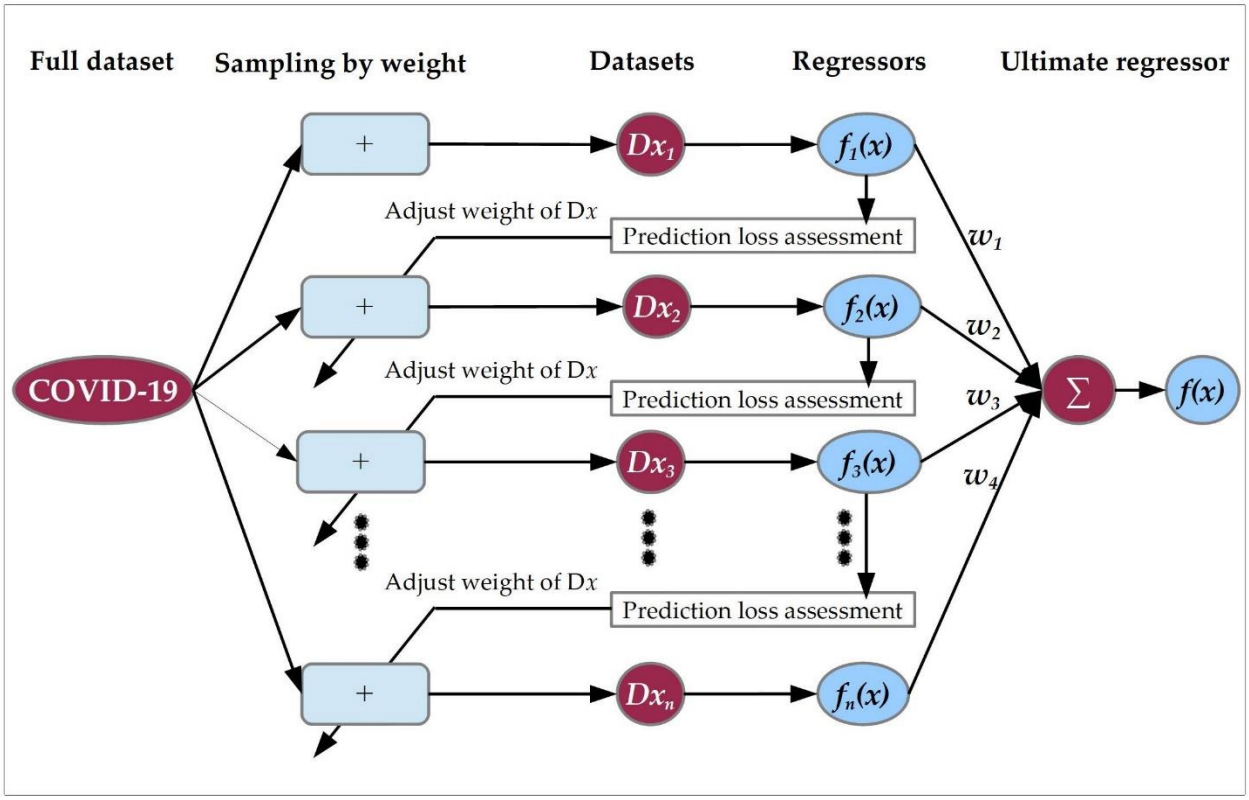



**Figure XX1:** The schematic diagram of AdaBoost regression

As we can observe from the figure, the model process the input COVID-19 dataset and let us denote this dataset as $D_x$. Initially, each data of $D_x$ was assigned and equal weight and this weight determined the chance of being sampled. Due to this weight the model selected the training dataset ($D_{x1}$) from the dataset $D_x$ with replacement sampling and hence, use the training dataset to train the regressor $f_1(x)$. As we can see from the schematic presentation, the prediction weight assessment was applied to assess the trained regressor 1 [$f_1(x)$] and calculate the weight '$w_1$' for the regressor. This assessment is to adjust the weight for the main dataset $D_x$. In the weighting process, the larger the prediction error, the larger the weight for that specific trained dataset. Finally, the model parameter used in this study to build the AdaBoost model after a lot of try and error was (Base estimator: *tree*, Number of estimators: *4*, Algorithm: *Samme.r*, and Loss (regression): *Square*)

Min H and Luo, X. (2016) has summarized the overall procedure of AdaBoost in eight steps and presented as follows [22]:

**Step 1:** Given the dataset $D_x$ with training samples $\{(x_j, y_j)\}_{j=1}^{M}$

**Step 2:** assign equal distribution of weight $\{p_{ij} = \frac{1}{L} \mid i = 1,2,...K; j = 1,2,...M\}$ for each of the training samples initially for i=1 and starts the loop

**Step 3:** at the $i^{th}$ iteration, the sample M training data from $\{(x_j, y_j)\}_{j=1}^{M}$ with replacement according to their distribution with $p_{ij}$ and use the sampled data to train a regressor $g_i(x; \beta_i)$

**Step 4:** Calculate the prediction loss $L_j = L[y_j, g_i(x_j; \beta_i)]$ for each member of $D_x$, where $L_j \in [0,1]$.Also, calculate the weighted average of the loss $\bar{L}$.

$$L_j = \frac{L[y_j, g_i(x_j; \beta_i)]}{D}, D = \sup\{L_j\}, j = 1, 2, \ldots$$

$$\bar{L} = \sum_{j=1}^{M} p_{ij} L_j$$

**Step 5:** calculate the weight of the regressor $g_i(x; \beta_i)$ by the following formula:

$$w_i = \frac{\bar{L}}{1 - \bar{L}}$$

**Step 6:** If 'i', in step 5, equals to the maximum number of iteration K, it will quit the loop and move to step 8.

**Step 7:** Updating the distribution weight of the dataset $D_x$ by making i=i+1 in equation number 6 (at Step 4) and move to the loop:

$$p_{ij} = \frac{p_{ij} w_i^{1-\bar{L}}}{Z_i}$$

Where $Z_i$ is a selected normalized factor and hence, $P_{ij}$ will be a random distribution

**Step 8:** Incorporate the obtained K regressors into a single regressor according to their corresponding weight $\{w_i\}_{i=1}^{K}$ and we have a formula:

$$g(x; \beta_{weight}) = \sum_{i=1}^{K} w_i g_i(x, \beta_i)$$

#### 2.4.1.2. K-Nearest neighbor regression (KNN regression)

KNN regression is one of the best-known and simplest non-parametric regression type and it does not explicitly assume the parametric form of the target variable and it is more or less similar to the KNN classifier [23]. Given a value for K and a prediction point $X_0$, KNN regression first identifies the K training observations that are closest to $X_0$, represented by $N_0$. It then estimates the target variable Y using the average of all the training responses in $N_0$. The small number of K provides the most flexible fit that have a low bias but high variance, and hence, the optimal value for K will depend on the bias-variance tradeoff.

We can present the prediction formula of KNN as: $Y = \frac{1}{K} \sum_{x_i \in N_0} y_i$

In this study, the model parameters for the KNN was decided after a lot of try and error of the model development process and hence, the parameter that makes KNN to predict better than other parameters were (Number of neighbors: *2*, Metric: *Manhattan*, and Weight: *Uniform*).

#### 2.4.1.3. The Artificial Neural network (ANN-6)

The 'ANN-6' is a type of AI-driven model and it is considered as the most crucial model, because it can build a link between feature variables and the target variable by training the neural networks without having a detail information

on the dataset [24]. ANN is more efficient and more practical in different domains of sciences [25], Biomedical, Technology, agriculture and Business. This is due to its ability of self-learning simulation function, which demonstrates the capacity of ANN to predict and model complicated processes including daily number of mortality due to COVID-19. Hence, the ANN-6 with forward propagation algorithm was selected to predict mortality due to COVID-19. The model parameters of the ANN-6 was (Hidden layers: *200*, Activation: *tanh*, Solver: *L-BFGS-B*, Alpha: *1*, Max iterations: *500*, and Replicable training: *True*).

The ANN-6 with the Broyden-Fletcher-Goldfarb-Shanno (BFGS) optimization algorithm with three layers, input layer, hidden layer and output layer, was selected after many try and error assuming different parameters with optimum prediction capability. In addition to the try and error, the BFGS has a proven performance even for non-smooth optimization [26] like the daily mortality of COVID-19.

#### 2.4.1.4. The support vector machine (SVM)

The SVM is an AI-driven model and of supervised machine learning algorithm type designed for classification and regression [2, 27, 28]. The regression of SVM was applied to predict using the regression known as support vector regression. Before applying the SVM, it is important to select the kernel function. Hence, this study used the radial basis function (RBF) kernel type after training the model with 70% of the data to predict mortality, due to COVID-19 in Ethiopia, by combining of all feature variables. The performance ability of RBF is better than the rest kernel types (sigmoidal and polynomial) and RBF has fewer turning parameters than others [2, 29], hence, we prefer to model the SVM by using the RBF. The final parameters of the SVM model after a trial and error was (SVM type: *SVM, C=1.0, ε=0.10000000000000003,* Kernel: *RBF, exp(-auto|x-y|²),* Numerical tolerance: *0.001, and* Iteration limit: *300*) and it is presented in **Table X**.

### 2.4.2. Data normalization and Model performance evaluation

Before modelling the AI-driven models and the Boosting model, standardizing of target variable and feature variables were conducted to normalize the data into the standardized value between 0 and 1. This standardization will assure that to reduce dimensions among variables and to have equal attention in the modelling process [2, 30]. Let the variable to be normalized is 'X', the normalization formula will be:

$$X_n = \frac{x_i - x_{min}}{x_{max} - x_{min}}, i - 1, 2....n$$

Where $X_n$, $x_i$, $x_{min}$ and $x_{max}$ represented the normalized, the actual, the minimum and the maximum value of the variable X.

In the performance evaluation of models, the root mean square error (RMSE), the mean absolute error (MAE) and the determination coefficient (DC) were calculated. The best performing model was selected based the calculated value of RMSE, MAE and DC. Therefore, a model with lowest RMSE or with lowest MAE and a model with DC value near to 1 was considered as a best performing model.

## 3. Results and discussion

In this study, one boosting model (AdaBoost) and three AI-Driven models (kNN, FFNN and SVM) were developed, and all these models were trained on the 70% of the COVID-19 dataset and tested by 30% of this dataset. In this section, the feature statistics, the sensitivity analysis, modelling of AI-driven models and comparison of these models with the boosting model were successively reported.

### 3.1. Feature statistics

The minimum, mean, maximum and Standard deviation values of the target and feature variables are presented in **Table XX** for both training and test datasets. The average number (mean ± SD) of daily mortality due to COVID-19,

between 01 April 2020 and 01 April 2022, was (9.13±8.21) for the training dataset and (13.27±12.78) for the test dataset. The number of daily average cases were (604.08±539.79) for the training dataset and (756.02±1063.06) for the test dataset. In addition to daily deaths and daily cases the average bed capacity per/1000, the daily mask use (measured from 1), and the pneumonia status were (0.17±0.02), (0.42±0.16) and (0.96±0.09), respectively for the test data.

**Table XX:** The descriptive statistics of target and feature variables of COVID-19 dataset

| Variables | Training Dataset (n = 584, 70% of the data) | | | Test Dataset (n = 146, 30% of the data) | | |
|---|---|---|---|---|---|---|
| | Mean±SD | Min | Max | Mean±SD | Min | Max |
| New deaths | 9.1298±8.2090 | 0 | 47 | 13.2667±12.7766 | 0 | 49 |
| New cases | 604.0812±539.7915 | 0 | 2372 | 756.019±1063.059 | 7 | 5185 |
| Bed capacity | 0.1647±0.0235 | 0.1245 | 0.1856 | 0.1729±0.0213 | 0.1345 | 0.1741 |
| Mask use | 0.4279±0.1633 | 0.0000 | 0.6689 | 0.4163±0.1641 | 0.0000 | 0.8679 |
| Pneumonia_st | 0.9615±0.0961 | 0.8213 | 1.0929 | 0.9629±0.0963 | 0.8132 | 1.1294 |

The radar chart described the daily number of new deaths in **Figure XX**. In this chart, four largest numbers of daily mortality due to COVID-19 were 49, 48, 47 and 47 deaths on 28 September 2021, 01 October 2021, 09 September 2021, and 20 April 2022, respectively. In addition to the largest number of daily deaths, 38 and more daily deaths were registered in the country from 13 September 2021 to 14 October 2021. Therefore, we can conclude that this period was the peak time of mortality due to COVID-19 in Ethiopia from 01 April 2020 to 01 April 2022.

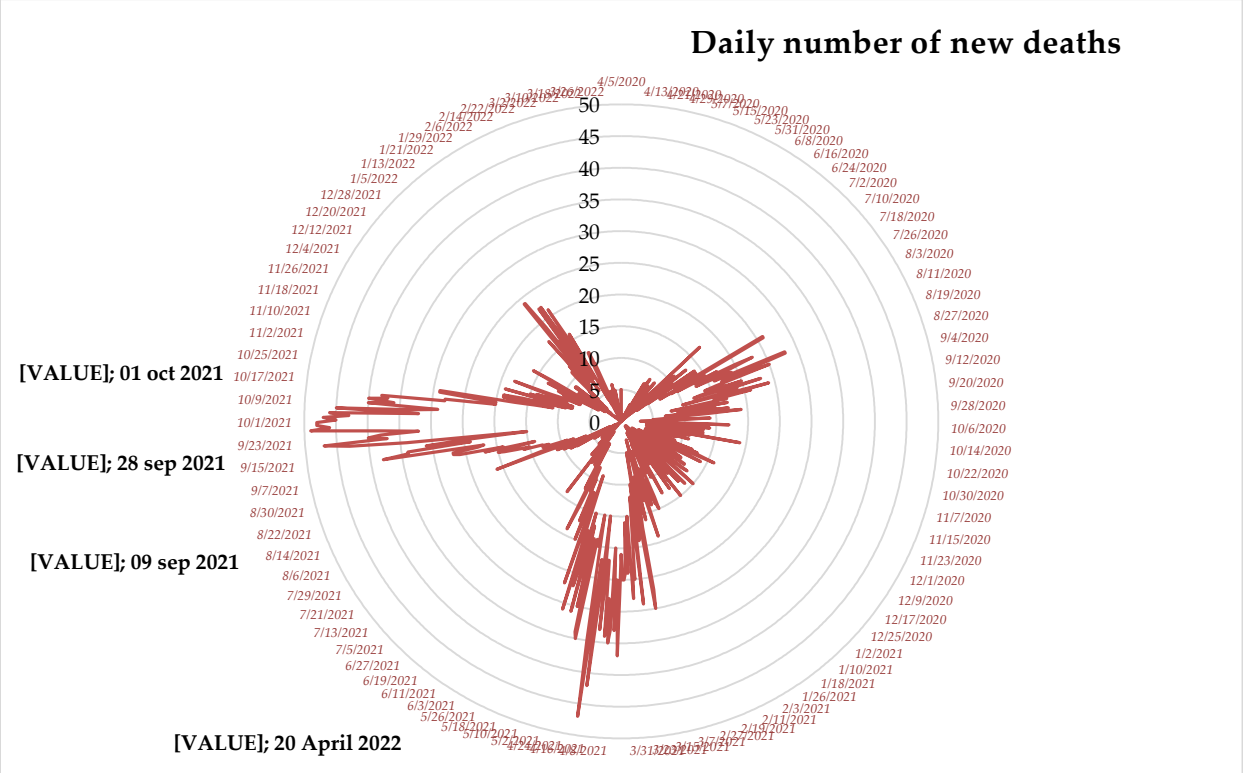



**Figure XX:** The radar chart to present the daily COVID-19 mortality

### 3.2. Sensitivity analysis to select dominant features

To obtain the optimum level of prediction of AI-driven models, the most important step is to carefully select the most relevant feature variables and to adjust model parameters for every model. In the sensitivity analysis, seven variables were included. These were: 'mask_use', 'all_bed_capacity', 'new_cases', 'pneumonia_st',

'icu_bed_capacity', 'hosp_admission', and 'daily_infection'. In previous classical models, the linear sensitivity analysis techniques were applied to select the dominant feature variables. However, the daily recorded data related to the COVID-19 have a non-parametric nature. Henceforth, the neural network sensitivity analysis (the FFNN) was conducted to select the dominant feature variables and presented in **Table XXX**.

As we can observe from **Table XXX**, four variables were scored the DC value greater than 0.5, and accordingly, 'mask_use', 'all_bed_capacity', 'new_cases', and 'pneumonia_st' were ranked from first up to fourth, respectively and they were used to build all models in this study. However, those feature variables with DC value smaller than 0.5 were excluded in the model building.

**Table XXX:** The sensitivity analysis applied to select the dominant feature variables

| Features included | Longer description of feature variables | DC | Rank |
|---|---|---|---|
| 'mask_use' | Percent of population reporting always wearing a mask | 0.867 | 1st |
| 'all_bed_capacity' | Total number of beds that exist at the location | 0.815 | 2nd |
| 'new_cases' | Daily number of new case | 0.796 | 3rd |
| 'pneumonia_st' | Ratio of pneumonia deaths to the average annual deaths | 0.768 | 4th |
| 'icu_bed_capacity' | Total number of ICU beds that exist at the location | 0.421 | 5th |
| 'hosp_admission' | Daily COVID-19 hospital admission | 0.401 | 6th |
| 'daily_infection' | The number of daily infections | 0.253 | 7th |

### 3.3. Prediction of COVID-19 using single AI-driven models

In the modelling process, the data were trained and tested by using three AI-driven models (kNN, SVM and NN) and one boosting model (AdaBoost). Hence, prediction performance of models of each models are presented in Table XI.

**Table XI:** AI-driven models to predict COVID-19 in Ethiopia using the combination of the first four dominant features.

| Model | Feature combinations | Model parameters | Training dataset | | Test dataset | |
|---|---|---|---|---|---|---|
| | | | RMSE | $R^2$ | RMSE | $R^2$ |
| AdaBoost | mask, all_bed, cases, pneumonia | Samme.r | 1.9358 | 0.9449 | 2.0549 | 0.9422 |
| kNN | mask, all_bed, cases, pneumonia | Uniform | 3.0834 | 0.8601 | 3.1858 | 0.8618 |
| SVM | mask, all_bed, cases, pneumonia | RBF | 4.3482 | 0.7218 | 4.5461 | 0.7171 |
| ANN-6 | mask, all_bed, cases, pneumonia | L-BFGS-B | 1.9358 | 0.8553 | 3.1749 | 0.8629 |

The boosting algorithm that we applied in this study, to boost the prediction performance of COVID-19 in Ethiopia was the AdaBoost model. In this model, a variant called "AdaBoost.SAMME.R" were applied to predict the mortality. This variant works with classifiers that can output prediction probabilities. Hence, values of DC and RMSE were 0.9422 and 2.0549, respectively, which implies that the AdaBoost model was the best performer in predicting mortality due to COVID-19 in Ethiopia.

The first AI-driven models used, to predict COVID-19, in this study was kNN. In this model, both assumptions of weight (uniform and distance) were tried in the modeling process. However, the kNN with 'distance' weight is going to be over fitted and the kNN with 'uniform' weight was best fitted. Therefore, the value of DC and RMSE were 0.8618 and 3.1858, respectively. Accordingly, the kNN was the third best performer model to predict COVID-19 in Ethiopia, next to the AdBoost and the ANN-6.

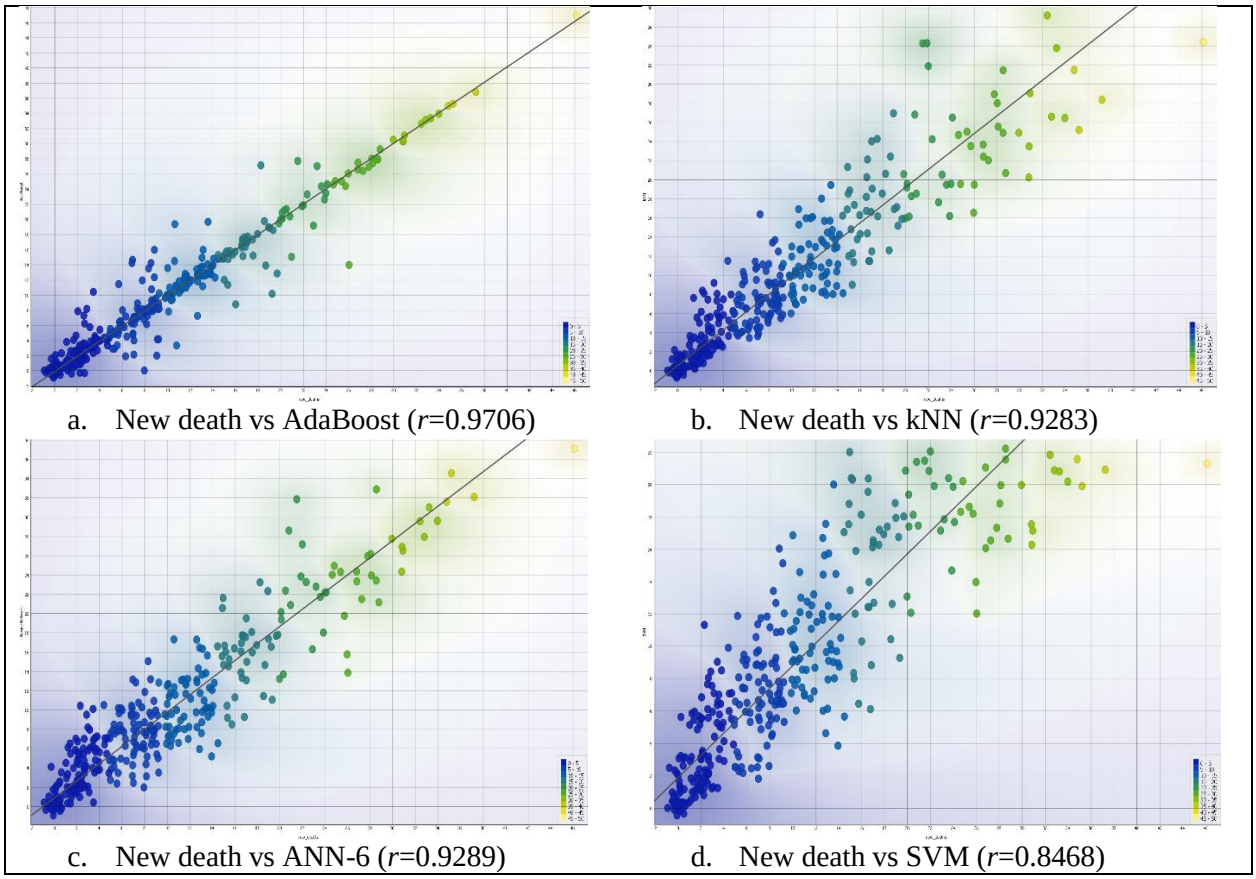
The second AI-driven model used, to predict COVID-19, in this study was SVM. To build the SVM model using selected dominant feature, the kernel of the radial basis function (RBF). This function was selected due to its good performance than the other types of functions under the SVM in predicting COVID-19 in eastern qAfrica [2]. As it is presented in **Table XI**, the prediction performance of SVM in predicting COVID-19 were reported in the form of

DC and the RMSE. Hence, the value of DC was 0.7171 and RMSE was 4.5461 in the test dataset. This result implies that the prediction performance of SVM was lesser than the rest prediction models.

The third AI-driven model used, to predict COVID-19, in this study was the ANN-6. The Broyden-Fletcher-Goldfarb-Shanno (BFGS) optimization algorithm was selected due to its proven performance even for non-smooth optimization [26]. This implies that the ANN-6 was good estimator for non-linear data like COVI-19 daily mortality. Therefore, the value of DC was 0.8620 and the RMSE was 3.1749 in the test dataset, which implies that the ANN-6 was the second best performer algorithm to predict COVID-19 in Ethiopia next to the boosting algorithm and the first AI-driven algorithm among three models.

### 3.4. The correlation between the actual and the predicted COVID-19 mortality values.

The relationship between the actual and the predicted values of daily mortality due to COVID-19 using four AI-driven models (AdaBoost, kNN, SVM and ANN-6) was calculated and presented in **Figure XX**. In this visual presentation, the rank of AI-driven models in predicting COVID-19 was presented in bivariate correlation values. Hence, the correlation value were 0.9706, 0.9289, 0.9283, and 0.8468 for AdaBoost, ANN-6, kNN, and SVM respectively. This implies that AdaBoost, ANN-6, kNN, and SVM were the first, second, third and fourth models, respectively to indicate fewer spread points in the correlation with mortality due to COVID-19 in Ethiopia and producing better estimated value of the mortality.



a. New death vs AdaBoost ($r$=0.9706)

b. New death vs kNN ($r$=0.9283)

c. New death vs ANN-6 ($r$=0.9289)

d. New death vs SVM ($r$=0.8468)

**Figure XX:** The correlation between the predicted and the actual values of COVID-19 mortality using AI-driven models

We understood from results of the AI-driven models in **Table XI** and the result from the scatter plot in **Figure XX** showed that the boosting algorithm performed the better than the other AI-driven models in predicting mortality due to COVID-19 in Ethiopia. Hence, these results conclude that the AdaBoost algorithm was the best AI-driven model in predicting COVID-19 data collected in a daily basis.

The bivariate correlation analysis using the spearman correlation coefficient was conducted and the result is presented in **Figure XXX**. In this analysis, the observed value of daily mortality was correlated with each observed feature variables and each predicted values from the AI-driven models (AdaBoost, kNN, ANN-6 and SVM). The predicted values with AdaBoost, ANN-6, kNN and SVM algorithms were the first, second, third and fourth highly correlated with 0.971, 0.931, 0.929, and 0.867, respectively. In addition to this, the mask use, all bed capacity, and daily new case were the first three highly correlated feature variables with 0.873, 0.796, and 0.765, respectively. However, the pneumonia cases was the lowest correlated feature variable with the observed daily mortality due to COVID-19 in Ethiopia. Hence, we understood from this result that the spearman correlation value was improved among AI-driven models.

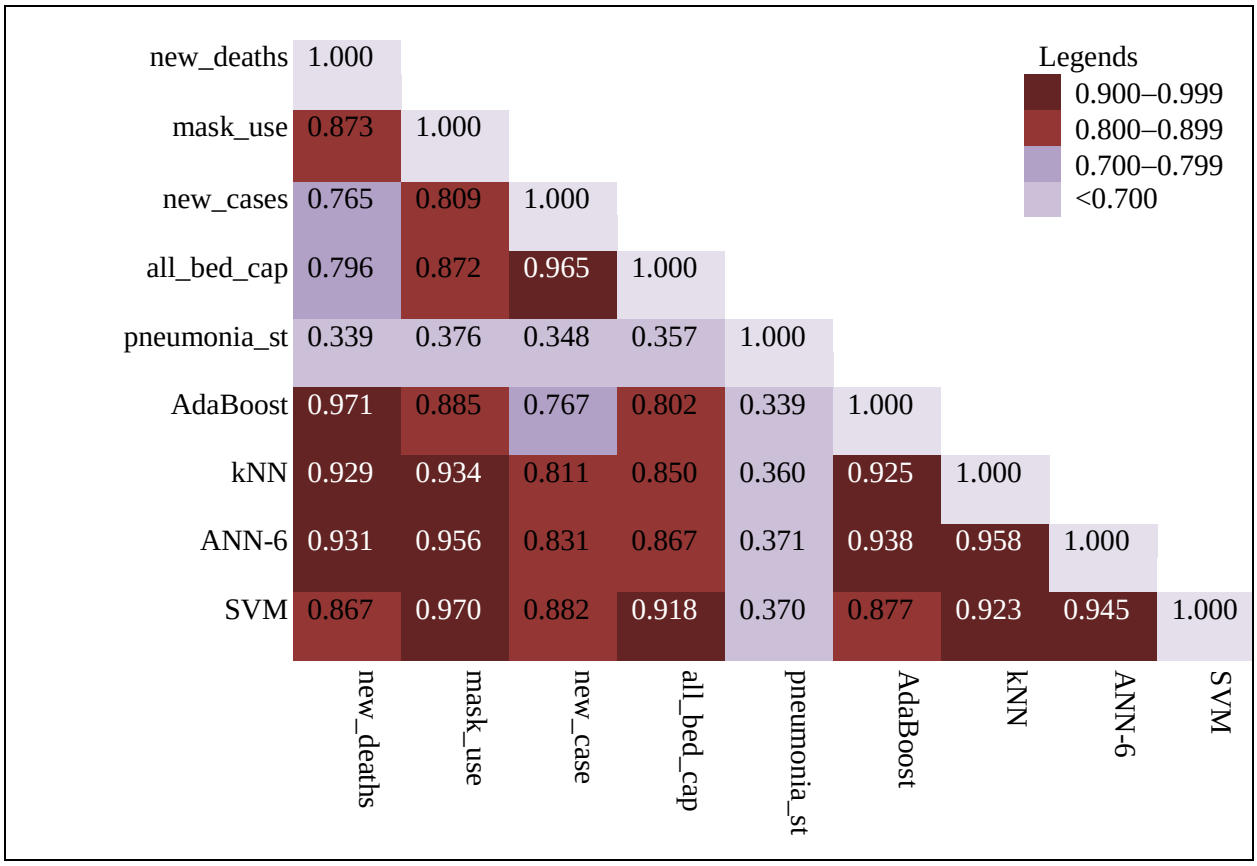



**Figure XXX:** the correlation statistics among the input variables and the predicted mortality

### 3.5. Comparison of AdaBoost with AI-driven models

In **Table V**, the comparison of prediction performances of AI-driven models, both at training and test datasets, with the boosting algorithm was presented. As a result, the AdaBoost algorithm boosted the predicting performance of kNN, ANN-6 and SVM models in a training dataset by 8.48%, 22.31%, and 8.96%, respectively. In addition, the AdaBoost boosted the predicting performance of kNN, ANN-6 and SVM models in a test dataset by 7.94%, 22.51%, and 8.02%, respectively. Hence, these findings suggested that boosting algorithm can be applied to predict mortality due to COVID-19 in Ethiopia more efficiently than the tested single AI-driven models.

**Table V:** The comparison of boosting model with weak AI-driven models

| Boosted Model vs. Single Models | The difference in percent | |
|---|---|---|
| | Training dataset | Test dataset |
| AdaBoost vs. kNN | 8.48% | 7.94% |
| AdaBoost vs. SVM | 22.31% | 22.51% |
| AdaBoost vs. ANN-6 | 8.96% | 8.02% |
| kNN vs. SVM | 13.83% | 14.57% |
| kNN vs. ANN-6 | 0.48% | 0.08% |
| ANN-6 vs. SVM | 13.35% | 14.49% |

### 3.6. the Taylor's diagram

To easily understand the performance of multiple AI-driven models, we can visualize it in a single diagram called Taylor's Diagram. As it is presented in **Figure XXXX**, this diagram is a two-dimensional diagram that coordinates the standard deviation (SD) and the correlation coefficient (*r*) of every AI-driven model's (AdaBoost, kNN, ANN-6 and SVM) predicted value and the observed values of mortality due to COVID-19. The importance to use this diagram is that it displays the predicting performance of different models in a single visual display, and quantifies the level of resemblance between the predicted values and the observed values of mortality. In **Figure XXXX**, we can easily observe that 'AdBoost' was the best AI-driven model to perform in predict mortality due to COVID-19 in Ethiopia, with (r=0.9706 and SD of 0.0907), and the SVM was the poorest model, in performance, with (r=0.8468 and SD=0.0934).

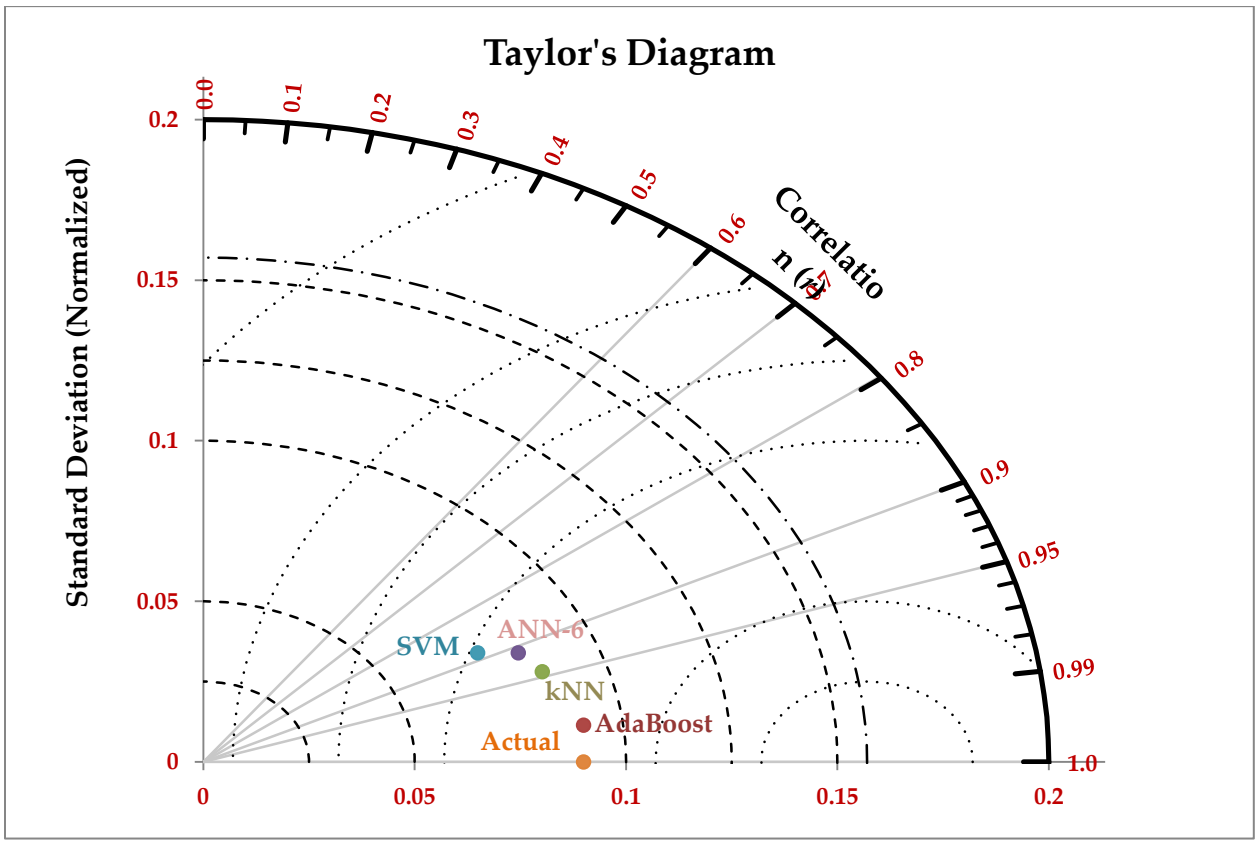



**Figure XXXX:** the Taylor diagram to visualize the prediction performance of models

## 4. Conclusion and recommendation

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# 5. A FRAMEWORK AND RESEARCH AGENDA ON TECHNOLOGICAL CAPABILITY IN A DYNAMIC MARKET: A BIBLIOMETRIC REVIEW: BY: ASS.PROF : ABDELLA KOSSA


## Abstract

*Technological capability makes simpler the transform of inputs into outputs, which contributes to business success. However, there is no a well-defined framework for technological capabilities which can fit to a dynamic market. In order to make the most use of the resources available, it is also unclear how organizational competences and technology capabilities are integrated. As well, there was no agreement on the fundamental causes and effects, which causes some determinants and results to be overlooked. To address this, a bibliometric analysis and systematic review are used to create a framework for technological capabilities (TC) in the dynamic market. The study provides a comprehensive framework for this rapidly evolving field of study and integrates TC's existing knowledge with new concepts. The framework shows how businesses' strategic orientations direct them to build strong TCs that are interwoven with other capabilities like innovation capability, marketing capability, dynamic capability, absorptive capability, and so on, in assuring business success. The provision of comprehensive scientific knowledge on the subject of TC in the dynamic market is aided by the presentation of integrative findings on the conceptual relationship of TC with the numerous antecedents and consequences. Additionally, the study put forth new constructs that were created by combining TC with other organizational capabilities, which would later be empirically tested.*



**Key words:** Technological capability, dynamic market, framework, research direction

## 1. Introduction

An environment with a high degree of uncertainty is one that is characterized by fierce competition, rapid market change, and turbulent technology (Wilden & Gudergan, 2014). Technological capability (TC) helps market-oriented businesses receive, analyze, and disseminate information and be more responsive to environmental changes (Eng & Okten, 2011). Because, TC is an organization's ability to use technologies to turn inputs into outputs through managing technological resources by (re)combining components, methods, processes, and techniques to offer products. This typically entails significant resource commitments, a firm's capacity to produce and use technological resources; and other factors (Afuah, 2002; Cordero, Paez, Cristina Pinho, and Prange, 2022). TC is also important in making companies grow globally (Guerra and Camargo, 2016) and allow for the creation and appropriation of value (Franco, 2009).

Companies that invest in technology advancements while simultaneously adjusting to changing market demands will fare better than those whose operations are restricted by inertia in any one area. Strategic renewal initiatives like these help businesses adjust to shifting conditions (Franco, 2009). Therefore, in order to attain increased performance, strategic orientations that demand the integration of TC with other types of competence are required. Due to the rapid market shift, most businesses are unable to develop new products effectively using only internal resources (Deeds et al., 2000); as a result, these businesses must collaborate with other stakeholders (Hillebrand and Biemans, 2004; Cai Haowen; Chen & Antai, 2014). In this regard, TC can help companies grow global since it makes it possible to build strategic alliances, invest in R&D, share resources, transfer technology, and achieve economies of scale (Guerra and Camargo, 2016). This demonstrates how strategically organizing TC with other resources for company success depends on both internal and external strategic components. This leads to investigating what firms do when faced with multiple opportunities in regard to organizing the TCs with the other capabilities to respond to the market shifts.

Earlier studies (Eisend, Evanschitzky, and Calantone 2016) looked at different kinds of capabilities related to specific organizational function areas, such as marketing, technological, and manufacturing capability. Besides, the infrastructure, R&D, and other resources, personnel,

skills, and competences that enterprises accumulate through time are often embodied by TCs (Zahra, 2018). Thus, TC has to be integrated with different capabilities such as dynamic capability (Wilden & Gudergan, 2014), marketing capability ((Ju et al., 2018), absorptive capacity (Yang et al., 2019; Wilden & Gudergan, 2014), innovation capability (Wilden & Gudergan, 2014), and collaborative capabilities (Hillebrand and Biemans, 2004). Besides, the acquisition of technological competence can either be facilitated or hindered by capacity absorption (Guerra and Camargo, 2016). Thus, marketing capability, R&D capability and knowledge capability is supporting the TC towards enhancing the firm's performance. However, still it's not clear how this capabilities are integrated and commonly enhancing the firms performance.

Despite some literature suggesting a connection between TC and other organizational capabilities, it still lacks clarity and consistency. Since TCs alone are insufficient to produce market success (Wilden & Gudergan, 2014), it's critical to demonstrate how TC works with other organizational capabilities to ensure business success. While some research focuses on examining the various types of capacities in isolation, others attempt to analyze the integration of TC with MC (eg., Su et al., 2015) and TC with DC (eg., Wilden & Gudergan, 2014). However, there is a need to further examine how TC is integrated with other organizational competencies like IC, AC, and R&D capabilities. Additionally, we still don't fully comprehend how businesses might align various types of skills with changes in their environment (technological, competitive, and market factors) (Wilden & Gudergan, 2014). Thus, considering the TC simultaneously with other capabilities such as innovation capability, market capability, dynamic capability, and other organizational capabilities becomes crucial for firms competing in the dynamic market. Further explanation of how this integration is accomplished in various institutions and evolving situations is also required. This research then offers clues on how to use TC and integrate it with other organizational competencies in order to achieve both organizational and consumer objectives, especially in a dynamic market.

In the context of international marketing, it is crucial to overcome the extra difficulties brought on by doing business abroad, such as unfamiliarity with the industry and a lot of uncertainty and instability (Morgan, Feng, and Whitler 2018). Consequently, the research has shown interest in how TCs can encourage enterprises to internationalize (Teece, 2014). However, incumbents may still be able to employ some resources and capabilities from an earlier market in the new market

segment while losing use of others (Franco, 2009). On the other hand, technology is a good predictor of product innovation, even though high levels of technological competence may limit the product from creating innovation (Zhou & Wu, 2010; Yu et al., 2014; Guerra and Camargo, 2016). The use of the TC for promoting new product development (NPD) in the dynamic market context must therefore be made clear. However, when businesses encounter environmental volatility, good marketing and technology capabilities may turn into liabilities (Leonard-Barton 1992), particularly if capability gaps develop (Day 2011; Wilden & Gudergan, 2014). Future scholars will need to look into these contentious findings more thoroughly.

The topic of TC has been the focus of various investigations. Unfortunately, because different researchers are offering alternative definitions from various points of view, the concept is still vague and poorly defined. Additionally, there was no consensus on the antecedents and effects, which leads to overlooking some determinants and outcomes. This is one of the motives for carrying out this review study. Then, this paper sought to present a comprehensive framework of this rapidly evolving field of study and integrate the TC field's existing knowledge with fresh concepts. The framework could aid company leaders in considering the various elements when making sensible judgments in addition to its contribution to future study.

This study provides a broad range of contributions to the research fields. First, by carefully studying and bibliometrically analyzing the literature, this study has relevance by revealing a research trend, influential studies, significant terms, and concepts in the field of TC in the dynamic market. Particularly in the earlier investigations, contentious conclusions are presented. Su et al., (2015)'s controversial finding that market instability enhances the performance effect of marketing capability but deters that of technological capability was one of their main points of contention. In the meanwhile, as technology advancements continue, market volatility limits marketing advancements. Further study and clarification of how technological and marketing capabilities are combined to successfully manage a business are required to resolve this tension. Likewise, while Zhou & Wu (2010) discovered that high levels of TC may prevent from generating new products, Renko et al. (2009) found that TC is an effective predictor of product innovation (Guerra and Camargo, 2016). These contentious results show that the current idea needs more research and is not conclusive. Above all, these controversial theoretical consequences pose fresh problems for our understanding. This encourages us to develop a comprehensive framework that will be empirically supported by future studies.

Second, scientific mapping was used to organize the integrated framework for further refinement and future research direction by highlighting the gaps and areas left unexplored by earlier research, such as the integration of technological capabilities with external elements like stakeholder networking, strategic alliances, and partnerships. The framework exemplifies how TC is combined with various techniques, such as market dynamics and other organizational competencies, and how they relate to elements like strategic orientations, commercialization, worldwide market expansion, and corporate success. Topics like DCs and its connection to company performance, in particular, have received excessive attention, but complete frameworks for TC and its elements that affect a firm's success are still lacking. Using the clusters produced by the keyword analysis, the study then gives a thorough investigation of the contributions made by numerous TC-related factors. The provision of comprehensive scientific knowledge on the subject of TC in the dynamic market is aided by the presentation of integrative findings on the conceptual relationship of TC with the numerous antecedents and consequences.

Third, this study suggests new constructs that were generated by integrating TC capabilities with associated constructs. Theoretically, studies have demonstrated the integration of TC and DC (Wilden & Gudergan, 2014), TC and MC (Su et al., 2015) and TC and IC (Wilden & Gudergan, 2014). The study thus demonstrates the need for new constructs, such as market-oriented TC (MoTC) and dynamic technological capability (DTC). Determining how the combined construct of DTC, TIC, and MoTC improves business success through collaboration and the development of new products is also helpful. Additionally, as an integration still it’s not studied previously how the TC and marketing capability is combined under DCs. This study advances the topic that needs more research by demonstrating the importance of this integration. By indicating the necessity of this integration, this study therefore advances the subject matter which requires further studies on how the factors will be integrated.

Fourth, the study developed a framework that includes the proposed moderator and mediator variables in addition to the antecedents and consequences of TC. This framework proposed the expected roles of various variables. Testing the precise ways that TC is combined with particular kinds of capabilities, such as absorptive and adaptive capability, in order to have a joint effect on business success is also crucial. Future researchers will therefore need to conduct an empirical examination of the moderating effect of these particular capabilities. Similarly, even if some theoretical evidence suggests that strategic management has an impact on technological

capability and TC has an impact on performance, the role of TC as a mediator has to be tested. Additionally, the contribution of TC to technological knowledge creation and how this technological knowledge promotes TC commercialization and innovation through market and industry knowledge has not been thoroughly investigated by scholars. Future researches should generally evaluate the indicated specific factors' potential to act as moderators or mediators.

Fifth, in terms of methodology, this study is one of the first to quantitatively examine a significant amount of data on the subject of TC in a dynamic market. This aids in bringing up several TC-related concepts. The study also gives future researchers a clue to quantitatively examine the effect of certain strategic orientations on TC, especially in light of the dynamic market. Additionally, the integration of the TC and theoretically related constructs adds to the body of information that is currently known. In other words, this study gives a list of potential effects on TC that will be built upon and clarified in further research. For instance, the strategic orientations' value in developing TCs in the competitive market is made clear by this study. However, prior research identifies market orientation, technological orientation, and entrepreneurial orientation as elements of strategic orientation (Eng & Okten, 2011). Others also view learning orientation, innovation orientation, and internationalization orientation as strategic orientations (e.g., Behyan et al., 2015; Knight and Cavusgil, 2004). In light of this fact, the study directs future researchers to develop dimensions for strategic orientations and examine each dimension's items using EFA and CFA.

Given the above gaps, this study tends to investigate the research areas in the subject matter of TC in the dynamic market. Therefore, the study tends to answer the following research questions; 1) What are the different types of organizational capabilities integrated with TCs? 2) What are the main foundational themes in the field of TC in the dynamic market? 3) What are the trends in the TC researches in the dynamic market environment? What are the critical areas that requires future investigations in the discipline of TC in the dynamic market?

## 2. Methodology

Researchers in business and management disciplines continue to rely on superficial and narrative reviews without a systematic analysis of the literature because there are currently few methodological recommendations for how to gather and arrange reviews accessible in the management sciences (Linnenluecke et al., 2019). Many evaluations leave it up to the reader to

determine why certain articles, books, or conference papers were included (or excluded) by the authors in place of others (Tranfield et al., 2003). This study typically combines systematic reviews with bibliometric analysis conducted with VOSvewier software to address these concerns. Because, in order to synthesize the body of literature that already exists in an area, systematic literature reviews are becoming a more popular methodology (Kraus et al., 2020); in other words, they utilize a precise technology designed to reduce bias through thorough literature searches (Tranfield et al., 2003). Establishing a context and defining a research problem, seeking theoretical support, separating what has been done from what needs to be done, identifying the main findings, and avoiding fruitless research are other things that systematic literature review can help with (Linnenluecke et al., 2019).

Despite cautions from studies like Post et al. (2020) and Breslin and Bailey's (2020) that many bibliometric studies lack novel theoretical insights, more recent studies like Mukherjee et al. (2022) noted that bibliometric studies tend to be more objective and comprehensive in scope than other types of reviews which are conducted manually (eg. thematic reviews). Therefore, in addition to a systematic review, Business, economics, and social sciences are paying attention to bibliometric analysis, which is utilized for exploring and interpreting huge volumes of scientific data (Donthu et al., 2021). Given this significance, bibliometric analysis was chosen for this study in order to sense vast amounts of unstructured data in rigorous ways and drawing the body of scientific knowledge on the technical capability in the dynamic market. Moreover, we have adopted the stages suggested by Linnenluecke et al. (2019), which include developing research setup, inclusion and exclusion criteria, data cleaning, and data analysis and synthesis, given the relevance of systematic review and bibliometric review as mentioned above.

The study used both qualitative (thematic and content analysis) and quantitative (e.g., publication year, top publishing journals, total citations, and disciplines) techniques to analyze data. To acquire pertinent and trustworthy data for this, we used a typical search approach in the Web of Science (WoS) data base. An exploratory search was conducted to assess the topic's applicability and relevance, which was then used to create research questions. The search was conducted taking into account the research issues raised in the area of TC in the dynamic market. The terms used have to do with technological capability and dynamic market. Therefore, the terms used are technological capability and dynamic market. Accordingly, a total 1972 articles were retrieved. Then, articles deemed pertinent for addressing the study topics were chosen using the inclusion

and exclusion criteria. The standards pertain to the type of document (i.e. only journal articles) and the language (i.e., English). There are no limitations in terms of publication year, country, or academic discipline. In terms of the study's exclusion criteria, technical reports, books, editorial letters, and conference papers were excluded. Articles written in language other than English were also excluded. Then, the remaining 373 articles were exported to RIF format for further analysis.

Analyses were conducted using both quantitative and qualitative methods. The quantitative analysis takes into account descriptive factors like the year of publication, the total amount of citations, the top publishing journals, the field of study, and scientific mapping factors like co-authorship and co-word analysis. Co-authorship and co-word analysis are utilized to visualize a research on the topic or defined themes using the VOSviewer software. The technique is employed because it enables the researcher to understand the evolution of a topic or body of research by analyzing and synthesizing historical and contemporary notions (Nederhof and Van Wijk, 1997). Last but not least, the researcher can utilize this analysis to pinpoint theories, concepts, and methods that can be used in areas of interest to the researcher (Westgate et al., 2015). Further, the qualitative analysis is content and thematic based analysis, which has been qualitatively elaborated from the clusters established using the co-word analysis.

## 3. Results and Discussion

This section provides the results of analysis which includes both descriptive and bibliometric analysis.

### 3.1. Descriptive analysis

The number of articles published in the discipline of technological capability in the dynamic market is showing increasing trends, with the highest number of articles published in 2020 (n=41) followed by 2021 (n=31), and 2019 (n=29) and 2017 (n=2017). This indicates that the topic has been getting increased attention recently, particularly in the last five years.

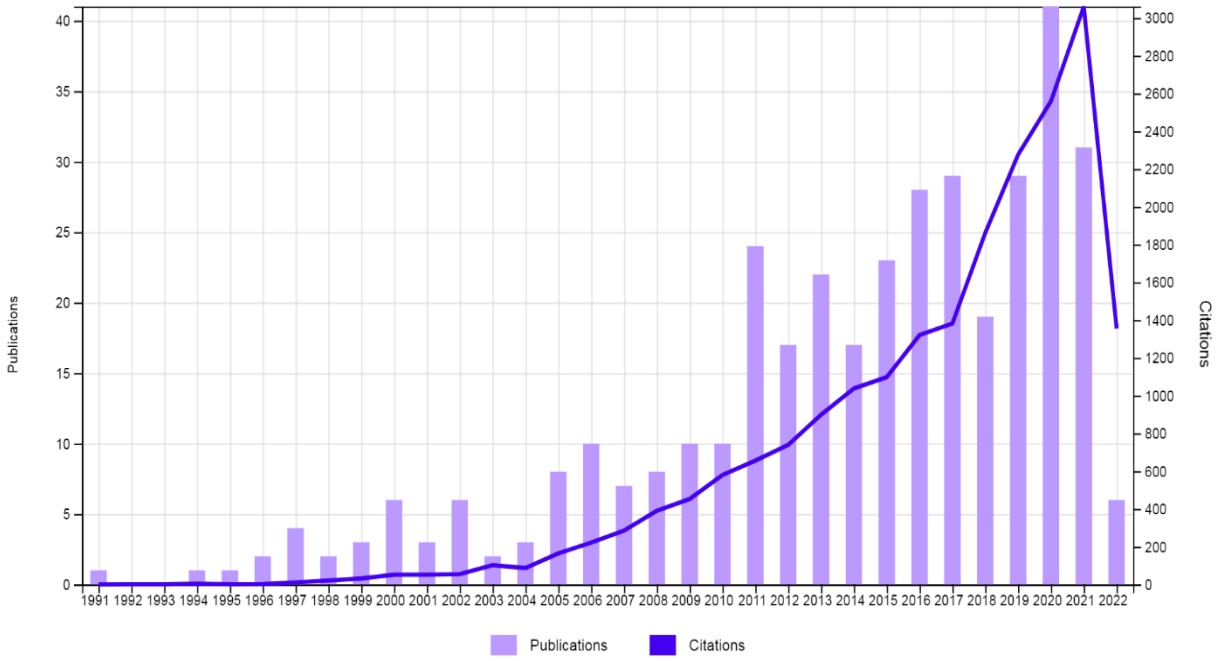


Figure 1: number of total publications and citations per year

Regarding the citations report, it shows an increasing trend, which reaches above 3000 citations in 2021 followed by above 2500 and above 2200 in 2020 and 2019 respectively. Figure 1 shows that the number of citations significantly rose after 2016. This shows that the topic is a recent phenomenon and current research agenda, which has received increased attention from many scholars. Therefore, future researchers can use this developing field of study as a guide to continue their studies and do cutting-edge research that advances knowledge.

In terms of citations, Gereffi et al., (n=3137), Kogut, B and Zander, U (n= 1564), and O'Reilly, CA; Tushman, ML (n=865) are the highest cited articles. The article by Gereffi et al., focused on testing the effect of integrated factor of TC and firm-level learning on determining global value chains. While the study of Kogut and Zander studied about what firms has to do in coordination, identity, and learning, while the study of O'Reilly and Tushman focused on studying organizational ambidexterity from the point of view of exploring and exploiting in mature technologies and markets. In general, the prior study on TC is scattered across diverse disciplines and is linked to numerous topics. In order to provide a thorough understanding of the subject matter and advise future researchers on the areas that need more research, this study offers a comprehensive agenda on TC in the dynamic market.

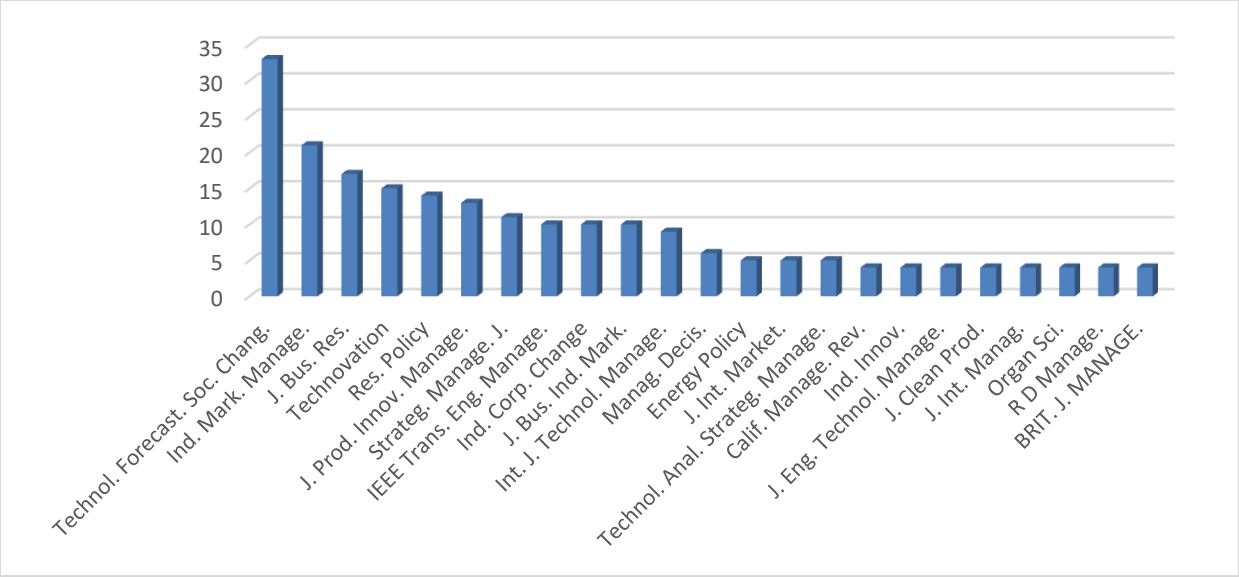


Figure 2: Top publishing journals

Figure 2 presents the top publishing journals such as Technological Forecasting and Social Change (n=32), Industrial Marketing Management (n=20), Journal of Business Research (n=16), Technovation (n=14), Research Policy (n=14), and Journal of Production and Innovation Management (n=10). Most of these journals are related to the fields of business and technology, which shows the topic of technological capability in the dynamic market is an integration of business and technological aspects.

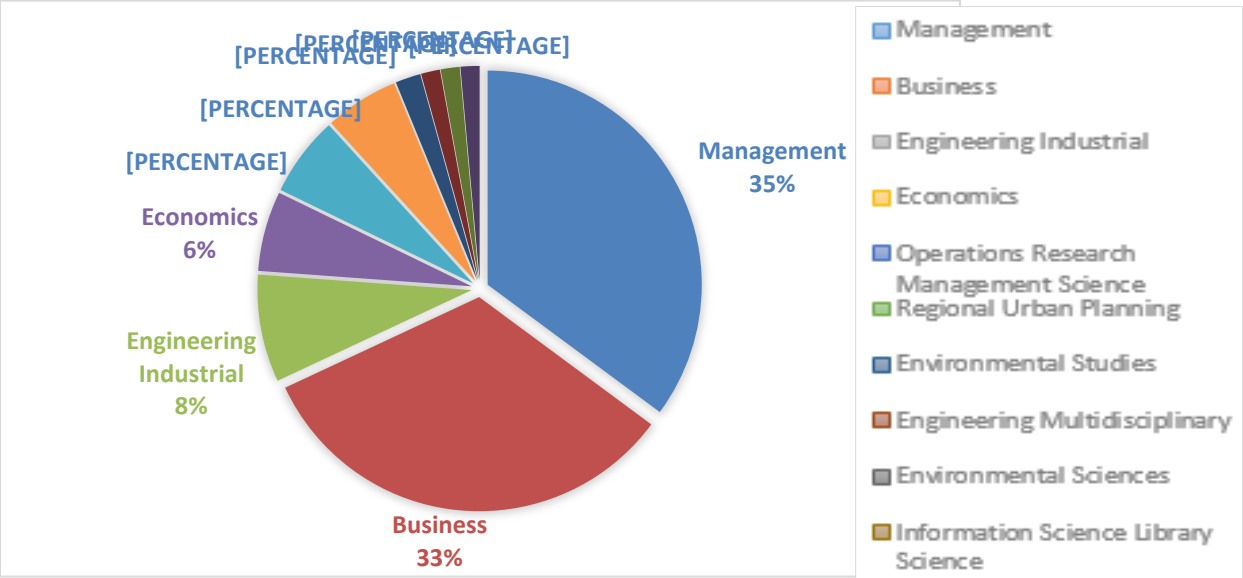


Figure 3: Top ten disciplines by WoS categories

The articles retrieved from the WoS database show that the topic is categorized under several disciplines (i.e., 48 entries in the WoS database). However, the above figure shows the top ten fields of study in the WoS categories, which include management (59.25%), business (55.50%), engineering industrial (13.67%), economics (10.19%), operations research management science (10.19%), regional urban planning (9.38%), environmental studies (3.22%), engineering multidisciplinary (2.41%), environmental sciences (2.41%), and environmental sciences (2.41%).

### 3.2. Co-authorship analysis

There is abundant evidence that research collaboration has become the norm in all fields of scientific and technical research (Bozeman et al., 2013). In particular, co-authorship analysis was undertaken to study the interactions among scholars in the field of study since collaborations among scholars can lead to improvements in research as well as contributions from different scholars can contribute to greater clarity and richer insights (Tahamtan, Safipour Afshar, & Ahamdzadeh, 2016). Figure 4 shows the results of co-authorships with author analysis.

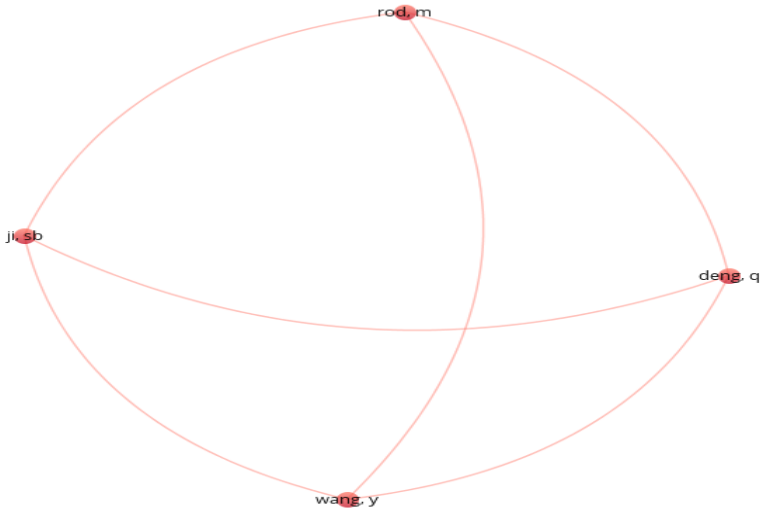


Figure 4: Network of Co-authorship with author's analysis

The visualized bibliometric network shows the four interconnected authors based on the co-authorships from the initial dataset of 280 authors by selecting two as the minimum number of documents for an author, which leads to 33 meeting the thresholds. These 33 authors were obtained in topics addressed and can be reduced to a set of four authors in a cluster. In this particular analysis, fourteen authors are identified as co-authors in two or more articles. Among the 33 authors, Rod M, Ji SB, Wang Y, and Deng Q are the most networked authors with 6 total

link strength. All the four authors collaborated with each other. These researchers are the most frequent co-authors in the field of technological capability in the dynamic market, having published two articles each. However, only one major group with three coauthors is identified, which indicates the lack of author groups who are contributing to the specific topic of TC focusing on the dynamic market.

### 3.3. Thematic Analysis using keyword analysis and title and abstract based analysis

Thematic analysis is undertaken using key word analysis and title and abstract based analysis.

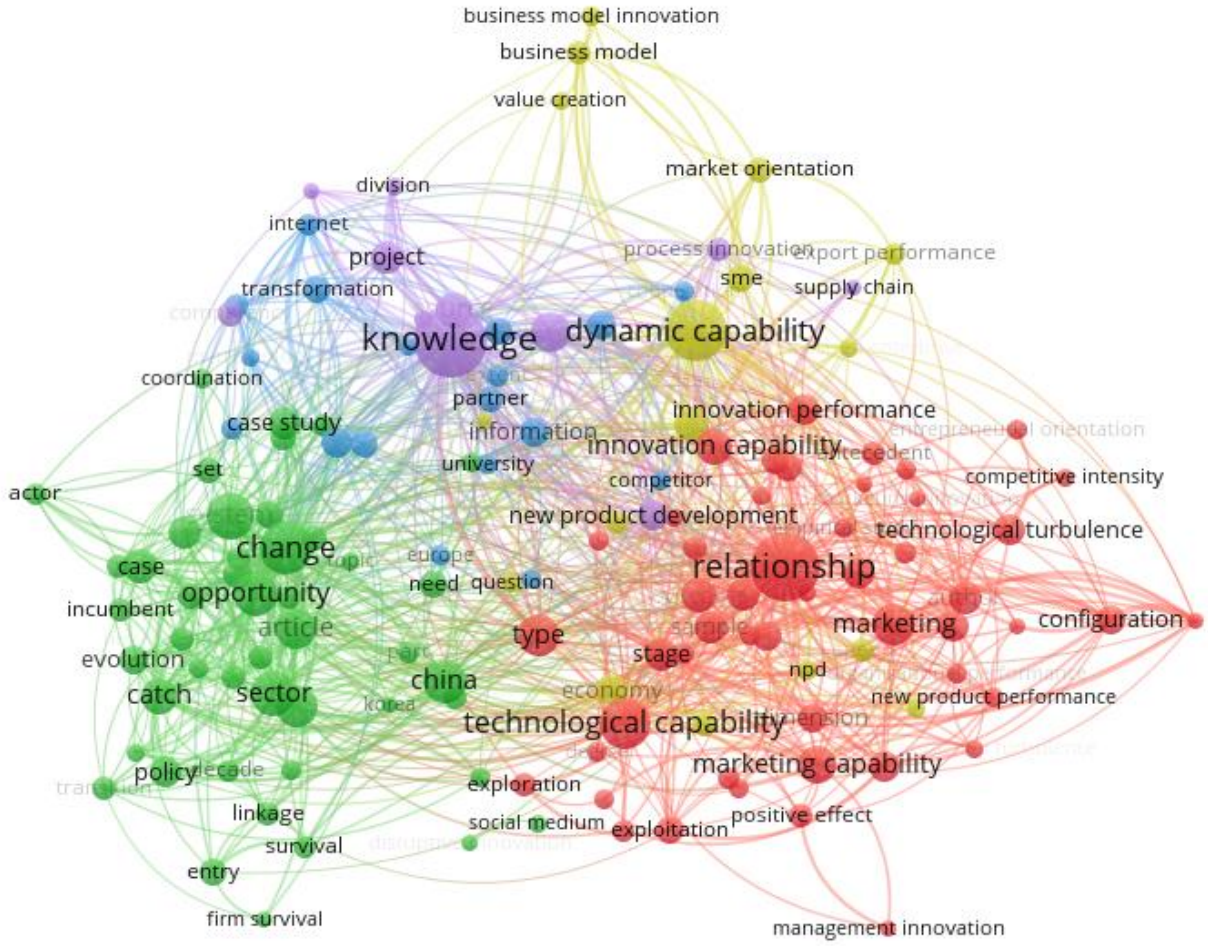


Figure 5: Title and abstract based analysis

Using a minimum number of 10 occurrences of keywords, of the 6922 keywords, 238 meet the thresholds. For each of the 238 terms, a relevance score will be calculated. The default choice of selecting 60% of most relevant terms is considered and 143 terms has been selected. By setting minimum cluster size to 10, five clusters have been emerged (Figure 5).

The thematic analysis form the title and abstract based analysis shows five clusters. The first cluster (red) represents TC and related concepts such as marketing capability, Innovation capability, new product development and performance. The second cluster (green) indicates terms such as change, systems, and opportunity are frequently appeared topic and linked to TC. The cluster further indicates establishment of TC related systems in exploiting opportunities from the changing market environment in different countries and sectors. The third cluster (blue) represented with terms such as experience, information, partner and alliances. This cluster indicates the necessity of linking TC with learning by allying with partners and exploring information. The fourth cluster (yellow) contains a theme about dynamic capability. It also contains related concepts such as SMEs, business model, and market orientation. Finally, the fifth cluster (purple), knowledge, is related with concepts such as integration, NPD, and competency is linked with TC. In general, TC is directly connected with DC, knowledge, and changes, but weak linkage is established with learning and alliance.

The co-word analysis assumes that words that frequently appear together have a thematic relationship with one another and is further used to predict forthcoming trajectories, since the co-word analysis provides a preview of the future of the research field (Donthu et al., 2021). The coword analysis is used to illustrate the association between keywords in the sample of articles. Figure 5 illustrates the main overlay visualization occurrences of terms by the keyword, showing the co-occurrences of words in the field of technological capability in the dynamic market.

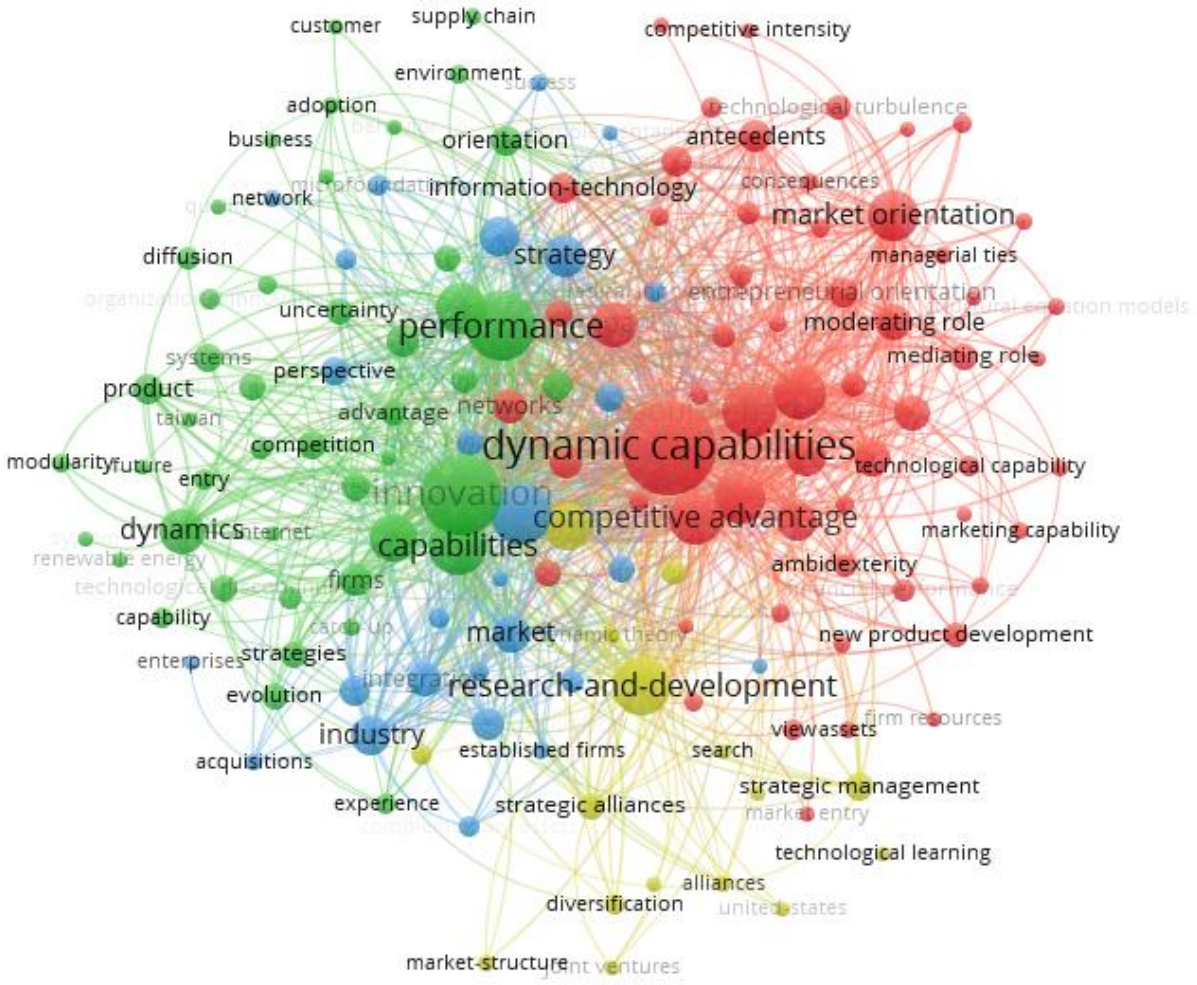


Figure 6. A co-occurrence network of the most frequently used keywords (full counting analysis).

Using a minimum number of 5 occurrences of keywords, of the 183 keywords, 25 meet the thresholds, and 25 numbers of terms were obtained in topics addressed can be reduced to a set of four clusters with 25 items. The most widely studied topics related to the technological capability in the dynamic market under each clusters are presented in Figure 6. The first cluster (red) represented by DC contains the various themes such as performance absorptive capacity, RBV, TC and competitive advantage. The second cluster (green) is about innovation, which contains terms such as performance and growth, capabilities, management, technology, and dynamics. The third cluster (blue) is about knowledge and contains related concepts including; strategy, product development, industry, market, and innovation. The fourth cluster (red) is about

research-and-development, which also contains firm/organization, strategic management, alliances, market-structure, and international expansion.

Based on the themes established above, the following discussions were made by the authors.

### 3.3.1. Strategic orientations for integrating technological capability with other capabilities towards firm performance

Eng & Okten (2011) investigate TC as it is essential to a corporation's innovation strategy and sources of competitive advantage by adopting a capability viewpoint of the resource-based theory of the firm. Because existing research indicates that greater performance may result from resource uniqueness, resource reconfiguration and integration, or the ability to react properly to the environment (Song et al., 2016). According to Franco (2009), the relative benefits of TC will be greater for market pioneers than for responders, meaning that technological "smarts" are more important to market pioneers than to responders. Market pioneering advantages are likely to be more strongly dependent upon the magnitude of the firm's technological capabilities (Franco, 2009).

#### A. Strategic orientations towards technological capability

The strategic orientations serve as the foundation for the advancement of technological capabilities. Numerous orientations have been extensively researched in the literature as moderators between resources and business performance or as antecedents of capabilities (Byoungho Jin, 2017). Additionally, by examining what businesses do when presented with several possibilities throughout time, we may analyze the effects of businesses' strategic capabilities to anticipate or adapt to changes in technology and the market (Franco, 2009). This strategic focus aids in the creation of technology capabilities that adapt to the turbulent and dynamic environment. However, inertia is lost as a result of firms' strategy renewal efforts, and new competencies are created that protect against obsolescence during environmental changes (Franco, 2009). This is due to the fact that quick access to markets and consumers is made easier by strong TCs (Zahra, 2018). As a result, the firm's strategic orientation in terms of technological orientation, market orientation, and entrepreneurial orientation aids in the development of relevant capability (Trainor et al., 2011) that takes into account market dynamics that are influenced by entrepreneurial activities.

Along with entrepreneurship orientation and technology orientation, market orientation has been considered by researchers as a component of strategic orientation (Eng & Okten, 2011). Additionally, a variety of firm orientations, such as an entrepreneurial orientation (e.g., Rialp et al., 2005), an internationalization orientation (e.g., Behyan et al., 2015), an innovation orientation (e.g., Knight and Cavusgil, 2004), or a learning orientation (e.g., Rhee et al., 2010) are crucial to improving the performance and matching resources with the changing environment (Byoungho Jin, 2017). These strategic focuses are crucial for the advancement of TC, which boosts business performance. For instance, a focus on entrepreneurship aids in allocating technological and other resources for the advancement of TC. Additionally, market orientation plays a crucial role in creating value for customers and boosting company performance when paired with technology factors (Randhawa et al., 2020), since marketing capabilities can be linked to market orientation (Eng & Okten, 2011). By developing technology capabilities, which boosts a company's performance, this aspect of strategic orientation helps generate value for the consumer. The TC to provide new values for the newly established market is also a requirement for those engaged in strategically altering their activities. This strategic viewpoint encourages the development of TC that mirror the learning processes used to experiment with new technologies (Eng & Okten, 2011).

### B. Integrating technological capabilities with other organizational capabilities

Even if TC significantly contribute to a company's success, they cannot account for all of it. Technological capability requires support from other capabilities in order to have a significant impact, including dynamic capability (e.g., Wilden & Gudergan, 2014), marketing capability (e.g., Wilden and Gudergan, 2015; Su et al., 2015; Lisjak & Buhovac, 2008), absorptive capacity (e.g., Yang et al., 2019; Wilden & Gudergan, 2014), innovation capability (e.g. (eg., Jackson, 2017). These elements are crucial since mere ownership of cutting-edge technology cannot be considered a competency alone. Therefore, there is a need to integrate TC with other organizational capabilities to have more contributions towards enhancement of firm’s performance.

According to Gheitarani et al. (2022) absorptive capacity is further demonstrated as a dynamic capability by the notion that TC is specifically thought of as an ongoing process of developing or absorbing technology. This absorptive capability's integration with TC enables better performance and helps businesses adapt to changing market conditions. For instance, by utilizing

outside expertise, TC might raise the worth of the business (Gheitarani et al., 2022). The integration aims to take advantage of market opportunities in light of better performance. In other words, collaboration with foreign rivals to acquire access to cutting-edge technology and marketing systems is encouraged in order to hasten technical catch-up (Jackson, 2017). According to Wilden and Gudergan (2014), environmental turbulence may result in a capability gap between a company's current configuration of its marketing and technological capabilities and value-maximizing configuration in a new environment (Wilden & Gudergan, 2014). This necessitates the fusion of technological and marketing capabilities. But increasing profits in a dynamic market is not an easy task; it necessitates taking into account market knowledge, utilizing technology, being innovative through learning and R&D, and networking. It is necessary to reconfigure the assets in the form of capabilities in order to present a comprehensive picture of organizational capabilities. This capabilities might be dynamic capabilities, market capabilities, innovation capabilities, and so on. Then, there is a necessity to integrate this capabilities to provide a meaningful organizational capabilities, which is helpful in converting the inputs to outputs and exploiting opportunities in the dynamic market.

### C. The role of dynamic capability in integrating Technological Capability and marketing capability

DC is crucial for fusing technology and marketing capabilities to provide competences that boost a firm's competitiveness and growth. Because consumers' expectations are not reached by either the technology or the marketing aspects alone, more value is generated when technological and marketing capabilities are linked. The way DCs contribute to updating marketing and technological capabilities appears to depend on the level of competitive intensity and the combination of DC dimensions, despite the fact that configurations of DC dimensions affect marketing and technological capabilities (Cordero et al., 2022; Wilden and Gudergan, 2015). Since technological and marketing capabilities operate in an integrated manner in a highly uncertain environment characterized by intense competition, technological turbulence, and quick changes in the market, it is crucial to understand how they can be successfully leveraged (Su et al., 2015; Wilden & Gudergan, 2014). Thus, DC is crucial in the integration of marketing and technology capabilities because marketing capability aids in the selection of key technological assets through environment scanning. Additionally, combining technological and marketing skills through dynamic capability helps businesses, especially when it comes to adapting to a

volatile and dynamic market environment. This is so that internal resources and external competences can be built and rearranged to better suit the needs of a market that is constantly changing and a fast-paced environment. In order to address these changes in the dynamic market environment and produce better values by utilizing cutting-edge technologies, market capabilities are crucial.

TCs aid in the growth of a firm's use of scientific knowledge and cutting-edge technologies in the creation and provision of new values to customers. However, this will be accomplished by adopting and utilizing marketing capabilities to satisfy the demands of stakeholders in the competitive market. In this situation, DC is crucial to adapting the current technology and marketing capabilities to the changing market conditions through the application of innovative technologies. To get a competitive edge in the dynamic market, businesses must develop dynamic capabilities to align technology innovation with market realities. However, the value of technology and marketing capabilities changes in proportion to environmental turbulence, necessitating the identification of the optimal match between technological and marketing capabilities and the specific environmental turbulence conditions (Su et al., 2015). Because not all integrations are effective in the same way, the outcome may vary depending on the sort of market, the size of the organization, and its character. Clarifying the nature of alignment in various organizational structures as well as in the context of shifting external factors is therefore necessary.

According to Su et al. (2015), marketing and technology capabilities complement one another and have positive implications on a company's performance. Protogerou et al. (2012) stated that DC supports the alignment of marketing and technology capabilities with market conditions, which can result in performance differentials (Wilden & Gudergan, 2014). Their impact on business performance extends beyond just technological or marketing factors and can have an impact on a number of organizational outcomes, including fostering future values, raising customer happiness, enhancing the success rates of new products, etc (Lisjak & Buhovac, 2008). Without the help of DCs that merge TC and marketing capability, which supports strengthening its contribution to the success of the firm in various ways, these improvements in customer satisfaction and product success rate are not successful. In particular, DC demonstrates how the fusion of technological and marketing capabilities aids in the creation of new products that

contribute to revenue generation and performance improvement by responding to the uncertain market.

### 3.3.2. The dynamics of technological innovation capabilities (TIC) management towards firms growth

The ability to create and use current resources (such technologies) and capabilities that support innovation initiatives is referred to as having an innovative capability (Eng & Okten, 2011). Businesses should rely on technology-related innovation to preserve a sustainable competitive edge and produce new value (Yang et al., 2019). Industries working on technical advances will offer cutting-edge solutions by routinely monitoring the environment and meeting the shifting wants of the client. To accomplish this, businesses must equip themselves on the latest technical advancements and industry trends. In today's business climate, the firm's capacity to consistently produce innovations is one of its most crucial capabilities due to the combination of TC with market change (Ellonen & Wikstro, 2009). In order to improve TIC, creativity must be combined with technology advancements while taking the market's volatility into account.

Current empirical research in this field has generally used a set of TC as a stand-in for an existing body of previous knowledge and has further fostered innovation. Additionally, researchers contend that superior TCs are linked to a better rate of return on innovation (Yang et al., 2019). This suggests that knowledge and R&D capabilities might further contribute to the improvement of a firm's performance and competitive advantage. Additionally, some businesses need to constantly look for new partners that can contribute cutting-edge technologies and knowledge since they lack the resources for innovation during the technological innovation process (Cai Haowen; Chen & Antai, 2014). As a result, it is essential to clarify, the process for developing and utilizing technological innovation capabilities in the case of limited resources through collaborations with stakeholders. Besides, Narasimhan et al. (2016) emphasized that a firm's R&D competence may be thought of as its ability to transform R&D expenditure (a resource) into innovations. The firm's marketing capability may also be defined as the efficiency with which it translates marketing expenditure (a resource) into measures like sales or customer satisfaction.

### 3.3.3. Strategies for commercialization of technological innovations through market and industry knowledge

Because of the rapid improvements in technology and the current state of the market, businesses are under more pressure than ever to innovate. However, there are potential to commercialize technology advance in this competitive markets. To foster innovation through the creation of new products, TCs must be combined with other capabilities, such as a blend of R&D capabilities (value creation) and technology commercialization (value appropriation) (Franco, 2009). To adapt to the changing market environment, the R&D capabilities in this case combine complementing knowledge with technology resources. Besides, the stage of the NPD process where the interaction between technology-related capabilities and marketing-related capabilities is most likely to occur is new product commercialization (Song et al., 2016). Then, businesses must collaborate with partners to enhance their NPD (Hillebrand and Biemans, 2004; Cai Haowen; Chen & Antai, 2014). That's, the commercialization strategies must take into account both the integration of internal resource configuration (such as NPD) and external networking with stakeholders. Because rival companies who collaborate on R&D often work on similar projects, the knowledge base of those companies is more relevant. Additionally, co-opetition between competitors can help partners increase their knowledge, skills, and capacity for absorption (Wu, 2014). That is, for the creation of a new product and its commercialization, technological and market knowledge is essential. Further, the combination of technological knowledge and innovation produces powerful technological innovation capability, which improves the commercialization of firms' products.

The knowledge-based view (KBV), a further evolution of the RBV addresses a synthesis of the value of intellectual capital and encourages a systematic strategy to fully utilise the organizational knowledge base (Ju et al., 2018). The information and know-how components of knowledge must be accumulated in order to acquire expertise and the dynamic capabilities required to adapt to changing circumstances, according to the OC framework by Shoham (2011). A firm is expected to develop industry expertise in addition to market information. In particular, Bruni and Verona (2009) show how marketing expertise is essential for technological innovation in order to commercialize the innovative technology. Here, the creation of a new product and its commercialization depend heavily on industry expertise.

In conclusion, technological know-how is developed through technological innovation supported by R&D and NPD. Moreover, the commercialization of technologically innovated products would strengthen the developed technological know-how when backed by industry and market knowledge. Additionally, the firms' ability to develop new knowledge through R&D was dependent on a range of firm resources, including complementary assets in the form of knowledge developed through R&D in technologically related industries and in the form of tangible assets that would be used in the commercialization of conversion processes (Helfat, 2016).

### 3.3.4. The role of strategic management in international market expansion

For the purpose of entering international markets, it is crucial from a strategic perspective to build clear internal procedures, choose technology and product specifications, form new strategic partnerships, or implement best practices (Teece, 2007). Thus, businesses have organized their internal resources in order to expand to international markets. In order to develop dynamic learning and make changes in the technology industry, supply networks, users, and local research institutes must be established to adapt to local technologies (Gheitarani et al., 2022). Therefore, creating partnerships with rival businesses and other stakeholders is crucial to addressing these difficulties. Because these alliances facilitate resource pooling, technological transfer, cooperative R&D, and operational procedures. Strong TCs are essential for the success of this alliance since they enable businesses to form alliances with other businesses, which makes international expansion simpler and less expensive. Additionally, these qualities are crucial for adapting to the shifting customer needs.

The additional difficulties for businesses resulting from doing business abroad, such as foreign markets unfamiliarity and high levels of uncertainty and instability, must be addressed by capabilities research in the context of international marketing (Morgan, Feng, and Whitler 2018). Because of this, technological advancements have facilitated globalization to a significant extent (Jaffe et al., 2001), which calls for the development of technological capability to deal with the unstable and dynamic market environment. Additionally, improving market capability is essential in order to create a new product that will satisfy the shifting needs of international consumers. Above all, strategies that incorporate market orientations, internal resource configuration, and building partnerships while considering the global market into mind are

beneficial in obtaining values from TCs. Furthermore, multinational business ventures heavily rely on TC to promote NPD due to their technological advantage. Because there are components of uncertainty in international markets that can affect the choice of target markets, they are risky (Ju et al., 2018). As a result, choosing and catering to these foreign markets requires the development of a new product that takes into account a new foreign market. In this sense, TC is more crucial because businesses with superior TCs will internationalize at higher rates (Zahra, 2018). Additionally, it is crucial to evaluate how foreign enterprises rely on marketing skill to nurture NPD in addition to TC (Ju et al., 2018). As a result, the enterprises will be able to expand their operations to the worldwide market by integrating the internal and external components of their plans toward developing a strong technological capability. In order to improve the international market expansion, this strategic integration of internal resources and external partnerships would necessitate the involvement of R&D and external stakeholder networking.

### 3.3.5. A comprehensive framework

Recent strategy research has discovered that a firm's performance is a result of interdependent capabilities, highlighting the importance of taking into account portfolios of resources that are complimentary in nature and enable value generation and appropriation as a whole (Franco, 2009). In this view, a company's strategic orientations such as its entrepreneurial, market, and technological orientations are essential for successfully integrating its current resources with emerging technology in a volatile market. The properly configured resources subsequently help to ensure the success of the company by generating value and enhancing competitive advantage and performance. In order to successfully integrate these interconnected resources, the organization must have a clear plan for allocating its assets and resources. Studies in this area demonstrate a direct link between the success of a firm's TC and its constituent parts. For instance, TC was discovered to have an impact on the performance of businesses (Shoham, 2011) because it can enable product customization and enable quick responses to shifting market demands (Zahra, 2018). This might be accomplished through developing TIC and understanding of the industry, market, and current technology. The commercialization of innovative products would be aided by TIC development and the growth of knowledge-bases. Winkelbach and Walter (2015) discovered that high levels of both prior knowledge and absorptive capabilities increase the impact of complex technological knowledge on value creation (Yang et al., 2019). Therefore, knowledge development in regard to NPD and R&D is essential for generating value

for clients since it enables the company to combine the knowledge gained from R&D to produce new items that are simple to market.

The resource-based theory places emphasis on a firm's collection of resources and capabilities as sources for the development of sustainable competitive advantage in addition to their impact on the performance of the firm (Eng & Okten, 2011; Day 2011; Ju et al., 2018). When networks are built externally and resources are strategically structured internally, the arrangement of technology resources will be increasingly significant. Depending on the strategic management approach used by the company, the internal manufacturing processes and facilities must be integrated with cutting-edge technologies and available technological resources. The use of NPD, R&D, and the advantages of strategic networking and alliances should therefore be linked. In other words, the resource and capability viewpoints emphasize that businesses require a variety of capabilities as they pursue global expansion. As a result, it's important to coordinate the organization's technology resources and capabilities with its other resources and capabilities. (Cordero, Paez, Cristina Pinho, and Prange, 2022) further added that new resource allocations may lead to reconfiguring the company’s resource base to address new technological opportunities effectively.

Research has produced significant findings that support the framework already in place. Researchers have also noted that the most important factor in sustaining competitive advantage is capacities, or the acquired skills that allow businesses to coordinate their efforts and allocate resources (Day 2011; Ju et al., 2018). However, while planning the use of technologies and other resources, it is important to take the shifting market conditions into account. Since there are strong obstacles to imitation due to the embeddedness of business capabilities, firms can preserve their competitive advantage over time (Day 2011). This means that the fundamentally static resource-based perspective of the firm, which emphasizes the so-called valuable, rare, inimitable, and non-substitutable (VRIN) attributes when explaining the sustainability of the competitive advantage. However, it's insufficient to provide sufficient theoretical foundations for a realistic analysis of the success factors of contemporary firms operating in turbulent uncertain global markets (Sandstr & Virkkunen, 2002). However, technologically connected competencies can help businesses operate better by integrating with other capabilities (e.g., Pisano, 1994). This shows the importance of integrating TCs with other organizational capabilities for successful international market expansion.

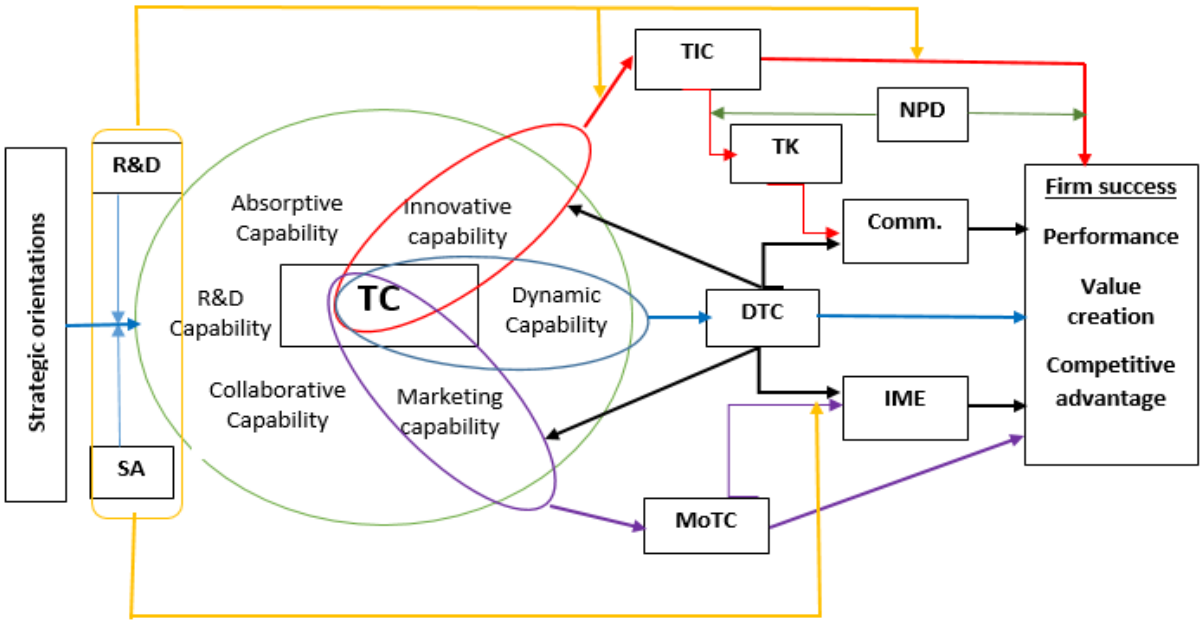


Figure 7: A comprehensive framework of TC inputs, integrated processes, and outcomes

Key: SA=strategic alliances; TIC=Technological innovation capability; TK=Technological knowledge; NPD=New product development; DTC= Dynamic technological capability; IME=International market expansion; MoTC=Market oriented technological capability; Comm.= Commercialization

According to the body of research, variations in organizations' DCs account for the majority of variations in innovative performance (Ellonen & Wikstro, 2009). The DC is required as an input when configuring TC with additional capabilities and resources. The integration of TC and innovation capability, in particular, is crucial for the marketing of new products created through R&D and strategic partnerships with other resources. On the other hand, in order to adapt to the volatile and dynamic market environment, DC is essential in integrating the TC with market capabilities. This is crucial in order to satisfy a more dangerous, ambiguous, and dynamic worldwide market demand. Since organizations with stronger TCs will have higher degrees of internationalization, TC is therefore more crucial (Zahra, 2018). Additionally, the TIC, market-oriented TC, and DTC are crucial in boosting the commercialization of innovative technology and broadening the global market in order to respond to the dynamically changing market demand. This achievement further makes the organizations to be successful in terms of value creation, improved firm performance, and enhanced competitive advantage.

## 4. Future research implications

Despite the significant growth of TC research, the causes and consequences of TC remain unclear. The links have not been systematically investigated in earlier studies. Additionally,

research are showing conflicting results about the directions of these relationships. Lack of systematic investigation on the causes, configuration, and effects of TC led to these complex interactions. Besides, there is a need to provide a hint for the researchers for further clarification of the variables related to TC. For instance, while studies have examined the role of R&D in enhancing international market expansion (e.g., De Massis, Frattini, & Lichtenthaler, 2012) and the impact of TC on this process (e.g., Zahra, 2018), there are still few studies that demonstrate how TC and R&D can be combined to enhance international market expansion.

In order to respond to the dynamic market environment, studies have shown how important it is to integrate technology capability with marketing capability (Wilden & Gudergan, 2014). Controversial findings are given, though. One of the contentious conclusions made by Su et al. (2015) was that market turbulence advances the performance effect of marketing capability but hinders that of technological capability. Meanwhile, technological capability improves but marketing capability is hindered by market turbulence. Therefore, it is essential to continue researching and clarifying how technological and marketing capabilities are combined to successfully run a business. On the other hand, there is no denying the significance of various talents for the performance and competitive advantage of the company. However, it is still unclear how the capabilities are integrated with the technological competencies and aligned with the dynamic and uncertain market environment, since the influence is not equally significant. This suggests that it is important to clarify how marketing and technological capabilities fit with other organizational capabilities, such DC. The combined impact of TC and other organizational capabilities on value creation, competitive advantages, and performance has to be studied by future researchers. Additionally, TC studies has to pay particular attention to the turbulent and uncertain market environment.

Although there is a connection between TCs and innovation, it is not evident how these two elements interact together to benefit the organization. For instance, Renko et al., (2009) revealed that TC is an excellent predictor of product innovation, while Zhou & Wu (2010) found that high levels of TC may prevent them from producing innovative products (Guerra and Camargo, 2016). Future studies will therefore need to provide more details on this controversial finding. They have to examine the reasons why excessive TC harms innovation in particular. TC is also recognized as one of the most important prerequisites for innovative enterprises developing new

products (Yu et al., 2014). However, if the innovation is introduced to increase product advantage, this finding might be reversed (Wong, 2012) since NPS may be negatively impacted by innovation (Guerra and Camargo, 2016). Therefore, in order to make sense of these conflicting conclusions, it is necessary to empirically clarify the significance of TC in developing new products and the role of NPD in linking TC with the performance of the firms.

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