

# **A Conceptual Framework of Industrial Revolution 4.0 and Entrepreneurial Orientation: Mediation effect of Innovation on Firm Performance: A Malaysian perspective**

**Fazal Akbar<sup>1</sup>, Dr, Fazli Wadood<sup>2</sup>, Prof Dr, Abdul Talib Bin Bon<sup>1</sup>, Saleh Nasser Abdullah Al-Subari<sup>1</sup>**

fazal.akbar22@gmail.com, talibon@gmail.com, wadoodam@gmail.com, snalsubari @ gmail.com

<sup>1</sup>Faculty of Technology Management and Business, University Tun Hussein Onn Malaysia, 86400, Johor.

<sup>2</sup>Faculty of Management Science, University of Buner Sowari, Khyber Pakhtunkhwa Pakistan

## **Abstract**

Communication technology is a major advance in manufacturing technology. IT and computing in recent years, information systems have enabled new ways of working in industrial and services sector. This evolutionary trend refers to the fourth trend in the industrial system, the so-called Industry 4.0. However, current and future trends are evolutionary in nature. This background of intelligent specialization and structural evolution is not driven by radical innovation, but acquired by adapting to radical change. By generating new information and knowledge for the future economic value of old techniques and old machines, new activities and new structural changes can be carried out by using existing common industrial products such as R & D, engineering, manufacturing and other capabilities that support innovation. It has been determined that entrepreneurial orientation plays an important role in the success of global entrepreneurs. The business phenomenon is constantly evolving. With the creation of new enterprises, the world has become an entrepreneurial economy, and entrepreneurs are hailed as the new heroes of economic development and competitive enterprises. In recent years however, Malaysian furniture manufacturers have come under increasing competitive pressure from other cheaper furniture producing nations particularly in China and Vietnam. Therefore, this situation leads the researcher to investigate the problem in detail, to provide a possible solution to the pressing problem and support the Industry 4.0, and to promote the entrepreneurial culture in furniture manufacturing industry in Malaysia.

**Keywords:** *Industrial Revolution 4.0, Entrepreneurial Orientation, Innovation, Performance, Malaysia*

## **Introduction**

The continuous development of global technology affects customer behavior, think, feel and perceive value. In fact, manufacturing has gone through all stages of change simulate human needs

and growing customer needs. As a result, innovation management, flexibility and optimal change management design within the company, it has become a highly relevant field of dynamic research Management Practice. The industrial revolution has gone through different stages, the transition from manual production methods to machines to the 18th century, to modern digital and internet technologies. In addition to revolution, each country has specific policies and plans for the adoption and implementation of the Industrial Revolution. In the absence of a clear course of action, companies tend to imitate themselves by tracking similar businesses, so much so that they consider themselves more Success (Stoffregen, 2014). By educating entrepreneurs and managers in an entrepreneurial-oriented manner, ultimately, organizations can succeed in their own way without having to follow the model of another company. The statement also mentions the innovative ability of managers and business owners, which is an important part of entrepreneurial orientation. Entrepreneurial orientation is an important determinant of a company's successful development and sustainable management, and is considered the key to higher performance (Freiling & Schelhowe, 2014). Successful implementation of entrepreneurial orientation can also improve a company's financial, social and economic factors. The term "entrepreneurial orientation" and its existing dimensions are considered the cornerstones of entrepreneurs and explain the methods for successfully creating new businesses and managing existing ventures for great success.

## **Theoretical background and analytical framework**

### **1. Theoretical background**

Theoretical base for the theory of constraints were developed and promoted by Dr. Eliyahu, a manufacturing expert in 1984. Majority of the researchers were earlier exposed to this concept through his book "The Goal". Goldratt, (1990) argues that the theory of constraints is a method for identifying the main restraints (i.e. constraints) that prevent a company from achieving its stated goals. Goldratt further states that organizations must continue to systematically improve on established constraints until they cease to be limiting factors. So this means that anything that prevents a company from achieving higher performance is a constraint. Constraint theory is improved using scientific methods. According to the Constraint theory of Mabin, (1999), each system must have at least one restriction that limits its output. Therefore, the theory says that the more complex the system, the fewer autonomous process paths and therefore the fewer the number of constraints. Generally, a multifaceted system has only one limitation at a particular time. Along the same lines, Şimşit, Günay, & Vayvay, (2014) argue that the TOC sees these processes as an interconnected chain as a system and should not be allowed to disintegrate by any bottleneck. The ideal system process cannot be the optimal system. Optimal systems enforce constraints on optimal capacity by focusing on their goals, and all other steps in the process must have excessive capacity to handle these constraints. Constraint theory provides a powerful set of tools to help achieve organizational goals. According to Goldratt (1990), the basic steps to achieve these goals are: methods to detect and eliminate so-called constraints; tools to analyze and solve problems; and methods to evaluate performance and guide management decisions.

In the furniture industry, in today's highly competitive environment, these constraints are issues related to reliability, inefficiency, productivity, exports, and skilled labor. Constraint theory is very suitable for entrepreneurial-oriented implementation in IR 4.0 and innovation is a way to detect the constraints that exist in the implementation in company and employee training. This is also a systematic approach to discovering and removing limitations so young Malaysians can be trained and IR 4.0 can be easily used in companies. Some of the constraints identified that could affect the implementation of Industry 4.0 include lack of financial resources, mismatched employee skills, IT infrastructure, maturity stage, company size, and unwillingness to change (Balasingham, 2016). The implementation of Industrial Revolution 4.0 brought the company the benefits of lower costs, greater flexibility, higher quality and efficiency, higher production, lower labor costs, and a higher competitive position (Plessis, 2017). From these statements, it can be concluded that this may be the best theory to explain the implementation of entrepreneurial orientation, Industrial Revolution 4.0 and the innovation in furniture manufacturing industry in Malaysia.

## **2. Analytical framework**

### ***2.1 Entrepreneurial orientation and innovation***

Prior research has found EO to directly and positively affect innovation Alegre & Chiva, (2013), both exploitative and exploratory innovations Kollmann & Stöckmann, (2014), export product innovation success Boso, Cadogan, & Story, (2013), new product characteristics and success Hong, Song, & Yoo, (2013), and new product speed to market Clausen & Korneliussen, (2012). In addition, as entrepreneurial orientation has been found to affect firm performance through its impact on organizational learning Real, Roldán, & Leal, (2014), learning orientation Wang, (2008), learning capabilities Zhao, Li, Lee, & Chen, (2011), and product development capabilities Lisboa, Skarmeas, & Lages, (2011), EO plays an important role in innovation, which are defined as "a novel creation that generate value" (Nagji & Tuff, 2012). Novelty refers to the uniqueness of creation, so it refers to the difference from existing creations. Whether it is a new product within a company, a new product on the market, or a new product in the world, creation can be novel (Sethi, Iqbal, & Sethi, 2012). A novel work may be related to products, services, technologies, processes and even complete business models (Bucherer, Eisert, & Gassmann, 2012). It can create value for customers, key companies or stakeholders important to key companies. In addition, innovation can be classified according to its ability to change the world. For example, an innovation can be incremental, which means that it has little impact on existing creations, or it can be radical, causing huge and even disruptive changes (Story, Hart, & O'Malley, 2009). Often, it has been proposed that entrepreneurial proactiveness, innovativeness, risk taking, autonomy and competitive aggressiveness can affect the creation of innovation in a number of ways. First, there have been proposals that entrepreneurial proactiveness increase business enthusiasm to increase alertness to new market opportunities (Wales, Parida, & Patel, 2013) and the number of opportunities addressed (Engelen, Kube, Schmidt, & Flatten, 2014). With recognized opportunities to bring ideas into the innovation process, EO can promote innovation. Secondly,

EO emphasizes innovation, because "innovation is generally considered as the exploration of new things that did not exist before", (Cho & Pucik, 2005). EO represents a favorable tendency for experiments and reduces resistance to unconventional ideas within the organization. Third, entrepreneurial firms startups tend to participate in ideas and opportunities with uncertain outcomes (Miller, 2011). Fourth, autonomy is a key element of entrepreneurial companies, who can explore ideas about self-confidence gained from organizations (Real et al., 2014). Fifth, as an entrepreneurial startup, the organization should be aggressive to overcome market competitors and implement ideas through new products and services (Sethi et al., 2012; Wang, 2008). Because innovation requires investment in financial returns ahead of time, the willingness to take risks allows companies to experiment. The more specific and adventurous this idea, the more entrepreneurial business risk it requires (Lumpkin & Dess, 1996).

## ***2.2 Industry 4.0 and innovation***

Industry 4.0 is closely related to innovation. Over the past decade, innovation has added more ingredients to the mix (mobile, cloud, social networks, and big data), and these ingredients can together form a perfect symbiotic relationship, create new concepts for the industrialization process, and transform the market into one new era of competition and product differentiation (Geiger & Sá, 2013; Morrar, Arman, & Mousa, 2017). According to Morrar et al., (2017), Industrial Revolution 4.0 represents a transition to an economy based on innovation with core concepts of knowledge, data and the Internet of Things (Geiger and Sá, 2013). This will impact the current structure, markets and business processes of the industrial age and pave the way for a new era of digitalization, "smarter" networks of production systems and interconnected business processes (Buhr, 2017). In the new industrial revolution, traditional competitive factors (such as market share, economies of scale, and access to resources) are now linked to other factors (such as innovation, intellectual property, smart technology, and access knowledge) (Buhr, 2017; Geissbauer, Schrauf, Koch, & Kuge, 2014). In addition, the role of consumers is changing in the production process. The availability of relevant information about consumers and business units allows them to build more interactive relationships that can better meet consumer needs (Geiger & Sá, 2013). The role of consumers in the production process is crucial. They are now co-producers (Geissbauer et al., 2014). At the same time, radical process innovation is related to the technological revolution. Tailored production series will replace industrial or large-scale production facilities (Morrar et al., 2017). In addition, customers have become more focused on results (Geiger & Sá, 2013), and the "make-for-me" approach represents a new business model. These trends have led to the emerging concept of mass customization in manufacturing (Silveira, Borenstein, & Fogliatto, 2001), and many companies have begun introducing new marketing interfaces and manufacturing processes to meet the individual requirements of customers they are willing to pay for personalized characteristics based on goods and services (Geiger & Sá, 2013). For example, the consumer now chooses his own education and accurately defines what he needs from the curriculum and knowledge, rather than through traditional and formal teaching methods, which has led him to believe that the education system is incremental and radically innovative and

project-based and interactive learning, as the highest priority (Buhr, 2017; Cingöz & Akdoğan, 2011; Geiger & Sá, 2013). The company is expected to modify innovative business models and insert flexible value chains to enhance its ability to respond to changes in consumer behavior. Smart factories with intelligent production systems will meet this demand while maintaining high-quality products and services (Buhr, 2017).

### ***2.3 Entrepreneurial orientation and firm performance***

The relationship between entrepreneurial orientation and company performance has become main topics of interest in past literature (Sethi et al., 2012). According to Rauch, Wiklund, Lumpkin, & Frese, (2009), companies that adopt EO may perform better than companies that adopt conservative orientation. Initially, one might question the importance of EO to business success. Therefore, previous research has shown that EO can significantly improve company performance (Covin & Slevin, 1989, 1991; Lumpkin & Dess, 1996; Lyon, Lumpkin, & Dess, 2000; Wiklund & Shepherd, 2005). Many research on EO and business performance have yielded positive results (Arshi, 2016; Chow, 2006; Coulthard, 2007; Keh, Nguyen, & Ng, 2007; Lee, Lee, & Pennings, 2001; Madsen, 2007; Wiklund, 1999; Wiklund & Shepherd, 2005; Wolff & Pett, 2006; Zahra, 1991; Zahra & Covin, 1995). However, there is no doubt that studies have shown that EO does not have a positive impact on company performance (Hart, 1992; Matsuno, Mentzer, & Özsomer, 2002; Morgan & Strong, 2003; Naldi, Nordqvist, Sjöberg, & Wiklund, 2007; Smart & Conant, 1994). Therefore, researchers agree with very few studies that EO will have a direct and indirect impact on a company's performance under different circumstances (Arshi, 2016; Couppey & Roux, 2007; Kellermanns, Eddleston, Barnett, & Pearson, 2016; Zahra, 2008). Therefore, many aspects of the research on EO, especially the one of Dess and Lumpkin (2005), are necessary because research shows that there is a link between EO and company performance.

### ***2.4 Industrial revolution 4.0 and firm performance***

New product development requires design thinking, customer feedback, market research and customer profile (Agrawal, Schaefer, & Funke, 2018). It also requires powerful, flexible and fast prototyping features such as 3D printing, CAD camera design and flexible machining capabilities. These are some of the features that Industry 4.0 provides to current production systems (Qin, Liu, & Grosvenor, 2016). By integrating customer needs and market research, "Design to create prototypes of any product or service", Industry 4.0 significantly improves the ability to release products, thereby greatly reducing product time, costs and also product development life cycle (Qin et al., 2016). The improvement of production efficiency and the improvement of quantity strategy are closely related to the improvement of company performance (Agrawal et al., 2018). Data show that when companies launch new products at a higher rate, their company performance tends to be better than their competitors (Pujari, Wright, & Peattie, 2003). Greater product development will have a positive impact on the company's performance (Rubera, Chandrasekaran, & Ordanini, 2016). Therefore, if Industry 4.0 is strategically integrated with the company's new product development strategy, the company's performance will improve.

## **2.5 Innovation and Firm performance**

Multiple studies show positive association between innovation and business Performance (Arshi, 2016; Basterretxea & Martínez, 2012; Crepon, Duguet, & Mairessec, 1998; Kafouros, Buckley, Sharp, & Wang, 2008; Karabulut, 2015; Loof & Almas, 2002; Mairesse & Mohnen, 2003). Hassan, Shaikat, Nawaz & Naz (2013) the type of innovation in company performance has had a positive impact on Pakistani manufacturing companies. Similarly, Prajogo & Ahmed, (2006) point out that innovation in manufacturing sector is more radical than service industry and has a greater impact on firm performance. Gunday, Ulusoy, Kilic, & Alpkan, (2011) emphasized that some studies have explored the relationship between innovation types and performance. Damanpour, Walker, & Avellaneda, (2009) found that the type of innovation has a positive impact on firm performance. Therefore, Bowen, Rostami, & Steel, (2010) reveal the relationship between innovation and the company's future performance. Subramanian & Nilakanta, (1996) have shown a positive and innovative impact on company performance. In addition, Cingöz & Akdoğan, (2011) proposed a positive link between expected positive performance results and innovative behavior (Ul Hassan et al., 2013).

### **3. Conceptual Framework and the hypotheses model**

The conceptual framework pointed out by Miles, Huberman, & Saldaña, (2014) is just one roadmap for researchers in research or investigation fields. The research roadmap can be explained graphically or narratively. Therefore, the process of selecting the most relevant concepts in the literature is called conceptualization or construction of a conceptual framework (Jabareen, 2009; Miles et al., 2014). The reason behind this research is that furniture manufacturing companies face some challenges that seem to hinder their growth. Therefore, in order to ensure the growth and continuity of these companies, the concepts of entrepreneurial orientation and Industrial Revolution 4.0 must be adopted because it enjoys a certain good reputation among manufacturing companies. The entrepreneurial-oriented model proposed by Lumpkin & Dess (1996) and the industrial revolution 4.0 proposed by Hermann, Pentek, & Otto, (2015) will be adapted to test the impact of EO and IR 4.0 through mediation effect of innovation on firm performance of furniture companies in Johor manufacturing sector. In the forthcoming section is a graphical representation of the research conceptual framework.

### **4. Formulation of Hypothetical Model**

Figure 1, displays the dimensions of entrepreneurial orientation (Autonomy, Innovativeness, Risk taking, Pro-activeness, and Competitive aggressiveness) and industrial revolution 4.0 (Cyber-physical system, Internet of things, Smart factory and Internet of services) hypothesized as influencing the dependent variable, through Innovation (Radical innovation and Incremental innovation) the mediator variable, and firm performance is the dependent variable.

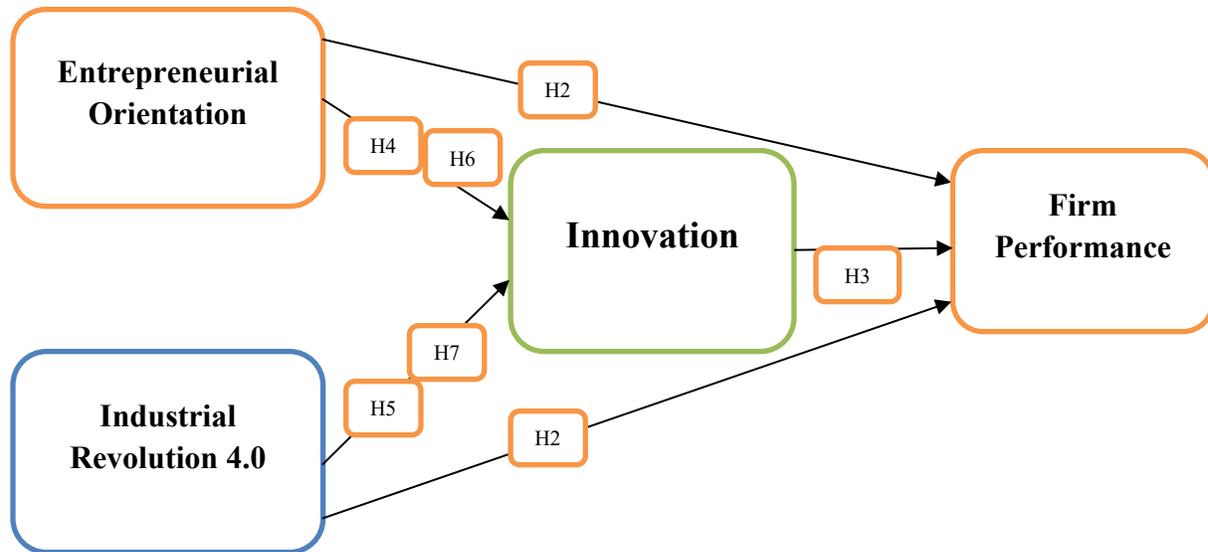


Figure 1: Conceptual Framework of the study

The hypotheses developed for the study are:

H1: There is a positive relationship between entrepreneurial orientation and firm performance.

H2: There is a positive significant relationship between industrial revolution 4.0 and firm performance.

H3: There is significantly positive relationship between innovation and firm performance.

H4: Innovation mediates significant positive relationship between entrepreneurial orientation and firm performance.

H5: Innovation mediates significant positive relationship between industrial revolution 4.0 and firm performance.

H6: There is significantly positive relationship between entrepreneurial orientation and innovation.

H7: There is significantly positive relationship between industry 4.0 and innovation.

## 5. Methodology

This study will use a quantitative approach to research design, using innovation (radical and incremental innovation) as a mediation to study the relationship between entrepreneurial orientation, Industrial Revolution 4.0 and firm performance. The research population will be furniture companies with common characteristics, including efforts to innovate and automate their production and develop more novel products. In addition, these companies differ in their organizational and technical capabilities, adjusting their strategic and functional performance based on market signals and institutional constraints. This study touched on previous data on the company's business and technology development from a Malaysian perspective. In line with the study framework developed and discussed in previous section, the author collects secondary data (prior research) and will also conduct actual (primary) field data from Malaysian furniture

manufacturers to extract empirical evidence of technological adoption and innovation in individual firms.

## **6. Discussion and Conclusion**

Achieving Industry 4.0 is not easy and can take a decade or more to complete. Currently, Industry 4.0 is a vision for the future because it involves many aspects and faces many types of difficulties and challenges, including scientific challenges, technological challenges, economic challenges, social issues, and political issues. In addition to these challenges, the most influential are entrepreneurial capabilities and openness to innovation. The rapid changes in traditional industries and the disruptive development of technology are threatening the survival of countries and companies in the manufacturing sector. For industrialized countries that suffer from high labor costs, stagnation and reduced labor, the Fourth Industrial Revolution is a breakthrough and at the same times and opportunity to hold leadership positions in the future. Malaysia's neighbors have transitioned to industrial revolutions such as Thailand, Vietnam, China and Singapore. Similarly, in terms of innovation and the transition to Industry 4.0, other Asian countries such as Japan and South Korea have also been added to the list. Malaysia is one of the countries that changed its industrial approach to export-oriented industrialization. Since Malaysia's open economy is heavily dependent on world trade, these actions to implement Industrial Revolution 4.0 can be used to produce large quantities of goods and services, which can be attributed to huge economic expansion and to lower non-tariff dealings. Malaysia still has broad prospects for the development of manufacturing, a sector comprised of electronics, automotive, and construction that can meet growing consumer demand while considering Industry 4.0 and upcoming machine operations around the world.

### **Impact on Society, Economy and Nation**

From this research, there will be a new form of industrialization which will help to boost the economy. Via the findings, it will help the companies to stabilize their production in the highly competitive environment. Through the stabilization of the furniture companies, it will increase the economic benefits of the companies and then will contribute to the country economic value. Social status of the resident will be increases because when the companies are well established then the economy will be stable and growing.

## **References**

- Agrawal, A., Schaefer, S., & Funke, T. (2018). Incorporating Industry 4.0 in Corporate Strategy. *IGI Global Germany*, 12(October), 161–176. <https://doi.org/10.4018/978-1-5225-3468-6.ch009>
- Alegre, J., & Chiva, R. (2013). Linking entrepreneurial orientation and firm performance: The role of organizational learning capability and innovation performance. *Journal of Small Business Management*, 51(4), 491–507. <https://doi.org/10.1111/jsbm.12005>
- Arshi, T. A. (2016). *Entrepreneurial Orientation and Its Impact on Innovation Intensity in the*

- Omani Corporate sector*. University of Bedfordshire.
- Balasingham, K. (2016). *Industry 4.0: Securing the Future for German Manufacturing Companies*. University of Twente. Retrieved from [http://essay.utwente.nl/70665/1/Balasingham\\_BA\\_MA.pdf](http://essay.utwente.nl/70665/1/Balasingham_BA_MA.pdf)
- Basterretxea, I., & Martínez, R. (2012). Impact of management and innovation capabilities on performance: Are cooperatives different? *Annals of Public and Cooperative Economics*, 83(3), 357–381.
- Boso, N., Cadogan, J. W., & Story, V. M. (2013). Entrepreneurial orientation and market orientation as drivers of product innovation success: A study of exporters from a developing economy. *International Small Business Journal*, 31(1), 57–81. <https://doi.org/10.1177/0266242611400469>
- Bowen, F. E., Rostami, M., & Steel, P. (2010). Timing is everything: A meta-analysis of the relationships between organizational performance and innovation. *Journal of Business Research*, 63(11), 1179–1185. <https://doi.org/10.1016/j.jbusres.2009.10.014>
- Bucherer, E., Eisert, U., & Gassmann, O. (2012). Towards Systematic Business Model Innovation: Lessons from Product Innovation Management. *Creativity and Innovation Management*, 21(2), 183–198. <https://doi.org/10.1111/j.1467-8691.2012.00637.x>
- Buhr, D. (2017). Social Innovation Policy for Industry 4.0. *Friedrich Ebert Stiftung*, 12, 1–24.
- Cho, H. J., & Pucik, V. (2005). Relationship between innovativeness, quality, growth, profitability, and market value. *Strategic Management Journal*, 26(6), 555–575. <https://doi.org/10.1002/smj.461>
- Chow. (2006). *The Relationship Between Entrepreneurial Orientation and Firm Performance in China*. Hong Kong: Irene.
- Cingöz, A., & Akdoğan, A. A. (2011). An empirical examination of performance and image outcome expectation as determinants of innovative behavior in the workplace. *Procedia Social and Behavioral Sciences*, 24(December), 847–853. <https://doi.org/10.1016/j.sbspro.2011.09.099>
- Clausen, T., & Korneliussen, T. (2012). The relationship between entrepreneurial orientation and speed to the market: The case of incubator firms in Norway. *Technovation*, 32(9–10), 560–567. <https://doi.org/10.1016/j.technovation.2012.05.004>
- Coulthard, M. (2007). The Role of Entrepreneurial Orientation on Firm Performance and the Potential Influence of Relational Dynamism. *Monash University, Business and Economics , Working Paper*, 18(7), 1–12. [https://doi.org/10.1016/S0006-8993\(97\)01529-1](https://doi.org/10.1016/S0006-8993(97)01529-1)
- Coupey, M., & Roux, Y. (2007). *Investigating the relationship between Entrepreneurial and Market Orientations within French SMEs and linking it to Performance*. Umeå University.
- Covin, J. G., & Slevin, D. P. (1989). Strategic Management of Small Firms in Hostile and Benign Environments. *Strategic Management Journal*, 10(1), 75–87.
- Covin, J. G., & Slevin, D. P. (1991). A Conceptual Model of Entrepreneurship as Firm Behavior. *Entrepreneurship Theory and Practice*, 2(4), 1–17.
- Crepon, B., Duguet, E., & Mairessec, J. (1998). Research, Innovation And Productivity: An Econometric Analysis At The Firm Level. *Economics of Innovation and New Technology*, 7(2), 115–158. <https://doi.org/10.1080/10438599800000031>
- Damanpour, F., Walker, R. M., & Avellaneda, C. N. (2009). Combinative Effects of Innovation Types and Organizational Performance: A Longitudinal Study of Service Organizations. *Journal of Management Studies*, 46(4), 650–675. <https://doi.org/10.1111/j.1467-6486.2008.00814.x>

- Engelen, A., Kube, H., Schmidt, S., & Flatten, T. C. (2014). Entrepreneurial orientation in turbulent environments: The moderating role of absorptive capacity. *Research Policy*, 43(8), 1353–1369. <https://doi.org/10.1016/j.respol.2014.03.002>
- Freiling, J., & Schelhowe, C. L. (2014). The Impact of Entrepreneurial Orientation on the Performance of Internationalization. *Journal of Entrepreneurship Management and Innovation*, 10(4), 169–199.
- Geiger, R. L., & Sá, C. M. (2013). Tapping the Riches Introduction : Innovation and Economic Relevance. *Harvard University Press*, 23(1), 1–7.
- Geissbauer, R., Schrauf, S., Koch, V., & Kuge, S. (2014). Industry 4.0: Opportunities and Challenges of the Industrial Internet. *PricewaterhouseCoopers Aktiengesellschaft Wirtschaftsprüfungsgesellschaft*, 2(3), 52. <https://doi.org/10.1016/j.futures.2014.12.002>
- Goldratt, E. M. (1990). *What is this thing called Theory of Constraints and how should it be implemented?* (James R. Martin, Ed.) (First). South Florida: North River Press. Retrieved from <http://maaw.info/ArticleSummaries/ArtSumGoldratt90WhatTOC.htm>
- Gunday, G., Ulusoy, G., Kilic, K., & Alpkan, L. (2011). Effects of innovation types on firm performance. *International Journal of Production Economics*, 133(2), 662–676. <https://doi.org/10.1016/j.ijpe.2011.05.014>
- Hart, S. L. (1992). An Integrative Framework for Strategy-Making Processes. *The Academy of Management Review*, 17(2), 327–351.
- Hermann, M., Pentek, T., & Otto, B. (2015). *Design Principles for Industrie 4 . 0 Scenarios : A Literature Review* (2015 No. 1). Lukasstr. <https://doi.org/10.13140/RG.2.2.29269.22248>
- Hong, J., Song, T. H., & Yoo, S. (2013). Paths to success: How do market orientation and entrepreneurship orientation produce new product success. *Journal of Product Innovation Management*, 30(1), 44–55. <https://doi.org/10.1111/j.1540-5885.2012.00985.x>
- Jabareen, Y. (2009). Building a Conceptual Framework: Philosophy, Definitions, and Procedure. *International Journal of Qualitative Methods*, 8(4), 49–62. <https://doi.org/10.2522/ptj.20100192>
- Kafouros, M. I., Buckley, P. J., Sharp, J. A., & Wang, C. . (2008). The role of internacionalization in explaining innovation performance. *Technovation*, 28(1), 63–74. Retrieved from <http://eprints.whiterose.ac.uk/3726>
- Karabulut, A. T. (2015). Effects of Innovation Types on Performance of Manufacturing Firms in Turkey. *Procedia - Social and Behavioral Sciences*, 195, 1355–1364. <https://doi.org/10.1016/j.sbspro.2015.06.322>
- Keh, H. T., Nguyen, T. T. M., & Ng, H. P. (2007). The effects of entrepreneurial orientation and marketing information on the performance of SMEs. *Journal of Business Venturing*, 22(4), 592–611. <https://doi.org/10.1016/j.jbusvent.2006.05.003>
- Kellermanns, F. W., Eddleston, K. A., Barnett, T., & Pearson, A. (2016). An Exploratory Study of Family Member Characteristics and Involvement: Effects on Entrepreneurial Behavior in the Family Firm. *Family Business Review*, XXI(1), 1–14. <https://doi.org/10.1111/j.1741-6248.2007.00107.x>
- Kollmann, T., & Stöckmann, C. (2014). Filling the Entrepreneurial Orientation–Performance Gap: The Mediating Effects of Exploratory and Exploitative Innovations. *Entrepreneurship: Theory and Practice*, 38(5), 1001–1026. <https://doi.org/10.1111/j.1540-6520.2012.00530.x>
- Lee, C., Lee, K., & Pennings, J. M. (2001). Internal Capabilities\_External Networks and Performance: A Study on Technology-Based Ventures. *Strategic Management Journal*, 22, 615–640. <https://doi.org/10.1002/smj.181> T4 - A study on technology-based ventures M4 -

Citavi

- Lisboa, A., Skarmeas, D., & Lages, C. (2011). Entrepreneurial orientation, exploitative and explorative capabilities, and performance outcomes in export markets: A resource-based approach. *Industrial Marketing Management*, 40(8), 1274–1284. <https://doi.org/10.1016/j.indmarman.2011.10.013>
- Loof, H., & Almas, H. (2002). On the relationship between innovation and performance: A Sensitivity Analysis. *Economics of Innovation and New Technology*, 15, 317–344.
- Lumpkin, G. T., & Dess, G. G. (1996). Clarifying the Entrepreneurial Orientation Construct and Linking it to Performance. *Academy of Management Journal*, 21(1), 135–172. <https://doi.org/10.2307/258632>
- Lyon, D. W., Lumpkin, G. T., & Dess, G. D. (2000). Enhancing Entrepreneurial Orientation Research: Operationalizing and Measuring a Key Strategic Decision Making Process. *Journal of Management*, 26(5), 1055–1085. <https://doi.org/10.1177/014920630002600503>
- Mabin, V. (1999). Goldratt's "Theory of Constraints" Thinking Processes: A Systems Methodology linking Soft with Hard. *School of Business and Public Management Victoria University of Wellington*, 12(20), 1–12. Retrieved from <http://www.systemdynamics.org/conferences/1999/PAPERS/PARA104.PDF>
- Madsen, E. L. (2007). The significance of sustained entrepreneurial orientation on performance of firms - A longitudinal analysis. *Entrepreneurship and Regional Development*, 19(2), 185–204. <https://doi.org/10.1080/08985620601136812>
- Mairesse, J., & Mohnen, P. (2003). R&D and Productivity: A Reexamination in Light of the Innovation Surveys. *Preliminary Papers*, 22(May), 1–8. <https://doi.org/10.16309/j.cnki.issn.1007-1776.2003.03.004>
- Masood UL Hassan, Sadia Shaukat, Muhammad Saqib Nawaz, S. N. (2013). Effects of Innovation Types on Firm Performance : an Empirical Study on Pakistan ' s Manufacturing Sector, 7(2), 243–262.
- Matsuno, K., Mentzer, J. T., & Özsomer, A. (2002). The Effects of Entrepreneurial Proclivity and Market Orientation on Business Performance. *Journal of Marketing*, 66(3), 18–32. <https://doi.org/10.1509/jmkg.66.3.18.18507>
- Miles, Huberman, & Saldaña. (2014). Designing Matrix and Network Displays. *Qualitative Data Analysis A Methods Sourcebook*, 3, 107–119. <https://doi.org/10.1136/ebnurs.2011.100352>
- Miller, D. (2011). Miller (1983) Revisited: A reflection on EO research and some suggestions for the future. *Entrepreneurship: Theory and Practice*, 35(5), 873–894. <https://doi.org/10.1111/j.1540-6520.2011.00457.x>
- Morgan, R. E., & Strong, C. A. (2003). Business performance and dimensions of strategic orientation. *Journal of Business Research*, 56(3), 163–176. Retrieved from <http://orca.cf.ac.uk/2700/>
- Morrar, R., Arman, H., & Mousa, S. (2017). The Fourth Industrial Revolution (Industry 4.0): A Social Innovation Perspective. *Technology Innovation Management Review*, 7(11), 12–20. <https://doi.org/10.22215/timreview/1117>
- Nagji, B., & Tuff, G. (2012). Managing Your Innovation Portfolio. *Harvard Business Review*, 23(6), 1–13.
- Naldi, L., Nordqvist, M., Sjöberg, K., & Wiklund, J. (2007). Entrepreneurial Orientation , Risk Taking , and Performance in Family Firms. *Family Business Review*, XX(1), 33–47.
- Plessis, C. J. du. (2017). *A Framework for Implementing Industrie 4 . 0 in Learning Factories*. Stellenbosch University.

- Prajogo, D., & Ahmed, P. K. (2006). Relationships between innovation stimulus, innovation capacity, and innovation performance. *R&D Management*, 36(April), 499–515. <https://doi.org/10.1111/j.1467-9310.2006.00450.x>
- Pujari, D., Wright, G., & Peattie, K. (2003). Green and competitive influences on environmental new product development performance. *Journal of Business Research*, 56(8), 657–671. [https://doi.org/10.1016/S0148-2963\(01\)00310-1](https://doi.org/10.1016/S0148-2963(01)00310-1)
- Qin, J., Liu, Y., & Grosvenor, R. (2016). A Categorical Framework of Manufacturing for Industry 4.0 and Beyond. In R. & V. P. of the scientific committee of the Changeable, Agile (Ed.), *Changeable, Agile, Reconfigurable & Virtual Production* (Vol. 52, pp. 173–178). Cardiff: ScienceDirect. <https://doi.org/10.1016/j.procir.2016.08.005>
- Rauch, A., Wiklund, J., Lumpkin, G. T., & Frese, M. (2009). Entrepreneurial Orientation and Business Performance: An Assessment of Past Research and Suggestions for the Future. *Entrepreneurship Theory and Practice*, 33(3), 761–787. <https://doi.org/10.1111/j.1540-6520.2009.00308.x>
- Real, J. C., Roldán, J. L., & Leal, A. (2014). From entrepreneurial orientation and learning orientation to business performance: Analysing the mediating role of organizational learning and the moderating effects of organizational size. *British Journal of Management*, 25(2), 186–208. <https://doi.org/10.1111/j.1467-8551.2012.00848.x>
- Rubera, G., Chandrasekaran, D., & Ordanini, A. (2016). Open innovation, product portfolio innovativeness and firm performance: the dual role of new product development capabilities. *Journal of the Academy of Marketing Science*, 44(2), 166–184. <https://doi.org/10.1007/s11747-014-0423-4>
- Sethi, R., Iqbal, Z., & Sethi, A. (2012). Developing New-to-the-Firm Products: The Role of Micropolitical Strategies. *Journal of Marketing*, 76(2), 99–115. <https://doi.org/10.1509/jm.09.0308>
- Silveira, G. Da, Borenstein, D., & Fogliatto, F. vio S. (2001). Mass customization: Literature review and research directions. *International Journal of Production Economics*, 72(2), 1–13. <https://doi.org/10.3233/JRS-1994-6203>
- Şimşit, Z. T., Günay, N. S., & Vayvay, Ö. (2014). Theory of Constraints: A Literature Review. *Procedia - Social and Behavioral Sciences*, 150(231), 930–936. <https://doi.org/10.1016/j.sbspro.2014.09.104>
- Smart, D. T., & Conant, J. S. (1994). Entrepreneurial Orientation, Distinctive Marketing Competencies and Organizational Performance. *Journal of Applied Business Research*, 10(3), 1–11.
- Stoffregen, R. M. (2014). Entrepreneurial Leadership as the Driving Force to Successfully Establish a Corporate Identity. *3rd IBA Bachelor Thesis Conference*, 3(2), 1–15. Retrieved from <http://essay.utwente.nl/65410/>
- Story, V., Hart, S., & O'Malley, L. (2009). Relational resources and competences for radical product innovation. *Journal of Marketing Management*, 25(5–6), 461–481. <https://doi.org/10.1362/026725709X461803>
- Subramanian, & Nilakanta. (1996). Organizational Innovativeness: Exploring the Relationship Between Organizational Determinants of Innovation, Types of Innovations, and Measures of Organizational Performance. *International Journal of Management Science*, 24(7), 631–647. [https://doi.org/10.1016/S0305-0483\(96\)00031-X](https://doi.org/10.1016/S0305-0483(96)00031-X)
- Wales, W. J., Parida, V., & Patel, P. C. (2013). Too Much of a Good Thing? Absorptive Capacity, Firm Performance, and the Moderating Role of Entrepreneurial Orientation. *Strategic*

- Management Journal*, 34(1), 622–633. <https://doi.org/10.1002/smj>
- Wang, C. L. (2008). Entrepreneurial Orientation, Learning Orientation, and Firm Performance. *Entrepreneurship Theory and Practice*, 32(4), 635–656.
- Wiklund, J. (1999). The Sustainability of the Entrepreneurial Orientation-- Performance Relationship. *Entrepreneurship Theory and Practice*, 42(19), 37–48.
- Wiklund, J., & Shepherd, D. (2005). Entrepreneurial orientation and small business performance: A configurational approach. *Journal of Business Venturing*, 20(1), 71–91. <https://doi.org/10.1016/j.jbusvent.2004.01.001>
- Wolff, J. A., & Pett, T. L. (2006). Small-Firm Performance: Modeling the Role of Product and Process Improvements. *Journal of Small Business Management*, 44(2), 268. Retrieved from <https://www.jstor.org/stable/4033662>
- Zahra, S. A. (1991). Predictors and financial outcomes of corporate entrepreneurship: An exploratory study. *Journal of Business Venturing*, 6(4), 259–285. [https://doi.org/10.1016/0883-9026\(91\)90019-A](https://doi.org/10.1016/0883-9026(91)90019-A)
- Zahra, S. A. (2008). Being entrepreneurial and market driven: implications for company performance. *Journal of Strategy and Management*, 1(2), 125–142. <https://doi.org/10.1108/17554250810926339>
- Zahra, S. A., & Covin, J. G. (1995). Contextual influences on the corporate entrepreneurship-performance relationship: A longitudinal analysis. *Journal of Business Venturing*, 10(1), 43–58. [https://doi.org/10.1016/0883-9026\(94\)00004-E](https://doi.org/10.1016/0883-9026(94)00004-E)
- Zhao, Y., Li, Y., Lee, S. H., & Chen, L. B. (2011). Entrepreneurial Orientation, Organizational Learning, and Performance: Evidence From China. *Entrepreneurship: Theory and Practice*, 35(2), 293–317. <https://doi.org/10.1111/j.1540-6520.2009.00359.x>