Tomas Bata University in Zlín
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Doctoral Thesis

Examination of factors contributing to SMEs Innovation outcomes in the Visegrad Countries

Zkoumání faktorů přispívajících k výsledkům inovací malých a středních podniků v zemích V4

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DEDICATION

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ABSTRACT

Innovation has become a major factor affecting firms' competitiveness and growth. Firms have over the years' emphasis on introducing new ideas to support their growth and position itself on the market for higher profit. Small and Medium Scale Enterprises (SMEs) account for the bulk of businesses globally and are key contributors to job creation, poverty reduction and global economic development. Despite their growing importance in the national and global economy, they are face with varied challenges such as access to finance, increased competition, capacity limitations related to innovation, knowledge, and creativity. The visegrad group of countries are considered less innovative in the European Union, meaning that SMEs in these countries have weak innovation potentials because of their ecosystem. Until now, less studies especially in visegrad countries have focused on how firms especially SMEs can optimise innovative ideas to withstand the intense market competitions and staying profitable. This thesis examined the various factors contributing to SMEs innovation outcomes in these countries. The thesis examined the role played by both the internal and external environment of these SMEs and how it can influence their innovation outcomes. This study used the doubly robust estimation models, which helped overcome issues of confounding and endogeneity. Data for the empirical study was from the Business Environment and Enterprise Performance Survey (BEEPS V), conducted by the World Bank and the European Bank for Reconstruction and Development (EBRD) between 2017 to 2019. The final combined sample included 2494 SMEs pooled from Poland (1101), Czech Republic (380), Slovakia (338) and Hungary (675). The logit model results have shown positive and significant results that internal factors such as internal R&D, machinery, lines of credit and internet security aided in SMEs product and process innovation outcomes in the Visegrad countries. The results on the external factors demonstrate that government contract, financial services, external R&D and informal competition positively impacted technological innovation outcomes. The research further obtained a qualitative data of 15 respondents who are lecturers and academic researchers through interview guide (unstructured instrument) and found similar variables to examine innovation outcomes. They asserted that financial obstacle deterred SMEs in their quest for technological innovations and technology acquisition. Finally, the study also finds that tax rates, inadequate labour, financial obstacle, and loss due to theft impeded SMEs innovation outcomes in Visegrad Countries. The study offers theoretical and practical implications on how SMEs in these transition countries can improve their innovation outcomes.

ABSTRAKT

Inovace se staly hlavním faktorem ovlivňujícím konkurenceschopnost a růst firem. Firmy v průběhu let kladou důraz na zavádění nových nápadů, které podpoří jejich růst a pozici na trhu za účelem zvyšování zisku. Malé a střední podniky (SMEs) představují většinu podniků na celém světě a jsou klíčovými přispěvateli k vytváření pracovních míst, snižování chudoby a globálnímu hospodářskému rozvoji. Navzdory jejich rostoucímu významu v národní a globální ekonomice čelí různým výzvám, jako je přístup k financím, zvýšená konkurence, kapacitní omezení související s inovacemi, znalostmi a kreativitou. Země visegrádské skupiny jsou v Evropské unii považovány za méně inovativní, což znamená, že malé a střední podniky v těchto zemích mají kvůli svému ekosystému slabý inovační potenciál. Až dosud se méně studií, zejména v zemích visegrádské čtyřky, zaměřovalo na to, jak mohou být firmy, zejména malé a střední podniky, inovativní, aby obstály v intenzivním konkurenčním prostředí na trhu a zůstaly ziskové. Tato práce zkoumala různé faktory přispívající k výsledkům inovací MSP v těchto zemích. Autor zkoumal, jakou roli hraje vnitřní i vnější prostředí MSP a jak může ovlivnit jejich inovační výsledky. Tato studie používala probit regresi a model logistické regrese. Data pro empirickou studii pocházela z průzkumu podnikatelského prostředí a výkonnosti podniků (BEEPS V), který provedla Světová banka a Evropská banka pro obnovu a rozvoj (EBRD), v letech 2017 až 2019 s 2494 respondenatmi - SME z Polska, ČR republiky, Slovenska a Maďarska. Výsledky průměrného dopadu opatření ukázaly pozitivní a významné výsledky, že vnitřní faktory, jako jsou výkonnostní pobídky poskytované zaměstnancům, využití kapacit zdrojů / vstupů, efektivní strategie obchodních operací, pomohly při výsledcích inovací produktů, procesů a patentů v zemích Visegrádu. Výsledky studie ukázaly pozitivní a významné výsledky, že interní faktory, jako jsou výkonnostní pobídky poskytované zaměstnancům, kapacitní využití zdrojů/vstupů, efektivní obchodní operační strategie napomáhající výsledkům inovací produktů a procesů v zemích Visegrádu. Výsledky naší studie externích faktorů opět ukázaly, že technologie, licencované od zahraničních firem, externí spolupráce v oblasti výzkumu a vývoje, nehmotná aktiva, jako jsou ochranné známky a autorská práva, pozitivně ovlivnily výsledky inovací procesů a produktů. Výsledky logistické regrese však ukázaly, že daňové sazby, politická nestabilita, kriminalita, krádeže a nepořádek bránily malým a středním podnikům v procesech, produktech a výsledcích získávání patentů v zemích Visegrádu. Studie nabídne teoretické a praktické důsledky toho, jak mohou malé a střední podniky v těchto transformujících se zemích překonat a zlepšit svou nízkou míru inovací.

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LIST OF ABBREVIATIONS USED

2SPT	Two-Step Probit Test
BEEPS	Business Environment Enterprise Performance Survey
CIS	Community Innovation Survey
EBRD	European Bank for Research and Development
EC	European Commission
EU	European Union
GDP	Gross Domestic Product
IPWR	Inverse-probability Weight Regression
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
RBV	Resource Based View
SME	Small and Medium Enterprise
TE	Transition Economies
UK	United Kingdom
WB	World Bank

1 INTRODUCTION

1.1 Research background

Small and medium enterprises (SMEs) are considered to play major roles in countries' economic growth and well-being (Odei & Novak, 2020; Dey et al., 2022). Small businesses are seen as the most vibrant business sector for most start-ups and create jobs for the populace. In terms of innovation, SMEs undergo several innovation activities which help to transform the business through the provision of improved service deliveries and adoption of new product development. Small businesses are known to be the most functioning and vibrant business sector for start-ups and new job creation. In terms of innovations, they undertake several innovation activities which meaningfully help to advance their businesses in terms of improved service deliveries and new product development. Small firms constitute a pulsating of the European countries' main type of businesses, forming about 99 per cent of firms (Bassi & Guidolin, 2021). SMEs constitute about 90% of businesses in transition and developing countries (Srebalová & Vojtech, 2021). SMEs with fewer than ten employees and yearly profit of less than € 2 million are classified as micro-enterprises. Small enterprises have less than 50 employees and make an annual profit below €10 million. Medium-sized enterprises comprise less than 250 employees with yearly profits not exceeding € 50 million (European Commission, 2016; Nugent, 2016).

The relevance of studying SMEs innovation outcomes can be elaborated from different perspectives (Agostini & Nosella, A2019). First, SMEs have a huge impact on unemployment and gross domestic product (GDP). As described above, SMEs have reduced unemployment and contributed their share in GDP worldwide (Del Giudice et al., 2021). Secondly, in the context of the world's economy, there has been rapid growth in national economies due to globalisation and has adapted to the rapid changes in the innovation-friendly environment (The Dey et al., 2022). Thirdly, SMEs have encouraged entrepreneurship leading to competition (Afshari et al., 2020). Finally, they engage in research and development activities and the commercialization of economically viable research and innovations which can have positive externalities on economic growth. Although SMEs operate in different geographic regions, some authors discovered that SMEs play key roles in technological innovation development which is fundamental for achieving and sustaining economic growth (Piwowar-Sulej & Kołodziej, 2022: Zygmunt, 2018).

In recent times, knowledge, research, and development are driving the firm's growth. Innovation is very important to firms in new European Union countries, considering there is increased competition due to the fast pace of globalization. Innovation is seen as the vital resource that can enhance and position firms competitively in the tensed global markets (European commission, 2016). Although it cannot be disputed that innovation helps firms to be very competitive,

it has been highly beneficial to the European regions (Stejskal & Hajek, 2015). Studies on innovations in the Visegrad group of countries have overly focused on large firms at the expense of small businesses albeit the constitute the bult of businesses. This bias means that our understanding of firm-level innovations in these countries is not balanced. A comprehensive understanding of innovation will warrant a focus on small businesses. This thesis therefore fills in this gap by focusing on understanding the factors driving small businesses innovations. This thesis focused on the empirical analysis of the internal and external factors capable of driving small businesses innovation performances. The analysis also focused on examining the business environment in these countries to see which aspect of it can impede small businesses quest for innovation. The nexus between the businesses environment and small businesses innovation has not received ample scholarly attention although it can buttress and sustain firm-level innovation process.

This thesis is structured as follows; chapter one introduces the subject and current state of small businesses innovations. Chapter two outlines the motivations of this dissertation, the research methodology, aims of the dissertation. Chapter three focused on the theoretical background, and reviews of recent literature on factors driving small businesses innovations. The conceptual framework, research hypotheses and definitions of all constructs used are also elaborated. Chapter four outlines the methodologies and research design comprising sample, data collection tools, and analytic techniques. Chapter five presents the empirical findings of the dissertation and presents a general discussion of the results of the research in relation to recent existing literature. Chapter six concludes the thesis and provides contributions to theory and practice, limitations and suggestions for future research.

2. LITERATURE REVIEW

2.1 Theoretical underpinnings

Innovation economists primarily believe that drivers of economic growth in a recent knowledge-based economy are not the accumulation of wealth as neoclassical economics believes, but with innovative ideas coupled with knowledge and technology (Braunerhjelm et al., 2018). Economic development in innovation economics factors knowledge, policies, technological spillovers, collaboration and creating innovative environments (Fromhold-Eisebith et al., 2021).

The endogenous growth theory is very prominent, considering its role in knowledge spillovers and the economic development processes (Romer, 1990; Grossman & Helpman, 1994). However, other growth theories are considered to be among the role of knowledge in the economic growth process (see Aghion & Howitt, 1998). According to Solow (1957), the level of development can be attributed to the role played by technological advancement but needs to use consultants and external collaborators in the scientific processes irrespective of the economic factors. But according to strong proponents of endogenous growth theories, knowledge occurrence is not a coincidence when it comes to economic and social development; it takes conscientious effort and the availability of resources to be efficient. Policymakers invest heavily in utilizing resources through effective collaboration with research institutions to produce novel knowledge. Mazzucato & Li (2021) also emphasize that a public good that possesses spill resources over with zero marginal cost is knowledge. The spillover effect is heavily connected with diverse knowledge, which forms the basis of increasing revenues, which helps long-term economic development. Knowledge spillovers happen when knowledge and information concerning an innovative activity are used to generate new ideas that can transform the business setting. Due to innovation, new services and product development have been attributed to knowledge spillovers (Stejskal & Hajek, 2015). The relevance of knowledge spillover is that the rate at which development increases is equivalent to the total number of labours engaged in collaboration with research and development. The policy implies that both public and private sectors increase the number of labourers for research to increase the growth rate in knowledge stock, increasing per capita growth in the long run.

The endogenous growth model seeks to address the production function on knowledge which is schematic to the advancement of knowledge creation. This means the number of new ideas from academic research depends on the labour input for R&D activities. Romer (1990) believes that knowledge spillover in a country would heavily depends on the stock of knowledge.

The Romer model assumes that economic knowledge comes first when it comes to innovation activities, but we should note that knowledge can spill over. Knowledge spillovers can result in inter-temporal spillovers, which would result in endogenous growth in the long run. The firm heavily investing in R&D would generate huge sums of revenue in future. Mazzucato & Li (2021) also pointed out that knowledge inherently differs from all the old factors of production. New ideas depend on the ‘‘intertemporal spillover knowledge’’ of future researchers. The efficient application of technology and knowledge production is made possible due to historical growth such as stock of scientific, technological know-how’’ (Fromhold-Eisebith et al., 2021).

Innovation has come to be part of human existence. Therefore, there is a need for all firms to adopt systematic advancement of products, processes, and organizational work methods to embrace it. This is why Joseph Schumpeter's work on innovation in 1934 has widely been accepted, contributing to the field. Schumpeter (1934) defined innovation as new ways of producing things and exploiting new markets in an organized business. This definition to date is being used, and Eurostat's Community Innovation Surveys and Oslo Manual (OECD, 2005) affirms it. The Oslo Manual emphasizes that ideas with insufficient novelty can be classified as something other than innovation. Conversely, those significant improvements to organizational performance are acknowledged as innovative (OECD, 2005; Reçica, 2016).

Firms could develop a model for new processes or products through innovation activities. According to González-Fernández & González-Velasco (2018), a newly developed framework may represent inventions, but not necessarily innovations. To become innovative, conceptual models must meet commercial standards. Stefko et al. (2020), asserts that coming up with an idea may not be necessary if it cannot be implemented. A new innovative model could be of economic value if it has the potential to be commercialized. Innovation does not necessarily mean an invention but depends on the inputs and the research, which may lead to inventions and innovation even though it may fail to generate output (Schumpeter, 1934).

Companies engage in innovation processes to increase their competitiveness, productivity, and market share, ultimately increasing turnovers (Odei et al., 2020). Various innovation theories and firm performance have changed drastically during the era of Schumpeter. While the neoclassical school of thought affirms that all markets always tend towards an equilibrium, the Schumpeterian theory posits technologies create a continuous market disequilibrium. One limitation of the neoclassical theory is that it does not factor in technological change as a significant factor. This has been pointed out in the new growth theory (Romer, 1990; Grossman & Helpman, 1994), which emphasizes that growth and technology development must be simultaneous.

Alternative theories are more of an evolutionary view which assumes that if the human environment continuously evolves, then the way humans perceive innovation could also change (Bubak, 2021).

According to Penrose & Penrose (2009), the resource-based view (RBV) suggests that employees are crucial to innovation development and growth. The RBV accentuates that owning strategic resources offer firms golden opportunities to build and sustain competitive advantages over other market rivals as firms can take advantage of these strategic resources to innovate (Lundvall, 1998; Barney et al. 2011). Strategic resources encompass both capital and physical assets such as land, human and social capital, new knowledge, organizational processes, firm features, capabilities, and coordinative structures. New knowledge is widely accepted as a valuable strategic resource which can propel sustainable firm performance leading to improved competitiveness. The challenge of firms having limited internal resources, which would help in their innovation outcomes, was suggested in the 'open innovation' approach, where R&D collaboration for external knowledge and resources are considered viable for firm's innovation outcomes (Weissenberger-Eibl & Hampel, 2021).

In line with various literature and the effect of innovation on economic development, innovation can be seen as the major driver for change at micro and macro levels. The European Union sees innovation as an avenue for growth and to be more competitive with other world economies, so the EU is heavily increasing its R&D investments. For the EU to exceed this target, the private sector enterprises would have to play a major role as the generators and owners of the innovation processes. This is very important for transition economies seeking full EU integration and those new EU member countries that still need to catch up to other advanced economies regarding innovation activities and firm growth. In addition to developmental issues, transition economies (TE) face some form of reforms, and their market environment targets industrialized economies to reach their targets. While the literature on innovation activities and firm performance has mainly focused on advanced economies which has classified them as technological innovation leaders, research in transition economies has attracted less attention.

2.2 Firm innovation theories

Research on the impact of firm performance and innovation outcomes has attracted many studies. According to Kline & Rosenborg (1986), profits earned from first-mover innovators face a threat from competitors who imitate the products to take a share of the market and turnover.

Therefore, too many firms will eventually be in the market, bringing down the average profit of firms into the expected profit. This effect will drive subsequent innovation by some firms as whoever makes the bold decision to invest in innovation gains more competitive advantage. This process of adopting

innovation eventually changes the economy. An OECD (2005) report has affirmed that innovation has no economic impact without diffusion. Again Schumpeter (1934) affirms that innovation theory has had massive modification throughout the 20th and 21st Centuries since he published his first work on innovation. Improved data availability significantly affected some research methodologies and theoretical views, which evolved mainly in the last thirty years.

2.2.1 Schumpeter's contribution to the literature on innovation

The discussion on the impacts of firm-level innovation dates back to the classical economist theory. Freeman (1982) claimed that "Wealth of Nations" by Adam Smith (1776) suggested some important role of innovation activities but under different themes, as an improvement mechanism by those firms who want transformation and development in terms of their process, product and marketing. Furthermore, other authors have seen that apart from Adam Smith, Karl Marx, in their models connected to the capitalist economy of 1858, highly acknowledged the significance of the technical change in capital goods, while Alfred Marshall (2009), in his "Principles of Economics" described knowledge as a critical factor to economic development. Despite all the indications pertaining to the importance of innovation as posited by the earlier economist in their work on innovation, "The Theory of Economic Development" in 1934 and later in "Capitalism, Socialism and Democracy" in 1942. The earlier researchers' ideas on innovation helped develop the first book, which is now referred to as Schumpeter Mark I (1934), while those are Schumpeter Mark II (1942). Eggink (2013) notes that when Schumpeter published his theories earlier in his research, innovation was not part of mainstream economic thinking. However, it started attracting the attention of many economists in the 1980s. As suggested by Carlsson & Eliasson (2003), Schumpeter's work on innovation has contributed massively to the economic literature, which has been a positive way for society to understand sources of economic growth and development. Schumpeter Mark I theory is characterized by the significant role played by businessmen and new firms entering the market and factoring in innovative activities. Schumpeter (1934) assumes a constant disequilibrium created mainly by new ideas, leading to innovation among firms.

2.2.2 Alternative theories on innovation

Following the neoclassical school that considered innovation essential to organizational growth and development. Solow's (1957) works presented a growth model that also factored in technological change as an exogenous explanatory growth factor, emphasizing that technology is an external factor influencing innovation outcomes. Solow asserts that the impact of technological changes on firms' productivity considered labour and capital equal, meaning that any change in the firm's innovation performance would have the same effect on its labour and capital, which could be termed as 'neutral technological change'

(Woodhead & Berawi, 2020). Neoclassical economists view firms as optimal allocators of resources, which means that firms can adapt to external shocks leading to movements in and along the production function (Larentis et al., 2013). Neoclassical economists affirm that firms can adopt stable economic growth depending on internal factors such as competent employees and substantial working capital. The exogenous technological change would determine the long-term growth of the firm with sustainable policies (Zumbung et al., 2014; Odei et al., 2020). According to Lazonick (2012), firms should not only consider exogenous factors to innovate but combine other factors to justify the neoclassical theory of firms' innovation. The significant difference between the neoclassical and Schumpeterian theories is that the neoclassical theory assumes an economy which tends towards equilibrium, whiles the Schumpeterian theory takes an economy at continuous disequilibrium caused by innovation (Eggink, 2013). Although the Schumpeterian theory of innovation is essential, the empirical literature on innovation growth and development was mainly based on Solow's neoclassical model until the 1990s.

Since the early 1990s, the neoclassical growth theory has evolved, and new ideas are considered endogenous to growth (Romer, 1990; Aghion & Howitt, 1998). The endogenous growth theory asserts that the level of innovation activities and technology explains economic growth. In contrast, innovation activities depend on the share of GDP (Grossman & Helpman,1994). The endogenous growth theory posits the simultaneity in the relationship between innovation and growth from the macroeconomic point of view. However, similar feedback effects are also assumed at the organizational level. In recent times, endogenous growth theory has been at the centre of most studies regarding innovation at the macro and micro levels (Del Giudice et al., 2021). Furthermore, earlier studies on endogenous growth theory posit that innovation considers internally determined factors, such as internal firm knowledge, research and development expenditures, and organizational structure (González-Fernández & González-Velasco, 2018; Santos et al., 2018). This theory considers innovation development from an organizational point of view and needs to factor in employees making innovative decisions connected to the Schumpeterian theory (Eggink, 2013). It also shows that innovation activities should be adapted to the changes in the market environment and the practical implementation of innovation activities within the organization. According to kline & Rosenborg (1986), innovation can be perceived as a non-linear model where the results would be a result of R&D expenditure and the stages of production. The authors emphasized that the various steps involved should be accounted for in the innovation process and should not only factor in how innovation inputs are changed into output in a linear dimension. In addition, other authors also suggested that the market environment and management are crucial in determining the innovation models for the firms (Edquist, 2010; Bubak, 2021).

The continuous growth in knowledge utilization and the interaction between actors involved would lead to introduction of innovation systems (Edquist, 2010). The main contributions to the literature on innovation systems seek to classify the major role played by institutions as a facilitator of innovation on the microeconomic level (See also Freeman, 1982; Lundvall, 1998).

According to Lundvall et al. (2002), the concept of innovation systems and the role played by stakeholder institutions can change any economy worldwide. The idea that the market solves all the issues in developed economies made innovation systems more peripheral. Before Solow's neoclassic growth model, which clarifies the significance of firms' resources to the advancement of innovation, Penrose (1959) earlier emphasized that innovation should be more structured and organized to have an impact on societal development. The economic literature from Penrose was considered the basis of the intellectual foundation of the "resource-based theory" for firms. Cantwell (2000) links her theory to the Schumpeterian, or a neo-Schumpeterian school of thought assumes that innovation is an internal firm factor, and that R&D plays a crucial role in large firms. According to Penrose (1959), in the longer run, companies' profit, rate of firm survival, and growth would be based on the firm's ability to create a resource base that can help in the adaptation of their business operations despite the rapid changes in the firm's dynamics to the economy. Furthermore, other researchers see her work as the foundation of the resource-based theory, which supports that their heterogeneous resources determine firms' heterogeneous growth (Wernerfelt, 1984; Cool & Schendel, 1987). The resource base theory aims to optimize the firm's current resources and capabilities and increase its resource base for the future (Penrose and Penrose, 2009). Wernerfelt (1984) defines three essential resources companies depend on to develop innovation: human capital, physical capital and organizational resources. Among the three types of resources, Penrose and Penrose (2009) suggest that human resources constitute an essential factor for adapting to new knowledge, changing environment, and continuous learning. Similarly, the resource-based theory also suggest that the competitive advantage depends on how resources are valued (Cohen & Levinthal, 1990).

However, according to Odei & Novak (2020), the importance of new ideas encourages firms to organize whichever resources are better than their competitors because having new ideas is a unique resource for developing radical innovation. In this regard, most of the literature on the resource-based theory has focused on the knowledge heterogeneity of firms (Poazi et al., 2017). Correspondingly, Poazi et al. (2017) suggest that companies' knowledge-based theory assumes that wealth-creation capacity is based on the knowledge and capabilities they acquire to maintain all innovation activity.

The resource-based theory has been criticized as it is yet to be applicable in developing economies with limited resources. Odei et al. (2020) claim that innovation is weaker in emerging economies, thus lacking internal firm knowledge aiding innovation activities. Unlike developed economies where incremental innovation prevails, the resource-based theory's concept may not be appropriate. However, this problem can be tackled through external collaboration with firms (De Faria et al., 2010) though, as Laursen & Salter (2014) argue, collaboration within the resource-based view takes a different vertically integrated research approach which looks at the in-depth rather than the breadth of knowledge. Several pieces of literature on firms' innovation activities seek to combine diverse sources of knowledge that are more likely to lead to the creation of ideas for innovation (Odei et al., 2020; Poazi et al., 2020). This is somehow true for developing economies, where internal firm knowledge is limited (Descubes et al., 2013) than for advanced economies. However, it has been hugely neglected in recent innovation literature which needs to be captured. In line with these studies, recent innovation studies promote all kinds of collaboration in the innovation process. Open innovation uses internal and external knowledge to execute innovation activities. Chesbrough (2003) assumes that a firm's internal knowledge can be commercialized so that companies value it, while external knowledge can be internalized to utilize the value created outside the business environment. Chesbrough further argues that using intellectual property only for internal purposes and neglecting external knowledge is not an optimal option for firms. Still, alternatively, they should find ways of collaborating to make use of goods in the market and gain new ideas from research.

Overall, we may say that, compared to other studies on innovation, open innovation considers both the internal and external knowledge resources in its integration model and thus aims to increase firms' knowledge and efficiency of the innovation process. Knowledge is also considered a strategic resource as suggested by the resource-based view.

2.3 Innovation and types of innovation

Globalization has heightened the competitive pressure in markets in recent, the adoption of technological changes in new product and process development for small and medium enterprises (SMEs) could be the solution to withstanding these intense market competitions. Innovation plays a key role for SMEs in building firms' competitive advantage (Anwar, 2018). According to Bayarçelik et al. (2014). The Organisation for Economic Co-operation and Development (OECD) classifies innovation into four types, namely: process, product, marketing and organizational innovation (European commission, 2016). Other researchers, classify these four innovation types into two groups thus technological innovation which broadly consist of products and processes while

non-technological innovation also broadly comprises of both marketing and organizational innovations. Technological innovation involves several activities like utilizing and adopting new technologies, production techniques, management strategies, improving existing production techniques, exploring new markets, and reaping profits. It can be inferred that technological innovation necessitates R&D, improving production processes, efficient organisation decision, which when done effectively could contribute to greater sales turnover (Yigitcanlar et al, 2019; Afshari et al., 2020). Non-technological innovation refers to kind of innovation activities which do not have technological motives (Hervas-Oliver et al., 2021). Non-technological innovation is pertinent for firms' innovation and its related activities as it balances technological innovation, and it can be described as introducing improvements into firms' new marketing systems and organizational structure. Non-technological innovation is exemplified in the use of improved management practices, the implementation of appropriate organizational structures and new corporate strategies.

Advances in modern technologies, numerous consumer preferences and the short life cycle of the products have increased keen competition among SMEs, and this has been a compelling reason to innovate. These intensified competitions have coerced small businesses to improve their methods of producing new products, processes and services deliveries. The processes and techniques used in creating the product can be new to the firm that used it, or it could be new to the market. Based on the degrees of novelty, innovations can be classified as major and minor. **Minor innovations** refer to discoveries (products) that are substantially new to the business that created them (Granstrand & Holgersson, 2020). They could be created based on continuous R&D, making them significantly distinct from all other firms' goods. Major innovations therefore comprise of radically new technologies or the blending of current and advanced technologies. Contrariwise, **major innovations** can be described as product innovations produced by companies that are new to the markets environment where the firms operate; by this, they become the first to offer these new products to the market ahead of their market rivals (Granstrand & Holgersson, 2020). According to Schumpeter (1940), the theory of creative destruction posits that companies involved in innovative activities have a competitive advantage in tackling noninnovative firms. Theoretically, SME innovation is expected to boost a firm economic performance. Nonetheless, empirical studies' results have constantly contradicted innovation outcomes (Martínez-Román et al., 2020). Several studies indicate that innovation does not necessarily lead to improved and better performance.

Studying innovation helps explain how some firms innovate more quickly than others by identifying driving factors that help their innovation outcomes. However, there have been problems identifying some success factors driving a firm's innovation outcomes worldwide (Campos & Giovannoni, 2007). Although

there have been issues surrounding some factors contributing to firms' innovation performance, many studies still need to provide a more integrated framework for innovation. This could be attributed to the higher expectations of companies to satisfy their customers and maximize profit through several actors like networking with academic institutions, including academic universities, companies, and the public in the area of operation coupled with organizational policies. Such forms of collaboration provide a clear picture of SMEs' innovation activities. According to Cohen & Levinthal (1990), a research model on the concept of innovation was suggested for us to understand the whole innovation framework.

Many recent studies have developed different models to assess firms' innovation outcomes using the structural equation model and multiple equations (Hall, 1987; Chen et al., 2017). Similar studies have been conducted on societal & environmental responsibilities, which tend to increase organizational performance through "green practices" (Rekik & Bergeron, 2017).

The variant literature reviewed considered SME innovation outcomes at the macroeconomic level, but we can also understand a firm's performance in detail by looking at the microeconomic factors. Studying at the microeconomic level has more advantages since it will consider all the determinants of SME innovation.

2.4 Defining SMEs innovation factors

A company’s internal and external conditions affect their aptitude to innovation as a result of changes in the business milieu, competition, short product cycle, and technological advancement (Saunila & Ukko, 2013). Innovation ensures that firms meet consumer needs and capitalize on new marketing opportunities, making firms more competitive to retain the market or obtain a new set of clients (Tian et al., 2018).

2.4.1 Internal factors

Firm-level factors such as the availability of resources, competent skilled personnel, and the firm’s ability to conduct research and development significantly impact technological innovation outcomes (Mikalef & Krogstie, 2020). Inconsistencies by SME managers in determining the causes of their failure to adopt technological innovation have been a major setback to SMEs in Europe (Győri et al., 2019).

2.4.2 Firms characteristics

Reviewed literature supports that companies' attributes are the endogenous factors that affect their survival. Thus, identifying some of these factors will enable firm managers to know which aspects need investment to be innovative

(Wong et al., 2020). Examples of firm's demographic factors are explained briefly below.

- Age and size of the firm

Many authors assert that the age of a company could affect its survival and growth (Baumöhl et al., 2020). The entrance of new SMEs to the market puts the firm at a greater risk to survive than existing firms because new firms do not have previous experiences to learn from to improve. They also lack legitimacy or reputation when compared to older firms that limit their access to external resources. Furthermore, SMEs find themselves in highly competitive environment, so old firms might have devised strategies to withstand this competitive pressure than younger firms. A study by Heider et al. (2021), found among others that being small and owning limited resources negatively correlates with the SME's survival rates in adopting technological innovation.

- Organizational structure and Community networks

The organizational structure of firms can also influence on its innovation prospects. The structure and strategic roles are the major factors that may affect the survival and growth of the organization. This structure can affect its decision-making process including the innovation decisions. Complex structures could make decisions on innovations difficult as it can delay the innovation process. How successful they will be in the quest for innovation also depends on the network they establish with other partners such as other firms, institutions such as universities and higher education. Social networks could be beneficial to small businesses innovation if they have the absorptive capacity to assimilate new knowledge from these partners (Chen et al., 2017).

- Product competitiveness

Competitive advantage is the factor that allows a company to produce quality goods and services better or more cheaply than its competitors (Muscio & Ciffolilli, 2020). Furthermore, competitive advantage allows firms to survive, have greater market share, and have effective marketing strategies for developing and improving existing products (Dai et al., 2021). Firms' inability to offer new products makes them uncompetitive, which often leads to a decline in sales (Williamson et al., 2020).

- Human capital

Human capital can be defined as the commitment, attitudes, knowledge, values, educational qualification, experience, skills and abilities in employees that help individuals to be innovative (Diebolt & Hippe, 2022). Highly skilled human capital has human capital externality as they as able to absorb new knowledge and assimilate that into the innovation process. They also have the skillset needed to fuel the innovation process and they usually have higher

knowledge gained from higher education. Usually, people with higher university degrees are classified as having higher knowledge. Human capital is an internal determinant for a company's survival as it helps employees to grow and makes them productive with their new ideas of manufacturing. According to Astor (2021), human capital is very necessary in the development and survival of the firm, which enables the firm to compete with other firms.

Many researchers have shown that there exists a positive relationship between SME's human capital and the success of the business (Sobakinova et al., 2019). Newly established SMEs are liable to failure due to inadequate human resources to execute the aims and business strategy of the company. However, human capital factors that affect either the success or failure of newly established SMEs involve the active workforce's background. Although these successes or failures are connected to the attitudes and motivation from management to employees, effective and competent resource personnel should be recruited.

In the past, economic theorists have attributed the key role of SMEs in building a strong economic system through technological innovation and the recruitment of individuals with an entrepreneurial mindset which has led to economic growth and regional development (Odei & Novak, 2020). However, employee recruitment should be emphasized to the experienced personnel to new entrants SME as they can determine best technological practices to be innovative. Furthermore, technological innovation is the central point for employees to be trained constantly and develop new ideas. The technology transformation process itself is the creation of new ideas with employees within a firm to produce a distinctive product in the market.

2.5 External factors influencing innovations

According to Yoruk (2019), the macro-environment is defined as exogenous factors around companies that facilitate technological innovation during start-up and SME lifecycle across Europe. Some authors assert that external factors present threats, opportunities and all the necessary information affecting SME external environment, regardless of the firm’s business concept and background (Odei et al., 2021).

Some authors list external factors such as socio-demographics, cultural, political, economic, markets (local, international, emerging and well-established markets), legal, infrastructure and other physical factors found in an environment (Yoruk, 2019; Sobakinova et al., 2019). According to Tian et al. (2018), the macro-environmental factors are not easily controlled. The success of SMEs depends on management’s ability to blend these factors with their internal activities. However, Rustin & Poynter (2020) argued that for newly established firms across the European region to be successful depends on the state of specific factors within the European boundaries with a stable political, economic, and

social factor. Moreover, these factors significantly impact the level of risk, access to markets, financial support, and networking. The study groups external factors into two major categories: market environment and macro-economic. The market environment involves all productive factors that attract firm opportunities and make them competitive, whereas macro-economic factors include all economic, political-institutional and social-cultural factors.

2.5.1 Market opportunity factors

These are firm-specific factors connected with SME, they constitute market conditions with consumers' interest, considering suppliers' and intermediaries' demand. These factors are briefly discussed below:

- Market conditions

Market conditions are crucial for the life cycle of SMEs and can facilitate technological innovation. The weakness and complexities of SMEs led to low predictability, which does not allow for the proper planning of the firm (Sein & Vavra, 2020). The growth and expansion of SMEs compel them to adopt technological innovations to be able to command large market share. Suitable market conditions such as favourable competitions could be a significant factor that can ensure the success of SMEs (Muscio & Ciffolilli, 2020). Favourable markets conditions are well enhanced by favourable competitive laws in a country, without these laws, some firms will be better off whilst others will be worst off. For instance, a poor selection of a market will lead to market heterogeneity and poor growth prospect due to limited market size, which can negatively affect technological innovation (Edeh et al., 2020). Therefore, knowing the market conditions have a positive impact on technological innovation.

- Demand for supply and competition

Firms rely on markets for survival, and the markets in which these companies sell their products have to factor in the demands of their customers for adequate supply, leading to market attractiveness (Martínez-Román et al., 2020). The demand for SMEs products is a key factor influencing the success of an SME. Greater demand will lead to increased sales which can lead to higher turnovers. However, low demand for products and services is a bit of challenge limiting SME growth outcomes (Edeh et al., 2020). In recent times, SMEs have operated globally, and their activities are characterized by such an intense competition from rival firms. Moreover, concentration on competition within a market helps the SME to utilize new strategies to technological innovation and counter-competition from rivals.

- Geographical location and access to markets

The geographical location has implications for SME managers to access the market and other resources such as finance, infrastructure, distribution, and logistics (Sein & Vavra, 2020). SMEs success depend on accessible location and continued future business operations within the vicinity (Tian et al., 2018). Stable access to the market and meeting consumers will help curb barriers that prevent new entrants to the market. Again, other factors such as limited export opportunities and inadequate access to profitable markets do not encourage technological innovation (Srhoj & Walde, 2020). The era where firms' internationalization has become vital, the location of the firm can allow it to benefit from the positive gains of exporting (Odei et al., 2021). Some peculiar reason for the success of smaller firms to export their products lies in the determinants of the new entrants to the competition and the demand by international buyers.

2.5.2 Economic factors

The success of SMEs depends on the state of the national economy conditions within the firms' country of operation and market. Examples of such economic factors are discussed briefly below:

- Fiscal policies

One major factor inhibiting SMEs development and growth is fiscal policies taxation (Sein & Vavra, 2020). Tax rates for instance can be an incentive and disincentive to firms' innovations. If tax rates are high, they reduce the SMEs' profit margin, taking away investment that could be used for the innovation process, contrary, lower tax rates can encourage small businesses to invest in innovations as the taxes do not significantly reduce profit margins. In Europe, the cost of doing business has been smoothly structured and incorporated value-added tax (VAT). Furthermore, good exchange rates allow for the export of commodities, meaning that firms that export can gain foreign currencies and invest in their operations and innovations. Low-interest rates from the financial sectors facilitate access to capital, meaning SMEs management can have uninterrupted access to needed resources for their business.

- Political-institutional factors

The linkage between innovation and political and institutional factors have been well established in the bourgeoning innovation literature (see Tomizawa et al., 2020). Globally, governments play essential roles in resource allocations particularly in transition and developing countries where institutions are characterized as weakly developed (Kafouros and Aliyev, 2016). Deep-rooted political instability promotes distrust and insecurities, serving as a strong impediment to sustainable innovations. Political instability is generally associated with incompetent institutional abilities, uncertain innovation

outcomes, economic growth rates, and decreased investment (Tomizawa et al., 2020). Institutional excellence influences territorial behavioural responses to start innovative activities, if not, it stifles innovation investment (Kafouros and Aliyev, 2016). Another area where political institutions can determine the innovation process is by factoring emigrant skilled workforce such as engineers, researchers, and scientists to promote it.

2.5.3 Macro-economic policies

According to Ratten (2019), the Macroeconomic policies and framework could facilitate or hinder technological innovation outcomes among SMEs. All the necessary trade and investment policies could provide an enabling environment that encourages the sustainability of SMEs' operations and innovation outcomes. In addition, a hostile business environment can determine the inconsistency in the legal and regulatory system, making the cost of doing business very expensive. The European Union laws are considered flexible, but there are some challenges to enforcing rules, regulations, and policies to promote national interest that constitutes the vibrancy of SMEs in selected member countries (Sein & Vavra, 2020). Although some regulations are still an issue, the EU has put in place trade deregulation that has supported technological innovation (Nichiforel et al., 2020).

- The judiciary

Consistencies and reliability of the judiciary are very important for SME development as they provide legal protection against any infringement against intellectual property rights, implement competition laws, enforce contractual obligations between SME parties, and administer effective company laws (Martínez-Román et al., 2020). Weaknesses in the judicial institution could make it incapable of functioning effectively and efficiently to promote firm-level innovations. Activities that render the judicial system ineffectual to enhance firms' innovations include extortionate transaction costs, bribery and corruption, and delays in the adjudication process. Weak institutional frameworks in transition countries such as the Visegrad could largely explain the inability of legal institutions to efficiently promote firm-level innovations. Our result on the weak judicial system's inability to promote innovations has been studied in various emerging economies and supports this study.

- Public support

Public innovation is a vital determining factor for improved national and regional innovation functioning (Meijer, 2019). Detailed innovation policies span a broad array of traditional policy areas, which goes beyond R&D, to include policies on finance (public and private), education, fiscal policies, industrial competition, and innovation networks. The rationale for public support for innovations and its related activities is deep-seated in the traditional market

failure argument (Lapuente & Suzuki, 2020). When prices are high, market failures contribute to the uneven allocation of resources and the unavailability of funds to reinvest in innovation activities. Public financial support is a remedy to eliminate all forms of hindrance to social development and could slow down regional innovation systems.

- Political stability

The relationship between innovation and political instability has been well proven in the growing innovation literature (see Athanasouli & Goujard, 2015). Stronger governmental influence is a vital factor distinguishing the business.

2.5.4 Socio-cultural factors

Environment of developed economies from developing and transition countries. Political instability fosters scepticism and doubts (Allard et al., 2012), serving as a strong obstacle to sustainable technological development and innovations. Political instability is generally linked with ineffectual institutional functioning, modest economic growth rates, and reduced investment inflows. Political institutional quality helps develop behavioural response initiatives to undertake innovations and its related activities (Martínez-Román et al., 2020).

Good climatic conditions encourage all staff members to be energetic and motivate them to be innovative by accepting all kinds of risk, which help them to adopt professionalism (Rigtering & Weitzel, 2013). An innovative, friendly environment is an innovative culture that takes all the necessary risks to ensure employees are being creative and always sharing ideas. According to Kanu (2015), one critical factor of an innovation-friendly environment is promoting safe surroundings and permitting employees to try innovation processes. The impact of government policies, such as reducing corruption in acquiring SME operation licenses, could lead to firms' performance (Kanu, 2015). Socio-cultural conditions could determine the country's development stage. Most of these conditions talk about culture, which may create an enabling environmental condition that may benefit SMEs to adopt technological innovation. Some examples of socio-economic factors are discussed below:

- Culture

This is considered as the shared values, norms and beliefs in a society. This is an important contextual factor affecting SME development in each community or region. Moreover, the levels of SMEs activities are affected by cultural norms because the difference in culture generates differences across regional and national boundaries (Del Giudice et al., 2017). Communities with low entrepreneurial culture discourage members of the society from indulging in SME business and not talking about innovation which brings them achievement and social recognition. According to Hofstede (1982), the innovation-friendly culture

details how technological innovation's social and cultural determinants can transform a country's development. Hofstede stressed how culture determines an innovation-friendly environment to promote and improve firms' growth through innovation activities (Hofstede, 1982). Hofstede sees innovation as a driver of economic growth, and he emphasized the ability of firms to orient themselves to certain societal factors in a cultural environment which is very friendly towards innovation. Hofstede (1982) concluded in his research that creativity and the culture of innovation are skills which could be translated into institutional reforms for the European region.

- Access to public infrastructure

R&D infrastructure plays significant roles in enhancing innovations both at the macro and micro levels. R&D infrastructure can contribute to facilitating the innovation as they can be the medium on which science and R&D can thrive. Governments can improve science and technical education through the provision of important infrastructure for innovations such as laboratories, science parks and intellectual property rights protection etc. SMEs across Europe have access to services such as water, electricity, good telecommunication networks, accessible roads, electronic media and good postal services, which are needed to stimulate innovations (Gray et al., 2020). Limited access to these public infrastructure affects their operations and restricts their access to the market. Most SMEs in Europe have access to public infrastructure, which makes their operation successful.

- Access to financial support

The source of public financial support for innovation is contingent on the form of governmental system a country has. Across the European Union, there exist three main sources of public subsidies for innovations and R&D. The first is from the national governments, which are specifically aimed at promoting innovation collaboration with governments and other country-wide institutions such as public research institutions and universities (Radicic et al., 2020). Secondly, the European Union (EU) funding sources is intended to narrow the innovation spending gap among EU member countries and other main global economies. EU funding harmonizes various national policies intended to encouraging investments in innovations and R&D activities (Czarnitzki & Lopes-Bento, 2014). The final source is normally from sub-national government sources designed to promote innovations at the sub-national level. Access to funding is a major contributor for innovation to be successful. According to Kamasak (2015), financial resources have contributed to firms adopting new innovative ideas and using modern technology to execute innovation. Innovation capacity is defined as firms having all the necessary structures and collaborating with research institutions to tackle internal and external issues (Hagen et al., 2014). All firms need financial support in order to start their innovation activities. According to

Kastrati (2015), companies need some capital to adapt to new technologies, irrespective of the firm's size. However, the sources of funds to improve the SME sector has remained low (Ranga & Etzkowitz, 2015).

- Access to skilled labour

The availability of qualified skilled workforce (human capital base) of countries and businesses can also be a significant factor of firm-level innovations. The availability of knowledgeable and experienced skilled labour force (generally measured with the total number of graduates with higher education degrees) is a notable necessity for successful and sustainable innovations (Bartelsman et al., 2019). This is because higher education produces graduates with essential skills and knowledge needed for the innovation process. Skilled labour has higher externalities, they can contribute to increasing productivity and innovations by generating new knowledge that can be assimilated in the production and innovation processes (Kuivalainen et al., 2013). Highly skilled personnel have enhanced absorptive capacities, able to incorporate new knowledge into their daily work procedures (Voinea, 2015). Regular training of skilled employees through knowledge sharing and creativity helps to inspire new ideas that could be applied to enhance productivity and innovations.

- Crime

Low crime and security are prerequisites for the survival and growth of businesses across Europe. High crime rates negatively affect investment activities and sales output and increase operating business costs (Jawadi et al., 2019). Across Europe, the crime rate is low and has encouraged both new and existing SMEs to adopt technological innovation to facilitate their business operation. New emerging SME firms benefit more from innovation activities than already existing ones. This makes emerging firms enjoy successful innovation, especially when the environment is free from theft and crime. The flexibility of new emerging SMEs doing business smoothly in their environment depends on how these companies adopt new technology to eradicate cybercrimes. Cybercrimes will likely decrease sales output (Jarvis et al., 2018). However, the order for firms to achieve successful innovation outcomes depends on governmental policies against cybercrime.

2.6 Innovation input

The literature usually measures innovation input with R&D expenditure devoted to innovation and its related activities. Odei & Novak (2020) also used employees and research scientists as an input to analyse overall innovations, while Rossi et al. (2012) also used the number of hours employees commit to the role. Some authors consider only internal R&D expenditures as the measure to the firm's innovation input (Bartelsman et al., 2019; López-Fernández et al., 2021). Alternatively, Benavente & Bravo (2009) measured innovation intensity

using the firm's turnover. Other researchers define innovation expenditure in a broader perspective, including investment in machinery and other valuable assets that are not directly connected to the firm's innovation (Mairesse & Mohnen, 2010; Widjaja et al., 2020). In his first published work in 1934, Schumpeter used firm size as one of the key determinants of innovation outputs. The renowned researcher posits that firm's size determines the idea behind its innovation but explained that larger firms innovate faster than smaller firms due to readily available resources resulting from their profit margins. However, Mazzucato & Li, 2021) suggested that firms in a competitive market have higher motivation to innovate than firms operating under monopolistic conditions. Most literature has shown a positive and significant relationship between firms' size and their innovation intensity (see Benavente & Bravo, 2009; Torkkeli et al., 2009), while other studies discovered a negative and insignificant relationship (Widjaja et al. 2020; Bubak, 2021). This means that the results are not consistent across different studies.

Moreover, regarding market dominance, Schumpeter's assertions that firm size contributes to innovation input is confirmed empirically by several studies (Voinea, 2015; Weresa, 2018). Some authors used different approaches to assess the effect of market competition on innovation input but still found a positive relationship (Kingston, 2001; Aghion et al., 2005), whiles others discovered a negative relationship (Levin et al., 1985). Furthermore, Cohen & Levinthal (1990) argue that knowledge base factors are rudimental to firms' innovation input. They further defined knowledge as skills developed by employees through involvement in technological research or technically called 'absorptive capacity.

Although firms indulge in innovation, they are expected to increase their knowledge and the possibility of completing future innovation projects, although companies do not complete a project (Mention, 2011). Although the use of internal knowledge is very crucial to innovation, firms require internal resources. However, Freeman (1982) suggests that a company's innovation activity highly depends on collaboration with external consultants. Later, Chesbrough (2003) developed the concept of 'open innovation' which posits that there would be effective innovation activities among firms if there exist effective collaboration outside the firms, then internal factors should not be ignored.

In line with the innovation's systems approach, institutions' major role in promoting innovation can be facilitated through public funding. Conversely, a study by Odei & Novak (2022) indicates that most studies on innovation that focus on public funding limit private investment in R&D. Among other reasons, they emphasise financial constraints and the high risk of R&D contributing to the crowding of private investments. However, several studies in transition economies indicate that public funding support contributes massively to

innovation outcomes. Still, they are not governments' priorities because they allocate limited funds and resources compared to developed economies.

Again, firms belonging to international group positively contributes to innovation inputs. Firms have complete access to marketing activities leading to technological innovation outcomes and financial resources (Yigitcanlar et al., 2019). According to Rodriguez et al. (2016), foreign-owned firms are more likely to adopt innovation successfully than firms that do not belong to any international membership group (Guadalupe et al., 2012).

Another factor proven to influence innovation outcome is the protection of intellectual property using tools such as utility models, trademarks, patents etc. If firms operate in an enabling environment where innovation activities are safeguarded, the chances of receiving full benefits of innovation are higher. According to Bartelsman et al. (2019), a positive relationship exists between intellectual property rights protection and how firms heavily invest in radical innovation. All these inputs determinants could be hindered by market and cost, which negatively influences the innovation input process but positively affects innovation outcome.

2.7 Innovation output

Innovation output processes have been identified and measured in different ways. According to Hall (1987), patents are used to measure innovation activities. Some authors also use product, process or another type of innovation to measure innovation outputs (Haar, 2018), whiles others used the proportion of sales outputs to measure general innovation outcomes.

Innovation outcomes could be explained by investment in R&D and other innovation activities (Bubak, 2021). The resource base theory suggests that firms become more productive depending on their resources (Mention, 2011). Creating new knowledge and internal R&D activity over time is very important (Calik et al., 2017). According to Taques et al. (2021), the novelty of product innovation is significantly explained by internal R&D activities, which could impact the novelty of innovation in advanced economies.

Odei et al. (2020) argue that external consultants enhance innovation outcomes as an alternative to firm internal-based innovation. Mention (2011) emphasize that collaboration with external firms is crucial for enhancing radical innovation. The rationale behind firms employing the services of consultants is to facilitate the use of new innovative ideas. Collaboration with third parties such as academic universities may result in a multidisciplinary approach in introducing unique products to compete with competitors (Odei et al., 2020). Most studies have investigated the effects of collaboration on innovation output and have found substantial influence on firms' innovation outcomes (see López-Fernández et al., 2021; Bubak, 2021).

Furthermore, access to information is an important factor for explaining innovation output. A study conducted by Paredes-Frigolett et al. (2021) discovered that informational network sources and conducting research positively influence innovation and the degree of novelty, while a firm's network information sources have insignificant effects. Again, a study by Mention (2011) found out that market information increases a firm's ability to increase radical innovation, whiles business strategic information sources result in incremental innovation. Similar studies conducted by Hashi & Stojcic (2013) have found both positive and negative impacts on sales outcomes. The inconsistencies in most of the research conducted may be explained by country specifics and different methods employed during the studies.

Another factor that cannot be overlooked is firms' ability to protect intellectual property, influencing innovation output. Firms doing well in innovation activities are measured by patents, copyrights and trademarks, which helps firms to come up with new products. Some studies that posit that firms' ability to protect intellectual property enhances innovation output (see also Brandl et al., 2019; Rani et al. 2021).

2.8 Overview of SMEs in the Visegrad Countries

Recently, SMEs have evolved as the fundamental source of positive business development in the Visegrad Group (Pasnicu, 2018). SMEs need more capital and human resource personnel to enable business operations (Watkins, 2012). Thus, SMEs are more vulnerable to business risks than larger firms (Falkner & Hiebl, 2015). In taking business risks regarding innovation activities, SMEs incur losses and damages due to their negligence in business operations. SMEs mostly encounter challenges during business operations' early or final stages (Wang et al., 2016; Ghenţa & Matei, 2018). However, SMEs are exposed to different forms of risk, such as taking operational, financial, strategic, and hazardous risk assessments (Cepel et al., 2019). The variant literature shows how firms handle risk to achieve their goals in the long-run (Ferreira de Araújo Lima et al., 2020). SMEs are therefore encouraged to embrace calculated and uncalculated risk in their strategic plans.

SMEs in V4 Countries are well-known for their positive economic contributions, although they face global competition (Antoniuk et al., 2018). Innovation in the Visegrad countries is yet to be fully embraced compared to advanced economies such as the UK, even though some barriers must be avoided. The Visegrad Countries are noted for similarities in economic development, history, and political ideologies.

2.9 Indicators and measurement of innovation outcomes

This section carefully assesses the characteristics of different indicators of innovation used in the economic literature and discusses their limitations and strengths. According to Paredes-Frigolett et al. (2021), one of the major challenges has been emphasized in the literature, with input and output being measurement indicators. The last stage in the innovation process could be seen in the product outcome. To achieve sustainable innovation, firms must actively recruit and engage competent employees and heavily invest in technological innovation. Research and development (R&D) expenditure and employee headcount in relation to R&D are commonly used in the economic literature to determine innovation inputs. All input indicators could be R&D expenditure which would help assess the financial costs can help check the return on innovation activities at the micro and macro levels. The R&D indicator helps to set innovation targets at the country level. However, R&D expenditure can be used to determine the input intensity of the innovation process, but its commercial output can be used to check its successful factor. As defined by the Oslo Manual (OECD, 2005), no innovation occurs if innovation outcomes do not lead to a commercialisation.

Therefore, the innovative capacity of the Visegrad countries can be measured by its ability to produce and commercialize their innovations for long-term economic development. Innovation capacity depends mainly on the environment and infrastructure on innovation. Although these two key determinants drive innovation at the national level microeconomic-based factors, ideas-driven growth and the national innovation system are major contributors to the growth of Visegrad Group. To measure the country-specific factors that drives innovation outcome, we consider each of the three approaches to determine the flow of innovation towards national development. According to Porter (1990), the microeconomics that drives national competitive advantage, technological innovation and economic growth are:

1) Availability of innovation inputs (skilled, qualified and competent R & D personnel).
2) Rewards and incentives.
3) Domestic demand for various producers and services.
4) Collaboration between social institutions.

Furthermore, potential growth of each country can be attributed to industrial collaborations, educational system, governmental policies, cultural traditions and other factors and non-governmental bodies (Xie et al, 2021). The National Innovation System (NIS) places emphasis on the interactions among social institutions such as higher educational institutions, firms and governments. These interactions account for innovative behaviour of firm in each country with the main objective of identifying key innovative players and the role played by the

government in observing the system. NIS has over the years determine the flow of innovations in countries that has helped to determine the direction of the national innovation capacity. According to Lundvall et al. (2002), the NIS adapts the best approach for countries through the nature of higher education system, the extent of intellectual property right and the division of labour within industries. Lastly, the differences in innovation outcomes between countries can be attributed to economic geography and governmental policies on innovation.

Overall, a broad range of indicators helps analyse whichever innovation outcomes, but the results cannot be used for general discussions as it also depends on other factors. The input, such as R&D expenditure, can determine innovation output, while patents as an output indicator may only sometimes lead to product commercialisation. Alternatively, commercialised innovation outcomes can be used directly to measure successful innovation. Likewise, the data on newly introduced products which are sold on the global market can provide information on the degree of innovation novelty; thus, it distinguishes between radical from incremental innovation. This is key in analysing the determinants of the firm's ability to introduce radical innovation and what extent innovation can be attributed to the firm's performance.

Table 1: Internal and contextual measurement of innovation outcomes

Category	Variables	*Literature adapted from*
Firm internal factors		
Firm's overall characteristics	Age / Size / Firms Ownership / Past performance records	*(O'Cass& Weerawardena,2009) Deschryvere,(2014)*
Firm's logistics	Assets / operational facilities / Protection mechanisms for employees	*(Ranga & Etzkowitz, 2015)*
Firm's structure	Formal & Informal structure / structured firm / competent employees	*(Odei & Novak, 2020)*
Control variables	Membership Association/ Countries	*Guadalupe et al. (2012)*
Firm's innovation culture	Resistant to change/ Innovation oriented	*(Kanu, 2015).*
Management practices	Firm's leadership Hierarchy / qualification of managers/ working experience /risk avoidance/ Perception of innovation outcomes	*(Kuivalainen etal., 2013)*
Business's strategy	R&D assets / outsourcing department strategies / technology equipment /	*(Ranga & Etzkowitz, 2015)*

	Advance Marketing strategies / Monitoring of competitors / Annual turnover / Profit margins	
External variables		
Firm's industry variables	Sector / Industry demand growth / Industry concentration	*(Ranga & Etzkowitz, 2015)*
Firm's location variables	External markets proximity	*(Rigtering & Weitzel, 2013)*
Collaboration	R&D centres/competitors	(*Ranga & Etzkowitz, 2015*)
	membership associations / external consultants / customers engagement	
Foreign Technology	Trademarks / technology license acquisition	*Guadalupe et al. (2012)*
Acquisition		
Governmental policies	Funding/Infrastructure development	*(Hagen et al., 2014), Ranga & Etzkowitz, 2015)*
Enabling environment	Environment free from theft, crime & disorder/Political instability	*Rigtering & Weitzel, 2013),*

Source: Becheikh et al. (2006)

2.10 Barriers to value creation for innovation

Obstacles to innovation may arise from internal or external threats to the firm, which may also be categorized according to how firms see them, which could be endogenous or exogenous. Internal barriers may result from human-related risk from top managers, inadequate personnel (researchers), or poor record-keeping on the SME operators. Conversely, it could also be assessed based on external environment which could be affected by legal institutions, economic institutions, policy stability and cost of telecommunication among others.

Inadequate human capital is an obstacle that could hinder innovations within SMEs. Although we can recognize the impact of highly skilled resource personnel as the key factor to innovation, the demand for these resource personnel has been hindered by low wages, quality of education (Nugent, 2016). From a different dimension of human capital problems, the intent of SMEs to collaborate is deeply affected by the innovative tendencies as a result of the competent employees in the field with high absorptive capacities (Birgit et al., 2018). This is usually measured with the percentage of the population with university degrees. It is assumed that university graduates will be able to absorb and assimilate new knowledge vital for innovation production and sustaining. When this cannot be guaranteed it could serve as a barrier for firms' innovation search.

Furthermore, embarking on innovations is a cost intensive activity, so without sufficient research funding firms will not be able to innovate. If they start

and run out of funds, they may abandon the process leading to resource wasting. Small businesses are usually resource constrained and this affect their access to innovation funding from financial institutions. They do not usually meet the demands of financial institutions to be granted loans. Issues such as collateral demands pose a challenge to access to funding. This inadequate access to funds hampers SMEs innovation performances leading to low levels of innovation in comparison to large firms that abound in resources.

In academia, some studies have revealed that economic and human-related issues affect these institutions' innovation hubs. In recent times, there has been a tremendous transformation in higher education due to the rise in the number of international students and collaboration, making higher education competitive in Europe. Some European universities' studies discovered transparency, nepotism and corruption-related issues as some leading factors hindering SME innovation (Lašáková et al., 2017).

Insufficient research funding and an unfriendly environmental innovation environment strongly influence firms within the European Union. There have been factors that have deterred both regional and community development. On the market, the demand for products and insufficiency of firms to meet competitors' demand has been crucial to innovation failures.

3. RESEARCH PROBLEM, QUESTIONS, OBJECTIVES AND SCOPE OF THE STUDY

3.1 Research gap

The growing innovation literature in Visegrad countries and other transition economies exhibit numerous caveats that limit the degrees to which firms' innovation can be significantly understood and evaluated. They usually understate innovations in small businesses, they are usually biased and often centre on large firms in the manufacturing sector (See for instance Odei et al., 2020). Albeit SMEs are known to significantly influence the economies of these countries, they do not receive enough scholarly attention like large firms (Mura et al., 2017). We argue that for a comprehensive understanding of general innovations in countries, SMEs that form most enterprises need to be given greater consideration. Furthermore, the extant literature reviewed also showed that studies on innovations in these countries have neglected vital factors such as the business environment in which firms operate that can be an incentive or disincentive to firms' innovations. We argue that studying the business environment could offer very valuable insights to understanding the innovation ecosystem and aspects of it that can be improved to enhance innovation outcomes, technology and knowledge diffusion in these countries. The neglect of these important factors makes our knowledge of innovation in these countries inadequate, therefore calling for research that incorporates all these for better comprehension of innovation. This these fills these identified research gaps by

building upon and extending the open innovation, resource-based view theory and national innovation systems models to internal, external factors and business environment factors by focusing on small businesses (Tu & Wu, 2021). This study asserts that positive gains on SME innovation outcomes can be influenced by both internal and external factors within and beyond SMEs (Fernández-Olmos & Ramírez-Alesón, 2017; Lašáková et al., 2017).

The latest innovation performance report on the Visegrad countries paints a mixed picture of innovation in these countries (Hudec, 2015). As shown in Table 2 below, these four countries are categorized as moderate innovators with weak innovation capabilities and trailing EU average on all innovation benchmarks (Odei et al., 2021). Current science technology and innovation (STI) policy follow the traditional centralized top-down nature. Current sectoral innovation policies often ensue in embryonic national and regional innovation systems and weak innovation performances. Given that innovation, new knowledge and technologies are crucial means to achieving rapid and sustainable growth, these economies innovation performances seem to be on the wrong footing. Aspects of the innovations in these countries making them lag other EU countries include low public support for innovations and R&D, ineffective firms' partnership, weak patent applications, shortage of skilled human capital, along with low adoption of new technologies (Skala & Beauchamp, 2017; Gyimesi, 2021).

Figure 1. Map of the study area Source: European Innovation Scoreboard (2020)

Table 2. Country Ranking of Innovators

Leaders of EU Innovation	Strong Innovators including the UK	Moderate Innovators (EU)		Modest Innovators in EU
Sweden (SE)	Germany (DE)	Croatia (HR)	Spain (SE)	Romania (RO)
Finland (FI)	Belgium (BE)	Portugal(PT)	Poland (PO)	Bulgaria (BG)
Sweden (SE)	Ireland (IE)	Slovakia (SK)	Lithuania (LT)	
Netherlands (NL)	United Kingdom (UK)	Hungary (HU)	Malta (MT)	
Denmark (DK)	France (FR)	Greece (GR)	Poland (PO)	
	Luxembourg (LU)	Estonia (EE)	Latvia (LV)	
	Austria (AT)	Slovenia (SI)	Czech Republic (CZ)	
			Italy (IT)	

Source: European Innovation Scoreboard (2020)

3.2 Research objectives and research questions

The main aim of this dissertation is to examine the factors influencing SMEs' innovation performance across Visegrad countries.

Specific objectives of this study

The first specific objective of this thesis is to examine the internal factors that can drive small businesses innovation performance. The focus will be on assessing whether internal factors such as internal R&D, overdraft facility, membership organization, machinery, lines of credit, internet security, training could impact on innovation outcomes. Other firm characteristics such as sectors, were considered as internal as they are embedded in firms. Measures of innovations considered here are product and process innovation. We consider whether these internal factors outlined above could impact SMEs innovation outcomes. Some studies on the internal factors within the Visegrad countries (see also Mura et al. 2017; Odei & Novak, 2020).

Table 3. Explanation of Variables World Bank Data (Internal factors)

Variables	Description	Studies used
Dependents		
Innovations Outcome	Product innovations (0,1)	Cieslik et al. (2014), Krasniqi & Desai, (2016)
	Process innovations (0,1)	
Independent		
Overdraft facility	Production targets given to employees on weekly and annual basis for product and process innovation (0,1)	Cieœlik et al (2003).
Internal R&D	In-house training and reward schemes (0,1)	Belas et al. (2017) Rahman et al. (2017)
Internet security and lines of credit	Adopting strict business operation strategies internally (0,1)	Cieslik et al., (2014), d'Agostino & Pieroni, 2019
Membership organisation	Firms belonging to internal organisation (0,1)	Ashyrov & Masso, (2020), Rahman et al (2017).
Machinery	Effective Business Strategies (0,1)	Akhvlediani, (2017)
Control variables		
Sectors	Manufacturing activities calls for innovation (1,2,3)	Cieslik et al., (2014); d'Agostino & Pieroni, 2019
Countries	Countries ranking in terms of innovation activities internally (1,2,3,4)	Moller & Skaaning, (2010).

Source: Own elaborations

In pursuant to meeting the first specific objective outlined above, the following research question was formulated.

RQ1: Which internal factors are capable of influencing SMEs innovation outcomes?

The second specific objective is a follow up of the previous objective stated above. Besides the above-mentioned internal factors, it is expected that SMEs search for innovations will be affected by several external factors which is in line with the open innovation theory. Thus, internal capabilities will not be sufficient for sustainable innovations. This theory proposes that firms search for innovation need to be extended to factors beyond the firms internal confined. The external factors can impact on innovations, but SMEs might not have direct control over make the cost of innovations been expensive to firms. Thus, it is imperative for

SMEs to know the external factors they can harness to improve their innovations. Some studies on external factors leading to a firm's innovation outcomes in the Visegrad (Zygmunt 2018; Odei et al., 2021). Innovations in the Visegrad countries are improving, although at a slower pace. Countries in the Visegrad fall into the moderate innovator group, with their performance lying between 50% and 90% of the EU average performance (Moller & Skaaning, 2010: Cieslik et al. 2014). But little is known about the external factors such as governmental grants, external R&D activities, etc., driving SME firms' technological innovations and patent acquisition outcomes in the Visegrad countries. Improving the external innovation outcomes of firms in Visegrád countries calls for further research.

International technology linkages could also be beneficial for SMEs in these countries for instance. Strengthening international technology linkages could be more beneficial to improving innovation outcomes, as it can have technological spill over effects in these Visegrad four which are characterised with low levels of innovations and technologies. SMEs could therefore acquire these technologies from foreign countries through licensing agreements with foreign own companies. Other factors such as public support are external to the firm, but when they have access it can contribute to spur innovations. This specific objective therefore analyses whether these external factors could impact SMEs innovations. Table 4 below provides a general overview of the variables used for the empirical estimations.

Table 4. Explanation of variables external factors

Variables	Description	Studies used
Dependents		
Innovations Outcome	Technological innovations (1,0)	Cieslik et al. (201), Krasniqi & Desai (2016)
Independent		
Government contracts	Public support from the EU and governments in various countries (0,1)	Cieœlik et al (2003).
Technology license from foreign firms	Acquiring technology from foreign owned firms (0,1)	Belas et al. (2017) Rahman et al. (2017)
External R&D	Collaborating with R& D firms (0,1)	Cieslik et al., (2014), d'Agostino & Pieroni, 2019
	Collaborating with external consultants (0,1)	
Informal competition	Effective Business Strategies (0,1)	Akhvlediani, (2017)

Financial services	Whether firms have access to funds in operating at the international front (0,100)	Rahman et al (2017)
Control variables		
Membership Association	International recognition certificate (0,1)	Moller, J., & Skaaning, (2010)
Countries	Countries ranking in terms of innovation activities internally	Moller, J., & Skaaning, (2010)

Source: World Bank survey, (2021)

Therefore, to fulfil the second specific objective outlined above, the research question to be addressed is.

RQ2: Which external factors influence small businesses' innovation outcomes in Visegrad countries?

The third specific objective examined the barriers that possibly affect SMEs in their search for innovations. It is expected that SMEs search for innovations will not be without obstacles. We analyse the barriers which are usually embedded in the business environment that could negatively affect cost of investments in innovations and operations. Within the business environment obstacles such as fiscal policies (tax rates), labour regulation, inadequate labour, losses due to theft and inadequate financial obstacle, etc, could be strong disincentive SMEs in the Visegrád Group of countries innovations. The focus was to assess which of these barriers significantly impact SMEs innovation performance. The results will guide firm managers and policy makers on measures to implement to reduce the negative impacts of these barriers on SMEs innovations. Some studies that have highlighted on SMEs innovation outcomes (Oláh et al. 2019; Nemec et al. 2021). We used country dummies as control variables to examine which of these countries could be negatively influenced by these outlined innovation barriers.

Table 5. Explanation of variables in the specification

Variables	Description	Studies used
Dependents		
Product innovations	If the firm introduced product innovations (1, 0)	Cieslik et al. (2014), Krasniqi & Desai (2016)
Foreign technology licenses	If the firm presently uses technology licensed obtained from foreign-owned firms (0,1)	
Independent		
Tax rates	The extent to which tax rate was perceived as an obstacle to firms' operations (0, 1, 2, 3, 4)	Cuaresma et al. (2014).
Tax license	The extent to which tax licence was perceived as an obstacle to firms' operations (0, 1, 2, 3, 4)	Voinea, (2015).
Labour regulation	The extent to which labour regulation was perceived as an obstacle to firms' operations (0, 1, 2, 3, 4)	Cieslik et al., (2014), d'Agostino & Pieroni, 2019
Inadequate labour	The extent to which inadequate labour was perceived as an obstacle to firms' operations (0, 1, 2, 3, 4)	Campos & Giovannoni (2007).
Financial obstacle	The extent to which inadequate finance was perceived as an obstacle to firms' operations (0, 1, 2, 3, 4)	Cuaresma et al. (2014).
Losses due to theft	The extent to which crime and theft were perceived as obstacles to firms' operations (0, 1, 2, 3, 4)	Moller, J., & Skaaning, (2010)
Control variables		
Countries	Countries ranking in terms of innovation activities internally	Moller, J., & Skaaning, (2010)

Source: World Bank survey, (2021)

Note: Description based on measures used in the Enterprise Survey

Therefore, the third research question to be addressed to answer this research objective is

RQ3: Which innovation barriers significantly influence SMEs' innovation outcomes?

3.3 Conceptual framework

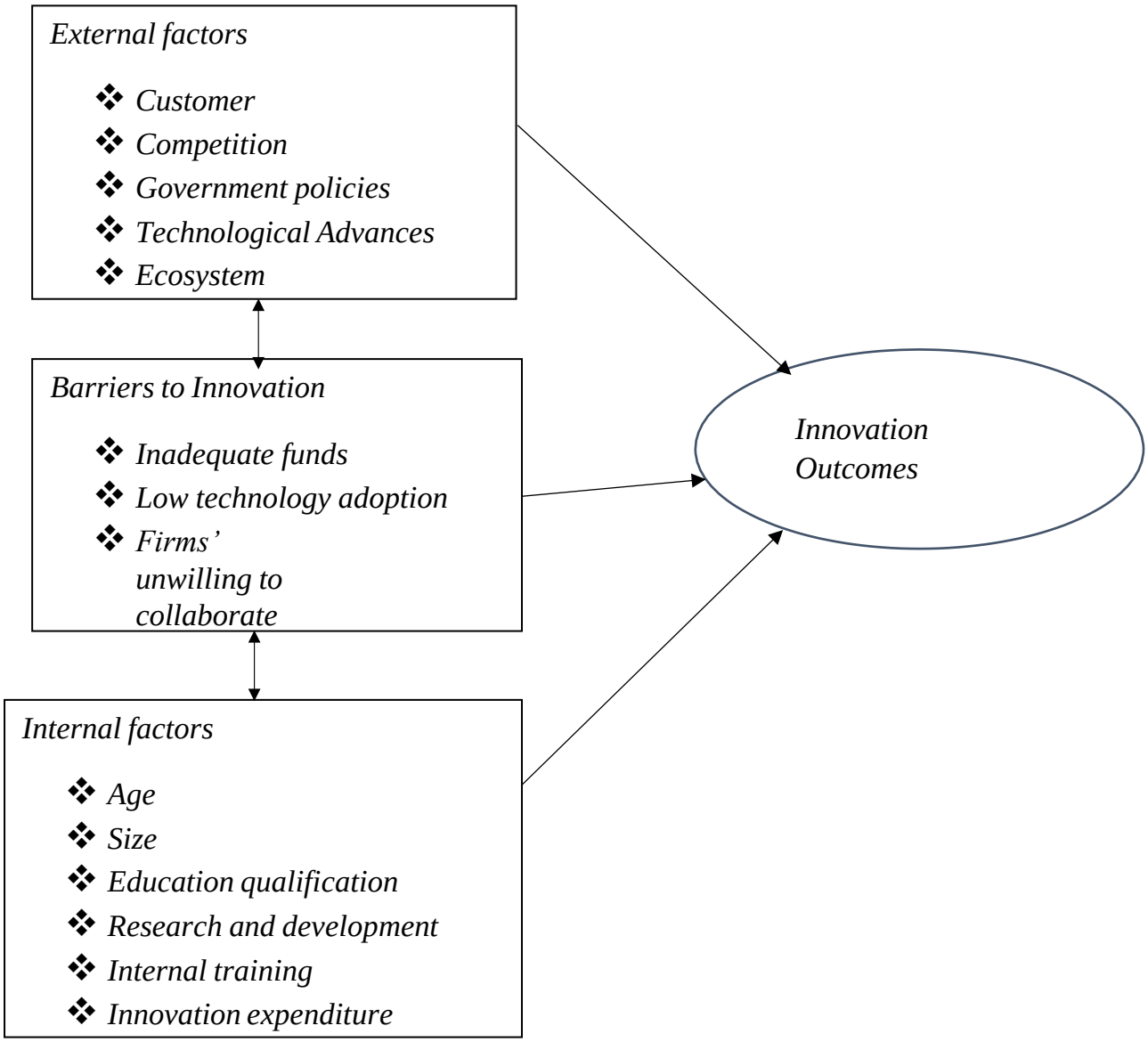

Figure 2. Conceptual model for SME's innovation outcomes (Source: author's own)

3.4 Definition of constructs and literature sourced

Table 6. Definition of constructs and literature sourced

S/N	Some constructs for external &Internal factors	Definition	*Literature adapted from*
1	Firm Investment	The size of the SME and technology the firm adopts is a crucial factor whenan investment is needed.	*(O'Cass & Weerawardena, 2009) Deschryvere, (2014)*
2	Human resources	Human resource managers tend to provide both direct and indirect role which allows research and development through firm's collaboration	*(Kuivalainen et al., 2013)*
3	Intellectual asset	The creative expressions of new ideashave been keen in the knowledge acquisition for firms and expert scientist	*(Ranga &Etzkowitz, 2015),*
4	Linkages	Collaborative research as a circumstance where ''expert scientist and firm's jointly commit financial, human and physical resources to a particular project''	*(odei et al., 2021)*
5	Research system	In-house technological capability involves intensive training of the ITexperts and must be a continuous routine	*(Odei & Novak, 2020)*
6	Financial support	financial resources are main drivers for innovation which can happen if SMEs adopt to new innovative ideas through modern technologies	*(Hagen et al., 2014), Ranga& Etzkowitz, 2015)*
7	Innovation-friendly environment	Innovative friendly environment involves innovation culture which involves taking risk, involvement of employees through creativity and sharing of roles assigned to them	*(Rigtering & Weitzel, 2013), (Kanu, 2015).*

Source: Researcher original construction based on literature

4. METHODOLOGY

4.1 Research design

The study commences with theoretical research on examination of factors contributing to SMEs innovation outcome in the Visegrad Countries. The conceptual model as shown in the literature would be implemented based on the research design on the page below (Figure 3).

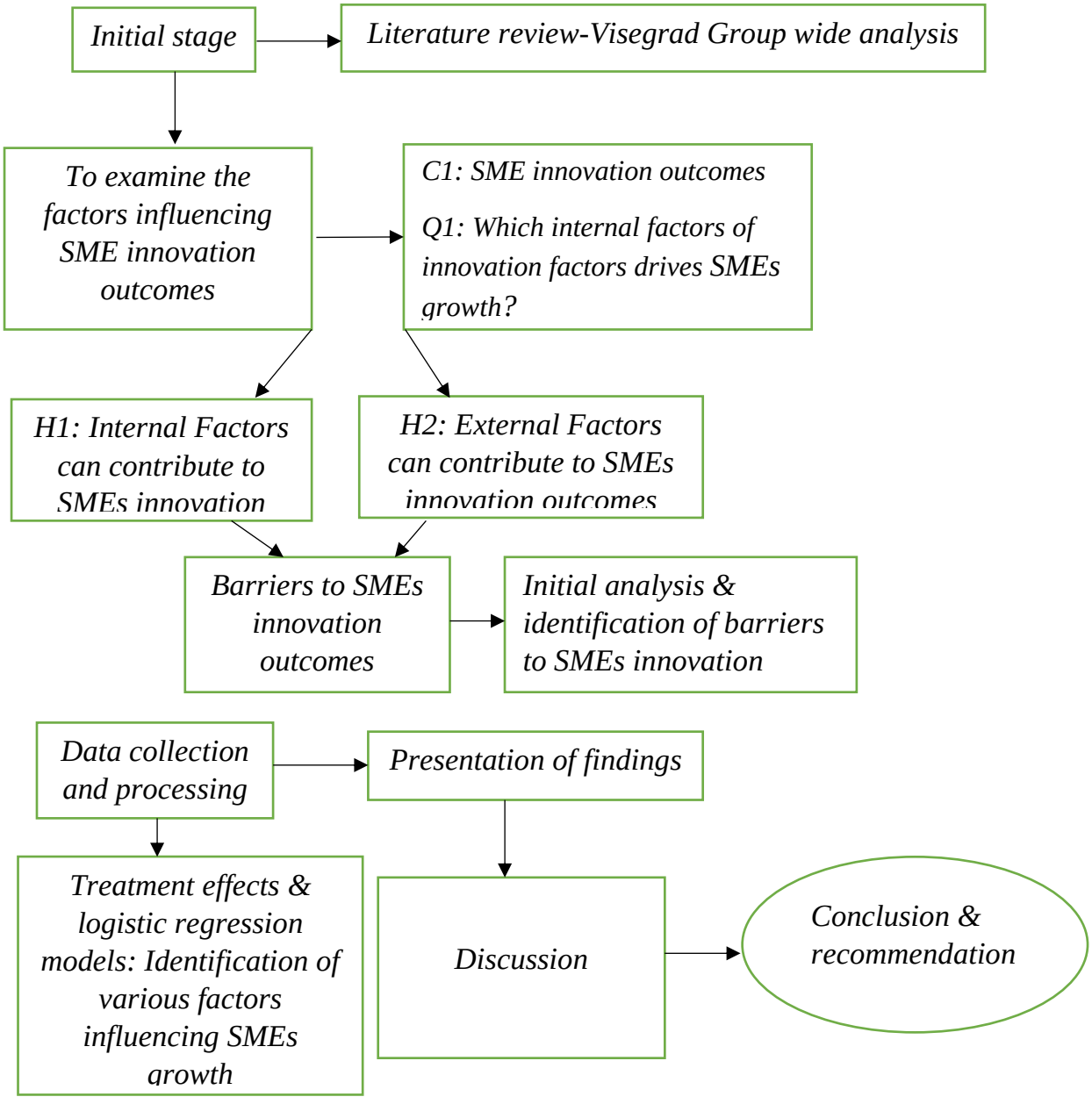

Figure 3. Research process (Source: author's own)

4.2 Methods

When conducting research, two different methods are available for use: qualitative or quantitative. The two different methods possess various abilities depending on the aim of the research. The quantitative research approach focuses on quantifying data, and it's built on the deductive reasoning, whilst the qualitative approach mainly focuses on the verbal description and interpretations of responses. Qualitative research follows the inductive perspective between provided theories that factors the continuous flexibility of modern society and tend to be more open-ended than the quantitative approach (Peterson, 2019). The inductive approach of qualitative research design helps strengthens research, thereby assisting in gaining access to rich information. However, the qualitative method enables researchers to collect further in-depth data from respondents (Bryman, 2016).

This dissertation used both quantitative and qualitative research design since it conforms to the study's objective (Stockemer, 2018). The quantitative research design's main aim is to establish the causal relationship between an independent variable and a dependent variable. It can involve any type of empirical research about social issues that starts by testing theories that involve descriptive study that establishes the only relationship between variables or an experiment that measure variables likely to explain the mechanism of treatment (Bryman, 2016). Quantitative research helps respond to questions about how an event occurred over a period or the rate at which a sampled population is affected by a phenomenon. According to Tu & Wu (2021), as researchers seek answers to a series of research questions in a study, the quantitative research approach is useful in formulating and testing hypotheses. Furthermore, the basis of research can be generally grouped into four categories: descriptive, explanatory, emancipatory and exploratory (Stockemer, 2018). This dissertation is empirical in nature. Thus, it strictly employed all scientific methods, enabling its outcomes to be generalized to cover the Visegrad countries where the samples are taken from.

Qualitatively, this involves collecting and assessing non-numerical data in the form of text to understand the opinions of other researchers (Belotto, 2018). This research method was adopted to get an in-depth understanding of the research problem we are focused on to generate new ideas for the research method. Qualitatively, the researcher mainly interviewed experts (researchers, lecturers, or professors with some renowned publications in Scopus, web of science, Google scholar, etc.). It is important to remind readers that both approaches were tailored toward getting a clear picture and detailed understanding of the actual situation of small businesses innovations from the expert point of view to compare to what the quantitative data affirmed. By virtue of this, the thesis' primary aim is to establish empirical links among the study constructs adopted within our proposed framework; thus, it makes sense to say

that both the positivism and interpretivism approach fits the overall scope of the current study (Elkatawneh, 2016).

The qualitative method was conducted with expert opinions based on the objective of this study by interviewing lecturers or academic professors and practitioners who have expert knowledge about the subject matter from the Visegrad Group. The interviews were conducted through emails, Skype and zoom across the Visegrad countries. The interview helped to obtain relevant answers from practitioners and academic researchers on SMEs innovation outcomes in the Visegrad countries. A virtual interview with an open-ended questionnaire was used by the researcher and practitioners well vexed in this field. The virtual interview has become relevant due to the coronavirus pandemic, and travel costs to these countries. According to Gray et al. (2020), this approach is a data collection tool that has been widely used to improve response rates. Respondents background information including job experience, educational status, and other details are obtained from these experts and summarized in our discussion.

Two research methods widely used for similar analysis were used for the model specifications. The following studies have used these methods for similar analysis so this dissertation will apply them, i.e., Probit regression (Hayden et al., 2020) and logistic regression (Arbolino et al., 2019). Also, the treatment effect analysis was employed to control for confounding and endogeneity. Their doubly robust nature, allowed to correct any selection biases when using binary variables (Hayden et al., 2020).

The statistical software adopted for the analysis includes the Statistical Package for the Social Sciences (SPSS 20) and Stata 13 computed for the model specifications. Numerous authors have used this statistical software for similar analysis (see Galán-Muros & Plewa, 2016; Purwanto et al., 2021). I used excel to organise the data for the empirical analysis.

4.3 The Probit regression model

The probit regression is like the logistic regression model, which consists of the dependent variable, a dichotomous random variable that only takes either yes or no responses (Oudgou, 2021). The probit model estimates the probability that the result of certain characteristics will be grouped into different forms. This model was chosen for this research because the questionnaire in the Enterprise Survey, which was used for the dissertation, has a dependent variable which is binary in nature. The probit model is part of the probability model's group, which works by estimating the model parameters based on the maximum likelihood approach. The maximum likelihood technique seeks to estimate the model by maximising the given data's general result, predicting the probability of an event occurring. This makes the maximum likelihood technique one of the best estimators for estimating economic situations and provides some reliable results (Minasyan et al., 2021). In the first stage of the probit analysis, the probit model assists in estimating the likelihood of whether the variables used for the analysis

will or not influence firms' technological innovations (technological innovations, R&D and foreign technologies). The probit model shows a converse relationship in the standard normal distribution of probability; hence, the model assumes a linear relationship between the combined independent and dependent variables (Fox, 2015). We assume the linear association between firms' internal activities, such as research and development, etc., on the technological innovation outcomes. We provide the formula for the probit model as.

$$\boldsymbol{prob}(\boldsymbol{Y_i = 1|X_i}) = \int_{-\infty}^{\boldsymbol{x'\beta}} \emptyset(\boldsymbol{t})\boldsymbol{dt} = \emptyset(\boldsymbol{X'i\beta}) \quad (2)$$

Where,
β is a vector of parameter estimates
$\emptyset$ is a cumulative distribution function (the normal, logistic, or extreme value)?
X is a vector of explanatory variables
P is the probability of a response
t is the natural (threshold) response rate

4.4 Average Treatment Effect-Inverse Probability Regression

The treatment effect estimation was used in the second stage of our analysis due to its robustness. The treatment effect inverse-probability weight regression (IPWR) estimator was employed to estimate the additionality effect of how the variables used would impact a firm's innovation. The IPWR allowed us to calculate the average causal effect of a dichotomous variable on an outcome variable of scientific interest activities. IPWR estimators depend on probability regression coefficients to estimate the intermediate outcomes of predicted treatment levels, where the coefficients represent the projected inverse likelihoods of treatment (Cattaneo, 2010). The doubly robust approach factors in the regression model's outcome and average treatment scores. Using the outcome regression, the probability estimator would help overcome any selection bias from the confounding variable, which may affect the results. Again, the doubly robust IPWR estimator uses two main approaches, with at least one of the two models could correctly indicate whether it can achieve an unbiased effect estimator. This permitted us to consistently estimate the outcome parameter by reducing residual biases, i.e., assuming the association between firms' internal activities, such as patents, adopting sophisticated machinery, performance bonuses to staff members, etc., and how they lead to technological innovation outcomes.

4.5 Logistic Regression

Logistic regression model is used to examine the relationship between a categorical dependent variable and a group of independent variables (Xie et al., 2021). The logistic regression is used when the dependent variables have only responses such that they are coded as 0 and 1 respectively. If dependent variables have three or more values, such as widowed, single, or married, the multinomial

logistic regression is used (Nyarko et al., 2021). Logistic regression computes discriminant analysis useful for analysing categorical-response variables. Some authors assert that logistic regression is more robust for modelling most statistical situations than discriminant analysis (Sperandei, 2014; Sujatha & Sridhar, 2021). Logistic regression does not normally display that independent variables could be normally distributed compared to the discriminant analysis it performs. Hence all the reports on logistic regression display its goodness of fit; it shows its deviance and includes odd ratios and their confidence intervals. Logistic regression performs a comprehensive residual check, including the plots and residual diagnostic reports. Again, the logistic regression performs an independent variable selection search that seeks to bring the best regressors with few independent variables (Sujatha & Sridhar, 2021).

The set of explanatory variables is used to predict the mean of a continuous variable in multiple regression (Xie et al., 2021). Logistic regression in a mathematical model verifies independent variables used to predict a logit transformed dependent variable. The outcome of the mean variable would be proportional to positive responses.

If p forms part of the observations with an outcome of 1, then 1-p is the probability of an outcome of 0. The ratio p/(1-p) is called the odds, and the logit is the logarithm of the odds, or just log-odds (Park, 2013). Mathematically, the logit formula is given by (Park, 2013):

$$\boldsymbol{ln\left[\frac{P_i}{1-P_i}\right] = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki}} \qquad (1)$$

where

subscript *i* represents the *i-th* observation in the sample,

P is the probability of the outcome,

β_0 is the intercept term

$\beta_1, \beta_2, \ldots, \beta_k$ are the coefficients associated with each explanatory variable $X_1, X_2, \ldots, X_k$.

4.6 Two-step Probit with endogenous variables

Once there is the presence of endogeneity of some of the variables used, the results of the estimation of the model using the logit alone would not be appropriate. This therefore warrants testing for the potential presence of endogeneity. The two-step endogeneity test is usually used to test for the robustness of the method used to authenticate the results (Weisburd & Britt, 2014; Fox, 2015). This method was applied to control for whether there is the potential presence of endogeneity in the variables used for the empirical specification. The presence of potential endogeneity in the variables can create causality problems, that can negatively affect our results. To test for potential endogeneity in the models, we utilised the Instrumental Variable (IV) probit regression model and factored the Newey's two-step evaluation method. The Wald test of exogeneity was also used to assess whether the null hypothesis of exogeneity is supported by

the BEEPS data used for the analysis. The Wald test results confirm whether it is necessary to use instrumental variable models or not because, when there is no endogeneity detected in IV models, the results from the logit model could be considered consistent and reliable (Brada & Singh, 2017). This methodological approach helped to completely treat and eliminated all potential endogeneity concerns. Instead of presuming the presence of endogeneity in some covariates and adopting the logit alone, this study also used more reliable and efficient two-step probit techniques to obtain robust estimates. The use of this methodological approach permitted the computation of the potential endogeneity present in some of the covariates of interest to obtained more efficient outcomes.

4.7 Data

4.7.1 World Bank dataset

This dissertation used data from the Business Environment and Enterprise Surveys (BEEPS) which is jointly undertaken by three banks namely the World Bank, the European Bank for Reconstruction and Development (EBRD) and the European Investment Bank (EIB), in conjunction with the European Commission (EC). To meet the objectives of this dissertation, we used the current data conducted in the year 2019 in Visegrad countries. The study within the Visegrad country was conducted with a combined random sample of about 2,494 firms. It contains questions relating to firms' characteristics, innovation activities, and the perceived influence of business environment and how they shape firms' operations. The EBRD report explains that the survey examines how the quality of the business environment that determines various indicators showing firms' interactions and regions. The enterprise survey uses the random sample technique to select from the population of firms from both the manufacturing and services sectors and it is designed to be representative of the general population of these firms. The sample is distributed across all major industrial sectors and regions within each nation, and its sectoral composition consists of companies considered in the survey based on various sectors' contributions to the GDP outputs. The sample is stratified to make sure that at least ten per cent of firms in each country at least falls in the following groupings: small and medium enterprises, large firms, foreign-owned firms, and exporting firms. Since BEEPS surveys uses the random samples of firms, it is possible to pool them together to work with a large sample size, on condition that the questionnaires in their respective country surveys follows the standard methodology and contains homogenous questions.

The BEEPS survey comprises of questions that would allow us to specify the variables that are described in theoretical framework and utilize the advantage on the number of observations with about 2,002 firms across different sectors. The WBES data source will serve as both innovation variables and control variables at the at the firm level which will replicate the most recent situation of SMEs firms within the study areas. Kaur & Kaur, (2021) used the same database to assess different innovation types among 9,281 SME firms. Lundvall (1998)

used this dataset to access knowledge management and innovation outcomes among firms in Albania and Slovenia whose result was showed that learning organization characteristics have a significant impact on job rotation.

4.8 Distribution of firms in the sample

Table 7 below provides a brief and general overview of how firms in the sample are distributed in the Visegrad group. The results show that about 35% of SMEs in these countries are found in the manufacturing sector and about 40% were found in the service sector. About 25% of SMEs were found in the retail sector. These sectors contributed massively to these countries economic health, job creation, and driving salaries and wages. For example, the manufacturing sector in Hungary alone accounts for about one-quarter of its GDP and brings in foreign direct investment (FDI) of around 71.6 billion (Dvořák et al., 2017). According to Brada & Singh (2017), the Czech automotive industry employs about 120 000 and contribute to 47. 3 % of its GDP. According to Olczyk & Kordalska (2017) the manufacturing sector in Poland alone accounts for about 20% of GDP and provides over 30% of job opportunities to citizens of Slovakia. The manufacturing sector in Poland has seen tremendous growth in GDP and has contributed massively to economic growth (Naudé et al., 2019).

Table 7: Distribution of firms across sectors in the Visegrad countries

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Product innovation	2488	.793	.0081	.4055
Process innovation	2480	.886	.0064	.3180
Overdraft facility	2326	.537	.0103	.4987
Internal R&D	2470	.117	.0065	.3210
Membership organisation	2492	.381	.0097	.4857
Machinery	2265	.296	.0096	.4567
Lines of credit	2145	.214	.0089	.4105
Internet security	2214	236.187	51.8009	2437.3941
Training	2404	.31	.009	.462
Technological innovation	4968	.839	.0052	.3674
Government contract	2386	1.809	.0369	1.8009
Technology licensed	2470	.123	.0066	.3286
Int'l quality certification	2466	.251	.0087	.4339
External R&D	2480	1.956	.0041	.2041
Informal competition	2368	1.775	.0086	.4177
Financial services	2268	.613	.1161	5.5275
Financial obstacle	2439	4.069	.1740	8.5920
Losses due to theft	2154	89.648	52.0212	2414.3668
Inadequate labour	2833	7.94	.082	4.346
Labor regulations	3166	7.11	.072	4.043
Tax rates	2441	2.375	.0191	.9413
Sectors	2494	1.555	.0147	.7364
Countries	2494	2.859	.0229	1.1460

Source: Author’s own computations with BEEPS data.

Measures

- Methods and data description

For the data analysis, the logistic regression model was used to assess external factors contributing to SME's innovation outcome in the Visegrad Group. The logistic regression model was chosen for this analysis due to the dichotomous nature of the outcome variables. The logistic model was employed to examine the probability that SMEs innovations would be contingent on certain external determinants such as government grants, technology licensed from a foreign company, competition against unregistered firms, external R&D, intangible assets from foreign firms such as trademarks or licensed would influence SMEs innovation outcomes within the Visegrad Group. For the empirical evaluation,

we used the combined data sourced from the Business Environment Enterprise Performance Survey (BEEPS) conducted between 2017 to 2019. The BEEPS dataset provides relevant information about SMEs' innovation activities. It focuses on establishing firm-level innovation, which seeks to provide accurate information on various sources of knowledge, public funding, and innovation expenditures. Following variant literature (see Belas et al., 2017), we sampled 2494 SME firms that adopted technological innovation activities from 2017-2019 in Hungary, the Czech Republic, Poland, and Slovakia. The individual combined sample included SMEs pooled from Poland (1101), Czech Republic (380), Slovakia (338) and Hungary (675). Numerous research have employed the BEEPS datasets to analyse firms' innovation activities (see Cieslik et al., 2014; d'Agostino & Pieroni, 2019; Ashyrov & Masso, 2020).

5. RESULTS AND DISCUSSION

5.1 Influence of internal factors on SMEs innovations

The specific objective one seeks to find out the internal factors driving SMEs innovations. *To fulfil this objective the research question sought to find out the internal factors driving firm-level innovations.* The logit regression model was employed in the first stage to establish the relationships between internal factors and other firm characteristics. Then we used the marginal effects analysis to quantify the magnitude and directions of change in these associations as described in the methodology section. We start the results and discussion section with the summary statistics to provide a brief overview of the sample characteristics. The summary statistics results are shown in Table 8 below. The results demonstrate that about 80% of the SMEs reported to have introduced product innovations whiles 89% reported having introduced process innovations. These results show that these SMEs are strong technological innovators. Regarding finances, about 54% of the SMEs reported to have overdraft facilities, while about 21% reported having lines of credit. About 12% of these small businesses reported to undertake internal R&D, which seems to be a bit low. Regarding training for innovations, about 31% of these small businesses stated to have carried out training activities related to the innovation process. About 38% of these SMEs reported to belong to business membership organisations such as, chambers of commerce and trade unions which are very beneficial for their internal innovation outcomes. Most of these SMEs reported to have acquired new machinery aiding in their internal innovation quest which was around 30%. Regarding the sectoral composition, majority of these firms could be classified as micro enterprises. The country with the large share of small businesses in the sample is Poland.

Table 8: Descriptive statistics for the combined countries

Variables	N	Mean	Stand. Dev.
Product innovations	2488	0.793	0.406
Process innovations	2480	0.886	0.318
Overdraft facility	2326	0.537	0.499
Internal R&D	2470	0.117	0.321
Membership organisation	2492	0.381	0.486
Machinery	2265	0.296	0.457
Lines of credit	2145	0.214	0.411
Internet security	2214	236.187	2437.394
Training	2404	0.308	0.462
Sectors	2494	1.555	0.736
Countries	2494	2.859	1.146

Source: own calculations

Note: N equals the total number of observations

Table 9 below illustrates the results of the Pearson chi-squared (χ^2) goodness of fit test to establish the relationships between overdraft facility, lines of credits, internal R&D, membership organisation, machinery acquisitions, internet security, innovation trainings, sectoral and country dummies, and small businesses technological innovations (process and product). The Pearson chi-squared (χ^2) results show that all the variables have positive and statistically significant associations with product innovations apart from the innovation trainings and sectoral dummies variables. On the other hand, the Pearson chi-squared (χ^2) results also showed that all the used variables have positive and statistically significant relationships with process innovations but for the overdraft facilities and innovation trainings variables. The results further demonstrated that internal R&D has the strongest relationships with product and process innovations as seen from the Cramer's V results.

Table 9: Pearson chi-squared analysis results

	Product innovation		Process innovation	
Variable name	Chi square(P-value)	Cramer's V	Chi square(P-value)	Cramer's V
Overdraft facility	4.905(0.027)*	-0.046	2.929(0.087)	-0.036
Internal R&D	182.935(0.000)***	-0.273	125.103(0.000)***	-0.226
Membership organisation	3.919(0.048)*	-0.093	19.774(0.000)***	-0.0893
Machinery	39.206 (0.000)***	-0.131	44.981 (0.000)***	-0.141
Lines of credit	30.449(0.000)***	-0.119	22.639(0.000)***	-0.103
Internet security	58.966(0.001)***	0.163	64.255(0.000)***	0.171
Training	3.205(0.073)	0.037	3.382(0.066)	-0.038
Sectors	3.152(0.207)	0.036	28.616(0.000)***	0.107
Countries	55.597(0.000)***	0.149	76.507(0.000)***	0.176

Source: Own estimations

NOTE: Significant at the 99% confidence interval (CI)-***; significant at the 95% CI-**; significant at the 90% CI-*. P-values reported in parenthesis.

The results of the two logit models with their respective marginal and treatment effects are shown in Table 10 above. We begin with a brief discussion of the predictive powers of both models. We see that the coefficients of determinations of our model is 0.0974 for the product innovation model and 0.126 for the process innovation model. These results show that our models are statistically significant in terms of their explanatory powers and can therefore be said to lead to accurate predictions (Megaravalli, 2017).

We begin the results and discussion with the product innovation model, with its marginal and treatment effects. We find no statistically significant relationship between internal funding assessed with lines of credit and overdraft facilities and product innovations (β=-0.099, $p>0.05$; β=-0.342, $p>0.05$). This result means that internal funding from these sources are not significant factors influencing SME product innovations. These results are surprising because we expected that overdraft facility could allow SME access to money from the account even if they have no balance, but the results show otherwise. The results of the marginal and treatment effects further confirm the negative correlations between these internal funding sources and product innovations. Lines of credits reduces the likelihood of product innovations marginally by 5 percentage points. The treatment effect results also affirmed the negative association. SMEs that reported having lines of credits are likely to reduce their product innovations by 12 percentage points compared with SMEs without any lines of credits. Contrary, the same results were witnessed for the process innovation model. We also found that these sources of internal funding have negative but statistically insignificant influence on process innovations (β=-0.084, $p>0.05$; β=-0.141, $p>0.05$). The results further proved that these funding sources do not exert any marginal effects

on process innovations. The ATE results however offers a different result for lines of credits which demonstrated to have a negative additional effect. We found that SMEs with lines of credit it reduces the likelihood of process innovations by 8 percentage points. These results on the negative influence of these funding sources on product innovations could be attributed to the fact that these amounts of funding might not be enough for SMEs to invest in innovation undertakings.

Table 10: Results of the factors driving product innovations

Product innovation	logit model	Marginal effect	Treatment Effect
Overdraft facility	-0.099 (0.424)	-0.015(0.424)	-0.037(0.026)**
Internal R&D	-1.502(0.000)***	-0.227(0.000)***	-0.344(0.000)***
Machinery	-0.389 (0.002)**	-0.059 (0.002)**	-0.119(0.000)***
Lines of credit	-0.342 (0.020)*	-0.052(0.020)*	-0.119(0.000)***
Internet security	-0.399 (0.002)**	0.061(0.002)**	-
Training	-0.236 (0.061)	-0.036 (0.061)	-.0321(0.079)
Control variables			
Membership organisation	-0.154(0.335)	-0.023(0.335)	-0.033(0.051)
Other services	0.066(0.641)	0.009(0.639)	
Retail	-0.225(0.197)	-0.036(0.210)	
Hungary	0.558(0.004)**	0.082(0.005)**	
Poland	0.046(0.777)	0.008(0.778)	
Constant	-1.173(0.000)***	-	
Summary statistics			
Pseudo R^2	0.0974		
N	1973		
Prob>chi^2	0.000***		
Log pseudo	-937.12		
LR chi^2(11)	202.25		

Source: Own calculations.

NOTE: Significant at the 99% confidence interval (CI)-***; significant at the 95% CI-**; significant at the 90% CI-*. P-values reported in parenthesis.

These results on the insignificant internal fundings influence on these SMEs technological innovations is supported by a similar study by Győri et al. (2019) in Hungary who also concluded that external financial resources (subsidies) positively contribute to SMEs innovation activities than other internal financial resources. Our studies contradict studies conducted by Kaur & Kaur (2021), who asserted that overdraft facilities are correlated with firms' innovation and could lead to the discovery of new products and processes.

The result further show that internal R&D is negatively correlated with both product and process innovations (β=-1.502, $p<0.001$; β=-0.938, $p<0.001$). These results signify that engaging in internal R&D reduces the likelihood of contributing to technological innovations. These results are however not

surprising because the mean result in Table 8 shows that just about 12% of these SMEs engaged in internal R&D. These low levels of engaging in internal R&D by these SMEs in these countries corroborate the findings of research by (Hervas-Oliver et al., 2021). The marginal effects results demonstrate that any increase in internal R&D leads to a decrease in product innovations likelihood by 27 and process innovations by 9 percentage points respectively. The ATE results also revealed that for SMEs that carried out internal R&D it results in reduced likelihood of influencing product innovations by 34 and process innovations by 23 percentage points. These results are surprising because R&D is proven to be a reliable source of new knowledge which serves as a catalyst in the innovation process (Audretsch & Belitski, 2020). These results show that majority of these SMEs do not carry out R&D internally, it is probably that they depend on the open innovation search for their R&D. This result is confirmed by a study conducted by Hervas-Oliver et al. (2021), who also concluded that SMEs do not heavily invest in internal R&D due to their continuous resource constraints, so it is not likely to improve their technological innovations.

Table 11: Results of the factors driving process innovations

Process innovation	logit model	Marginal effect	Treatment Effect
Overdraft facility	-0.084 (0.597)	-0.007 (0.597)	-0.022 (0.085)
Internal R&D	-0.938(0.000)***	-0.089 (0.000)***	-0.223(0.000)***
Machinery	-0.625 (0.000)***	-0.059 (0.000)***	-0.100(0.000)***
Lines of credit	-0.141(0.435)	-0.013 (0.434)	-0.081(0.000)***
Internet security	0.433(0.009)**	0.041 (0.009)**	0.175(0.028) *
Control variables			
Membership organisation	-0.554(0.004)***	-0.053(0.004)**	-0.059(0.000)***
Training	-0.090(0.568)	-0.009 (0.568)	-0.026(0.076)
Other services	0.969(0.000)***	0.084 (0.000)***	
Retail	0.858(0.001)***	0.008 (0.000)***	
Hungary	0.809(0.000)***	0.091(0.000)***	
Poland	0.879(0.000)***	0.097(0.000)***	
Constant	-1.246(0.000) ***		
Summary statistics			
Pseudo R^2	0.1262		
N	1970		
Prob>chi^2	0.000***		
Log pseudo	-637.88		
LR chi^2(11)	184.21		

Source: Own calculations.

NOTE: Significant at the 99% confidence interval (CI)-***; significant at the 95% CI-**; significant at the 90% CI-*. P-values reported in parenthesis.

Furthermore, we did not find sufficient confirmation in the sample buttressing that the acquisition of machinery could improve SME technological

innovations. We found that acquisition of machinery result in reduced likelihood of influencing product and process innovations (β=-0.389, $p<0.001$; β=-0.625, $p<0.001$) respectively. These results are supported by both the marginal and treatment effects. We found that the acquisition of machinery marginally reduces product and process innovations by 6 percentage points correspondingly. The ATE results, which were used to control for confounding and endogeneity also show that SMEs that invest in machinery reduce their likelihood of product innovations by 12 percent points and process innovations by 10 percentage points when compared to firms that do not finance machinery acquisitions. All these results are contrary to our beliefs as innovations require investments in new machinery to thrive, so when firms invest and procure these machines, it can boost their production techniques, which can increase technological innovations in the long run. These results contradict a previous study carried out by Hervas-Oliver et al. (2021) in transition countries in Eastern Europe that concluded that SME innovations are more closely associated with acquisition of machinery and equipment (i.e., embodied knowledge). Relatedly, Apanasovich et al. (2016) study in Belarus also found that SMEs innovation dynamics significantly depends on the effective use of new machinery which is contrary to our results.

We found no compelling proof in the sample supporting the relationship between internet security and technological innovations. The results indicate that internet security negative influence product innovations but not process innovations respectively (β=-0.399, $p<0.002$; β=0.433, $p<0.009$). Before the COVID-19 pandemic, SMEs had no option but to set up home offices, and thus internet security was needed to prevent firms from cyber-attacks. Our results have shown that internet security was statistically significant, which has enabled SMEs to safeguard their software and has compelled SME managers to make informed decisions about their organizations' digital security. The marginal results of about 6% have indicated that firms in the Visegrad countries are protecting their firms from cyber-attacks, although results are negative. The reason for internet security boils down to the need for optimization. According to our results, internet security can reduce the enormous gains for SMEs output, such as decreasing manufacturing outputs and operational costs. Our results differ from studies conducted by Nagy (2021) who found that internet security has safeguarded and promoted innovation activities in the Visegrad countries as well as Romania. Lastly, our results also contradict the findings of a research by Sun et al. (2022), who asserted that internet security had compelled firms to improve their product innovation outcomes.

In-service trainings are shown in the growing literature to be significantly related to firm-level innovations. However, our empirical analysis results have shown otherwise that training programs organized for employees of SMEs that were sampled were not statistically significant to their product and process innovations (β=-0.236, $p>0.05$; β=-0.090, $p>0.05$). The study found that innovation training programs undertaken by these SMEs are not statistically

significant in inducing technological innovations. These insignificant correlations were also supported by both the marginal and ATE results. Innovation trainings are vital source of new knowledge for firm-level innovations which can fuel innovations, however our results did not affirm this importance. In-house training boosts employee's competence and is also a source of new knowledge and ideas that could contribute to firms' innovations because the acquired new knowledge from these trainings can complement existing knowledge. When we compare the results with the descriptive statistics, we see that just about 31% of these SMEs reported to have conducted these innovation trainings. The results can mean that for these few SMEs, their innovation trainings are not effective to induce new knowledge into the innovation hence its insignificance. These results could be attributed to the low absorptive capacities of these firms, which makes them incapable to efficaciously absorb and assimilate new knowledge from these innovative trainings (Cohen & Levinthal, 1990). Our results contradict similar studies conducted by Odei et al (2020) who discovered that training activities contributed to about 48% in product innovation outcomes in the Visegrad countries. Demirkan et al. (2022) study of German SMEs also concluded that there exists a positive association between enhanced investments in workers training and product innovation potentials which contradicts our results.

The results of the control variables however are mixed. We find that SMEs from the other services and retail sectors are not probable to be product innovators (β=-0.236, $p>0.05$; β=0.066, $p>0.05$). Contrary different results were established for process innovations, we found that firms in the service sectors were likely to be process innovators (β=0.969, $p<0.001$; β=0.858, $p<0.001$). For these sectors there is the likelihood that process innovations could increase marginally. Lastly, the results on the country dummies show that SMEs in Poland are product and process innovators. The SMEs in Hungary were process innovators.

Additionally, the results revealed that other factors, such as membership organisations as an internal factor, can negatively drive SMEs product innovation (β=-0.154, $p>0.051$) and process innovations (β=-0.554, $p<0.01$). These results signify that SMEs part of organizations like trade unions, chamber of commerce does not benefit from them as they rather reduce the likelihood of influencing innovations. The negative correlation between membership associations and technological innovations is supported by the marginal effects results. Being part of business memberships reduces product innovations marginally by 2 and process innovations by 5 percentage points correspondingly. Similarly, the ATE results points to the same trend, SMEs part of membership associations are probable to reduce their product innovations by 3 and process innovations by 6 percentage points respectively. These results are all not as expected because these business associations are pool of experts who occasionally engage their members on measure to improve their innovations. The results could mean that these SMEs network with membership in business associations in these group of countries do not strongly focus on innovations. These results conflict the findings of Hashi &

Krasniqi (2011), who concluded that networking (membership in business associations), positively and significantly influence SMEs central and Easter European countries. Similarly, Gashi et al. (2014) also found that there exist a positive and statistically significant correlation between networking (membership in business associations) and firms' productivity (innovations).

5.1.1 Summary of results and practical implications

This section of the thesis focused on analysing the various internal factors that influence small businesses innovation performances. Measures of innovations adopted were technological in nature which specifically focused on technological innovations (products and processes). The research question that was answered was what internal factors influence small businesses innovations? The results of the empirical examination provided mixed results. The study found among others that internal funding measured with lines of credits and overdraft facilities are not positively connected with SMEs technological innovations. These funding sources reduce the probability of technological innovations both marginally and additionally. The study also revealed that machinery acquisitions do not statistically influence technological innovations.

Again, the study found that innovation trainings undertaken by these small businesses do significantly enhance both technological innovations (thus new product and process development). These results can be due to the weak absorptive capacities of these firms that make them unable to soak up and assimilate novel knowledge from these occasional training. Surprisingly, we found no evidence in the sample supporting the positive correlation between internal R&D and technological innovations outcomes. This result can be attributable to the fact that few of these small businesses in these countries reported to undertake R&D internally. It is probable that they collaborate with other innovation partners such as other research organisations and universities. The results of the control variables also show that networking with business associations is negatively correlated to small businesses technological innovations. For the sectoral comparison, we found that firms operating in the service sector are not probable to be product innovators. Contrary, we find that small businesses in the service sectors are process innovators. Finally, the results on the country dummies show that firms in Poland and Hungary are process innovators, while only firms in Hungary are product innovators.

The discussed results in this section call for invaluable insights as well as practical implications that could be adopted by business managers and policy practitioners to enhance small businesses innovation performance.

1. Internal funding available to SMEs demonstrated to be insignificant in boosting technological innovations. Governments and policy makers in the Visegrad group must consider increasing financial supports to innovative

small businesses as this can have spill over effects. These finances could be invested in the innovation process.

2. Another important policy implication for small business managers and policy makers in the Visegrád Group is to introduce appropriate measures to enhance SMEs absorptive capacities to ensure they can effectively adopt and make good use of new knowledge from innovation training activities. Policy initiatives can be focused on employing skilled personnel with university degrees and technical and vocational certificates.
3. As possible implication for practitioners, we recommend small businesses in the Visegrád Group to simultaneously invest in internal as well as external R&D. Increasing the levels of R&D both internally and externally will require these small businesses to improve their absorptive capacities to make sure they able to incorporate new knowledge emanating from this research.
4. Policy makers in the Visegrád Group should consider investment in new tools and machinery as part of innovation policies and should provide supports and incentives for their expansion as medium for small businesses innovations.

5.2 Analysing the external factors influencing SMEs innovation

The specific objective two seeks to find out the external factors driving SMEs innovations. *To fulfil this objective the research question sought to find out which external factors drive small businesses innovations?* The logit regression model was employed in the first stage to establish the relationships between external factors and other firm characteristics due to the binary attribute of the dependent variables. Then we used the marginal effects postestimation analysis to quantify the magnitude as well as the directions of changes in these relationships as described in the methodology section. We again begin the discussion of the results with the summary statistics to provide a brief overview of the sample characteristics. The results are showed in Table 12 below, it is seen that about 84% of the SMEs reported to have introduced technological innovations whiles 12% reported having acquired foreign technologies through licensing agreements. These results show that these SMEs are strong technological innovators. Regarding government contract, few of the firm's reported to have gain government contracts in the past and majority were involved in external R&D activities. About 25% of these small businesses reported to have international quality certificate. Regarding informal competition, majority of the firms reported to have faced tougher competition from unregistered firms. About 61% of these firms received financial services from the banks which is very beneficial for their external innovation outcomes. Regarding the sectoral composition, majority of these firms could be classified as micro enterprises. The country with the large share of small businesses in the sample is Poland.

Table 12: Descriptive statistics for the combined samples

Variables	N	Mean	Stand. Dev.
Technological innovation	2468	0.839	0.367
Technology license	2470	0.123	0.328
Government contract	2386	1.809	1.800
External R&D	2480	1.956	0.204
International quality certificate	2466	0.251	0.433
Informal competition	2368	1.774	0.417
Financial services	2268	0.612	5.527
Sectors	2494	1.554	0.736
Countries	2494	2.859	1.146

Source: own calculations
Note: N equals to the total number of observations

5.2.1 Test of endogeneity in the variables

To reaffirm objective two of this study, we created a two-step probit with endogenous regressors to test data reliability, methodological robustness, and validity of the data for the study. Checking whether endogeneity in the variables being utilised can result in reverse causality, which could have a detrimental effect on the outcomes, is involved in this. To examine the likelihood of endogeneity in the data, we used Newey's two-step Instrumental Variable (IV) probit approach. Once more, the BEEPS data were used to do the Wald test of exogeneity to determine whether the null hypothesis of exogeneity was supported. The results are presented in Table 13 below; the Wald test results show that the Chi2 (1.81), Prob > Chi2 = 0.4046. As this finding is not statistically

significant at the 95% level, we should accept the null hypothesis that the variables are exogenous rather than endogenous. We can therefore conclude that the dataset used does not have endogeneity problems (Hult et al., 2018). This finding confirms that instrumental variable regression models are not required because the binary logistic model's output is accurate and consistent even in the absence of endogeneity. Having confirmed the data’s robustness and validity for the study, we then proceed to run the analysis using the binary logistic model to fulfil the study objective two.

Table 13: Result of the Wald Test of endogeneity

Technological innovation	coefficient		Standard Error	P-Value
Government contract	14.727		353.251	0.967
International quality certificate	-56.709		1406.89	0.968
External R& D	-17.22		443.428	0.969
Constant	38.219		959.97	0.968
Instrumented		Government grant, international quality certificate		
Instruments		External R&D, financial services, informal competition		
Summary statistics				
Wald test of exogeneity $Chi^2(2)$		1.81		
$Prob>chi^2$		0.4046		
N		2123		
Wald $chi^2(3)$		0.001***		
$Prob>chi^2$		0.99		

Source: Own calculations

Note: Significant at the 99% confidence interval (CI)-***; significant at the 95% CI-**; significant at the 90% CI-*

The results of the logit models with their corresponding marginal and treatment effects are shown in Table 14 below. We begin with a brief discussion of the predictive powers of the models. We see that the coefficients of determinations of our model is 0.0915 for the technological innovation outcomes. These results show that our model is statistically significant in terms of their explanatory powers and can therefore be said to lead to accuracy of prediction (Megaravalli, 2017).

We proceed to the results and discussion with the technological innovation model, with its marginal and treatment effects. We find no statistically significant correlation between government contracts and technological innovations ($\beta=0.259$, $p>0.121$). This result means that demand-side policies do not necessary compel SMEs to be innovative especially giving that innovation is part of the selection criteria for procurement contracts selection. Adoption of innovation can position SMEs competitively to win public contracts, although the causality can go both ways. Our result could also be attributed to the fact that government contracts could be biased towards big firms at the expense of small businesses. Again, our results could also mean that these small businesses do not win the bids because they are not innovative enough to meet the selection criteria. Where this process is not done fairly, SMEs without the required financial capacity would

not be able to get government contracts. Similar studies have accessed how government contracts are not yielding a positive impact on technological innovation (see Mergel, 2016).

Table 14: Results of the factors driving technological innovations

Technology innovation	logit model	Marginal effect
Government contract	0.259 (0.121)	0.025 (0.0166)
External R&D	0.869 (0.001)***	0.085 (0.001)***
International quality certificate	-0.588 (0.001)***	-0.057 (0.000)***
Informal competition	0.127 (0.464)	0.012 (0.464)
Financial services	0.034 (0.076)	0.002(0.077)
Other services	0.976 (0.000)***	0.086 (0.000)***
Retail services	0.642 (0.008)***	0.063 (0.002)***
Hungary	0.773 (0.000)***	0.103 (0.000)***
Slovakia	1.557 (0.000)***	0.165 (0.000)***
Poland	1.192(0.000)***	0.141 (0.000)***
Constant	-1.261 (0.051)*	
Summary statistics		
Pseudo R^2	0.0915	
N	2028	
Prob>chi^2	0.000***	
Log pseudo	-682.58	
LR $chi^2(11)$	126.47	

Source: Author's own computation

NOTE: Significant at the 99% confidence interval (CI)-***; significant at the 95% CI-**; significant at the 90% CI-*. P-values reported in parenthesis.

The results show there is a positive correlation between external R&D and technological innovations have been confirmed across the sampled firms (β=0.869, p>0.001). This means that firms involved in external R&D activities with other innovation partners are expected to increase their technological innovation outcomes marginally by 85 percentage points. Our results indicate that external R&D proved to have the highest marginal effects on SMEs technological innovation. This, therefore, calls for these SMEs to conduct R&D externally though this is a cost-intensive activity. With their financial and resource constraints, they could also contract or cooperate with other dependable innovation partners such as higher educational institutions and other research institutes. The central government and EU funding meant for this investment must be properly utilized. To fully benefit from this innovation funding, SMEs must endeavour to improve their absorptive capacities to be able to assimilate these investments. Our studies affirm similar studies conducted by Odei et al.

(2021), who found out investing in external R&D contributed significantly to technological innovation outcomes in Visegrad Countries.

The result shows that external factors such as foreign technological connections evaluated with international quality certifications is negatively but statistically significantly associated with technological innovation outcomes (β=-0.588, $p<0.001$). This result demonstrates that small businesses that establish international technological partnerships with foreign quality standard organizations are expected to plunge their technological innovation marginally by 57 percentage points compared to firms without these quality certificates. The quality certificate has become an important part of the technological innovation processes, and having these certificates proves that firms have met all international quality standards. Innovations is part of the quality assurance process, but our result does not support the fact that these small businesses positively benefit from such international technological linkages. This means that SMEs with internationally recognized certifications such as ISO 9000 or 14000 or HACCP for operating their business externally are incapable of being innovative. This result contradicts the findings of related studies by Paunov (2016), who found that international quality certificates are associated with firms' innovations. Similarly, Terziovski & Guerrero (2014) also found that international quality certificates such as ISO 9000 positively influence process innovation outcomes which also contradicts our findings.

The results on the importance of competition from unregistered firms have demonstrated that unhealthy competition from informal sector firms does not urge SMEs to quickly adopt technological innovation outcomes (β=0.127, $p>0.464$). This result means that competition from unregistered firms do not compel small business to innovate as they do not see these unhealthy competitions to be a factor. Therefore, it is unethical for firms to quickly change their processes and products to catch up with their competitors. Again, our results mean that unregistered firms' activities are limited in the Visegrad countries as all firms need to operate with licenses for quality control purposes and to save the public from bad products or services. Our results mean that SMEs in the Visegrad countries follow their usual ethical procedures to boost their technological innovation outcomes and are not perturbed by activities from informal competitors. A study by Amin (2021) however found that informal competition influence firms' technological innovation.

The study found among others that financial services do not positively influence SMEs technological innovation performance (β=0.034, $p>0.076$). The European Union has supported governments to sustain their activities through funding. The positive results imply that financial services derived from banks' loans could benefit technological innovation outcomes. Our results have shown that the European Union's SMEs grant to various financial institutions like European Central Bank has substantially improved technological innovation outcomes within the Visegrad countries. This result contradicts the findings of

other related research by Odei et al. (2021), whose study established that financial services have contributed to technological innovation outcomes within the Visegrad countries. Similar studies conducted by Čučković & Vučković (2021), also discovered that financial services support significantly influenced technological innovation among firms across the EU.

The results on the control variables are all as expected. We find that SMEs in the other services and retail sectors are more probable to be technological innovators (β=.976, $p<0.001$; β=0.642, $p<0.01$). For these sectors there is the likelihood that technological innovations could increase marginally by at least 9 and 6 percentage points respectively. Lastly, the results on the country dummies show that SMEs in the Visegrad are more probable to be technological innovators as seen with the significant p-values. The prospects of technological innovations among small businesses in these countries could be increased marginally.

5.2.2 Summary of results and practical implications

This section focused on analysing the various external factors capable of influencing small businesses' innovation performances. Measures of innovations adopted was solely technological due to data constraints. The research question that was answered to fulfil specific objective two was *what external factors influence small business innovations?* The results of the empirical investigation provided mixed results. The study found, among others, that government contracts and informal competition from unregistered firms are not positively connected with small businesses technological innovation outcomes. These factors reduce the likelihood of technological innovations' outcomes marginally within small businesses in the Visegrad group of countries.

Again, the study found that international quality certificates acquired by these small businesses through international technological linkages have a negative relationship but are statistically significant in enhancing technological innovations outcomes. This result means that these international technological linkages do not generate positive technological externalities in these economies. These results can be due to the time frames for obtaining these international quality certificates. Also since innovations is a criterion to obtain them, it could be that these firms are not innovative enough to meet the selection criteria hence their inability to acquire the.

Furthermore, we found a positive correlation between external R&D and technological innovation performance. This result could be attributed to small businesses in these countries' collaborations with external firms. They probably collaborate with other R&D partners for external knowledge to complement their internally generated ones. The benefit of external knowledge to firms' innovation development is well acknowledged in the innovation literature.

Again, the study established a positive and significant correlation between financial services, resulting in technological innovation outcomes. The financing

of technological innovation through loans, etc., has been a massive boost for SMEs to adopt modern technologies and become more competitive across all countries under consideration.

The results on the selected control variables also allowed for sectoral comparison, we find that firms in the service sector are not prone to be technological innovators. Contrary, we find that small businesses in the service sectors are constantly adopting technological innovation. Finally, the results on the country dummies demonstrate that firms in Poland and Hungary are likely to adopt technological innovations, while only firms in Hungary are adapting to technological innovations but on at a slower pace.

The results discussed in this section call for important insights as well as practical implications that could be considered and implemented by small businesses managers and policy practitioners to improve innovations outcomes.

1. First, the results on government contract show that it has no additionality effects on technological innovations outcomes. This calls for policy makers in these economies to effectively use demand-side policies that are beneficial to small businesses. Since small businesses are resource constrained, policies need to protect them from unhealthy competitions from large firms. Special quota schemes can be used to allocate some contracts solely for small businesses.
2. Our empirical results further revealed the significant importance of novel knowledge that firms can obtain from external R&D cooperation with other innovation partners. This result requires policies supporting small businesses open innovation search. Public subsidies can be used as a tool to promote small businesses to collaborate with other social partners to promote new knowledge production and assimilation which can have spill over effect on the economies in general.
3. Furthermore, external R&D is proven to be a significant factor influencing SME's innovation outcomes across all the model specifications for the logit regression. Therefore, this calls for these SMEs to conduct external R&D as it has demonstrated to have additionality effects on SME's innovation measures. With external R&D collaborations, firms can acquire the services of external consultants for their successful contribution and infusion of new knowledge into the innovation process.
4. Furthermore, this study recommends various governments to review SMEs international quality certificates by acquiring globally recognised quality certificates. This would help SMEs Improve the quality of their products which will mean that these firms will be able to identify fake products from unregistered firms. These certificates need to be regularly renewed to signify their commitments to improved quality.
5. The outcomes of SMEs sponsoring technical advancements also require policy consideration. According to our findings, financial rewards from a variety of stakeholder sources are ineffective at fostering the success of

technical innovation. To assist improve the current lending environment, stakeholders must carefully examine the loan rate and all mandatory procedures that affect SME borrowing. Government and banking institutions need to carefully analyse financial policies since they are frequently characterised as resourceful, and most SMEs are financially constrained.

6. The key theoretical implication of our findings is that these Visegrád Group economies should adjust their knowledge production function or model to consider global technology linkages. In accordance with quality assurances and management standards, establishing international technical alliances, as demonstrated by licencing agreements, has been proved to have a favourable impact on technological advances through technological spill over effects.

5.3 Results of the barriers to SMEs innovation outcomes

The specific objective three seeks to find out some impeding factors driving SMEs innovations outcomes. To fulfil this objective the research question sought to find out the factors impeding firm-level innovations. The logit regression model was employed in the first stage to establish the associations between the impeding factors and other firm characteristics. Then we subsequently used the marginal effects analysis to help compute the magnitude of change in the directions of these relationships as described in the methodology section above. The selected variables used for the empirical models focused on the various obstacles to firms' innovations and operations. We start the discussion of the results with the summary statistics to provide an overview of the sample firms. The results are presented in Table 15 below, about 80% of the SMEs reported to undertake product innovations whiles 12% reported having acquired foreign technologies through licensing agreements. Small businesses reported the tax rates as moderate obstacle to their innovation activities, while labour regulation and inadequate labour were about 7%. About 90% of these firms' inability to innovate were because of losses due to theft. Small businesses stated that access to funding was a very critical impediment to their operations and innovations.

Table 15: Summary statistics

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Product innovation	2488	0.793	0.008	0.406
Technology licensed	2470	0.123	0.007	0.327
Tax rates	2441	2.375	0.019	0.941
Labour regulations	3166	7.11	0.072	4.043
Inadequate labour	2833	7.94	0.082	4.346
Losses due to theft	2154	89.648	52.021	2414.367
Financial obstacle	2439	4.069	0.1740	8.592

Source: own calculations
Note: N equals the total number of observations

We commence the results discussion with the product innovation model which was investigated using the logit model and its corresponding marginal effects Table 15. We used the sensitivity analytical approach for the empirical estimation by introducing each of the barriers to small businesses innovations separately with their control variables (country dummies). Two measures of innovation widely used in the innovation literature thus process innovations and foreign technology licenses were used as the dependent variables. The results revealed that there a negative but statistically significant relationship between product innovation and tax rates (β=-1.165; $p<0.005$). The study found that governmental fiscal policies (taxes) negatively influence SME product innovation. As shown by the marginal effects results in Table 17, any increase in the tax rate reduces product innovation by 3 percentage points (β=-0.026; $p<0.005$). This result shows that fiscal policies in these group of countries are disincentive to small businesses innovation. Higher corporate taxes can impede small businesses innovations because it decreases corporate income or profits which can serve as a disincentive for innovation activities. Our result on the negative impact of tax rate as an obstacle to small businesses innovations is like similar research conducted by Buno et al. (2015) in Visegrad countries, who concluded that tax rates impeded innovation among Slovak firms.

Again, our results have shown that labour regulations do not significantly impede product innovation (β=.018; $p>0.147$). The marginal results have also confirmed that labour regulations have no positive influence on small businesses' product innovation. Although government regulations are more important for formulating innovative policies, governmental regulation has not affected labour policies in these countries. This result means that SMEs product innovation activities are not affected by labour regulations as there is transparency and accountability in the labour market regulation in these group of countries. Again, although the Visegrad countries have weaker institutions due to their transition,

governmental policies do not impact SME labour regulations which could impede product innovation. Our results affirm similar studies conducted by Blind (2016) who asserts that regulations are often negative to innovation outcomes on the short-term basis.

Similarly, when it comes to human capital which is vital for the innovation process to thrive, we find convincing statistical evidence within the sample supporting that it poses a great threat to small businesses innovations. We find a statistically significant correlation between product innovation and inadequate labour ($\beta=0.030$; $p<0.014$). The marginal effects results demonstrate that inadequate labour in these regions can inflate the cost of engaging in product innovations by 4 percentage points. The inability of firms to hire qualified and competent employees has accounted for the moderate performance of SMEs within the Visegrad countries. This phenomenon of inadequate human capital in these countries can be attributed to the negative impacts of innovation drain. Highly qualified and competent human capital emigrate from these countries to Western European countries in search of improved remuneration and living conditions leading to weakened local knowledge networks. This innovation drain syndrome can also weaken the absorptive capacity of firms as they will not have highly skilled workforce that are known to have higher absorptive capabilities as situation that can impact investments in R&D activities. Supposed SMEs are hiring and training employees to be innovative in product development; this would not have impeded product innovation. Our logit results have shown labour cost firms' inability to acquire external competence. Also, the high cost of training has contributed to SMEs' failure to adapt to product innovation. Moreover, inadequate labour is an important barrier for SMEs to adapt to product innovation. Our results on inadequate human in these economies have been supported by several studies such Ivanová and Čepel (2018), Hvolkova et al. (2019) and Odei et al. (2021) who all acknowledged inadequate labour as a restraining factor for small businesses innovations.

Furthermore, our results have shown that loss due to theft impedes SMEs' product innovation and has no positive relationship with product innovations ($\beta=0.004$; $p>0.05$). This result signifies that the level of theft is lower in these countries as many firms did not report this as a major obstacle to their current operations and innovation. The results of the marginal effect confirm that there is no correlation between loss due to theft and product innovation. This means that the security situation is conducive for small business operations, so they do not have to further spend on security as the existing is enough to guarantee their operations. A similar study by Ratten (2019) contradicts that cybercrime has impeded process innovation among firms across the European region.

Lastly, our results found that financial obstacles shockingly did not impede SMEs' product innovation ($\beta=0.006$; $p>0.05$) albeit the descriptive statistics found that small businesses considered this as an acute obstacle to their

operations. Firms without ample funds can't finance innovations and its related activities. Our results have shown that though this is reported as an obstacle it does not influence SMEs innovation activities. Our results could mean that these SMEs within the Visegrad countries benefit from other financial sources that are reliable for their investing in R&D and innovations. However, our result contradicts the findings of Wziątek-Kubiak & Pęczkowski (2021), who concluded among others that inadequate access to finance was a major obstacle to product innovation among Polish manufacturing firms.

Finally, the results of the country dummies show that small businesses in Poland, Hungary, and Slovakia were likely to be product innovators as shown by the significant p-values, and there is the likelihood that they can improve their product innovations marginally.

Table 16: Regression Analysis of overall factors impeding product innovation outcomes

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Tax rates	-0.164(0.005)***				
Control variable					
Countries					
Hungary	-0.809(0.000)***				
Slovakia	1.160(0.000)***				
Poland	0.881(0.000)***				
Constant	1.014(0.000)***				
Summary statistics					
Pseudo R2	0.0239				
Labour regulations		0.018(0.147)			
Control variables					
Countries					
Hungary		0.848(0.000)***			
Slovakia		1.227(0.000)***			
Poland		0.807(0.000)***			
Constant		0.495(0.001)***			
Pseudo R2		0.0213			
Inadequate labour			0.030(0.014)**		
Control vriables					
Countries					
Hungary			0.843(0.000)***		
Slovakia			1.179(0.000)***		
Poland			0.881(0.000)***		
Constant			0.406(0.005)***		
Pseudo R2			0.0279		
Loss due to theft				0.004(0.097)	

Control variables					
Countries					
Hungary				0.835(0.000)***	
Slovakia				0.355(0.791)	
Poland				0.765(0.000)***	
Constant				0.653(0.000)***	
Pseudo R2				0.0187	
Financial obstacle					0.007(0.710)
Control variables					
Countries					
Hungary					0.865(0.000)***
Slovakia					1.060(0.000)***
Poland					0.799(0.000)***
Constant					0.637(0.000)***

Source: Author's own

NOTE: Significance at 99% confidence interval (CI)-***; significance at 95% CI-**; significance at 90% CI-*

Table 17: Marginal effect results of factors impeding product innovation outcomes

Variables	Coefficient	Robust Std. Error	P-Value
Tax rates	-0.026	0.009	0.005***
Control variable			
Countries			
Hungary	0.156	0.028	0.000 ***
Slovakia	0.204	0.031	0.000***
Poland	0.167	0.027	0.000***
Labour regulations	0.003	0.002	0.147
Control variable			
Countries			
Hungary	0.162	0.028	0.000***
Slovakia	0.213	0.031	0.000***
Poland	0.155	0.027	0.000***
Inadequate labour	0.004	0.001	0.014
Control variable			
Countries			
Hungary	0.159	0.028	0.000***
Slovakia	0.204	0.030	0.000***
Poland	0.165	0.027	0.000***
Loss due to theft	0.0001	0.002	0.097
Control variable			
Countries			
Hungary	0.157	0.028	0.000***

Slovakia	0.074	0.261	0.775
Poland	0.146	0.026	0.000***
Financial obstacle	0.001	0.001	0.371
Control variable			
Countries			
Hungary	0.161	0.028	0.000***
Slovakia	0.188	0.034	0.000***
Poland	0.151	0.026	0.000***

Source: Author's own

NOTE: Significance at the 99% confidence interval (CI)-***; significance at the 95% CI-**; significance at the 90% CI-*

The results of the second model with foreign technology license as the outcome variable is also shown in Table 18, which was investigated using the logit model with marginal effects. We find no statistically significant association between tax rates and small businesses abilities to acquire foreign technology licenses which can have technological spill over effects (β=.102; $p>0.05$). The result shows that the existing tax rates do not positively contribute to SME technological license acquisition. Our results have shown that the corporate tax rates do not limit firms' quest for a technological license from foreign countries which usually abound in advanced technologies. The result means SMEs do not see higher corporate taxes as a major obstacle that hinders them from acquiring these technologies through licensing agreements. It is probable there are other financial support available for these small businesses to network with foreign firms for technologies which might be lacking in these countries. This result contradicts the findings of a similar studies conducted by Mukherjee et al. (2017) that discovered that tax rates impeded firms' abilities to obtain advanced technologies from foreign sources via licensing agreements to impact domestic innovation outcomes.

Again, the results have revealed that labour regulations do not significantly impede foreign technology license acquisition (β=0.019; $p>0.05$). The logit and marginal results have both confirmed that labour regulations do not significantly impede technology license acquisition. Although government regulations are more important for formulating innovative policies, governmental regulation has not affected labour regulations. This result means that SME technology license acquisitions are not affected by labour regulations as there is transparency and accountability on the part of the EU government. Again, although the Visegrad countries have weaker institutions due to their transition compared to advanced economies such as the UK, Netherlands governmental policies do not impact SME labour regulations which could impede technology license acquisition. Our results contradict studies by Pelkmans & Renda (2014) who found out that regulations stimulate technology licenses acquisition and innovation outcomes.

Similarly, the high cost of labour does not serve as an inhibiting factor to small businesses technology acquisitions. We found out that there exists a non-statistically significant relationship between inadequate labour and the ability of small businesses to obtain foreign technologies through licensing agreements (β=.015; $p>0.05$). Our results mean that though there exist the problem of inadequate human capital, it does not significantly influence small businesses' propensities to obtain technologies through international technological linkages with other firms. Again, our results have proven that inadequate labour does not deter firms from acquiring technology licenses. This result is a bit surprising as highly skilled labour will be required to utilize these acquired foreign technologies, without which we expect that it should pose a challenge. The results could also mean that although there are the reported human capital shortfalls, the few available will have the needed skills to absorb foreign technologies hence the reason it does not pose a challenge to small businesses ability to secure the. Also, firms can train the few employees on how to utilize these acquired foreign technologies. Our result differs from the findings of Ivanová and Čepel (2018), who identified inadequate labour as a restraining factor impeding foreign technology acquisitions which can positively influence innovation outcomes.

Furthermore, our results have shown that obstacles such as crime and theft is likely to negatively influence small businesses abilities to obtain foreign technologies through international technological linkages (β=-0.001; $p<0.050$). Loss due to crime and theft has also demonstrated to have marginal effect on the propensity to acquire foreign technologies. Theft here could be understood as physical stealing of these obtained technologies or even stealing of the concept when the intellectual property rights (IPR) regimes are weak. It could also be on the soft side when people can steal the ideas and knowledge behind these acquired foreign technologies. This will make foreign firms reluctant to provide their technologies to small businesses. In the case of the Visegrad group, physical theft could not be a probable reason for small businesses inability to obtain foreign technologies because the security situation is better. The probable reason could be due to the weak IPRs as not all innovative firms will be capable of protecting these foreign technologies (Baklanova et al., 2020). This result calls for strict enforcement of IPR protection laws to insulate small businesses from crime and theft of knowledge and technologies. Our result is analogous to the findings of a similar study by Ratten (2019) who found that crime and theft restricts technology acquisition among firms across the European Union.

Our results found that financial obstacles impede SMEs' likelihood of acquiring foreign technologies through international technological licensing agreements (β=0.020; $p<0.001$). The positive and statistically significant association is also confirmed by the marginal effect, which shows that inadequate finance marginally influences small businesses aptitude to obtain foreign technologies. This result is as expected as the acquisition of foreign technologies is cost-intensive and small businesses are usually known to be financially

unstable, hence they won't be able to afford the investment in advanced technologies. Their small nature compounds the problem of access to funds from financial institutions as they are seen as not creditworthy or may not have the collateral demanded by financial institutions (Odei et al, 2021). Our result is analogous to the findings of a related research in the Visegrad economies by Éltető (2021), who also concluded that lack of financial resources hinders small businesses' ability to introduce Industry 4.0 technologies. Our result conforms with the findings of Hall et al. (2016), who found that finance was a major obstacle to technology licenses among firms across the European region.

Lastly, our results on the country dummies show that small businesses in Hungary, Slovakia Republic are more likely to acquire foreign technologies via international technological connections. However, firms in Poland are not likely to obtain these foreign technologies.

Table 18: Factors impeding Technology license acquisition

Variables	Coefficient	Standard Error	P-Value
Tax rates	0.102	0.071	0.150
Control variable			
Countries			
Hungary	-0.684	0.218	0.002 ***
Slovakia	0.997	0.196	0.000***
Poland	-0.250	0.185	0.176
Constant	-2.160	0.221	0.000***
Summary statistics			
Pseudo R2	0.049		
Laborregulations	0.019	0.017	0.265
Control variable			
Countries			
Hungary	-0.692	0.218	0.002***
Slovakia	1.063	0.202	0.000***
Poland	-0.148	0.184	0.422
Constant	-2.094	0.208	0.000***
Summary statistics			
Pseudo R2	0.048		
Inadequate labour	0.015	0.016	0.334
Control variable			
Countries			
Hungary	-0.697	0.218	0.001***
Slovakia	1.007	0.196	0.000***
Poland	-0.430	0.202	0.034**
Constant	-2.060	0.201	0.000***
Summary statistics			
Pseudo R2	0.0613		
Loss due to theft	-0.001	0.007	0.050*

Control variable			
Countries			
Hungary	-0.692	0.217	0.001***
Slovakia	4.807	2.030	0.018
Poland	-0.181	0.182	0.318
Constant	-1.934	0.152	0.000***
Summary statistics			
Pseudo R2	0.019		
Financial obstacle	0.020	0.006	0.001***
Control variable			
Countries			
Hungary	-0.715	0.220	0.001***
Slovakia	0.676	0.224	0.003***
Poland	-0.189	0.184	0.304
Constant	-1.989	0.154	0.000***
Summary statistics			
Pseudo R2	0.0540		

Source: Author's own

NOTE: Significance at the 99% confidence interval (CI)-***; significance at the 95% CI-**; significance at the 90% CI-*

Table 19: Marginal effect results of the factors impeding technology license acquisition

Variables	Coefficient	Standard Error	P-Value
Tax rates	0.010	0.007	0.150
Control variable			
Countries			
Hungary	-0.059	0.019	0.003 ***
Slovakia	0.156	0.030	0.000***
Poland	-0.025	0.019	0.194
Laborregulations	0.001	0.002	0.265
Control variable			
Countries			
Hungary	-0.057	0.019	0.003***
Slovakia	0.166	0.031	0.000***
Poland	-0.015	0.019	0.434
Inadequatelabour	0.002	0.002	0.333
Control variable			
Countries			
Hungary	-0.059	0.019	0.003***
Slovakia	0.157	0.029	0.000***
Poland	-0.040	0.019	0.434
Loss due to theft	-0.001	0.001	0.051**
Control variable			

Countries			
Hungary	-0.058	0.019	0.003***
Slovakia	0.817	0.104	0.000***
Poland	-0.018	0.019	0.333
Financial obstacle	0.002	0.001	0.001***
Control variable			
Countries			
Hungary	-0.062	0.020	0.002***
Slovakia	0.096	0.033	0.003***
Poland	-0.019	0.020	0.320

Source: Author's own

NOTE: Significance at the 99% confidence interval (CI)-***; significance at the 95% CI-**; significance at the 90% CI-*

5.3.1 Summary of Implications and Recommendations

This thesis session assessed the various determinative factors impeding SME innovation outcomes. The set of independent variables consisted of various obstacles impeding SME innovation. Two sets of dependent variables that help capture firm-level innovations were considered: product innovations and technology licenses. Foreign technologies have been widely used in the extant innovation literature to analyse firms' innovations as it can have domestic spill over effect. The research question that was answered was: Do SMEs face some challenges in their quest to be innovative? The result of the empirical analysis provided a mixed result. The study found that loss due to theft and financial obstacle positively impeded product innovation outcomes and technology license acquisition.

These variables reduce the likelihood of product innovation outcomes and technology license acquisition. We also found that inadequate labour, government taxes and labour regulation do not statistically influence product innovation and technology license. These results can be credited to the fact that they do not pose significant challenges to small businesses innovations although they identify them as challenges. The results have proven that losses due to theft had a marginal influence on product innovation and technology license acquisition. Losses due to crime and theft used in this thesis denote to employees sharing companies' ideas/shares to competitors when they leave the company. The results on loss because of theft was a significant factor impeding SMEs product innovation outcomes and technology license acquisition across the model specifications for the logit regression results. This calls for policy makers to have policy plans on strengthening the intellectual property right regimes to safeguard knowledge and technology adoption and assimilations. Finally, the results on the country dummies show that firms in Slovakia and Hungary are more probable to

innovate their products and likely to obtain foreign technologies through international technological linkages.

The empirical results discussed in this section call for valuable understanding as well as practical implications that SME managers and policymakers in these countries might consider to boosting small business innovations.

1. Policy makers in the Visegrad economies should put in measures to improve upon the human capital which is needed for innovations to thrive in the region. There need to be a shift in the focus of education in these economies to science, vocational and technical education. These can equip labour with the requisite skillsets needed to sustain the innovation process.
2. Foreign technologies can also have domestic spill over effects in these economies, this result calls for policies to ensure that small businesses have uninterrupted access to foreign technologies. Government subsidies and innovation vouchers can be used to support small businesses to forge international technological linkages.
3. Funding available to SMEs demonstrated to be insignificant in boosting technological innovations. Governments and policy makers in the Visegrad group must consider increasing financial supports to innovative small businesses as this can have spill over effects. These finances could be invested in the quest for product innovation outcomes and technology license acquisition.
4. Policies should also focus on strengthening and strict enforcement of intellectual property right protection in these economies. This can allow small businesses to benefit from foreign technologies which can have domestic spill over effects.

5.4 Supplementary research findings from the qualitative enquiry

The researcher then employed a qualitative instrument to create empirical words from a small number of lecturers and academic researchers using an interview guide, to increase the validity and reliability of the study constructs used. The requested details are presented as an addition to the main research findings. Using the information from their research papers about innovation in V4 countries, a total of 75 questionnaires were sent to the responders through email. At the end of the survey, we received only 15 responses making the response (return) rate to be 20%. The results from the survey are shown in Table 20 below.

Table 20: Responses from the qualitative enquiry

Respondent / question	1. Do you teach in the university?	2.Could you indicate the Institution/Organization/ Company/Agency you work for?	3.How many years of research experience do you have on innovations research?	4.In your Opinion, what's the present overview of SME's innovation in the Visegrad Countries.	5.Which internal factors (activities) are vital for SMEs innovations?	6.Which internal factors should SMEs focus on to be innovative, in your opinion?	7.Which external factors influence SMEs innovations performance?	8. In your opinion which of these external factors significantly impact SMEs innovation performances?	9. In your opinion, which major obstacles do SMEs in the Visegrad countries face in their quest to innovative?	10. Which measures can be adopted by SMEs in Visegrad countries to minimize these innovation obstacles?	11. What policy recommendations (measures) need to be implemented to make SMEs more innovative.
1.	Yes	University of Pardubice	4	Based on the EIS data, all V4 states are moderate innovators	I will say a bit lagging in comparison with other Western counterparts in EU, CZ seems to be showing better result and improving, but general improvement is required.	Firms' specific resources-human capital, capabilities; organizational culture and openness (collaborative activities); R&D, funding of innovative activities,	More attention on internal resources and funding	1. Technology advancement and supply 2. Volatility of economic conditions and competition 3. Legal frameworks-Regulation, most importantly the environmental regulation 4. Labour market situations 5. Decisions of other competitors and suppliers	All of them impact, but to me items 2, 3,1 and 5 have the greatest impact in that order	Public support to create collaborative activities among firms Infrastructural development and non-financial support	Support policies both financial and non-financial Creating conducive economic conditions for investment

2	Yes	Metropolitant University Prague	4	They are better than Countries such as Bulgaria, Maldova who are classified as weaker innovators	Massive recruitment in human resources	More focus on competent and skilled employees	Decisions of other unregistered firms who compete with SMEs	Competition plays a major part	Firms unwilling to change	Investment in Infrastructural development	Support the growth of local businesses by eliminating huge taxes
3	No	Poltava University of Economics and Trade	2years research experience with Poltava University and now working as Independent Researcher and publishing on innovation	Comparing to Ukraine, Maldova, etc the V4 are advancing but not yet to the rate at which the Western economies are advancing.	Internal R&D and funding of innovative research	More attention on internal R&D funding	Government grant	Government grant has the greatest impact to SMEs innovation outcome	Low funding of innovation research.	Financial support for innovation activities.	Support SMEs development through special aid by various government.
4	Yes	University of Pardubice	4	Based on the CIS data, I can classify Hungary, Czech Republic, Slovakia and Poland to be moderate innovators	They are behind advanced economies such as the UK	Internal funds and Human capital	More attention on Human capital	Conducive business environment	Continuous changes in prices calls for adaptation of innovation.	Motivation R&D department	EU should constantly allocate funds for SMEs growth
5	Yes	Tomas Bata University in Zlin	8years	Based on the EIS data, all V4 states are moderate innovators	SMEs are bent on making quick structural changes in their operations to	finance, staffing (Human resource), current technology.	Experts' opinions and strategists, and technology.	Competitive and Market pressure,	Regional financial/economic variability, differences in trade policies, Sudden Geo-	Adopting friendly and common trade policies. Minimizing tax and giving	Adoption of workplace diversity in SMEs Minimizing tax and

					meet customer demands as a result of the covid-19.				political issues, pandemic crises (Covid-19 for instance)	subsidies to aid in R& D by governments within the Visegrad enclave	giving subsidies to aid in R& D by governments within the Visegrad enclave
6	Yes	Rzeszów University of Technology, Poland	7years	The Czech Republic are advancing at a faster rate compared to other members of the Visegrad countries if we take their automotive industry as an example.	Internal funding helps in all aspect of innovative development	More attention on internal funding	Infrastructur e	Infrastructure impact SMEs innovation externally.	Export restrictions to Countries such as Russia threating's SMEs operation.	Funds smoothens the ease of setting up innovative structures to proceed.	Creating conducive business environment would attract more firms in the Visegrad group.
7	No	Oracle research department, Czech Republic	6years	I will say a bit improving in comparison to Belgium, France, etc.	I think the larger the firm and the older they are, the higher their capacity and the more experience they have to handle the innovative demands, pushbacks and release to the market.	More attention on internal resources and funding	According to SLEPT, taxes should shrink their net revenue available to the firm to be assigned to other ventures hence the more favourable the environment is, the better it is for the	All kinds of taxes impact innovation activities.	cybercrime and privacy policy in the EU affect Innovation outcomes. Financial operating cost affect the establishment of SMEs in the Visegrad countries.	More focus on resources into research and innovation.	The more favourable the environment, the better it is for innovation.

							firm to innovate.				
8	Yes	Hungarian University of Agriculture and Life Sciences	3years	Czech Republic, Slovakia, Hungary, and Poland are considered as transition countries which makes their innovation activities average.	Capital investment in innovative activities and recruitment of competent employees	Capital investment would put the firm on the global market	1. International certification 2. Tax rates	They are all significant a certification is needed to put the firm on the global market, but taxes need to be moderate to allow smooth operation.	High tax rates. Firms replicating inventions.	Government should make tax chargers moderate to encourage new firms into the market	Provide incentives to new entrants in the EU market.
9	Yes	Faculty of Economics, South Bohemia University	4years	They are always manufacturing new products and therefore shows they are improving.	In my opinion internet connection, size of the firm,Wifi, power/electricity supply internal all contribute to SMEs innovation outcomes	More attention on size of firm as larger firm adapts quickly to innovation than smaller firms.	Taxes, public support, enabling environment.	An enabling environment calls for innovation activities.	V4 have bad political reputation in EU framework in general.	It depends on IT department and protection.	New Green EU Deal.
10	Yes	International University of Rabat	4years	The outbreak of the covid-19 has brought about structural change in the day-to-day operation, which has led to several diversified and	I will say a bit lagging in comparison with advanced Countries such as UK or Netherlands, the Visegrad Countries seems to be	Human resources, Internal R&D, funding of innovative activities,	Funding of innovative research.	1. Export conditions 2. Market situations 3. Competition 4. Regulatory framework	Inadequate capital to aid in business operation. Firms sticking to traditional method of operation.	Firms adopting to technology. Firms should implement change gradually and not only adopt the old way of business operation.	Firms need more policies like the EU support for SMEs if they want to catch up with advanced economies such as the UK.

				customized products and services.	improving, although there is more room for improvement				Companies unwilling to collaborate with other firms.		
11	Yes	Tomas University in Zlin	4years	The outbreak of the covid-19 has brought about structural change in the day-to-day operation, which has led to several diversified and customized products and services.	Human resource, technology, and improved logistics and transportation	Contemporary experts and strategists, and technology	Demand push, supply pull, competition, global market forces including global brand	competitions	Regional economic instability, variations in individual trade policies, impact of Russia-Ukraine attack, Covid-19 pandemic	Common trade policies among member state. And also, a common external policy among non-member state.	There should be a free flow of factor (capital and labour) among member state.
12	Yes	Chai Mai University	6years	After several research in the EU and Visegrad Group, I could say the V4 countries are catching up and closing the innovation gap.	They have shown Significant improvement in innovative activities.	Collaboration and funding of R&D activities	More attention on collaboratio n to come up with inventions.	Advancement in technology	Inadequate support from governments across the Visegrad countries	Non-Governmental organisation should support SMEs activities	Support policies financial and non-financial organisations
13	No	Independent researcher	4years	Slovakia and Czech Republic seems to be showing	collaborative activities	Price fluctuation	Price fluctuation affects SMEs innovation outcomes.	Funding and infrastructure	Funding and infrastructure	Infrastructural development	Creating conducive environment for innovation to take place.

				improving result.							
14	Yes	University of Hradec Králové	7years	They are gradually improving.	They are weaker compared to advanced economies.	Funding and resources	More attention on internal funding	Legal frameworks	The legal framework impact innovation.	Infrastructural development and non-financial support	Support policies both financially and logistic
15	Yes	Czech University of Life Sciences, Prague	6years	They are performing better compared to advanced economies.	Internal R&D	Labour market situations Decisions of other competitors and suppliers	Economic conditions and labour market.	Unwilling to switch from traditional method of operating to modern way.	Funds should be invested in all aspect of business development	Funds should be invested in all aspect of business development	Supporting innovative policies.

Source: Author' field data collected using interview guide

5.4.1 Researcher's remarks from qualitative inquiry

To gain a thorough grasp of the topic, the study conducted a brief qualitative survey of specialists and academic scholars in addition to the quantitative enquiry. The researcher subsequently received (15) responses from respondents. We provide a summary from the qualitative findings as follows:
The initial findings have shown that most of the experts and academic researchers are mainly people who have researched on innovation in the Visegrad countries. They have at least some publications on the topic over the years.

With regards to the question: ***How many years of research experience do you have on innovations research?***

The results show that the average years of research by most of these respondents was 4 years. Implying that they have researched on the trend of the topic at least in the past four years.

General overview of innovations in the V4

Concerning the question: *What's the present overview of SME's innovation in the Visegrad Countries.*

Most of the respondents are of the view the Visegrad countries are improving in terms of their innovation and catching up with Western European countries. Again, they can be seen as moderate innovators based on the European innovation survey. The Czech Republic is performing better than the other three countries.

Internal factors influencing SMEs innovations

With regards to the question: *Which internal factors (activities) are vital for SMEs innovations?*

Most of the experts are of the view that innovations can be boosted internally by implementing the combination of internal activities. In most of the cases small businesses could benefit from the positive externalities from these activities. They reported that small businesses should diversify their internal funds so that they can have access to sustainable funding. Secondly, they reported that small businesses need to strengthen their internal R&D capabilities. The research believe that all these suggestions proposed by these experts could help enhance innovations, but this should be contingent on these firms improving their absorptive capabilities to be able to fully benefit from these proposed activities. Some of the experts were also of the view that, firm characteristics such size and age could play key roles as internal factors that can spur small businesses innovations.

Regarding the question -Which internal factors should SMEs focus on to be innovative, in your opinion?

Regarding this question, there was a different response from the various respondents. While some were of a different view of the internal R&D contributing to innovation outcomes, most of the respondents believed that innovation funding is crucial for SMEs in the Visegrad group of countries to catch up with advanced economies for effective innovation outcomes. The researcher believes that while all these are vital to enhancing innovations internally, small businesses need to boost their absorptive capacities to be able to contribute better to R&D also to make good use of internally generated funds.

External factors influencing SMEs innovations

Concerning the question: Which external factors influence SMEs innovations performance?

The responses centred on various factors such as demand-side, supply-side policies, competition, interactions in global innovation ecosystems. The responses revolved around decisions that small businesses can take for instance regarding taking part in procurement contracts and internationalizing through exporting to benefit from novel knowledge and technologies which abound in the international ecosystem. These open innovation search can allow small businesses to complement any internal weakness with external support from partners. Both domestic and international technological linkages could have a positive spill over effects on domestic innovations in Visegrad countries.

Regarding a different question: *which of these external factors significantly impact SMEs innovation performances?*

Most of the respondents reported that increasing and sustaining public support for innovation will be the foremost external determinant that can influence SMEs innovations. These supports could boost innovations as it leads to increasing funding to SMEs who are mostly resource constrained. These supports can help SMEs to have access to funding to expend on innovations as well as its interrelated activities. The researcher believes that calls from these experts on increasing public innovation support is in the right direction, but it also requires firms to improve their absorptive capabilities to be able to assimilate the benefits of these support. The experts also suggested that increasing and sustaining R&D collaboration with other partners can be a vital determinant of small businesses innovations. The researcher believes that calls for the funding could also be extended to firms that engage in these innovative partnerships.

Barriers to SMEs innovations

Again, regarding the question: ***In your opinion, which major obstacles do SMEs in the Visegrad countries face in their quest to innovative?***

The experts provided various barriers small businesses face in their operations. Notably, the innovation drain was seen as a major obstacle to small businesses innovations as it creates the problem of inadequate skilled workforce vital for the success of innovation. The region is losing its qualified human capital to other countries due to wage differentials especially between Western European countries and the Visegrad countries. Again, the results of the empirical investigations demonstrated that certain element of the business ecosystem such as abnormal corporate tax rate serves as a substantial obstacle to firms' product innovations. When corporate taxes are higher, it can upsurge the amount spent on introducing novel products and processes, making the expected returns to this investment more uncertain. Corporate tax regime can be obstacle that can reduce SMEs inducements and propensities to innovate. Abnormal corporate tax rates could affect and raise R&D investment expenditure and intellectual property rights protection which can go a long way to negatively influence new products and processes progress. Most of the experts also pointed out that inadequate capital investment was a huge problem that can prevent small businesses to embark on innovations. It can also result in small businesses abandoning the started innovation process because they may not have the capital to sustain it.

Concerning the question: ***Which measures can be adopted by SMEs in Visegrad countries to minimize these innovation obstacles****?*

Most of the experts opined those small businesses should constantly focus on human capital development, strengthen their partnerships with other firms and knowledge repositories as cooperation can be a means to share risk of these obstacles. To obtain and effectively utilise public financing support, which can help small enterprises overcome their resource constraints, it is equally important for them to ensure that their internal competencies are developed.

Concerning the question: ***What policy recommendations (measures) need to be implemented to make SMEs more innovative.***

Most of the respondents were of the view that country specific policies are key to enhancing innovations. Policies should focus on providing adequate financial resources for innovation support to these small businesses. The researcher believes that the effectiveness and efficiency of these public investments will require bold transformations of national R&D and innovation systems with particular focus on their allocated. Demand-side policies could also be made favourable for small businesses by setting quotas or even limiting some calls just to them. These policies can somehow protect them from unfavourable competitions from large firms.

6. CONCLUSION

Research and Development and innovation play vital roles in generating sustainable productivity, growth, and job creation. The tendency to generate new knowledge through research is fundamental to developing innovative services, products, and processes, which facilitate higher industrial competitiveness, productivity, and overall economic prosperity. SMEs have been exposed to global competition because of constant feedback from customers' demand for new and quality products. These intense market competitions imply that firms, especially SMEs, are constantly searching for strategies to survive and gain competitive advantage above their market competitors. There is no clear pathway to achieving sustainable innovations, so this requires different approaches. In this dissertation, the researcher advanced integrated research models to assess the internal and external factors as well as firm attributes capable of influencing SMEs innovation outcomes within the Visegrad countries. The main theoretical underpinnings of the thesis were resource-based view, open innovations, and the national innovation systems model. This research is subdivided into three parts based on the specific objectives outlined in the methodology section.

The first specific objective sought to assess the internal factors affecting SMEs product and process innovation outcomes within the Visegrad Group. We examined the influence of internal R&D, overdraft facility, membership organisation, machinery, lines of credit, internet security, training, sectors, and country dummies. The results of the empirical analysis proved that, in general terms, these internal factors promote SMEs' innovation outcomes which helps them perform better than their competitors internally. We found that internal R&D, machinery, lines of credit and internet security was a significant factor contributing to SMEs ' product and process innovation outcomes. We also concluded that a firm's investment in machinery was an influential factor in deciding on a firm's choice for product innovation. This study also concluded that firms in the Visegrad countries were likely to indulge in both process and production activities on an annual basis, which is quite remarkable as they are classified as modest innovators.

The second specific objective is to examine the external factors contributing to SME technological innovation outcomes. We concluded that determinants such as technology license, government contract, external R &D, international quality certificate, informal competition and financial services contributed to SME's innovation outcomes. We focused on analysing the above external factors contributing to SMEs' innovation outcomes in Visegrad countries. The results further revealed that external R&D, international quality certificate and financial services substantially impacted technological innovation outcomes. Finally, we discovered that country dummies positively influenced firms' technological innovations, implying that these countries could be

technological innovators. The results especially on technological licenses and international quality certificates show that they matter for small businesses innovation performance.

Finally, the third specific objective was devoted to analysing the potential barriers that impede SMEs' innovation outcomes. This study assessed the impact of tax license, tax rates, labour regulations, inadequate labour, losses due to theft and financial obstacle etc. and how they impede the product and technology license acquisition outcomes. The analysis results showed that tax rates, loss due to theft and inadequate labour significantly impede SME product innovation outcomes and technology license acquisition.

Our research result has long-established that both internal and external factors contributed considerably to innovation outcomes within the Visegrad countries. Therefore, we recommend that all SMEs firms invest massively for high turnover. Firms can reinvest the profit back into the firm or borrow from the bank to boost innovation activities. The result of our analysis further revealed that performance-based incentives also had the highest influence on innovation outcomes. Therefore, management of SMEs should ensure they motivate employees to contribute to product and process innovation. Therefore, we recommend that firms intensify their partnership with research organizations to encourage process or product development.

6.1 Theoretical and practical implications

SMEs have size disadvantages such as inadequate resource personnel, financial constraint, and limited information. They find it difficult to cope with government regulations that hinder the implementation of innovation and thus limit competitiveness (Liao, Kickul, & Ma, 2009). While SMEs tend to be less bureaucratic and more risk-tolerant than larger firms, innovation in larger firms generally happens more rapidly than in smaller firms. The internal decisions made by management are an attempt to encourage innovation. This research focused on analysing the internal and external factors that influence SME innovation. SME innovation is determined by several factors which differ across countries and industries. The result of this study will exend our knowledge on how firms' innovations could be initiated and sustained, especially firms in catching up countries like the V4. This thesis offers some remarkable contributions to both theory and practice and are outlined below as follows.

Theoretical contributions

- The study advances how we perceive firms in the Visegrad countries. Innovation contributes to new business ideas and how SMEs can be financed in the selected countries. This study has given academic researchers some form of practical enquiry into SME developmental activities within these regions where the research on SME innovation is scant.

- The study found that internal factors such as funding, human capital, R&D all matter for small businesses innovation outcomes. These internal factors are vital resources available to these small businesses which can be harnessed to enhance and sustain their innovations. This is in line with the resource-based view theory of the firm.
- The main theoretical implication of the results of specific objective two demonstrates that the existing knowledge production models in these countries should be modified to amalgamate international technological relationships as the results have shown that quality management and assurances, and foreign technologies acquisitions via licensing arrangements positively influence technological innovations. Our study proved that international technological links produce positive externalities to Visegrad countries which could contribute to stimulating innovations that at present day is depicted as weak. These findings contribute to and extends the national innovation systems and open innovation theories.
- Lastly, the econometric analysis for the specific objective three advances the understanding of SMEs businesses environment by showing that it could be for instance hindered by hysterical fiscal policies. Astronomical corporate taxes reduce the investments small businesses could expend on the innovation process, but this nexus between fiscal policies and firm-level innovations is terra-incognita by researchers in Visegrad countries. The result of fiscal policy influence on small businesses innovation contributes to the growing national (regional) innovation systems theory literature.

6.2 Practical implications

Practically, the research results offer several contributions to practice. Practically, these findings will,

- The results warrant firm managers and policymakers to fully capitalise on the opening-up process and obtain internationally recognised quality certificates and foreign technologies through various licensing agreements. The principal practical implication for SME managers in these countries is that readiness to accept infusions of foreign knowledge and technology scientifically improves and balance the quality of domestic resources resulting in improved services, products, and process development.
- According to the findings, Visegrad countries and other catching-up nations should target both small and large businesses with unique strategies, emphasising the need to encourage R&D and technology acquisition policies proportionately.
- Policymakers should also consider policies that make the business environment in these countries sensitive to small businesses innovations. Negative aspect of the businesses environment such high tax rates which

could pose a significant threat to innovations could be reviewed to make it favourable.

- Improving the quality of innovation support for firms and other knowledge repositories will also be key to ensuring that SMEs can stay innovative sustainably.
- Small businesses managers in these countries should place greater emphasis on demand-side policies such as engaging in public procurement process as this has been demonstrated to positively enhance innovations.
- Focused on human capital loss which is exacerbated by the innovation drain syndrome. Firms should also have enticing remuneration packages to be able to attract the right human capital needed for innovations to thrive.

6.3 Limitations of the thesis

This study's findings and conclusion need to be interpreted according to the dissertation's limitations. The cross-sectional characteristics of the data means that our results should be interpreted as innovations for the specified time. Secondly, the attribute of the data didn't permit the inclusion other widely known measures of innovation provided by the Oslo manual for instance non-technological innovations due to data unavailability as it was not contained in this edition of the survey. The studies sole concentration on technological innovations, implies that the results need to be interpreted as such and not to suggest overall innovations. The dataset also includes other measures that describe the nature of innovations in firms namely utility models or trademarks and scholarly publications. The absence of data on these measures constrains our understanding of other kinds of innovation. Finally, combining the Visegrad countries as a solitary analytical unit means that we cannot generalize the findings of the studies that these determinants influence innovation in each of these countries.

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APPENDIX

Appendix A: Objective one descriptive statistics- Czech Republic

Descriptive Statistics				
	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Product innovation	388	1.66	.024	.475
Process innovation	388	1.77	.022	.424
Overdraft facility	388	1.44	.025	.497
Internal R&D	388	1.69	.023	.463
Membership organisation	387	1.70	.023	.458
Machinery	388	1.32	.024	.467
Lines of credit	387	1.73	.023	.445
Internet security	388	1.37	.024	.482
Training	380	1.55	.026	.498
Sectors	380	1.94	.031	.611

Source: Author's own based on world bank data

Appendix B: Objective one descriptive statistics- Hungary

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Product innovation	672	1.82	.015	.387
Process innovation	672	1.88	.013	.331
Overdraft facility	671	1.51	.019	.500
Internal R&D	671	1.88	.012	.323
Membership organisation	675	1.10	.012	.305
Machinery	671	1.81	.015	.390
Lines of credit	668	1.72	.017	.447
Internet security	670	1.28	.017	.450
Training	675	1.68	.018	.465
Sectors	675	1.91	.025	.656

Source: Author's own based on world bank data

Appendix C: Objective one descriptive statistics- Slovakia

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Product innovation	339	1.86	.019	.349
Process innovation	339	1.92	.014	.267
Overdraft facility	337	1.35	.026	.478
Internal R&D	339	1.91	.016	.293
Membership organisation	339	1.83	.020	.375
Machinery	339	1.62	.026	.485
Lines of credit	339	1.87	.018	.340
Internet security	339	1.41	.027	.493
Training	337	1.56	.027	.497
Sectors	338	2.10	.038	.707

Source: Author's own based on world bank data

Appendix D: Objective one descriptive statistics- Poland

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Product innovation	1097	1.80	.012	.396
Process innovation	1089	1.92	.008	.264
Overdraft facility	1063	1.52	.015	.500
Internal R&D	1080	1.95	.007	.226
Membership organisation	1091	1.88	.010	.325
Machinery	1081	1.69	.014	.463
Lines of credit	1053	1.88	.010	.330
Internet security	1096	1.63	.015	.482
Training	1081	1.78	.013	.414
Sectors	1106	1.69	.020	.645

Source: Author's own based on world bank data

Appendix E: Objective two descriptive statistics - Czech Republic

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Technological innovation	776	1.71	.016	.453
Technology licensed	388	1.87	.017	.333
Government contract	388	1.76	.022	.431
External R&D	388	1.87	.017	.333
International quality certificate	385	1.64	.024	.479
Informal competition	376	1.76	.022	.426
Financial services	383	.20	.075	1.471
Firm size	388	2.40	.025	.500
Sectors	380	1.94	.031	.611

Source: Author's own based on world bank data

Appendix F: Objective two descriptive statistics -Hungary

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Technological innovation	1344	1.85	.010	.361
Technology licensed	672	1.93	.010	.253
Government contract	671	1.94	.009	.242
External R&D	672	1.93	.010	.258
International quality certificate	670	1.58	.019	.493
Informal competition	655	1.85	.014	.355
Financial services	661	1.05	.296	7.607
Firm Size	672	2.36	.019	.505
Sectors	675	1.91	.025	.656

Source: Own calculations

Appendix G: Objective two descriptive statistics -Slovakia

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Technological innovation	678	1.89	.012	.312
Technology license	338	1.72	.025	.452
Government contract	337	1.95	.012	.213
External R&D	338	1.92	.015	.272
International quality certificate	339	1.69	.025	.462
Informal competition	326	1.63	.027	.482
Financial service	336	.01	.009	.164
Firm Size	339	2.28	.026	.474
Sectors	338	2.10	.038	.707

Source: Author's own based on world bank data

Appendix H: Objective two descriptive statistics- Poland

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Technological innovation	2186	1.86	.007	.342
Technology license	1080	1.89	.009	.310
Government contract	1088	1.90	.009	.306
External R&D	1088	1.94	.007	.230
International quality certificate	1078	1.90	.009	.295
Informal competition	1018	1.77	.013	.418
Financial service	892	.45	.112	3.357
Firm Size	1098	2.36	.015	.494
Sectors	1106	1.69	.020	.645

Source: Author's own based on world bank data

Appendix I: Objective three descriptive statistics - Czech Republic

	N	Mean		Std. Deviation
	Statistics	Statistic	Std. Error	Statistic
Product innovation	388	1.66	.024	.475
Technology licensed	388	1.87	.017	.333
Tax rates	380	5.19	.134	2.606
Labor regulation	379	1.47	.054	1.050
Inadequate labour	379	1.74	.065	1.269
Financial obstacle	384	1.95	.040	.775

Source: Author's own based on world bank data

Appendix J: Objective three descriptive statistics - Hungary

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Product innovation	672	1.82	.015	.387
Technology license	672	1.93	.010	.253
Tax rates	675	8.06	.167	4.337
Labor regulation	675	.65	.033	.861
Inadequate labour	672	1.35	.050	1.309
Financial obstacle	675	8.13	.165	4.300

Source: Author's own based on world bank data

Appendix K: Objective three descriptive statistics - Slovakia

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Product innovation	339	1.86	.019	.349
Technology license	338	1.72	.025	.452
Tax rate	339	7.75	.237	4.368
Labor regulations	339	2.01	.050	.920
Inadequate labour	338	2.22	.052	.965
Losses due to theft	32	.44	.317	1.795
financial obstacle	339	7.88	.233	4.291

Source: Author's own based on world bank data

Appendix L: Objective three descriptive statistics - Poland

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Product innovation	1097	1.80	.012	.396
Technology license	1080	1.89	.009	.310
Tax rates	1102	8.13	.135	4.478
Labor regulations	1085	2.34	.027	.891
Inadequate labour	1066	2.41	.028	.920
Loss due to theft	114	.39	.183	1.949
Financial obstacle	1102	8.18	.127	4.207

Source: Author's own based on world bank data

Appendix M: Endogeneity Test result for internal factors

Product innovation	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]	
Internal funds	.0006666	.0032596	0.20	0.838	-.0057222	.0070553
Performance indicators	.0773007	.0421931	1.83	0.067	-.0053961	.1599976
Production targets	.0880704	.0344162	2.56	0.010	.0206159	.1555248
Capacity utilization	-.0028876	.0014171	-2.04	0.042	-.005665	-.0001101
Business operation	.0006224	.0005717	1.09	0.276	-.0004981	.0017429
Constant	.0618341	.2817736	0.22	0.826	-.490432	.6141001
Model summary						
Number of observations	= 289					
Dependent variable		Product innovation				
Instrumented		Capacity utilization of inputs				
Instruments		Constant, log of internal funds, log of firm's performance indicators, log of business operation strategies				

Source: Author's own computation

NOTE: Probit with endogeneous test -Null hypothesis: estimates are consistent Asymptotic test statistic: Chi-square (1) = 2.23 with p-value = 0.1353

LIST OF PUBLICATIONS BY THE AUTHOR

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1. Amoah, J., Jibril, A. B., **Odei, M. A**., Bankuoru Egala, S., Dziwornu, R., & Kwarteng, K. (2023). Deficit of digital orientation among service-based firms in an emerging economy: a resource-based view. Cogent Business & Management, 10(1), 2152891.
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5. **Odei, M. A.,** & Odei, S. A. (2020). The mediating effect of firm's R&D collaborations on their innovative performance. *Ekonomski pregled*, *71*(5), 493-511.
6. Amoah, J., Nutakor, F., Li, J., Jibril, A. B., Sanful, B., & **Odei, M. A.** (2021). Antecedents of social media usage intensity in the financial sector of an emerging economy: a Pls-Sem Algorithm. *Management & Marketing. Challenges for the knowledge society*, 16(4), 387-406.
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2. **Odei, M. A.,** Amoah, J & Novak, P. (2021). Key Barriers to Small and Medium Enterprises Innovation Performance across Europe. *In proceedings of 17th International Bata Conference,* pp 21-29
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11. **Odei, M. A.,** & Novak, P. (2022). The external factors leading to product innovation outcomes in the Visegrad Group-Structural Equation Model Approach, 21st European Conference on Research Methodology for Business and Management Studies. Academic Conference International (Accepted ACPI paper in Scopus).

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