

# Radical innovation, incremental innovation, and competitive advantage, the moderating role of technological intensity: evidence from the manufacturing sector in Jordan

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## Abstract

**Purpose** – The purpose of this paper is to identify the effect of radical innovation and incremental innovation on the competitive advantage of Jordanian industrial companies and identify the moderating role of technological intensity.

**Design/methodology/approach** – For this study's purposes, 303 questionnaires from employees of 30 manufacturing firms were analysed. Convergent validity and discriminant validity tests were performed through structural equation modelling in the Smart-PLS programme. Data reliability was confirmed. A bootstrapping technique was used to analyse the data. Multi-group analysis was performed to investigate the moderating role of technological intensity.

**Findings** – Empirical results showed that both radical innovation and incremental innovation explain 60.2% of the variance in competitive advantage and that both constructs have a statistically significant effect on competitive advantage. The results also revealed that the relationship between radical innovation and competitive advantage is modified through the high-tech industries. Meanwhile, the relationship between incremental innovation and competitive advantage is modified through the low-tech industries.

**Research limitations/implications** – This cross-sectional study provides a snapshot at a given moment in time, a methodological limitation that affects the generalization of its results and the results are limited to one country, Jordan.

**Practical implications** – This study promotes the idea of focusing on radical and incremental innovation to enhance competitive advantage in the Jordanian manufacturing sector and knowing the effect of technological intensity in this relationship.

**Originality/value** – This study has important implications for leaders in the Jordanian manufacturing sector in general, as the study highlights the importance of radical innovation and incremental innovation to enhance the competitive advantage, especially in light of the technological intensity in this sector, and thus, increase the innovative capabilities of this firms, which leads to an increase in the level of competitive advantage.

**Keywords** Radical innovation, Incremental innovation, Competitive advantage, Technological intensity, Manufacturing sector in Jordan

**Paper type** Research paper



## 1. Introduction

In light of a changing business environment and with significant competitive pressures on business organizations, especially in light of the COVID-19 pandemic, which has dramatically affected all business and activities in all countries of the world (Donthu and Gustafsson, 2020; Fairlie, 2020; Kwok and Koh, 2020), there is no country, organization or even individual left that has not been affected by this pandemic. The pandemic has created an environment of instability and ambiguity that has led to a clear, significant and essential disruption of the business environment (Altig *et al.*, 2020; Sharma *et al.*, 2020). The importance of innovation has emerged now more than before. Innovation is a source of competitive advantage (Abd Aziz and Samad, 2016; McDowell *et al.*, 2018) and a general economy engine (Fan *et al.*, 2017; Hogan and Coote, 2014). Innovation plays a pivotal role in improving human well-being and improving quality of life (Edwards-Schachter *et al.*, 2012). The innovative potential and capabilities of organizations and countries may increase well-being levels in those organizations or countries (Koo *et al.*, 2020).

Competitive advantage is defined as superiority over other organizations through the creation of different capabilities from competitors in the industry (Grant and Baden-Fuller, 2004; Rotjanakorn *et al.*, 2020). Competitive advantage reflects an organization's unique capacities and outperforms its counterparts from other organizations (Barney, 1991). Competitive advantage plays a pivotal role in improving an organization's position in the market and makes it more distinctive and successful (Kaur *et al.*, 2019). An organization's focus on competitive advantage improves operational and strategic activities in line with the organization's general plan, which focuses on creating a sustainable competitive advantage (Ma, 2000).

In innovation literature, several studies (Abd Aziz and Samad, 2016; Afraz *et al.*, 2021; Ali, 2021; Liu, 2017) discussed the relationship between innovation and competitive advantage. Isada and Isada (2017) demonstrated that innovation could be divided into two basic types according to its novelty, namely, radical innovation and incremental innovation. Radical innovation involves significant improvements in products and services and the provision of new products and services (Nguyen, 2018). Incremental innovation involves slight changes in technology and some new value or differentiation in current products, services and technology (Okuyama, 2017). When comparing these two types with their relationship to competitive advantage, empirical studies have concluded the importance of both in creating competitive advantage (Sumo *et al.*, 2016), especially when an organization's focus is on technological intensity and its interest in research and development (Zawislak *et al.*, 2018).

Several studies have investigated the effect of radical innovation and incremental innovation on competitive advantage through moderating constructs such as company size (Abd Aziz and Samad, 2016), organizational learning capability (Ferreira *et al.*, 2020) and entrepreneurial orientation (Ferreira and Coelho, 2020). However, understanding the relationships among radical innovation, incremental innovation and competitive advantage through technological intensity remains limited, especially in developing and emerging economies.

Technological intensity plays a vital role in promoting innovation in organizations. Technological intensity is defined as the degree to which scientific research efforts increase productivity and revenue (Palda, 1986). Competitive advantage will be greatly influenced by radical innovation and incremental innovation with high technological intensity. Therefore, this research paper aims to identify the effects of radical innovation and incremental innovation on competitive advantage and identify the moderating role of technological intensity in the relationship between radical innovation and incremental innovation on

competitive advantage in Jordan's manufacturing, which is an important economic sector. Manufacturing sectors are characterized as one of the most competitive and diversified industries in terms of innovation (Al-Omoush *et al.*, 2018), especially because this sector involves several firms within a knowledge-intensive industry (Yaseen *et al.*, 2018).

## 2. Theoretical framework

### 2.1 Radical innovation

Radical innovation is a crucial driver of enhanced organizational performance leading to competitive advantage (Ancona and Caldwell, 1987; Nguyen, 2018). An organization's radical innovation-oriented activities often require high-technology techniques and human resources to achieve these goals (Barba-Aragón and Jiménez-Jiménez, 2020). Radical innovation is defined as a new product that includes a completely different fundamental technology from its predecessor and provides higher benefits to customers than previous products (Kobarg *et al.*, 2019). Radical innovation consists of innovations that lead to giant leaps in technology and manufacturing methods and significantly change performance and price in products and services (Bouncken *et al.*, 2018). Radical innovation can be understood by the traditional concept of innovation, which leads to offering modern products and services that are entirely new from previous ones (López-Cabarcos *et al.*, 2020). These innovations require significant financial expenditure and capital investment (Bilkic *et al.*, 2013; Flor *et al.*, 2018).

Radical innovation is closely related to knowledge (Huang *et al.*, 2015; Medase and Barasa, 2019; Tiberius *et al.*, 2020). The knowledge accumulated in organizations significantly increases the level of radical innovation. Radical innovation involves acquiring new knowledge, leading to the development of new products or services (Benner and Tushman, 2003), and thus, improving these organizations' organizational activities (Kristiansen and Ritala, 2018). Because radical innovation is associated with the introduction of new concepts that did not previously exist, it also carries significant financial risks to organizations (Colombo *et al.*, 2017; Geels *et al.*, 2008; Hall and Wagner, 2012; Kennedy *et al.*, 2017; Onur and Söderberg, 2020). The high costs associated with research and development and the difficulty of implementing innovations play a key role in reducing organizations' activity in supporting radical innovations (Hu and Hughes, 2020; Rubera and Kirca, 2012). However, radical innovation has the advantage of penetrating the market and obtaining the highest possible share from the targeted market sector because radical innovations are characterized by destroying industries that rely on past innovations. This concept is called disruptive innovation. Disruptive innovation is defined as an innovation that creates new markets by providing new features previously unknown (Schmidt and Druehl, 2008).

Radical innovation is mainly driven by internal antecedents that facilitate its development (Datta, 2016; Forés and Camisón, 2016), such as organizational learning that leads to knowledge sharing among workers at all organizational levels (Chiva *et al.*, 2014; Sheng and Chien, 2016; Walker, 2014) and company size. Size is one of the decisive factors in supporting radical innovation because large firms have greater financial, scientific and human potential than small firms, and thus, bear the impact of implementing radical innovations more easily (Plehn-Dujowich, 2009; Sheng and Chien, 2016). Additionally, an innovation-oriented organizational culture that motivates workers to share innovative values, share knowledge, stimulate collective participation and think outside the box leads to improved levels of radical innovation (Martins *et al.*, 2019; Kalyar and Rafi, 2013; Shahzad *et al.*, 2017; Al-Khatib *et al.*, 2021) and senior management support for radical innovation initiatives. Active leadership within the organization plays a role in motivating and guiding

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workers towards innovation, especially radical innovation (Al-Omoush, 2020; Cooper, 2019; Hoonsopon and Ruenrom, 2012) along with the company's research and development (Zhao et al., 2020).

External antecedents may also act as facilitators in reaching radical innovation, including environmental changes in the organization's business environment because these changes create competitive pressure leading to organizational and administrative procedures directed towards innovation, especially new innovations that are previously unparalleled (Kwon and Motohashi, 2017; Mendi and Costamagna, 2016), government regulations and laws because they play a role as an engine of innovation (Park et al., 2018) and the national culture of the country because it can promote or undermine innovation. Chen et al. (2017) and Bukowski and Rudnicki (2018) confirmed that national culture is an essential antecedent for innovation and that the prevailing national culture pattern markedly influences innovation.

## 2.2 Incremental innovation

Incremental innovation involves slight changes in technology and the addition of some new value or differentiation in current products, services and technology (Okuyama, 2017). Incremental innovation is characterized by not requiring high and expensive technology to adopt such innovations (Kobarg et al., 2019; Oerlemans et al., 2013; Sen and Ghandforoush, 2011). High risks in radical innovation do not exist in incremental innovation (Beck et al., 2016; Wu et al., 2019). Because incremental innovation involves slight and cumulative changes, organizations can develop such innovations more easily than radical innovations. Incremental innovation is an output of knowledge existing within organizations and facilitates development additions to products and services (Robertson et al., 2012). Because incremental innovation does not require the introduction of entirely new technologies and techniques, the environmental conditions in which this type of innovation is created is more specific and sure than radical innovation and this reduces the potential risks of failure (Harris, 2017; Valle and Vázquez-Bustelo, 2009; Zirger and Hartley, 1994).

Incremental innovations do not involve a significant drain on the organization's resources and the cooperation among the organization and stakeholders, workers and other organizations is less complicated than radical innovation, which is highly complex in terms of supply chains, cooperation among employees and the apparent uncertainty of success (Aronson et al., 2006; Keizer and Halman, 2009). Incremental innovation is certainly more acceptable to organizations in which conservative and hierarchical cultures prevail. These cultures limit creative idea sharing and enhance standard and traditional production, which, in turn, results in a limited embrace of radical innovation in business activities (Gieske et al., 2020; Globerman and Lybecker, 2014; Lu and Chen, 2010; Miller and Friesen, 1982).

Nevertheless, organizations paying close attention to cumulative improvements in products and services must increase their organizational capacity and improve their resources to cope with developments in technology provided by other organizations and firms operating in the same industry (Shi et al., 2020; Rupietta and Backes-Gellner, 2019). Organizations must recognize that radical innovations delivered by competitors may destroy improved products and services through incremental innovation (González-Sánchez et al., 2020). Incremental innovation requires organizations to build a sustainable, innovative culture through which innovation initiatives are implemented so that any small improvements can have significant long-term benefits (Medne and Lapina, 2019).

The empirical literature (Auh and Menguc, 2005; Lin et al., 2020) confirmed that incremental innovations are usually effective and successful if they respond to customer requirements, improve the quality of products and services by exploiting the organization's

resources and capabilities, thereby improving the organization's competitive position and do not necessarily require significant financial expenditures (Maghsoudi *et al.*, 2016). However, incremental innovations may be highly susceptible to imitation and replacement (Lin *et al.*, 2013; Setijani and Sumartono, 2019). They are not necessarily protected by law as patented radical innovations might be because the slight product changes do not lead to novel conditions (Raja *et al.*, 2010).

Literature examining radical innovation and incremental innovation (Jansen *et al.*, 2006; Lennerts *et al.*, 2020; Lin *et al.*, 2013) explained that radical innovation is associated with exploration, whereas incremental innovation is associated with exploitation. Exploratory activities focus on searching for new knowledge and using unique and unfamiliar techniques to develop entirely new products or services. Exploitative activities are related to using the organization's resources more efficiently and organizing its capabilities to achieve improvements in products and services (Barba-Aragón and Jiménez-Jiménez, 2020; Lennerts *et al.*, 2020; Van Assen, 2020).

### 2.3 Competitive advantage

Competitive advantage is defined as an organization's ability to create new resources by using the available resources (Kaur *et al.*, 2019). Organizations seek to achieve competitive advantage (O'Shannassy, 2008) because long-term success depends on differentiation from competitors (Anning-Dorson, 2018; Atuahene-Gima, 2005; Mohebi and Farzollahzade, 2014). This advantage may be gained through several methods, such as a low-cost, innovation or quality strategy (Lin *et al.*, 2020; Pearson *et al.*, 2015; Porter, 1985; Reguia, 2014; Sutapa *et al.*, 2017; Yaseen *et al.*, 2016). According to Porter (1985), the low-cost strategy involves providing products and services through the economies of scale at lower prices than competitors regardless of the quality (Li and Zhou, 2010). Meanwhile, a differentiation strategy is related to the organization's innovative capacities and the ability to deliver new products and services that are not available through competitors (Cavusgil and Knight, 2015; Correia *et al.*, 2020). Organizations with entrepreneurial orientations and growth through learning can support a differentiation strategy (Gatignon *et al.*, 2002; Knight *et al.*, 2020; Shi *et al.*, 2020).

Organizations can reach a competitive advantage by relying on innovation strategies (Ali, 2021), which leads to better products and services than competitors, which makes achieving clear competitiveness for these organizations (Ferreira and Coelho, 2020). Quality plays a crucial role in creating a competitive advantage by working to achieve the greatest possible productivity with the least waste of resources and this leads to improving the level of organizational performance of these organizations and this lead to create of competitive advantage (Lakhal, 2009; Ferdousi *et al.*, 2019; AL-ghanem, 2021).

Researchers discussed competitive advantage through several theories. Resource-based view (RBV) theory holds that it is the organization's resources and capabilities that lead to competitive advantage (Lestari *et al.*, 2020; Madhani, 2009), and thus, these capacities and resources influence competitive advantage (Othman *et al.*, 2015). Through RBV, innovation can achieve a competitive advantage by investing the organization's human, financial and technical resources to allow the organization to take advantage of the creative ideas put forward and turn them into tangible innovations (Cho and Linderman, 2020; Zawawi *et al.*, 2016). In contrast, the dynamic capabilities theory has discussed competitive advantage from the point of view of organizations' success or failure through market competition (Denrell and Powell, 2016; Teece, 2007). The importance of dynamic capabilities in creating competitive advantage is recognized through sensing, seizing and reconfiguring (Ohr and Mattes, 2013). Dynamic capabilities can be defined as the organization's ability to create,

expand or purposefully modify its resources to address and adapt to changes in its environment (Ferreira *et al.*, 2020). Therefore, dynamic capabilities lead to a positive effect on innovation and lead to competitive advantage (Ferreira *et al.*, 2018; Weerawardena and Mavondo, 2011).

### 3. Research model and hypotheses

#### 3.1 The relationship between radical innovation, incremental innovation and competitive advantage

In the empirical literature, innovation has been recognized as a main and vital cause of competitive advantage (Distanont and Khongmalai, 2020; Lin *et al.*, 2013; Yaseen *et al.*, 2016, 2018). Innovative activities are necessary to ensure the continuity of the organizations' work in a quickly changing competitive environment (Lennerts *et al.*, 2020; Raisch and Birkinshaw, 2008). Innovation can achieve significant competitiveness for organizations, especially during environmental and technological disturbances (AL-Ajloni, 2020; Baron and Tang, 2011). Consequently, it is necessary to promote innovative activities within organizations through strategies such as radical innovation and incremental innovation (Nicholas *et al.*, 2015).

Bouncken *et al.* (2018) indicated that radical innovation is associated with significant changes in products and services provided to customers, leading to creating competitive advantages through the ability to achieve technical quality, add value and enhance the financial level of the organization by attracting capital (Hakala and Kohtamäki, 2011; Hughes *et al.*, 2020; Reid *et al.*, 2015; Salavou and Lioukas, 2003; Shih, 2018). Radical innovation achieves additional advantages for the organization by acquiring new customers and enhancing its brand name. Researchers found that the brand plays a critical role in increasing organizational performance and achieving competitive advantage (Panda *et al.*, 2019). One of the elements that attract customers and achieve a high market share is high-quality, innovative products. Zeng *et al.* (2015) explained that quality issues must be taken into account concerning innovation because both quality and innovation create value for customers, and thus, achieve competitive advantages (Ng, 2009).

Empirical studies confirmed that incremental innovation is associated with slight improvements in technology, and thus, the ability of organizations to achieve long-term competitive advantages may be difficult (Harris, 2017; Valle and Vázquez-Bustelo, 2009). Competitiveness is much more closely related to radical than incremental innovations (Di Benedetto *et al.*, 2008). However, previous studies by Berggren (2019), Ghosh *et al.* (2017) and Kim *et al.* (2019) discussed that incremental innovation creates competitive advantages by reducing cost and improving efficiency (Harris, 2017). Consequently, organizations that drive incremental innovation may create a competitive advantage over time from the transformation of incremental accumulation into new technology (Berggren, 2019).

The organizational and technological requirements of incremental innovations are quite different from radical innovations (Hu and Hughes, 2020; Slater *et al.*, 2013), small and medium-sized enterprises (SMEs) can adopt incremental innovations because of the low cost of research and development and the lack of a high risk taking (Bhaskaran, 2006; Mahmudaj and Krasniqi, 2020), which, in turn, encourages SMEs to focus more on innovative activities for improvement and development rather than on radical activities for the introduction of new technology, products and services (Chrisman and Patel, 2012). Therefore, organizations that embrace innovative incremental activities will focus on achieving competitive advantages and capacities through cost leadership and improved performance (Berggren, 2019; Ghosh *et al.*, 2017; Kim *et al.*, 2019). Thus, incremental innovation can allow organizations to increase their market base by targeting new customer segments

(Chang *et al.*, 2014) and increasing satisfaction with these improved products and services (Tontini and Picolo, 2014), leading to competitive advantages (Müller, 1991; Pei *et al.*, 2020). Le and Lei (2018) and Weerawardena and Mavondo (2011) concluded that innovation in general and incremental innovation in particular create significant competitive advantages, especially concerning differentiation and low cost.

From the previous discussion, the following hypotheses can be assumed:

*H1.* Radical innovation positively affects competitive advantage.

*H2.* Incremental innovation positively affects competitive advantage.

### *3.2 The moderating role of technological intensity*

The level of technological intensity is usually measured by dividing the average expenditure on research and development by the company's general revenues (Peyels and Thirumurthy, 1996). This means that the more a company spends on research and development, the higher the technological intensity level. However, several researchers have discussed different ways of measuring technological intensity. One of the most crucial technological intensity methods is classified by the Organization for Economic Co-operation and Development (OECD, 2003; OECD, 2007; Zawislak *et al.*, 2018). Technological intensity has been classified into four categories:

- (1) High-technology industries: This category refers to the most technology-intensive industries. These companies spend more on research and development. This category includes the aircraft and spacecraft industry, the pharmaceutical industries, office machines, accounting and computing, radios, television and communications, medicine and precise and optical instruments.
- (2) Medium-high-technology industries: This category refers to electrical machinery and appliances not classified elsewhere, including cars, trailers, semi-trailers, chemical industries (except pharmaceutical industries), machinery and equipment not classified elsewhere.
- (3) Medium-low-technology industries: This category includes ship and boat construction and repair, rubber and plastic products, coke and refined petroleum products, nuclear fuels, other mineral and non-mineral products, primary metals and manufactured mineral products.
- (4) Low-technology industries: These industries include recycling, timber, pulp, paper, paper products, printing and publishing, food products, beverages, tobacco, textiles, textile products, leather and footwear.

Despite the importance of the OECD classification in the study of technology intensity and its link to the literature of innovation (Zawislak *et al.*, 2018), there are many studies, such as the study of Harsh and Prasad (2020), that have divided this scale into three main categories; that include high-technology, medium-technology and low-technology industry. According to Rodríguez and Bielous (2016), these categories have divided the technological intensity according to the percentage of investment in research activities and practices, research and development activities and the introduction of new technology. In the context of this study, dividing the technological intensity into three categories as indicated (Lall, 2000; Harsh and Prasad, 2020) will lead to a greater understanding of the extent of the complexity in the technology needed to manufacture the products of these industrial organizations (Han and Liao, 2010).

Technological intensity plays a crucial role in promoting and developing innovation in industrial enterprises (Draca, 2013; Madanmohan, 2005; Martin-de Castro *et al.*, 2011), investment in research and development improves the organization's technological intensity and, in turn, promotes radical innovation (Raymond and St-Pierre, 2010). Radical innovation is positively associated with technological intensity because they both require high technical and cognitive requirements (Clausen *et al.*, 2020).

Gowen and Tallon (2005) and Garcés-Galdeano *et al.* (2016) referred to technological intensity leading to creating a competitive advantage for high-technology firms by improving innovation output.

Several studies, such as Prajogo *et al.* (2014), Wu (2012) and Zawislak *et al.* (2018) investigated technological intensity as a moderator variable. These studies showed that technological intensity moderated the relationships among many variables and constructs, but few studies have examined the moderating role of technological intensity in the relationship among radical innovation, incremental innovation and competitive advantage. High technological intensity and its significant impact on innovation are essential, and researchers agreed that the high level of technological intensity has a positive and clear impact on increasing levels of innovation and knowledge (Buenechea-Elberdin *et al.*, 2018; Kianto *et al.*, 2017; Palazzi *et al.*, 2020). However, several studies concluded that small, entrepreneurial firms that do not have high levels of expenditure on research and development to create new products and services (Zawislak *et al.*, 2018) turn to incremental innovations that do not require significant expenditure (Reboud *et al.*, 2014; Sadgui and Benchekara, 2018).

From the previous discussion, the following hypotheses can be assumed:

- H3.* Technological intensity will moderate the relationship between radical innovation and competitive advantage.
- H4.* Technological intensity will moderate the relationship between incremental innovation and competitive advantage.

#### 4. Methodology

##### 4.1 Measures and instruments

To achieve the study aims and examine the relationships between exogenous constructs (radical innovation, incremental innovation and technological intensity) and endogenous constructs (competitive advantage), a scale (questionnaire) was developed by adapting scales adopted from published studies (Barba-Aragón *et al.*, 2020; Lennerts *et al.*, 2020; Sumo *et al.*, 2016; Kamukama, 2013; Tu and Wu, 2020; Harsh and Prasad, 2020; Lall, 2000) on the subject matter. The questionnaire was presented to a group of academic specialists in strategic management and innovation management, and the scale was modified according to their observations, their observations were limited to minor linguistic modifications. The scale items fit with the local context so that these items conform to the study sample. The scale was then translated from English to the local language (Arabic) to reach the highest possible number of participants. The questionnaire items were developed using a five-point Likert scale with the lowest value representing strong disagreement (1) and the highest value representing strong agreement (5).

The distributed questionnaire included four sections as follows:

- (1) The first section contained general information about the participant and also information about his\her company.

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- (2) The second section is related to radical innovation construct items adopted by the studies of Barba-Aragón *et al.* (2020), Lennerts *et al.* (2020) and Sumo *et al.* (2016).
- (3) The third section contained incremental innovation construct items adopted by the studies of Lennerts *et al.* (2020) and Sumo *et al.* (2016).
- (4) The fourth section included the competitive advantage construct items adopted by the studies of Kamukama (2013) and Tu and Wu (2020).

Meanwhile, the technological intensity construct has been processed through a categorical variable comprising three groups by type of industry in the company where the participants work (high-technology, medium-technology and low-technology industry). This scale has been adopted by Harsh and Prasad (2020) and Lall (2000). Table 1 shows the questionnaire items distributed to the study participants.

#### *4.2 The study population and sample*

Based on this study's main aim, to identify the effects of radical innovation and incremental innovation on competitive advantage and identify the moderating role of technological intensity in the relationship between radical innovation and incremental innovation on competitive advantage in Jordan's manufacturing, the quantitative-deductive approach has been used to study the relationships between constructs because it is considered an appropriate method for causal studies (Lowry and Gaskin, 2014). A quantitative-deductive approach focuses on developing hypotheses through previously existing theories and then testing and analysing these hypotheses (Wilson, 2014). Therefore, this approach is considered one of the basic approaches in testing the relationships between different constructs. Simple random sampling was adopted as a technique in the distribution of the questionnaire. In this research paper, the study population comprised industrial companies listed in the Amman Financial Market and 30 companies were selected as a sample of this population. According to a study classification (Harsh and Prasad, 2020; Lall, 2000), Jordanian industrial companies were distributed into three groups, as shown in Table 2.

The questionnaire was distributed to participants in Jordanian industrial companies, with 365 questionnaires distributed and 303 questionnaires retrieved. Table 3 shows the distribution of participants by demographic and personal characteristics.

### **5. Data analysis and results**

For this study, structural equation modelling partial least squares (SEM-PLS) was used with the Smart-PLS V.3 programme. This technique provides greater flexibility than traditional parameters estimation methods and does not require a large sample size or normal distribution of data (Fornell and Larcker, 1981). In the case of using SEM-PLS, it must be ensured that the measurement model is used and the relationships and hypotheses are tested through the structural model (Hair *et al.*, 2014).

#### *5.1 The measurement model*

Convergent validity was confirmed by calculating factor loadings values for all items through SEM and confirmatory factor analysis. It was confirmed that average variance extracted (AVE) values achieved a statistically required level greater than 0.50 and that factor loadings have reached values greater than or equal to 0.70 as recommended by Fornell and Larcker (1981) and Hair *et al.* (2014, 2019). Internal consistency validity was also confirmed to be achieved and statistically accepted through the values of Cronbach's alpha coefficients and composite reliability so that all values were greater than 0.70. Items whose

Construct	Item code	Item	References
Radical innovation	RI1	The company focuses on new ideas and inventions	Barba-Aragón <i>et al.</i> (2020), Lennerts <i>et al.</i> (2020), Sumo <i>et al.</i> (2016)
	RI2	The company is working on testing new products in the local market	
	RI3	The company's marketing team works on marketing the newly produced products	
	RI4	The company is taking advantage of new opportunities in new markets	
	RI5	The company regularly uses new distribution channels	
	RI6	The company encourages and accepts customer opinions regarding new requests that are not provided by current products	
Incremental innovation	INI1	The company is continuously improving its organizational processes	Lennerts <i>et al.</i> (2020), Sumo <i>et al.</i> (2016)
	INI2	The company periodically improves and maintains production lines	
	INI3	The company is improving the delivery of current products to customers	
	INI4	The company is continuously adding slight modifications to its products	
	INI5	The company encourages employees to hold regular meetings to listen to them about the best ways to add improvements to existing products	
Competitive advantage	CA1	The company has the ability to learn more than its competitors	Kamukama (2013), Tu and Wu (2020)
	CA2	The company has the ability to respond quickly to changes in the market	
	CA3	The company enjoys a good reputation in the market	
	CA4	The company builds strategic partnerships with long-term suppliers	
	CA5	The company offers new products at the right time	
	CA6	The company enjoys a distinct market share compared to its competitors	
Technological intensity	–	Categorical variable (high-technology, medium-technology or low-technology industry)	Harsh and Prasad (2020), Lall, 2000

**Table 1.**  
Constructs  
measurements

Industry type	No.	(%)
High-technology industry	9	30
Medium-technology industry	9	30
Low-technology industry	12	40
Total	30	100

**Table 2.**  
The distribution of  
participating firms

factor loadings were less than 0.70 were excluded. Both INI1 and INI5, with low factor loading, were excluded from the incremental innovation construct. [Table 4](#) summarizes the convergent validity and reliability of constructs.

The second step in confirming the measurement model is to ensure that discriminant validity is achieved in all constructs in the study model through [Fornell and Larcker's \(1981\)](#) method. Based on this method, the values of the square root of the AVE of the variable must be greater than the values of the correlation coefficients between the construct and the other constructs. According to [Table 5](#), the values of the square root of AVE of all constructs were greater than the correlation coefficients among other constructs, and thus, the discriminant validity was achieved in the study model with all constructs.

### *5.2 Evaluating the structural model and testing the study hypotheses*

Relationships between constructs have been examined through the bootstrapping technique. This technique is provided by Smart-PLS when testing relationships and paths between exogenous constructs (radical innovation and incremental innovation) and

Characteristics	Category	No.	(%)
Gender	Men	201	66.3
	Women	102	33.7
Academic qualifications	Diploma and less	52	17.1
	Bachelor's degree	230	75.9
Industry type	Post-graduate degree	21	7.0
	High-technology industry	93	30.7
	Medium-technology industry	107	35.3
	Low-technology industry	103	34.0
Total		303	100

**Table 3.**  
Distribution of  
respondents

Construct	Item code	Factor loadings	Cronbach's alpha	Composite reliability	AVE
Radical innovation	RI1	0.823	0.890	0.916	0.645
	RI2	0.822			
	RI3	0.726			
	RI4	0.817			
	RI5	0.842			
	RI6	0.782			
Incremental innovation	INI1*	–	0.700	0.828	0.616
	INI2	0.814			
	INI3	0.795			
	INI4	0.742			
	INI5*	–			
	CA1	0.794			
Competitive advantage	CA2	0.779	0.853	0.891	0.577
	CA3	0.788			
	CA4	0.773			
	CA5	0.700			
	CA6	0.719			

**Table 4.**  
Convergent validity  
and reliability of  
constructs

**Note:** \*Removed item

endogenous constructs (competitive advantage). It is a nonparametric technique that does not require the normal distribution conditions, standard regression test conditions and large sample sizes (Streukens and Leroi-Werelds, 2016).

The results of SEM are summarized in Figure 1. The figure shows estimates of paths and causal relationships among radical innovation, incremental innovation and competitive advantage. The values of the path coefficients ( $\beta$ ), calculated  $t$ -values and  $P$ -value were used to evaluate relationships between exogenous constructs (radical innovation and incremental innovation) and endogenous constructs (competitive advantage). A rule of thumb from which to judge the hypotheses is that the calculated  $t$ -values must be greater than 1.96 and the  $P$ -value must be less than the probability of 0.05; if the result is otherwise, the null hypothesis is accepted.

The results of the direct relationship test are summarized in Table 6. The results supported the acceptance of the proposed hypotheses ( $H_1$ ,  $H_2$ ) because the relationships among radical innovation, competitive advantage, incremental innovation and competitive

No	Construct	1	2	3
1	Radical innovation	0.803		
2	Incremental innovation	0.674	0.785	
3	Competitive advantage	0.661	0.745	0.759

Note: The values highlighted in bold clarify the square root of AVE

Table 5.  
Discriminant validity

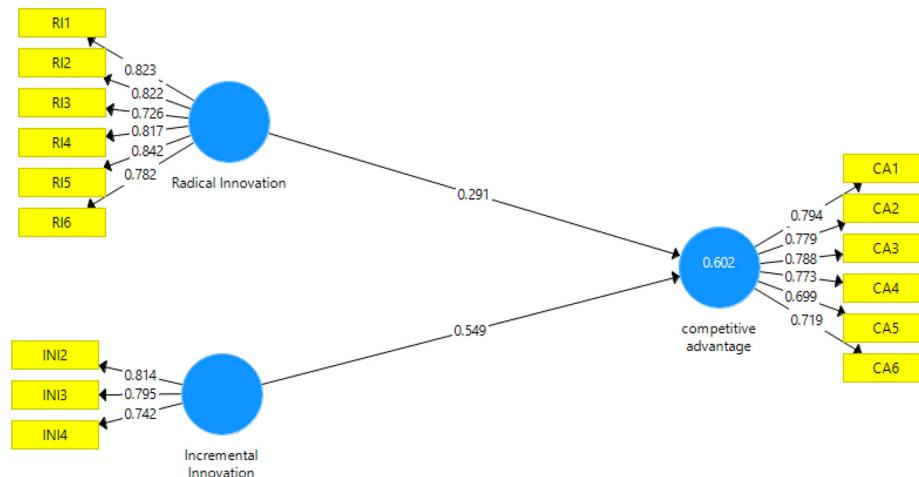


Figure 1.  
Structural equation  
modelling for study  
model

Path	Path coefficient	t-value	P-value	Result
RI $\Rightarrow$ CA	0.292	12.557	0.000	$H_1$ : support
INI $\Rightarrow$ CA	0.549	6.066	0.000	$H_2$ : support

Table 6.  
Results of testing the  
study hypotheses

advantage were statistically significant and positively affected. The results of the  $H1$  test, which explains the direct effect of radical innovation on competitive advantage were  $\beta = 0.291$ ,  $t = 6.066$  and  $P$ -value = 0.000 and the results of the  $H2$  test, which explain the direct effect of incremental innovation on competitive advantage were  $\beta = 0.549$ ,  $t = 12.557$  and  $P$ -value = 0.000. In general, the study model explains that 60.2% of the variance in the competitive advantage, with the value of  $R^2$ , is 0.602.

### *5.3 The moderating role of technological intensity on the relationships among radical innovation, incremental innovation and competitive advantage*

$H3$  and  $H4$  were both tested through a multi-group analysis test supported by the Smart-PLS (MGA-PLS) to ensure which of the three groups (high-technology, medium-technology and low-technology industry) play a moderating role in the relationship between exogenous constructs (radical innovation and incremental innovation) and endogenous constructs (competitive advantage). It is evident from Table 7 that all three groups had statistically significant path coefficients for both radical and incremental innovation because all values of  $\beta$  were at a probability of less than 0.05. Statistically, to find out the differences between groups, the MGA-PLS technique was used. The MGA is a statistical technique for testing two or more groups to determine whether there are statistically significant differences in the estimate of parameters per group (Matthews *et al.*, 2018; Memon *et al.*, 2019). This technique allows researchers to identify differences in the structural paths among multiple groups and is an effective method to evaluate the moderating effects through numerous relationships and structural paths (Hair *et al.*, 2012).

Table 7 shows the difference results in path coefficients between exogenous (radical innovation and incremental innovation) and endogenous constructs (competitive advantage) among the three groups. The high-technology and the low-technology industry groups (in the path from radical innovation to competitive advantage) showed a difference between the path coefficients ( $\beta = 0.243$ ,  $P$ -value = 0.023). This difference is statistically significant and in favour of the high-technology industry group. The differences in the path from incremental innovation to competitive advantage between medium-technology and low-technology industry groups were statistically significant ( $\beta = 0.179$ ,  $P$ -value = 0.05) and in favour of the low-technology industry group. Consequently, the two  $H3$  and  $H4$  are accepted. Thus, technological intensity played a moderating effect on the relationship among radical innovation, incremental innovation and competitive advantage and this moderating role was in favour of the high-technology industry group in the path between radical innovation and competitive advantage in favour of the low-technology industry group in the path between incremental innovation and competitive advantage (Table 8).

**Table 7.**  
Results of testing the  
study hypotheses  
according to groups

Path	All samples ( $N = 303$ )		High-technology industry ( $N = 93$ )		Medium-technology industry ( $N = 107$ )		Low-technology industry ( $N = 103$ )	
	$\beta$	$t$ -value	$\beta$	$t$ -value	$\beta$	$t$ -value	$\beta$	$t$ -value
RI $\Rightarrow$ CA	0.292	12.557**	0.420	4.723**	0.265	3.077**	0.178	2.292**
INI $\Rightarrow$ CA	0.549	6.066**	0.461	5.516**	0.519	6.380**	0.699	9.571**

Notes: \*sig at level (0.05); \*\*sig at level (0.01)

## 6. Discussion, conclusion and implications

This study aims to identify the effect of radical innovation and incremental innovation on the competitive advantage of Jordanian industrial companies and identify the moderating role of technological intensity in the relationship among constructs of this study through an MGA-PLS. The Jordanian industrial company sector is considered one of the most active and growing sectors in the Jordanian economy. The Jordanian manufacturing sector is characterized by the prosperity of several industries with a high knowledge intensity, such as the pharmaceutical industry (Yaseen *et al.*, 2018; Yaseen, 2019). The Jordanian manufacturing sector has attracted the attention of managers and specialists to the importance of innovation.

The study achieved many important results, including the acceptance of the *H1*: if there is a statistically significant effect of radical innovation on these companies' competitive advantage. The introduction of new products, modern technologies and the adoption of creative ideas will improve competitive advantage, especially concerning differentiation, diversity and quality. Radical innovation plays an essential role in enhancing the competitive advantage by creating a new competitive position for the organization that did not exist before, which leads to attracting more customers. This, in turn, creates great competitive advantages for the organization.

This study's results are largely in line with the innovation literature, suggesting the importance of radical innovation as a major factor in creating competitive advantage (Chatzoglou and Chatzoudes, 2018). The *H2* has also been accepted and supported, which confirms a statistically significant effect of incremental innovation on competitive advantage, which indicates that incremental innovation is appropriate and good for developing and emerging economies (Shankar and Narang, 2019). Companies with a conservative and stable orientation do not tend to commit to large investments with high levels of risk to adopt radical innovation. Consequently, the alternative is to improve product performance by introducing slight improvements to the current products, leading to creating a competitive advantage based on low cost. The results of the study are in line with the studies of Berggren (2019), Ghosh *et al.* (2017) and Kim *et al.* (2019).

The *H3* was accepted because of the moderating effect of technological intensity on the relationship between radical innovation and competitive advantage. Technological intensity contributes to strengthening the relationship between radical innovation and competitive advantage and this result is consistent with studies and theories supporting the importance of expenditure on research and development to improve innovation. The impact of radical innovation on competitive advantage was greater in the high-tech industry group than in low-tech companies and these results are in line with Harsh and Prasad (2020), Savrul and Incekara (2015) and Zawislak *et al.* (2018).

The *H4* was also accepted because technological intensity modified the relationship between incremental innovation and competitive advantage in favour of the low-tech company group compared to medium-tech companies, meaning that incremental innovation

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role of  
technological  
intensity

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Path	High-tech industry vs low-tech industry		High-tech industry vs medium-tech industry		Medium-tech industry vs low-tech industry	
	Path coefficient	P-value	Path coefficient	P-value	Path coefficient	P-value
RI⇒CA	0.243	0.023	0.156	0.104	0.087	0.774
INI⇒CA	0.237	0.983	0.058	0.694	0.179	0.050

**Table 8.**  
Multi-group (MGA-PLS) moderation analysis

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can create a competitive advantage even if the company's technical activities are low because incremental innovation does not involve major and radical changes to products. Organizations and companies can improve product performance by improving sales service and solving problems that companies may face, thus creating a competitive advantage (Coccia, 2017). This study's results agree with Harsh and Prasad (2020), Savrul and Incekara (2015) and Zawislak *et al.* (2018).

One of the most important theoretical implications is that this study is one of the few in the literature that has investigated innovation in two types – radical and incremental – and their relationship to competitive advantage with the existence of technological intensity as a moderator variable in this model. Details have also been provided on the relationships between different constructs, which may help researchers and specialists in the innovation field better understand the relationships between constructs found in the study model.

The results of this study have several implications for managers and practitioners in the manufacturing sector. The study recommends the importance of focusing on innovative activities, particularly radical innovation. It is essential that employees be encouraged to improve current products by being financially and morally motivated, especially SMEs and that company leadership recognize the importance of innovation in improving performance. It would be useful for managers of Jordanian industrial companies to recognize the importance of research and development and increase its role in enhancing technological intensity, thus contributing to innovation in general and radical innovation in particular. This, in turn, will enhance the competitive advantage of these firms by creating new markets and increasing market share because the competitive advantage is largely based on their orientation towards radical and incremental innovation. It is useful for managers of Jordanian manufacturing companies to work on attracting distinguished human resources, which are characterized by high skills, experiences and many knowledge, to develop the innovative incremental and radical capabilities of these companies in a way that achieves remarkable success over competitors, which, in turn, achieves a competitive advantage.

However, the current study is subject to numerous limitations. Firstly, the study was conducted by relying on cross-sectional data, so it would be useful to understand the relationship between the study's constructs through longitudinal data. The cross-sectional data do not provide empirical confirmation of causal inferences. Secondly, the study was conducted in Jordan, and it would be useful to conduct in greater depth studies in other environments and countries to confirm the findings. Thirdly, this study has relied on the questionnaire as a study tool, so other data collection tools such as interviews can be applied. The current study suggests conducting future studies focusing on mediator constructs such as knowledge sharing or organizational flexibility and knowing more about causal relationships with such constructs. It may be useful for researchers in the future to study the effects of the COVID-19 pandemic on the Jordanian manufacturing sector because the currently available data of the negative effects of the COVID-19 pandemic are not completely clear, it is useful to know the negative effects of this pandemic on innovation and advantage competitiveness in this sector in the future.

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