Human Capital, Reverse Engineering and New Venture Growth: The Moderating Role of Competitive Strategy

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Abstract

In this study, we propose human capital as an important enabler of new venture growth (NVG) and investigate how and when it enhances NVG. We examined this by considering a dynamic capability – reverse engineering– as a mediator and competitive strategy as an important contingency variable. Using survey data collected from 229 new manufacturing ventures in an emerging economy (Ghana), the results indicate that reverse engineering mediates the effect of human capital on NVG. The contingency analyses also revealed that the positive impact of reverse engineering on NVG is stronger at high levels of low-cost strategy. However, the relationship between reverse engineering and NVG is weaker when the differentiation strategy is high. The implications of the findings are discussed.

Keywords: *Africa*; *competitive strategy; human capital; new manufacturing firms; dynamic capabilities; reverse engineering; Ghana.*

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1. Introduction

There is little doubt that reasonable scholarly attention has been dedicated to the role of human capital in driving new venture outcomes within the broad strategy literature. The general consensus suggests that human capital is critical to firm performance (Becker & Huselid, 2006; Subramony, Krause, Norton & Burns, 2008). Furthermore, perspectives in the micro-organisational literature suggest that the nature of human capital significantly affects firms' growth (Takeuchi, Lepak, Wang & Takeuchi, 2007). Human capital is viewed as vital to firms' performance in the context of emerging economies (Adomako et al., 2021; Malik & Kotabe, 2009; Zhang & Zhou, 2016). In relation to this, research from developed economies shows that employees with high human capital (i.e., quality education and experience) enhance firms' ability to implement new technologies in a more effective manner (Shrader & Siegel, 2007; Siegel, 1999; Link & Siegel, 2007).

To date, some scholars have investigated the human capital–firm growth hypothesis from various theoretical and conceptual perspectives. In the main, past studies have focused on personal characteristics such as job tenure, age, and education as proxies for determining human capital given their influence on the decision-making process (Crook et al., 2011). For example, some scholars in the strategy literature have examined the relationship between salient demographic characteristics of entrepreneurs and/or employees and new venture growth (Davidsson & Honig, 2003; Riley, Michael & Mahoney, 2017; Ucbasaran, Lockett, Wright & Westhead, 2003). The general outcomes from these studies indicate that demographic characteristics (e.g., education and experience) are crucial to new venture growth (NVG). In addition, other studies suggest that personal characteristics constitute critical intangible resources to firms (Shrader & Siegel, 2007). This view seems logical given that intangible resources are recognised as key strategic assets on which firms build their market competitiveness (Wolfson & Mathieu, 2018; Kor & Leblebici, 2005; Youndt, Subramaniam & Snell, 2004).

Additionally, the literature suggests that reverse engineering, which hinges on the human capital, significantly affects the performance of emerging-market firms (Malik & Kotabe, 2009). Moreover, empirical evidence in the literature shows that the ability of a firm's human resources to absorb the know-how of new technologies and processes through reverse engineering enhances its effectiveness and innovation efficiencies (Zhang & Zhou, 2016; Wang & Kafouros, 2009). Arguably, the view that firms may leverage human capital and reverse engineering to enhance performance seems logical given the limitation of financial and technological resources in developing countries.

However, despite some research evidence and viewpoints that support the criticality of human capital and reverse engineering to firms' performance, important knowledge voids still exist that warrant research attention. A critical review of the broad literature reveals two main gaps. First, our review shows that current understanding concerning how human capital interacts with other relevant variables to influence firm growth is still limited. Even though we know that firms that possess weak R&D capabilities in developing economies tend to use reverse engineering as an alternative mechanism for product development (Malik & Kotabe, 2009; Zhang & Zhou, 2016), very little empirical research has focused on verifying how this capability influences the hypothesised link between human capital and firm growth. Consequently, this gap elicits some salient questions. For example, how do varying levels of human capital relate with reverse engineering to influence venture growth? Under what conditions do the integration of human capital and reverse engineering maximise firm growth? Therefore, additional research into the potential ways in which human capital contributes to firms' innovation performance and growth is important. This is because a significant percentage of the value of new products and services is likely to be determined by the quality of firms' employees (Semadeni & Anderson, 2010; Cappelli et al., 2014). We focus our study on a developing-economy's context because these economies often face resource constraints in the development of new products. As a result, leveraging reverse engineering has been noted

as a vital strategic approach, as it aids small firms in reducing the time for adopting new technology and product development (Kogut & Zander, 1992).

Second, even though previous research has established that reverse engineering is positively linked to growth in manufacturing firms in emerging economies (Malik & Kotabe, 2009; Zhang & Zhou, 2016), the boundary conditions of this dynamic relationship are under-researched. Accordingly, we draw insights from the strategy literature (Porter, 1980), and propose that the nature of a firm's competitive strategy offers an important avenue for deepening understanding of the human capital, reverse engineering, and firm growth nexus.

In this study, we make three main contributions to the literature. First, the study extends research on resource-based and dynamic-capability theories by showing how reverse engineering mediates the link between levels of human capital and firm growth. In doing so, we complement previous studies which have explored the role of human capital in NVG (Ahmad & Schroeder, 2003; Cook, Bowen, Chase, Dasu, Stewart & Tansik, 2002; Ployhart & Moliterno, 2011; Riley, Michael & Mahoney, 2017). Second, we extend the boundary conditions of this relationship by integrating insights from dynamic capabilities (Tang & Rai, 2014) and competitive strategy frameworks. Specifically, we examine the moderating effects of two main forms of competitive strategies (i.e., low-cost and differentiation) on the relationship between reverse engineering and firm growth. Addressing this problem is deemed important because manufacturing firms in emerging and developing markets often lack R&D capabilities (Malik & Kotabe, 2009), and thus tend to imitate foreign products. Consequently, the success of these firms depends on their ability to formulate and implement appropriate and coherent competitive strategies which effectively align with the positioning of their products. Third, the study extends the literature by testing the proposed research model on a sample of emerging-country manufacturing ventures. In this way, we enhance the external validation of the underlying theories of small firms' performance (Hoskisson, Eden, Lau & Wright, 2000). Additionally, from a practical perspective, the expected insights from this research will be

particularly germane to business managers and investors, given the growing interest in the development of manufacturing firms in emerging and sub-Saharan African economies.

2. Literature, theoretical perspectives, and hypotheses

2.1 Resource-based theory and dynamic-capability perspective

The resource-based theory (RBT) explains why human capital is considered very crucial to the outstanding performance of some firms (Barney, 1991, 2001). The central tenet of this perspective suggests that by developing and leveraging human capital, firms will be better positioned to outcompete their rivals in terms of growth (Barney, 1991; Barney & Clark, 2007; Sturman, Walsh & Cheramie, 2008).

Defined as "an individual's knowledge, skills, abilities and other characteristics that are relevant for achieving economic outcomes" (Ployhart et al., 2014, p. 373), human capital has been recognised as a key differentiator of growth among individuals, organisations and even nations (Becker, 1964; Ployhart et al., 2014; Wolfson & Mathieu, 2018). According to human-capital theory (Becker, 1964), investing in the skills development and training of workers helps to improve firms' access to knowledge, which ultimately enhances the competitiveness of the focal firms and their home nations in the long term. This is because through training, firms can upgrade the know-how of their workers to better inform subsequent courses of action (Dierickx & Cool, 1989; Sturman, Walsh & Cheramie, 2008). Moreover, the theory of human capital suggests that firm growth can be enhanced by the possession of superior knowledge, skills and expertise. Consequently, many firms have turned to personnel poaching as a means of accessing such unique assets whilst weakening their rivals (Amankwah-Amoah, 2020; Amankwah-Amoah et al., 2017). It has also been noted that the success of manufacturing firms in innovation is predicated on not only their ability to obtain raw materials but also on different kinds of resources, such as human capital (Zhang & Zhou, 2016).

While extant research has improved general understanding regarding the important role of human capital in firm growth, a critical analysis reveals that there is limited knowledge regarding the organisational mechanisms through which firms leverage their human capital to achieve growth. As a result, we derived insights from the dynamic-capability perspective (see Teece, 2018; Zahra et al., 2006) to argue that human capital indirectly influences firms' performance by facilitating their ability to reverse engineer or develop new products by relying on the proven innovation ideas and processes of the more endowed developed market firms.

The literature shows that emerging- and developing-economy firms can fast-track their innovation activities via reverse engineering (Malik & Kotabe, 2009; Zhang & Zhou, 2016) and *forward engineering* mechanisms (Chen & Guan, 2011; Zhang & Zhou, 2016). Reverse engineering refers to the acquisition of knowledge via the disassembling of products into observable technological units and assembling declarative and procedural knowledge (see Kogut & Zander, 1992) that paves the ways for replication and improvements in product designs (Malik & Kotabe, 2009). According to Malik and Kotabe (2009), reverse engineering results from the spillovers of product-specific knowledge from customers' ideas and insights from competitors' products to develop innovation outputs.

While reverse engineering often results in the imitation of other firms' innovation outputs or technologies (Zhang & Zhou, 2016), a related construct – forward engineering – is mainly characterised by R&D novelty (Chen & Guan, 2011). In other words, forward engineering results when firms leverage, and exploit insights and experiences gained from previous reverse engineering activities to generate new and independent designs (Zhang & Zhou, 2016). However, it is important to note that reverse engineering and forward engineering interact and weigh against each other in the innovation process (Pack & Saggi, 1997). Instructively, reverse engineering is different from *reverse innovation*, which refers to a process where products are designed first for consumers in low-income nations and then

adapted into disruptive offerings for industrialised/advanced economies (Immelt, Govindarajan & Timble, 2009; Winter & Govindarajan, 2015).

Zhang and Zhou (2016) propose reverse engineering capability as a particularly critical but neglected variable in understanding the innovation processes of emerging economies. The authors suggest that, together with other innovation predictors (e.g. R&D personnel, reverse engineering and technology accumulation), reverse engineering exerts a positive impact on firms' international performance through its effect on innovation outputs. Previous research evidence and insights support the hypothesised view of reverse engineering reverse engineering as an important factor (either as an antecedent predictor or mediator) in the performance of emerging-market firms. For example, Malik and Kotabe (2009) identified that reverse engineering exerts a positive and a significant effect on the performance of manufacturing firms from India and Pakistan. Similarly, Zhang and Zhou (2016) also found support for the indirect impact of reverse engineering on international sales of new products by Chinese high-tech firms.

Thus, overall, there is reasonable justification in the literature to suggest that reverse engineering is a vital organisational capability that can enhance the performance of firms, especially in emerging economies. Consequently, drawing insights from previous research (Teece, 2018; Zahra et al., 2006), this study conceptualises reverse engineering as an important dynamic capability in the innovation performance of emerging- and developing-economy firms. Moreover, this research focuses on reverse engineering because despite its criticality to developing/emerging-economy firms, it has received very limited research attention (Zhang & Zhou, 2016).

In addition to investigating the potential mediating role of reverse engineering in the innovation processes of SMEs, we explore the boundary limits of the mediating mechanisms through which it (reverse engineering) affects firm performance. We seek to achieve this by testing the moderating effects of firms' competitive strategies (Porter, 1980) on the relationship

between reverse engineering and firm growth. We concentrated on competitive strategies as potential moderators of the hypothesised relationship because the adoption of reverse engineering is usually aligned with a firm's strategic market positioning, which influences the implementation of marketing programmes, such as product development. Moreover, examining the role of competitive strategies in firms' performance is particularly germane to emerging-market firms. This is because these firms often face a "strategic dilemma" as to whether they should compete as innovation leaders, using internal R&D capabilities, or continue to follow low-cost and imitation-based competitive strategies (Hobday et al., 2004; Xiao et al., 2013; Wang et al., 2014).

2.2 Human capital and reverse engineering

In the face of scarce financial and human capital, firms in emerging countries are often motivated to adopt the low-cost approach to innovation. Despite issues with the ethicality of reverse engineering, its adoption has become more appealing to emerging-market firms which lack requisite resources to catch up with their peers in the developed Western world (Zhang & Zhou, 2016).

The extant literature suggests that the capacity of firms to reverse engineer is dependent on the level of capability of their human capital (Cappelli et al., 2014; Dierickx & Cool, 1989; Semadeni & Anderson, 2010; Zhang & Zhou, 2016). In addition, empirical evidence in the literature shows that the ability of a firm's human resources to absorb the know-how of new technologies and processes through reverse engineering enhances its effectiveness and innovation efficiencies (Zhang & Zhou, 2016; Wang & Kafouros 2009). Stated differently, the possession of capable human capital in R&D is vital to emerging firms' ability to exploit or imitate the innovation processes of the more resource-endowed developed market firms.

Furthermore, aside from attracting the right human resources with the required expertise, a crucial feature of firms which succeed in innovation performance is the possession

of rich human capital as well as their ability to stem the outward flow of top talent, whilst encouraging inward flows (Amankwah-Amoah et al., 2017). Accordingly, we contend that the possession of skilled human capital is more likely to enable such firms to study the processes, designs, inputs, ingredients and features of other firms' products for their productive activities. Thus, based on human-capital theory (Becker, 1964) and empirical-research insights (Zhang & Zhou, 2016; Wang & Kafouros 2009), we expect that the possession of high levels of human capital will enhance firms' ability to reverse engineer and thereby enable them to develop substantial competitive advantage over rivals, especially in an environment where there are few differentiating factors. Hence, we hypothesise that:

> **H1:** *In manufacturing small firms from emerging economies, the greater the level of human capital, the higher the level of reverse engineering*.

2.3 Reverse engineering and new venture growth

Reverse engineering has become a key feature of the operations of many firms operating in resource-scarce environments (Russell & Taylor III, 2008). In addition, since most emerging and developing countries lack stronger R&D capability development, the dominant form of new-product development has been the imitation of successful products (Malik & Kotabe, 2009). By dismantling products and learning from a competitor's products and processes (Coe, Capelle & D'Amico, 2009; Hill, 2007; Russell & Taylor III, 2008), firms can glean new knowledge from areas where they have no prior knowledge. A recent study (Zhang & Zhou, 2016) also suggests that reverse engineering can provide an opportunity to access fresh perspectives on innovative processes. Thus, it may be inferred that the reverse engineering process enables firms to build a reservoir of new knowledge that can be deployed to improve production processes, designs and products even in areas where they have limited expertise. Consequently, through reverse engineering, it is expected that firms can restructure their systems to create conditions for growth.

reverse engineering also offers a means for small firms lacking resources such as human capital and R&D budget to understand rival firms' products, assembly methods and usage of raw materials (Hill, 2007). However, new ventures are often confronted with challenges such as resource scarcity and limited ability to recruit the right talents during recruitment (Malik & Kotabe, 2009; Zhang & Zhou, 2016). Consequently, given the generally high failure rate of new-product development and costly R&D activities, it is reasonable to contend that there will be strong incentives for firms operating in resource-constrained environments, to resort to reverse engineering to sidestep environmental and firm-level limitations. As a result, we reckon that reverse engineering will allow small firms in emerging markets access to external knowledge that aids them in new-product development and eventually lead to improved growth. Thus, we suggest that:

> **H2:** *In manufacturing small firms from emerging economies, reverse engineering mediates the relationship between human capital and venture growth.*

2.4 Competitive strategy as a contingency variable

A few decades ago, Porter (1980) proposed three key business-level strategies encompassing cost leadership, differentiation and integrated (i.e. cost leadership and differentiation) strategies (see Hill, Schilling & Jones, 2019; Hitt, Ireland & Hoskisson, 2017) that firms can employ to safeguard, preserve or confront rivals in the marketplace. Extant research in strategy has shown the appropriate alignment and adoption of these competitive strategies have a strong influence on firms' outcomes (e.g. Acquaah, 2007; Campbell-Hunt, 2000; Lillis & Sweeney, 2013). By and large, cost leadership and differentiation strategies constitute the dominant logic of competitive strategy and form the strategic weapons that define the market scope (Chrisman et al., 1988; Grant, 1998). Since adoption of a specific strategy reflects how a firm develops a competitive advantage in a given industry relative to its competitors, it is reasonable to expect that the nature of competitive strategy will impact heavily on the extent to which reverse

engineering affects performance outcomes. We therefore discuss some ways in which the adoption of low-cost and differentiation strategy may impact the hypothesized effect of reverse engineering on venture growth.

2.4.1 Low-cost strategy

Cost-leadership strategy or low-cost strategy refers to a strategy whereby a firm seeks "to outperform competitors by doing everything the company can to produce goods or services" at a cost lower than that of rival businesses (Hill & Jones, 2009, p. 111; Johnson, Scholes & Whittington, 2008). By adopting this strategy, firms seek to develop routines, systems and processes encompassing materials handling and inventory control that enable them to produce goods or provide services with generally acceptable features or levels at the lowest cost compared with those offered by rival firms (Hitt et al., 2017). Firms pursuing such a strategy may opt for frugal innovation by utilising technologies developed elsewhere, standardisation of products, cheaper raw materials and simplified production processes to enable them to beat rivals through lower cost advantages (Hill & Jones, 2009; Hitt et al., 2017).

One of the main barriers facing manufacturing small firms from emerging economies is the lack of access to superior technology, financial resources and highly skilled individuals to power their innovation or research and development activities (Malik & Kotabe, 2009; Zhang & Zhou, 2016). Through reverse engineering, such firms are likely to sidestep most of the costs associated with new-product development and R&D. Accordingly, it is reasonable to suggest that firms which employ reverse engineering to secure knowledge and capabilities to develop new products (i.e. imitation) in emerging economies, are more likely to achieve success when they emphasise a high low-cost strategy. Based on the foregoing reasoning, we postulate that:

> ***H3a****: In manufacturing small firms from emerging economies, the positive effect of reverse engineering on new venture growth will be stronger at high levels of low-cost strategy.*

2.4.2 Differentiation strategy

Firms that implement a differentiation strategy tend to develop products or services that are perceived by customers as distinctive and valuable compared to competing brands (Hill & Jones, 2009). By opting to pursue a differentiation strategy, firms adopt a set of measures to equip them to produce goods that are perceived by customers to be of superior functionality or quality and, thereby, can command premium prices in the marketplace (Hill & Jones, 2009; Hitt et al., 2017). Generally, with standardised products, consumers compare and differentiate between alternative brands based on important features relating to reliability and functionality rather than on low price. Therefore, to command premium prices and outperform rivals, firms must invest considerable resources into research and development activities to understand customers to innovate and improve product functionalities (Hitt et al., 2017). However, offering extremely expensive products, could lead to the loss of large segments of the market (Hitt et al., 2017; Johnson et al., 2008), especially in emerging and base-of-the-pyramid (Prahalad & Hart, 2002) economies given the generally low-income levels.

Based on a differentiation strategy which emphasises innovation, firms create products and services that are considered unique by customers. Given that firms use their product innovation capabilities to produce unique products and services (Lechner & Gudmundsson, 2014; Miller, 1988), it is likely that the adoption of a differentiation strategy – by emerging-economy firms which are generally weak in R&D – will weaken the effect of reverse engineering on firm growth. The rationale is that firms that use the reverse engineering strategy tend to refrain from creating unique products and services but rather focus on mimicked ones to serve their customers. In addition, since a differentiation strategy requires that the firm develops stronger innovation capabilities to develop new products and services for customers at premium prices (Porter, 1980), it is likely to attenuate the positive impact of the reverse engineering strategy, which mimics the features of innovative products of competitors, on firm

growth. This is because the quality of such imitations is unlikely to reach the same level as that of the original products in the marketplace which come with premium prices. Thus, it might not be beneficial for manufacturing firms in developing economies to compete by emphasising on quality, as a differentiation and a high pricing strategy can unrealistically raise market expectations above the perceived performance of their products. Ultimately, this would negatively affect the sales or performance of their products, especially where these are targeted at upmarket consumers who prefer superior quality products. This reasoning led to the statement of the next hypothesis as follows:

> ***H3b**: In manufacturing small firms from emerging economies, the positive effect of reverse engineering on new venture growth will be weaker at high levels of differentiation strategy.*

3. Research method

3.1 The study context

Ghana was considered an appropriate context for this research for several reasons. First, the country shares many of the key characteristics of emerging and fast-growing sub-Saharan African economies (Amankwah-Amoah & Hinson, 2019; Amankwah-Amoah & Lu, 2019; Hoskisson et al., 2000). For example, the country has been described as relatively resource-constrained, reliant on less-skilled manufacturing workforces and dependent on older technologies (Amankwah-Amoah & Lu, 2019; Malik & Kotabe, 2009). Second, Ghana has effectively managed an open market economy for more than two decades, which has attracted significant foreign investment, mostly from Chinese and Western multinationals. Third, compared to many Western economies, Ghana ranks low on the Technological Capability Index. This indicates that domestic firms in the country have weak capability in the initiation of technological innovations (Archibugi & Coco, 2004; Archibugi et al., 2009), and are therefore more inclined to adopt reverse engineering as a catch-up strategy.

3.2 Sample and data

The sampling frame was derived from the Association of Ghana Industries (AGI). The following sampling criteria were used to select 690 firms for the study: (1) physical product manufacturers; (2) firms owned and operated by an individual entrepreneur/group of entrepreneurs; and (3) firms that were not part of any company group. Finally, the firm had to be for-profit, incorporated in 2009 or later and employing a maximum of 250 full-time employees. The Cardon and Kirk's (2015) approach to categorising new ventures was used to select firms which have been operational for up to 10 years to capture the various stages of their formation and development.

The data were collected in two phases. First, we approached the owner-CEOs (chief executive officers) of the 690 firms with questionnaires in person. The survey captured information on relevant issues relating to firms' human capital, reverse engineering, and competitive strategy. After two reminders, we received 259 responses (37.53%) (i.e., time 1). Second (i.e. time 2), to attenuate for potential common method bias (Podsakoff et al., 2003), we approached the finance managers of the 259 firms to capture venture growth measures immediately after time 1. After two reminders, we received 238 responses from the finance managers. The 21 firms that did not respond had no finance managers. After accounting for missing values, we obtained 229 completed and matched responses (33.18%). On average, the firms employed 25 full-time staff and had been in existence for seven years.

We examined non-response bias by comparing respondents and non-respondents (Armstrong & Overton 1977; Rogelberg & Stanton 2007). A comparison of the two groups in terms of firm age, size and market scope found no substantial differences. Thus, we believe that non-response bias had no substantial influence on our data.

3.3 Measures

Human capital. We measured human capital using the five items identified by Subramaniam and Youndt (2005). The items assessed the overall skill, expertise and knowledge levels of a firm's employees and were captured on a Likert scale with anchors ranging from 1 = strongly disagree to 7 = strongly agree.

Competitive strategy. Regarding Porter's (1980) generic competitive strategies, we measured this using the 10 items advanced by Acquaah (2007). Respondents were asked to indicate the extent to which their firms had utilised competitive strategies from 2013 to 2015 on a seven-point Likert scale ranging from 1 = not at all, to 7 = to an extreme extent. Based on a factor analysis, we obtained two factors: low-cost and differentiation strategies. We measured low-cost strategy with four items whilst the differentiation strategy was captured with six items.

Reverse engineering. We followed Malik and Kotabe (2009) and measured reverse engineering with four items. Two of these items captured the extent to which new-product development was influenced by competitors and customers. In addition, we examined whether firms disassembled competing products with the aim of gaining knowledge, underpinning the development of the products (Malik & Kotabe, 2009). Furthermore, we investigated if the focal firm's new products were designed based on the methods and technologies of competing products (Samuelson & Scotchmer, 2002). A factor analysis of the four items, utilising the principal component analysis method, produced a single factor with an eigenvalue of 2.48, which accounted for 66% of the variance.

New venture growth. To measure NVG, the finance managers were asked in the survey to record the level of employment growth in their firms in 2019 and three years earlier. Utilising this data and in line with previous streams of research (see Brouwer et al., 1993; Robson & Obeng, 2008), we included an annualised growth rate for employment in the regression.

Control variables. Based on insights from the broad literature**,** we included five control variables to isolate the potential effects of other factors which have been found to also explain firm performance. These were firm size, firm age, market scope, environmental munificence

(EM) and industry competition. *Firm size* was assessed as the number of full-time employees, whilst *firm age* was assessed as the number of years the firm had been in operation since inception. *Market scope* was denoted by a dummy variable that captured the extent to which a firm operates locally or internationally (0 = regional; 1 = international). We measured *environmental munificence* with two items taken from a past study, i.e. Jaworski and Kohli (1993). Finally, we conceptualised industry competition as a situation characterised by intense rivalry, which leads to inadequate opportunities for additional expansion (Auh & Menguc, 2005). Consequently, we employed the four-item scale advanced by Jansen et al. (2006) to capture *competitive intensity*. All the multi-item scales in this paper were measured on a seven-point Likert scale ranging from 1 = strongly disagree, to 7 = strongly agree. Integrated strategy (i.e. a combination of low-cost and differentiation strategies) was measured with a categorical variable (Acquaah, 2007). Hence, firms whose combined means for both the low-cost strategy and differentiation strategy was larger than the mean of each strategy were taken to be pursuing a combination/integrated strategy and were coded 0, whilst others were coded 1.

3.4 Common method bias, validity, and reliability

We tested for potential common method bias in our data using three approaches. First, we subjected the data to Harman's (1976) single factor test, and the results indicated that all the items loaded on their respective constructs. Second, we followed Cote and Buckley (1987) and estimated three competing method models (Table 1). Method 1 estimated a method-only model where all the indicators were conditioned to load on a single latent factor. Method 2 introduced a trait-only model in which each indicator could load on its respective latent factor. Then, we estimated a trait-method model where a common factor linked all the indicators in Model 2. We then compared all the three models and found that Model 2 and Model 3 were superior to Model 1. It was also found that Model 3 was not materially better than Model 2. Based on these results, it was concluded that common method bias did not influence our study. Third, the

approach suggested by Lindell and Whitney (2001) was utilised by including a marker variable in the survey and analyses. The marker variable measured job autonomy and included items such as "my job allows me freedom to decide how I do my own work". This item was selected because it has no theoretical link with our dependent variable. The analysis showed that job autonomy and NVG had a non-significant correlation of 0.02. Thus, overall, it is believed that issues related to common method bias were substantially alleviated.

Aside from the above procedures, all the constructs were subjected to confirmatory factor analysis (CFA) using the maximum likelihood method in LISREL 8.71. The CFA was performed to establish the psychometric properties of the multi-item scales. The CFA results show that the item loadings were in their hypothesised direction and were larger than the recommended threshold value of 0.40 and significant at $p < 0.001$ (see Appendix 1). These outcomes therefore indicated convergent validity of the scales (Anderson & Gerbing, 1988). The results also revealed acceptable degrees of Cronbach's alpha and composite reliability (see Appendix 1). In addition, to verify the discriminant validity of the measures, we inspected the average variances extracted (AVE) of each construct. The results show that each AVE exceeded the minimum threshold of 0.50 and was greater than the squared correlation between the various pairs of the constructs. Thus, these outcomes provided evidence of discriminant validity (Bagozzi &Yi, 2012).

Table 1. Common method bias nested models: goodness-of-fit statistics

Model	χ^2	df	χ^2/df	RMSEA	CFI	NNFI	GFI
M1: Method	1097.88***	983	1.11	0.153	0.21	0.23	0.17
M2: Trait	1321.44***	949	1.39	0.46	0.91	0.90	0.92
M3: Trait-method	1171.18***	885	1.32	0.53	0.93	0.93	0.94

*** $p < 0.001$. df, degrees of freedom; RMSEA = root mean square error of approximation; CFI = comparative fit index; NNFI = non-normed fit index; GFI = goodness of fit index

The overall model fit was assessed using the traditional chi-square and other recommended fit heuristics. The fit of the CFA was acceptable given the following output: χ^2/df = 1.38; RMSEA = 0.05; NFI = 0.96; CFI = 0.95). Thus, the CFA model provided adequate fit for the measurement items.

Table 2: Descriptive statistics and correlations

	Variable	1	2	3	4	5	6	7	8	9	10
1.	Firm size (Employees)	---									
2.	Firm age	0.13*	---								
3.	Market scope	0.05	0.15*	---							
4.	Environmental munificence	-0.06	-0.17*	-0.03	---						
5.	Industry competition	-0.01	-0.11	0.07	0.10	---					
6.	Low-cost strategy	0.10	0.09	0.19**	0.17**	0.32**	---				
7.	Differentiation strategy	0.02	0.03	0.15	0.11	0.19**	0.23**	---			
8.	Human capital	0.14*	0.32**	0.21**	0.05	0.17*	0.16*	0.12	---		
9.	Reverse engineering	0.11	-0.08	0.09	0.17*	0.11	0.19**	-0.11	0.23**	---	
10.	Employment growth	0.03	-0.04	0.22**	0.08	0.11	0.16*	0.04	0.19**	0.13	---
	Mean	24.96	6.79	0.42	4.66	4.49	4.47	5.11	4.78	4.91	5.06
	Standard deviation	19.08	2.45	0.50	1.32	0.44	1.08	0.73	0.88	0.76	0.63

*$p < 0.05$; **$p < 0.01$.

4. Results

A hierarchical regression approach was used to analyse the data. To minimise the possibility of multicollinearity, all the variables utilised in interaction were mean centred before the interaction terms were created (see Aiken & West, 1991). Moreover, the potential effect of multicollinearity was investigated by examining the output of the correlation matrix (refer to Table 2). In addition, the highest inflation factor value was 3.61, indicating that multicollinearity was not a concern in this study. Prior to testing the main hypotheses, we checked the data for potential problems related to violations of the normality assumptions and outliers in regression analysis. Using the Kolmogorov–Smirnov tests (Massey, 1951), we found

that the standardised residuals were sufficiently normally distributed (Z = 0.054, p > 0.100). This suggests no significant violations of the normality assumption. We further confirmed that data do not suffer from heteroskedasticity by using the White test (White, 1980).

The mean values, standard deviations and correlations for all variables are presented in Table 2. In Table 3, we present the results of the hierarchical regression analyses. Model 1 contains the control variables. Model 2 presents the results after inclusion of the moderating variables (low-cost and differentiation strategies). Hypothesis 1 proposed that greater levels of human capital positively relate to higher levels of reverse engineering in new ventures. The results in Model 3 show that Hypothesis 1 received support ($\beta = 0.17$, $p < 0.01$). Although we did not postulate for a direct relationship between reverse engineering and NVG, we found in Model 5 that the former had a positive effect on the latter ($\beta = 0.14$, $p < 0.05$).

Hypothesis 2 predicted that the effect of human capital on NVG is mediated by reverse engineering. To test the mediating effect of reverse engineering, we utilised the procedure advanced by Baron and Kenny (1986). In line with the logic of this approach, mediation is present if the effect of human capital on reverse engineering is significant, and the effect of human capital on NVG is attenuated with the addition of reverse engineering in the model. As shown in Model 3, the independent variable (human capital) positively relates to the dependent variable (NVG) ($\beta = 0.17$, $p < 0.01$). Furthermore, as shown in Model 4, the independent variable positively impacts the mediating variable (reverse engineering) ($\beta = 0.25$, $p < 0.01$). Similarly, the mediating variable (reverse engineering) exerted a positive effect on the dependent variable (NVG) ($\beta = 0.14$, $p < 0.05$). The results also demonstrate that when the mediating variable was introduced into the regression equation, the effect of the independent variable on the dependent was no more significant ($\beta = 0.03$, *ns*). These findings met all the conditions of mediation specified by Baron and Kenny (1986), and thus offered support for Hypothesis 2. In addition, we used the Sobel test to confirm the observed outcomes (MacKinnon & Dwyer, 1993; Preacher & Leonardelli, 2012; Sobel, 1982). The results revealed

that the indirect effect of levels of human capital on NVG ($z = 3.11$, $p < 0.01$) was statistically significant, thereby corroborating the previous analyses.

4.1 Potential moderating effect of competitive strategy

This section outlines the results of the moderating hypotheses (H3a andH3b). Model 6 tests the moderating effect of competitive strategies on the relationship between reverse engineering and NVG. Specifically, Hypothesis 3a stated that the positive effect of reverse engineering on NVG will be stronger at high levels of low-cost strategy. The results in Model 6 provide support for Hypothesis 3a ($\beta = 0.52$, $p < 0.01$). To probe the direction of the moderation, we plotted the interaction effect by using the mean-centred values (see Dawson & Richter, 2006). Figure 1 shows that the relationship between reverse engineering and venture growth is stronger at high levels of low-cost strategy. Additional analysis via a t-test comparison (Acquaah, 2007; Cohen & Cohen, 1983) showed that the beta coefficients for samples at high and low levels of low-cost strategy significantly differ ($t = 2.21$, $p < 0.05$), thus providing further support for Hypothesis 3a.

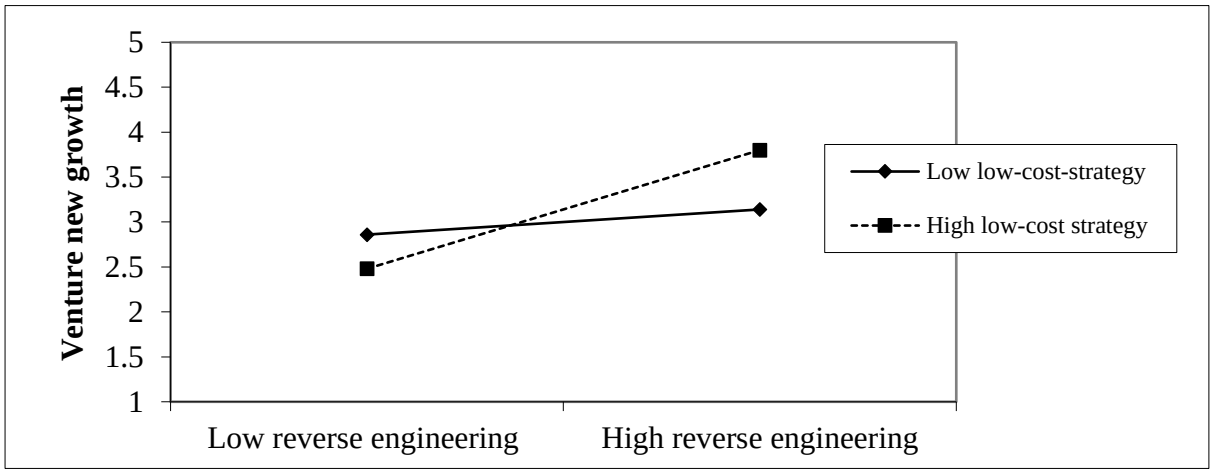
Hypothesis 3b argued that the positive effect of reverse engineering on NVG will be weaker at high levels of differentiation strategy. Hypothesis 3b also received support ($\beta = 0.05$, ns). The results in Model 6 show that the coefficient of reverse engineering reduced from $\beta = 0.14$, $p < 0.05$ to $\beta = 0.05$, ns when the interaction term was added. Additionally, a t-test comparison indicated a significant difference in the effects of samples at high and low levels of differentiation ($t = 1.53$, $p < 0.05$). Thus, overall, the results in Model 6 provide support for Hypothesis 3b, that the effect of reverse engineering on firm growth will be weaker for firms pursuing high levels of differentiation strategy.

Table 3: Results of direct and indirect effects (N = 229)

	Model 1: Employment growth	Model 2: Employment growth	Model 3: Employment growth	Model 4: Reverse engineering	Model 5: Employment growth	Model 6: Employment growth
Control variables						
Firm size	0.03	0.03	0.04	0.05	0.04	0.05
Firm age	-0.02	-0.03	-0.04	-0.03	-0.04	-0.02
Market scope (local = 0, international = 1)	0.12*	0.11*	0.12*	0.12*	0.10*	0.05
Environmental munificence	0.09*	0.10*	0.11*	0.12*	0.13**	0.11*
Industry competition	0.03	0.05	0.05	0.14**	0.14**	0.12*
Low-cost strategy		0.14**	0.14**	0.17***	0.13**	0.13**
Differentiation strategy		0.08*	0.09*	-0.14**	0.10*	0.06
Main effect						
Human capital			0.17***	0.25***	0.03	0.18***
Mediating effect						
Reverse engineering					0.14**	0.13**
Moderating effects						
Reverse engineering * low-cost strategy						0.52***
Reverse engineering * differentiation strategy						0.05
Model fit statistics						
F-value	2.14*	3.11**	4.69***	4.75***	3.22**	5.73***
R^2	0.09	0.12	0.16	0.19	0.20	0.23
Adjusted R^2	0.06	0.13	0.14	0.08	0.17	0.22

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$. Standardised coefficients are shown.

Figure 1. Interaction of reverse engineering with low-cost strategy on NVG



5. Discussion and conclusion

The possession of high human capital is arguably the most important resource for firm performance and growth (Becker & Huselid, 2006; Takeuchi, Lepak, Wang & Takeuchi, 2007; Subramony, Krause, Norton & Burns, 2008). Similarly, extant research suggests that reverse engineering, which hinges on the quality of an organisation's human capital, significantly affects the performance of emerging-market firms (Malik & Kotabe, 2009; Zhang & Zhou, 2016; Wang & Kafouros, 2009). However, despite the general view that human-capital investments affect firm growth, a critical literature analysis reveals gaps in knowledge regarding the organisational mechanisms and boundary conditions in which firms leverage their human capital to achieve growth. Accordingly, we derived insights from the resource-based theory and dynamic-capabilities framework to further investigate these nuanced relationships.

The findings from our study offer support for a direct and an indirect impact of human capital on venture growth. First, we found that high levels of human capital positively relate to reverse engineering, which in turn leads to NVG. Second, reverse engineering was found to mediate the relationship between human capital and NVG. Third, the results from a moderation

analysis revealed that the positive impact of reverse engineering on NVG is stronger at high levels of low-cost strategy. However, the positive effect of reverse engineering on NVG is weakened at high levels of a differentiation strategy. These findings offer theoretical contributions as well as strategic guidelines, particularly for the managers in emerging- and developing-market firms.

First, the finding that high human capital is strongly associated with the adoption of reverse engineering, extends the literature on resource-based theory and firm performance (Barney, 1991, 2001), as well as the broader empirical literature on the role of human capital in NVG (Ahmad & Schroeder, 2003; Cook, Bowen, Chase, Dasu, Stewart & Tansik, 2002; Ployhart & Moliterno, 2011; Riley, Michael & Mahoney, 2017). It also contributes to the literature on dynamic capabilities and firm performance (Teece et al., 1997; Wu & Vahlne, 2020). Even though previous studies suggest that emerging-market small firms, often characterised by weak R&D resources (Wells, 1983; Malik & Kotabe, 2009; Zhang & Zhou, 2016), are inclined to leverage reverse engineering in new-product development, these studies failed to address specific questions concerning how human capital relates to reverse engineering and firm growth. Consequently, this research extends our understanding of the dynamics of NVG by showing that firms equipped with high human capital may have a greater potential to leverage reverse engineering or competitors' innovative processes to enhance their own innovation capabilities.

Second, the finding that reverse engineering mediates the relationship between human capital and venture growth contributes to the few studies that have explored the mechanisms through which human capital may impact firm performance (Malik & Kotabe, 2009; Chen & Guan, 2011; Zhang & Zhou, 2016). The finding from our mediation analysis suggests that human-capital development can be an important locus for emerging-market firms to overcome resource limitations in areas such as R&D, by leveraging reverse engineering to achieve

superior growth outcomes. Thus, by exploring how human capital interacts with reverse engineering to facilitate firm growth, the paper throws more light on the dynamic-capability building mechanisms which affect NVG from an emerging-economy perspective. In this way, the finding supports the assertion that dynamic capabilities are rooted in the initial resource conditions faced by firms (Teece, 2018; Collis, 1994; Eisenhardt & Martin, 2000).

Third, through contingency analyses via low-cost and differentiation strategy, we provide a deeper clarification of when the adoption and implementation of reverse engineering may be more effective for improved firm growth. The finding that the positive effect of reverse engineering on NVG is enhanced at high levels of low-cost strategy is consistent with the prevailing theory by which firms can achieve competitive advantage in the strategy literature. This perspective suggests that firms that seek to gain competitive advantage in the marketplace based on low-cost strategy, are more likely to succeed through the adoption of frugal innovation processes such as reverse engineering (Hill & Jones, 2009; Hitt et al., 2017). Additionally, the finding that the relationship between reverse engineering and NVG is weaker at high levels of differentiation strategy, seems logical and consistent with the dictates of the strategy literature (Porter, 1980; Lechner & Gudmundsson, 2014; Miller, 1988). This is because the integration of reverse engineering with a differentiation strategy may lead to lower market performance due to credibility and ethical issues (Zhang & Zhou, 2016).

Even though some previous studies have examined the role of reverse engineering in firm performance on new-product development (Coe, Capelle & D'Amico, 2009; Hill, 2007; Malik & Kotabe, 2009; Russell & Taylor III, 2008), they did not consider the boundary conditions under which the adoption of reverse engineering enhance firms' growth. Thus, the findings from the moderation analyses provide a better understanding of the specific conditions under which reverse engineering may lead to NVG.

Beyond the theoretical implications, this study offers useful insights and guidelines especially for SME managers in emerging and developing economies. The study sheds light on how new ventures can achieve improved growth outcomes by leveraging human capital and reverse engineering. First, the findings concerning the positive impact of human capital on reverse engineering suggest that new ventures which possess highly capable human resources may overcome some resource constraints (e.g., R&D and finance) by using their skilled employees to imitate the superior technologies of more endowed firms from developed markets. Consequently, given that small firms from emerging markets are actively seeking new technologies to upgrade their capabilities, reverse engineering might be a viable and cost-effective option for harvesting short-term efficiency gains and achieving improved firm growth.

Second, the findings from the moderation analyses indicate that SME firms in emerging economies stand a better chance of boosting their growth if the adoption of reverse engineering is aligned with a low-cost strategy. Thus, by leveraging on reverse engineering, these firms can effectively compete in the global market by targeting consumers at the base of the pyramid (Prahalad & Hart, 2002). In other words, a reverse engineering low-cost approach may be, particularly, more appropriate for firms operating in developing markets in view of the numerical preponderance of value-seeking and price-sensitive consumers in these economies. Conversely, the findings indicate that it may not be appropriate for firms which depend on reverse engineering in product development to combine this approach with a differentiation strategy as this can negatively impact their growth. Thus, it may be imprudent strategy to combine reverse engineering with high-level differentiation strategy since many developing market firms suffer from the liability of weak country-of-origin effects, which limit their capacity to compete on differentiation and quality.

6. Limitations and future research

Despite the use of rigorous methods in this study, there are some limitations which offer avenues for future research. First, the data on venture growth was based on managerial ratings about the extent of employment growth in their firms. Since this measure was based on a self-report, it may have been tainted by managerial bias. Therefore, it would be useful if future studies use objective data on NVG such as actual sales, market share and profits to validate the current findings. Alternatively, both subjective self-reports and objective measures of firm growth can be obtained and used in the same research for triangulation purposes. Second, previous research has cautioned the use of cross-sectional data in mediation analysis (see Maxwell & Cole, 2007; Maxwell, Cole & Mitchell, 2011). Even though there was a year time-lag between the data on the independent and the dependent variables, the duration was relatively short to suggest any causal linkage. Moreover, our study's failure to capture the potential effects of other predictors of firm growth in our research model prevents us from inferring any casual relationships. Therefore, future research may address these limitations by using a longitudinal design and including other potential determinants of firm growth. For example, the time span between when data is collected on the independent and dependent variables can be spread over a longer period (e.g. three to five years). Such a design, combined with appropriate controls for other potential external factors (e.g. the level of regulatory and normative burden), could help in making reasonable causal claims regarding the human capital– reverse engineering –firm growth nexus.

Third, the study was based on data from only one country – Ghana. Although Ghana shares many characteristics of emerging economies, some countries in these regions may possess unique contextual elements that may limit generalisation of the findings reported in this study. Consequently, it would be useful for additional research to test the proposed model with multi-country data in order to examine the potential influences of unique local factors.

For example, given that sub-Saharan countries (compared to developed Western and parts of Asian economies) have weaker institutions (Adomako et al., 2019), it will be interesting for future researchers to further explore the extent to which differences in countries' institutional contexts (North, 1992) affect the observed relationships. For example, institutional factors such as normative impediments and regulatory burden (De Clercq, Danis & Dakhli, 2010) have been noted as important determinants of firms' behaviours and international performance. Therefore, it would be worthwhile for additional research to investigate the extent to which marked variations in local institutional conditions facilitate or inhibit the implementation of reverse engineering, and ultimately affect NVG. Such a design can result in the identification of more nuanced insights for theory development on NVG in emerging and developing economies.

Finally, even though the instruments used in measuring human capital are well-established measures (Subramaniam & Youndt, 2005), they do not capture the level of education or the level of expertise in a given field (e.g. number of years of experience or tenure). Therefore, we encourage future studies to measure human capital by including items capturing these omitted dimensions.

To conclude, this study provides research evidence and conceptual insights that show the importance of human capital as an important driver of NVG through its indirect effect on reverse engineering. It also reveals that these relationships (i.e. between human capital, reverse engineering and NVG) may be stronger at high levels of an low-cost strategy but weaker when firms follow a heightened differentiation strategy. This study is one of the few that focuses on illuminating the seemingly apparent but less understood nexus between human capital–firm growth. Aside from the extension of the literature, it offers useful directions on competitive strategies for improving SME performance in emerging and developing economies.

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