# THE IMPACT OF SOFT LEAN MANAGEMENT PRACTICES ON GREEN INNOVATION
## THE MEDIATING ROLE OF ABSORPTIVE CAPACITY: AN APPLIED STUDY IN THE
## MANUFACTURING SECTOR IN JORDAN

### Sakher A.I. AL-Bazaiah

## Article Info

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<tr>
<th>ARTICLE INFO</th>
<th>ABSTRACT</th>
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<tr>
<td>Purpose: This study aims to investigate the relationship between soft lean practices and green innovation in the presence of absorptive capacity as a mediating construct in the manufacturing sector in Jordan, which is thought to be a knowledge-intensive firm affecting the Jordanian economy.</td>
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| Keywords: | Theoretical Framework: Lean practices are gaining popularity in studies and are also seen as a model for innovation, particularly in knowledge-intensive industries. These procedures have grown to be essential to a company's success, particularly in intricate and rapidly changing business environments. |
| Soft Lean Practices; Absorptive Capacity; Green Innovation; Manufacturing Sector; Jordan. | Design/methodology/approach: All manufacturing companies doing business in Jordan make up the sample for this study. This industry was chosen because it is a knowledge-intensive industry that is a global innovation driver, setting it apart from other industrial sectors. 145 department heads, professionals, and knowledgeable employees from this company were randomly chosen to make up the study unit of analysis. The questionnaire's items were created using a review of the literature and all of the construct measures that had been tried and true in earlier research. |

| Findings: The results showed that soft lean practices and absorptive capacity are antecedent to green innovation and confirm that there is a significant and direct relationship between soft lean practices and green innovation, and an indirect relationship with absorptive capacity. | Research, Practical & Social implications: The analysis of lean practices' effects on green innovation hasn't received as much attention in the literature currently available on business as it has on the examination of lean practices' relationships with innovation and innovative performance. Few empirical studies have examined the moderating role that absorptive capacity plays in the relationship between soft lean practices and green innovation; however, absorptive capacity has been discussed as an intermediate construct in a few prior studies. |

| Originality/value: The findings offer valuable recommendations to managers for improving companies' absorptive capacity and green innovation. As a result, the current study examines the impact of soft lean practices on green innovation by absorptive capacity in the context of Jordan's manufacturing sector, which is home to some of the country's most successful and influential businesses in the country's knowledge-intensive industry. | Doi: https://doi.org/10.26668/businessreview/2023.v8i5.2147 |

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**A** Ph.D. in Public Administration. Al-Balqa Applied University. E-mail: bazaiah1@bau.edu.jo
Orcid: https://orcid.org/0000-0002-6648-8091
O IMPACTO DAS PRÁTICAS FLEXÍVEIS DE GESTÃO LEAN NA INOVAÇÃO VERDE O PAPEL MEDIADOR DA CAPACIDADE DE ABSORÇÃO: UM ESTUDO APLICADO NO SETOR DE MANUFATURA DA JORDÂNIA

RESUMO
Objetivo: Este ensaio tem como objetivo investigar a relação entre as práticas soft lean e a inovação verde na presença da capacidade de absorção como um construto mediatriz no setor manufatureiro da Jordânia, que é considerado uma empresa de conhecimento intensivo que afeta a economia jordaniana.

Estrutura teórica: As práticas enxutas estão ganhando popularidade nos estudos e também são vistas como um modelo de inovação, principalmente em setores com uso intenso de conhecimento. Esses procedimentos se tornaram essenciais para o sucesso de uma empresa, especialmente em ambientes de negócios complexos e em rápida mudança.

Projeto/metodologia/abordagem: Todas as empresas de manufatura que operam na Jordânia constituem a amostra deste estudo. Esse setor foi escolhido por ser um setor de conhecimento intenso que impulsiona a inovação global, o que a diferencia de outros setores industriais. 145 chefes de departamento, profissionais e funcionários experientes dessa empresa foram escolhidos aleatoriamente para compor a unidade de análise do estudo. Os itens do questionário foram criados por meio de uma revisão da literatura e de todas as medidas de construção que foram testadas e comprovadas em pesquisas anteriores.

Conclusões: Os resultados mostraram que as práticas flexíveis de lean e a capacidade de absorção são antecedentes da inovação verde e confirmam que há uma relação significativa e direta entre as práticas flexíveis de lean e a inovação verde, e uma relação indireta com a capacidade de absorção.

Implicações sociais, práticas e de pesquisa: A análise dos efeitos das práticas lean sobre a inovação verde não recebeu tanta atenção na literatura atualmente disponível sobre negócios quanto recebeu no exame das relações das práticas lean com a inovação e o desempenho inovador. Poucos estudos empíricos examinaram a função moderadora que a capacidade de absorção desempenha na relação entre as práticas lean e e a inovação verde; entretanto, a capacidade de absorção foi discutida como um construto intermediário em alguns estudos anteriores.

Originalidade/valor: Os resultados oferecem recomendações valiosas aos gerentes para melhorar a capacidade de absorção e a inovação verde das empresas. Como resultado, o presente estudo examina o impacto das práticas enxutas suaves sobre a inovação verde por meio da capacidade de absorção no contexto do setor manufatureiro da Jordânia, que abriga algumas das empresas mais bem-sucedidas e influentes do país no setor de conhecimento intensivo do país.


THE IMPACT OF FLEXIBLE LEAN MANAGEMENT PRACTICES ON GREEN INNOVATION THE MEDIATING ROLE OF ABSORPTIVE CAPACITY: AN APPLIED STUDY IN THE JORDAN MANUFACTURING SECTOR

RESUMEN
Objetivo: Este estudio pretende investigar la relación entre las práticas flexibles de gestión ajustada y la innovación ecológica en presencia de la capacidad de absorción como constructo mediador en el sector manufatureiro jordano, considerado una empresa intensiva en conocimiento que afecta a la economía jordaniana.

Marco teórico: Las prácticas Lean están ganando popularidad en los estudios y también se consideran un modelo de innovación, especialmente en sectores intensivos en conocimiento. Estos procedimientos se han convertido en esenciales para el éxito de una empresa, especialmente en entornos empresariales complejos y en rápida evolución.

Diseño/metodología/enfoque: Todas las empresas manufactureras que operan en Jordania constituyen la muestra de este estudio. Se eligió este sector porque es un sector intensivo en conocimiento que impulsa la innovación global, lo que lo diferencia de otros sectores industriales. Se seleccionaron al azar 145 jefes de departamento, profesionales y empleados experimentados de esta empresa para constituir la unidad de análisis del estudio. Los items del cuestionario se crearon mediante una revisión de la literatura y de todas las medidas de constructo que se han probado y comprobado en investigaciones anteriores.

Conclusiones: Los resultados mostraron que las prácticas Lean flexibles y la capacidad de absorción son antecedentes de la innovación ecológica y confirman que existe una relación significativa y directa entre las prácticas Lean flexibles y la innovación ecológica, y una relación indirecta con la capacidad de absorción.

Implicaciones sociales, prácticas y de investigación: El análisis de los efectos de las prácticas lean sobre la innovación verde no ha recibido tanta atención en la literatura empresarial disponible actualmente como la que ha recibido el examen de las relaciones de las prácticas lean con la innovación y el rendimiento de la innovación. Pocos estudios empíricos han examinado el papel moderador que desempeña la capacidad de absorción en la...
The Impact of Soft Lean Management Practices on Green Innovation: The Mediating Role of Absorptive Capacity

INTRODUCTION

With the recent massive spread of globalization and current rapid change in an increasingly complex business environment, innovation has become a central driver of both macroeconomic and microeconomic competitiveness (Fan et al., 2017; Hogan & Coote, 2014). Understanding and explaining the precedents of innovation is an important matter for technological, knowledge-intensive industries (Makri & Scandura, 2010; Nonaka & Takeuchi, 1995).

Therefore, business organizations devote significant effort to creating a sustainable competitive advantage through innovation (McDowell et al., 2018).

These organizations acknowledge that the complicated and fast-changing business environment that characterizes contemporary global economic markets cannot create a real sustainable competitive advantage that might increase an organization’s performance unless it is done by means of innovation (Haneda & Ito, 2018).

Previous literature acknowledged the important role that lean practices play as a success factor in and precedent for innovation (Bicen & Johnson, 2015; Gudem et al., 2014; Solaimani et al., 2019; Tuli & Shankar, 2015) and green innovation (Ogunbiyi et al., 2011).

However, existing studies have clearly focused on soft management of general innovation; studies that examine the relationship between soft management and green innovation are limited (Li et al., 2018).

Many empirical studies have confirmed the relationship between soft lean practices and innovation with intermediate constructs such as total quality management (Aoun et al., 2018).

However, understanding the relationship between soft lean practices, absorptive capacity, and green innovation is still not clear. With the increasing interest of researchers in soft lean practices and its consideration as a precedent of innovation, especially in knowledge-intensive companies, Hannola et al. (2016) and Asif et al. (2010) made these practices a determinative factor in companies’ success, particularly in complex and highly dynamic...
business environments (Madsen, 2010). Nevertheless, there are few studies that seek the effects of lean management on innovation and green innovation in Arab and non-Western countries (Cherrafi et al., 2018).

Therefore, this study aims to examine the effect of soft lean practices on green innovation in the presence of absorptive capacity as a mediating construct in manufacturing sector in Jordan, which are considered to be knowledge-intensive companies affecting the Jordanian economy (Yaseen, 2019).

**LITERATURE REVIEW**

**Lean Management Practices**

The concept of lean management has received much attention from management researchers after Womack et al. (1990) published the book *The Machine Changed the World*, in which a controversial assessment of the importance of lean management in manufacturing and production was presented. Womack et al. (1991) noted that the concept first appeared in the practices of the Toyota Car Company (Womack et al., 1991).

Leanness was defined as “[i]ntroducing goods and services in the lowest possible costs of temporary storage costs that is associated with long lead time and storage capacity” (Hopp & Spearman, 2004). According to Liker and Wu (2000) leanness means the philosophy of manufacturing that focuses on the quality of the product in the specified time and in the lowest possible cost with a set of strategic and tactical tools, philosophy and method of conducting various tasks and activities. Langstrand (2012) also explained that leanness, in addition to all of the above, is a philosophy that focuses on lean manufacturing and managing suppliers with an integrated system. Liker and Franz (2011) defined leanness as striving towards perfection by continuous elimination of waste by solving various problems.

Lean management was defined by Melović et al. (2016) as a managing producing and developing products and services that aims to make a real change for clients or suppliers. According to Thorhallsdottir, lean management means “a methodology to improve the procedure that is based on Toyota production system (TPS) which focuses on minimizing waste in production process and increase benefits” (2016, p. 326). Therefore, lean practices are “processes that maximize customer value while minimizing waste” (Endsley et al., 2006).

This is why lean management is considered an introductory and dynamic process that uses knowledge and focuses on clients to create value by eliminating waste (Melović et al., 2016). According to Leyer and Moormann (2014), lean management is characterized by the
following main principles—attention to clients’ needs, value streams, flows, withdrawal approach, completion, leadership, individual responsibility, and a culture of continuous improvement.

Previous studies’ interest in lean practices mainly concerned their relationship with organizational performance (Alsmadi et al., 2012; Chavez et al., 2015; Hernandez-Matias et al., 2019) and organizational success (Hwang et al., 2014). Many researchers divided these practices into two main areas: hard lean practices and soft lean practices (Abdallah et al., 2018; Fotopoulos & Psomas, 2009; Lewis et al., 2006). Soft lean practices center on the extent of management’s interest in the workforce, relationships, and organizational and management matters (Bortolotti et al., 2015), while hard lean practices emphasize technical and statistical matters that aim to support production operations (Bortolotti et al., 2015).

Soft lean practices are represented by principles, management concepts such as continuous improvement (Clark et al., 2013), management support (Prajogo & McDermott, 2005), employee training, and client and supplier partnerships (Rahman & Bullock, 2005). Technical practices that are represented by statistical operations (Lewis et al., 2006), preventive maintenance (Shah & Ward, 2007), equipment design for continuous flow (Rahman & Bullock, 2005), and reducing configuration time are considered to be hard lean practices (Bortolotti et al., 2015). The main objective of lean practices is producing products of high quality while fulfilling client requirements and efficiently reducing waste (Alsmadi et al., 2012; Eswaramoorthi et al., 2011; Marodin et al., 2018). These practices increase innovation (Möldner et al., 2020) and interest in the culture of continuous improvement, which improves the efficiency of the company’s operations and activities.

Thus, finding the best products of the highest quality with the lowest waste (Pinto et al., 2019) and continuously improving operations are cornerstones of lean thinking (Holtskog, 2013).

In this study, the following soft lean management practice constructs were examined with reference to the previous literature: lean leadership, employee training, continuous improvement, and supplier partnerships.

**Absorptive Capacity**

According to Cohen and Levinthal (1990), absorptive capacity is a company’s ability to identify the value of external new information, to assimilate it, and to apply it on its commercial
activities. Flatten et al. (2015) defined it as dynamic ability with regard to finding knowledge and using it.

According to the previous two definitions, absorptive capacity includes an organization’s ability to benefit from external knowledge obtained from several sources; knowledge that must be optimally exploited and integrated into the organization’s various work and activities. According to Teece (1997), absorptive capacity is a company’s ability to integrate, build, and recreate internal and external competencies to tackle fast-changing environments.

The concept of absorptive capacity is one of the most vital concepts in knowledge management because it measures an organization’s exposure to and assimilation of external knowledge and the extent to which the organization exploits it advantageously in its daily activities (Martinez-Sanchez & Lahoz-Leo, 2018).

Zahra and George (2002) divided absorptive capacity into two areas—realized absorptive capacity and potential absorptive capacity—and defined absorptive capacity as a “company’s ability to benefit from external knowledge” using three consecutive operations: using exploratory learning to recognize and understand new potential knowledge of value to the company, using transformation learning to assimilate this new knowledge, and then using exploitative learning to create new knowledge and commercial output.

This study focuses on two dimensions of absorptive capacity identified by Zahra and George (2002) absorptive capacity and potential absorptive capacity. Based on previous studies, potential absorptive capacity includes knowledge acquisition and assimilation operations. Realized absorptive capacity includes knowledge transfer and exploitation (Naqshbandi & Kamel, 2017).

Acquisition refers to a company’s ability to independently determine and acquire external knowledge from information about its surrounding environment (Fosfuri & Tribo, 2008). Assimilation refers to a company’s ability to develop operations, procedures, and policies that are useful for analyzing and understanding externally acquired knowledge (Flatten et al., 2011).

Transformation refers to development operations, policies, and improvements for combining current and acquired knowledge, and then assimilating it for future use (Zahra & George, 2002). Exploitation refers to a company’s ability to develop and use procedures, competencies, and existing technical know-how to create something new that depends on acquired and transferred knowledge (del Carmen Haro-Domínguez et al., 2007).
Several studies have confirmed the importance of absorptive capacity in creating a competitive advantage in organizations (Soo et al., 2016). The results of several studies such as those by Tsai (2001), Eastburn, (2018), and Costa and Monteiro (2018) demonstrated that absorptive capacity plays a significant role in innovation and therefore in increasing organizational and business performance (Hafeez et al., 2023).

**Absorptive Capacity and Innovation**

Many studies have revealed that absorptive capacity positively effects innovation (Costa & Monteiro, 2018; Duan et al., 2020; Fabrizio, 2009; Zou et al., 2018). Innovation depends heavily on knowledge and absorptive capacity plays a significant role in discovering and exploiting knowledge in companies (Velmurugan et al., 2022).

The importance of innovation lies in creating a competitive advantage for organizations that makes it prominent among other organizations in the same field (Distanont & Khongmalai, 2018).

Innovation activities can increase an organization’s market share by enabling it to introduce new products and services (Lee & Kim, 2013). Innovation can also strengthen an organization’s financial performance by increasing the value of its intangible assets such as patents and by increasing cashflow from selling such innovations or using them in organizational activities (Ho et al., 2018).

The Organization for Economic Cooperation and Development (OECD) defined innovation as “implement[ing] a new or significantly improved product (Good or service), process, new marketing procedure or new organizational procedure in business practices, work in the workplace or external relations” (2005, p. 46). Green innovation is defined as new products and operations that provide a value for the client and work, but reduces the negative environmental effects (Shin et al., 2018).

Green innovation is characterized by enhanced energy efficiency, reducing carbon emissions, the competent use of materials (Sehnem et al., 2016), the recycling of waste, improved environmental management, and green product design (Chang & Chen, 2013). Green innovation leads to new products and improves a company’s sustainable performance (Rio et al., 2010); a company’s interest in the environmental, social, and economic dimensions can create and promote its sustainable competitive advantage (Durst & Zieba, 2020; Reinhardt et al., 2019).
Research Model and Hypotheses

Various existing studies previously examined hard and soft lean practices simultaneously. However, this study only explores soft lean practices to examine the extent of their application to manufacturing sector in Jordan, which are considered to be knowledge-intensive companies (Cardinal, 2001), for methods and management concepts with regard with continuous improvement and waste reduction. Costa et al. (2019) confirmed that soft lean practices oblige a company’s senior management to support the requirements of total quality and implement lean management, thus increasing employees’ engagement in the company’s continuous improvement.

A company’s implementation of hard lean management practices in production and manufacturing requires a soft infrastructure that consists of management commitment, employee engagement, and continuous improvement (Mamat et al., 2015). Green innovation requires effective practices for lean management (Hallam & Contreras, 2016) because the management’s commitment to establishing a green organizational culture will enhance its implementation of green innovation (del Rosario et al., 2017) and leadership in environmental matters will unite employee efforts to consider the environmental aspects of all company activities (Singh et al., 2020).

Bortolotti et al. (2015) discussed the fact that soft lean practices’ direct effect on the success of lean implementation was proven and that soft lean practices affect a company’s absorptive capacity (Muraliraj et al., 2020). Management support in gaining new external knowledge, exploiting this knowledge, training employees to deal with this new knowledge, and disseminating the culture of continuous improvement can improve a company’s absorptive capacity.

Several empirical studies have previously revealed the role of soft lean practices in innovation (Bicen & Johnson, 2015; Gudem et al., 2014; Solaimani et al., 2019; Tuli & Shankar, 2015). Nevertheless, studies that address the relationship between soft lean practices and green innovation are still narrow, despite the fact that reducing waste and creating value for clients with continuous improvement can contribute to companies’ sustainability (Carvajal-Arango et al., 2019).

Therefore, we hypothesize the following.

H1: Soft lean practices have a positive effect on absorptive capacity.
H2: Soft lean practices have a positive effect on green innovation.
In the previous literature, several studies have confirmed that absorptive capacity is necessary for promoting innovation, especially in knowledge-intensive sector (Yaseen, 2019) in which a company’s ability to gain, implement, and benefit from knowledge increases its ability to innovate (Zahra & George, 2002).

By referring to previous studies, the positive effect for absorptive capacity for innovation was acknowledged by Hong et al. (2019) and Martínez-Sánchez et al. (2020) as well as green innovation (Aboelmaged & Hashem, 2019; Gluch et al., 2009). Thus, absorptive capacity enhances a company’s ability to create a competitive advantage (Chen et al., 2009; Liao et al., 2017; Teixeira et al., 2020) and improve its work performance (Eastburn, 2018; García-Morales et al., 2007) wherein absorptive capacity helps improve a companies’ cognitive abilities and integrate them with their current knowledge, which increases organizational performance.

We therefore hypothesize that:

**H3**: Absorptive capacity has a positive effect on green innovation.

Previous empirical studies have indicated that absorptive capacity plays an intermediate role in the relationship between leadership and innovation (Naqshbandi & Tabche, 2018; Yaseen et al., 2018) and between entrepreneurial orientation and innovative performance (Aljanabi, 2018).

Absorptive capacity is an intermediate factor influencing the relationships between technological ability, maintaining client relationships, and overall company performance. However, studies that examined absorptive capacity as an intermediate factor in the relationship between soft lean practices and green innovation are rare. In this study, we analyze absorptive capacity as an intermediate factor in the relationship between soft lean practices and green innovation in manufacturing sector in Jordan specifically.

**H4**: Absorptive capacity positively mediates the relationship between soft lean practices and green innovation.

**MATERIAL AND METHODOLOGY**

**Sampling**

The sample for this research study is comprised of all manufacturing firms operating in the Hashemite Kingdom of Jordan.

This sector was chosen because it is distinct from other industrial sectors as a knowledge-intensive sector and it is a worldwide driver of innovation.
The research unit of analysis includes 145 department heads, professionals, and knowledge employees randomly selected from this firm. Table (1) lists the demographic characteristics of the study sample.

### Table 1: Demographic Characteristics of the Study Sample

<table>
<thead>
<tr>
<th>Item</th>
<th>Category</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>98</td>
<td>67.5%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>47</td>
<td>32.4%</td>
</tr>
<tr>
<td>Age</td>
<td>Younger than 30 years of age</td>
<td>54</td>
<td>37.2%</td>
</tr>
<tr>
<td></td>
<td>30-39 years of age</td>
<td>40</td>
<td>27.5%</td>
</tr>
<tr>
<td></td>
<td>40-49 years of age</td>
<td>38</td>
<td>26.2%</td>
</tr>
<tr>
<td></td>
<td>50 years of age or older</td>
<td>13</td>
<td>8.9%</td>
</tr>
<tr>
<td>Working at the company</td>
<td>Knowledge factor</td>
<td>102</td>
<td>70.3%</td>
</tr>
<tr>
<td></td>
<td>Administrator</td>
<td>43</td>
<td>29.6%</td>
</tr>
<tr>
<td>Years of experience</td>
<td>Fewer than 5 years</td>
<td>39</td>
<td>26.9%</td>
</tr>
<tr>
<td></td>
<td>5-9 years</td>
<td>44</td>
<td>30.3%</td>
</tr>
<tr>
<td></td>
<td>10-14 years</td>
<td>51</td>
<td>35.1%</td>
</tr>
<tr>
<td></td>
<td>15 years or more</td>
<td>11</td>
<td>7.6%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>145</strong></td>
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</table>


### Measurements

The items in the questionnaire were developed based on a literature review adapting all of the construct measures that were tested and proven in previous studies. All items and responses were assessed using a Likert five-point scale in which “1 = Strongly Disagree” and “5 = Strongly Agree.” Details regarding the questions and constructs applied in this study are provided in Table (1).

The measurement tools were used in studies of soft lean practice constructs (Abdallah et al., 2018; Bortolotti et al., 2015). To measure the absorptive capacity construct (Soo et al., 2017), green innovation was measured by reference to a study by Chang and Chen (2013). All items in the questionnaire were translated from English into Arabic for the purpose of distributing it to the study participants.

A pilot study was conducted on a sample of the study population. The content of the questionnaire and the reliability of the questions were verified. Some amendments were made to questionnaire items. Table (2) shows the construct measurement items and their operationalization sources.

### Table 2: Measurement Scale of Construct Items

<table>
<thead>
<tr>
<th>Construct</th>
<th>Code</th>
<th>Measure</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean Leadership</td>
<td>LL1</td>
<td>All heads of major departments inside the factory accept responsibility for quality.</td>
<td>Abdallah et al., 2018</td>
</tr>
<tr>
<td>LL2</td>
<td>Company management creates and delivers a vision focused on improving quality.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>---------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LL3*</td>
<td>Company management provides personal leadership for quality products and quality improvement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LL4*</td>
<td>Company management is personally involved in quality improvement projects.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Employee Training</th>
<th>ET1</th>
<th>Our company’s employees receive training and development in workplace skills on a regular basis.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ET2</td>
<td>Management in this company believes that continuous training and upgrading of employee skills is important.</td>
</tr>
<tr>
<td></td>
<td>ET3</td>
<td>This company’s employees have above-average skills for this industry.</td>
</tr>
<tr>
<td></td>
<td>ET4*</td>
<td>Our employees regularly receive training to improve their skills.</td>
</tr>
<tr>
<td></td>
<td>ET5*</td>
<td>Our employees are highly skilled in this company.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supplier Partnership</th>
<th>SP1</th>
<th>We strive to establish long-term relationships with suppliers.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SP2*</td>
<td>Our suppliers are actively involved in the process of developing new products.</td>
</tr>
<tr>
<td></td>
<td>SP3</td>
<td>Quality is the number one criterion for selecting suppliers.</td>
</tr>
<tr>
<td></td>
<td>SP4*</td>
<td>We deal with suppliers that are certified.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Continuous Improvement</th>
<th>CI1*</th>
<th>If we do not constantly improve and learn, our performance will suffer in the long run.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CI2</td>
<td>We strive to constantly improve all aspects of products and processes, instead of taking a consistent approach.</td>
</tr>
<tr>
<td></td>
<td>CI3</td>
<td>Continuous improvement makes our performance a moving target that is difficult for competitors to attack.</td>
</tr>
<tr>
<td></td>
<td>CI4</td>
<td>Our company is not a static entity, but dynamically transforms itself to better serve its customers.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Absorptive Capacity</th>
<th>APAC1*</th>
<th>The company has a system to continuously collect information on its business activities.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>APAC2*</td>
<td>The company checks the external environment regularly for new information.</td>
</tr>
<tr>
<td></td>
<td>APAC3</td>
<td>Company employees are aware of the importance of external knowledge sources.</td>
</tr>
<tr>
<td></td>
<td>APAC4</td>
<td>Company management quickly realizes customer requirements and new opportunities to serve them.</td>
</tr>
<tr>
<td></td>
<td>APAC5</td>
<td>Employees at the organization register and store newly acquired knowledge for future reference.</td>
</tr>
<tr>
<td></td>
<td>APAC6</td>
<td>Company management holds regular meetings to discuss developments regarding market trends and product development.</td>
</tr>
<tr>
<td></td>
<td>APAC7*</td>
<td>Company employees meet regularly to discuss how to harness new knowledge to improve existing internal products or processes.</td>
</tr>
<tr>
<td></td>
<td>APAC8*</td>
<td>Company management supports the development of new models, products, services, and processes.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Green Innovation</th>
<th>GI1</th>
<th>The company selects materials that produce the least possible pollution when developing their products.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GI2*</td>
<td>The company selects materials for its products that consume the least possible amount of energy and resources.</td>
</tr>
<tr>
<td></td>
<td>GI3</td>
<td>The company’s manufacturing processes reduce the emission of hazardous materials.</td>
</tr>
<tr>
<td></td>
<td>GI4</td>
<td>The company carefully evaluates and assesses how easy it is to recycle its products.</td>
</tr>
</tbody>
</table>

* Items removed.

RESULTS OF DATA ANALYSIS
The Measurement Model

The partial least squares-structural equation model (PLS-SEM) measurement model included all exogenous (i.e., both first and second order) and endogenous constructs and their indicators were investigated using structural equation modeling using SmartPLS 3.0 software. All constructs in this research were designed as reflective.

Convergent and Discriminant Validity

The convergent and discriminant validity of the items and the dimensions of this research was confirmed. The confirmation of convergent and discriminant validity is considered as one of the necessary steps in confirming the overall validity of the model.

According to Hair et al., (2010, 2017) and Sekaran and Bougie (2016), the loading coefficients, composite reliability, Cronbach’s alpha coefficients, and average variance extracted (AVE) values must exceed acceptable thresholds. In this study, all calculated values were acceptable, that is, they exceeded the acceptable thresholds. After editing and deleting items, their factor loadings were less than 0.70. Thus, convergent validity was confirmed, as explained in Table (3).

Table 3 Reliability and Validity of the Study Constructs

<table>
<thead>
<tr>
<th>Construct</th>
<th>Indicator</th>
<th>Factor Loading</th>
<th>Cronbach’s Alpha</th>
<th>Composite Reliability</th>
<th>AVE*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean Leadership</td>
<td>LL1</td>
<td>0.868</td>
<td>0.856</td>
<td>0.913</td>
<td>0.777</td>
</tr>
<tr>
<td></td>
<td>LL2</td>
<td>0.891</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>LL3</td>
<td>0.884</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employee Training</td>
<td>ET1</td>
<td>0.770</td>
<td>0.798</td>
<td>0.882</td>
<td>0.715</td>
</tr>
<tr>
<td></td>
<td>ET2</td>
<td>0.911</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ET3</td>
<td>0.850</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplier Partnership</td>
<td>SP1</td>
<td>0.915</td>
<td>0.798</td>
<td>0.905</td>
<td>0.826</td>
</tr>
<tr>
<td></td>
<td>SP3</td>
<td>0.902</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous Improvement</td>
<td>CI1</td>
<td>0.873</td>
<td>0.856</td>
<td>0.912</td>
<td>0.776</td>
</tr>
<tr>
<td></td>
<td>CI3</td>
<td>0.880</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>CI4</td>
<td>0.888</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absorptive Capacity</td>
<td>APAC3</td>
<td>0.800</td>
<td>0.806</td>
<td>0.873</td>
<td>0.632</td>
</tr>
<tr>
<td></td>
<td>APAC4</td>
<td>0.840</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>APAC5</td>
<td>0.803</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>APAC6</td>
<td>0.734</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Innovation</td>
<td>GI1</td>
<td>0.784</td>
<td>0.718</td>
<td>0.841</td>
<td>0.639</td>
</tr>
<tr>
<td></td>
<td>GI3</td>
<td>0.752</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>GI4</td>
<td>0.859</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: “AVE” stands for average variance extracted.
Discriminant validity was implemented based on Fornell and Larcker’s (1981) method, wherein the square root of the AVE must be greater than the correlation between the construct and other latent constructs. As shown in Table (4), all values for the square root of the calculated AVE (explained in the dark shade) are greater than the correlation between the underlying construct and other underlying constructs. Therefore, it was possible to judge the existence of differential validity between the study constructs.

Table 4. Discriminant Validity between Study Constructs

<table>
<thead>
<tr>
<th>Construct</th>
<th>Absorptive Capacity</th>
<th>Employee Training</th>
<th>Green Innovation</th>
<th>Lean Leadership</th>
<th>Supplier Partnership</th>
<th>Continuous Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorptive Capacity</td>
<td>0.795</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employee Training</td>
<td>0.618</td>
<td>0.846</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green Innovation</td>
<td>0.664</td>
<td>0.516</td>
<td>0.800</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lean Leadership</td>
<td>0.503</td>
<td>0.743</td>
<td>0.591</td>
<td>0.881</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supplier Partnership</td>
<td>0.417</td>
<td>0.448</td>
<td>0.310</td>
<td>0.340</td>
<td>0.909</td>
<td></td>
</tr>
<tr>
<td>Continuous Improvement</td>
<td>0.595</td>
<td>0.800</td>
<td>0.653</td>
<td>0.663</td>
<td>0.294</td>
<td>0.881</td>
</tr>
</tbody>
</table>


Model Testing

The study model was tested by structural equation modeling using SmartPLS 3.0. Several measures were used to evaluate the model such as communality redundancy indices, path coefficients, coefficients of determination (R²) values, and predictive relevance (Q²).

To confirm the quality of the structural model and evaluate its statistical effectiveness, it was tested using cross validation and communality redundancy indices. The values of the tests for all constructs must be positive (Hair et al., 2014). In this study, the predictive validity of the model was confirmed, as shown in Table (5) below.

Table 5. Predictive Validity

<table>
<thead>
<tr>
<th>Construct</th>
<th>Communality</th>
<th>Redundancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft lean practices</td>
<td>0.435</td>
<td>0.493</td>
</tr>
<tr>
<td>Absorptive capacity</td>
<td>0.379</td>
<td>0.246</td>
</tr>
<tr>
<td>Green innovation</td>
<td>0.289</td>
<td>0.312</td>
</tr>
</tbody>
</table>


After confirming model validity, convergent validity and discriminant validity for the structural model was confirmed. The study’s hypotheses were tested using a bootstrapping procedure in SmartPLS.
The decision rule for testing a hypothesis is: if the calculated value of \( t \) is greater than the tabulated value of 1.96 at a probability of 0.05 or less, the alternative hypothesis is accepted. The conclusion is that this study’s assumptions have a statistical significance where it is clear from the hypothesis testing that the beta coefficients for soft lean practices have a positive significant effect on absorptive capacity (\( b = 0.654, \ p < 0.01 \)), therefore, hypothesis H1 is supported.

The results reveal that soft lean practices positively affect green innovation (\( b = 0.384, \ p < 0.01 \)) and that absorptive capacity also significantly positively affects green innovation (\( b = 0.413, \ p < 0.01 \)). As for the intermediate role of absorptive capacity, the research model implies that absorptive capacity plays an intermediate role on the relationship between soft management practices and green innovation in manufacturing sector, as confirmed by Preacher and Hayes’s procedure (2008).

This result is obvious from the direct and indirect course coefficients; this procedure indicated that zero should not cross the bootstrapped confidence interval values and the values of upper limit (UL) 95% (0.421) and lower limit (LL) 95% (0.119). Therefore, Preacher and Hayes’ (2008) rule was achieved; absorptive capacity plays an intermediate role on the relationship between soft lean practices and green innovation in Jordanian manufacturing sector.

With regard to the indirect effect of this study, the value of the indirect effect was 0.270 and the overall effect was \((0.654 \times 0.413) + (0.384) = 0.654\).

This structural model indicates that the value of the coefficient of determination for absorptive capacity was 0.427, which indicates that the value of the variance in absorptive capacity (42.7%) was attributable to soft lean practices, while the coefficient of determination in green innovation was 0.526, which indicates that the value of the variance in green innovation (52.6%) was due to soft management practices and absorptive capacity as an intermediate construct. Table (6) summarizes the tested hypotheses and Figure (1) shows the results of the structural model analysis, listing the estimated path coefficients and determination coefficient \( R^2 \) values.

<table>
<thead>
<tr>
<th>Path</th>
<th>Standardized Coefficient</th>
<th>Standard Error</th>
<th>( t )-value</th>
<th>Hypothesis Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLP ( \Rightarrow ) AC</td>
<td>0.654</td>
<td>0.065</td>
<td>10.014</td>
<td>H1 is supported</td>
</tr>
<tr>
<td>SLP ( \Rightarrow ) GI</td>
<td>0.384</td>
<td>0.086</td>
<td>4.474</td>
<td>H2 is supported</td>
</tr>
<tr>
<td>AC ( \Rightarrow ) GI</td>
<td>0.413</td>
<td>0.099</td>
<td>4.161</td>
<td>H3 is supported</td>
</tr>
</tbody>
</table>

Indirect Effect
The Impact of Soft Lean Management Practices on Green Innovation: The Mediating Role of Absorptive Capacity
An Applied Study in the Manufacturing Sector in Jordan

<table>
<thead>
<tr>
<th>Path a (SLP ⇝ AC)</th>
<th>0.654</th>
<th>95% LL 0.119</th>
<th>95% UL 0.421</th>
<th>H4 is supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Path b (AC ⇝ GI)</td>
<td>0.413</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: AC = absorptive capacity; GI = green innovation; SLP = soft lean practices; UL = upper limit; LL = lower limit.


CONCLUSION, DISCUSSION, AND IMPLICATIONS

It has been recognized that soft lean practices are an important and decisive factor for companies in achieving innovation.

The existing business literature has focused on the examination of lean practices and their relationship with innovation and innovative performance and analysis of their impact on green innovation is still limited.

Empirical studies examining the moderating role that absorptive capacity plays in the relationship between soft lean practices and green innovation are few in number; absorptive capacity as an intermediate construct was discussed in a few previous studies (Aljanabi, 2018; Hong et al., 2019; Martínez-Sánchez et al., 2020; Yaseen et al., 2018). Thus, the present study analyzes the effect of soft lean practices on green innovation by absorptive capacity in the context of Jordanian manufacturing sector, which are considered to be leading and effective companies in the Jordanian economy in a knowledge-intensive sector.

The empirical results of this study reveal that soft lean practices and absorptive capacity have a significant relationship with green innovation and confirm that soft lean practices and absorptive capacity are precedent to green innovation. The results also reveal a positive and significant relationship; they support and accept all the study’s hypotheses, indicating that soft lean practices affect absorptive capacity and green innovation. These results are consistent with previous studies (Martínez-Sánchez et al., 2020; Muraliraj et al., 2020; Solaimani et al., 2019; Tuli & Shanker, 2015).

In this study, the effect of soft lean practices on a company’s innovation by absorptive capacity was confirmed empirically. Absorptive capacity was confirmed as playing an intermediate role in the relationship between soft lean practices and green innovation.

Current studies have a number of implications in the literature on lean management and innovation. This study filled a research gap regarding the moderating role of absorptive capacity on the relationship between soft lean practices and green innovation. Studies on green innovation are still narrow and so studies that connect absorptive capacity with lean management practices have rarely been previously performed.
In addition to its theoretical contributions, this study also provides valuable recommendations for managers and officials. Managers should enhance their knowledge gain and assimilation to increase their company’s green innovation. Managers must increase their interest in soft lean practices that increase the interest in and benefit of knowledge sources, therefore increasing their level of green innovation. Thus, the current study encourages managers to take an interest in lean management practices such as lean leadership and continuous improvement.

This study has a few limitations that should be mentioned. This study focused only on soft lean practices and absorptive capacity in analyzing green innovation and considered them as precedents to green innovation. In the future, studying other intermediate constructs—such as knowledge-sharing, organizational learning, or the study of absorptive capacity as a modified construct in the relationship between soft lean practices and green innovation—is necessary to gain a greater understanding of green innovation’s precedents. Another limitation of this study was its use of cross-sectional information.

In the future, it is possible that a longitudinal research design might enable us to discover the extent of the stability of the current study results on the Jordanian manufacturing sector. Studying soft lean practices’ effect on green innovation with absorptive capacity as an intermediate construct in sectors other than the manufacturing sector such as the service sector, hospitals, or the industrial sector might also add great value to the business literature by providing information about how soft lean practices and absorptive capacity influence green innovation.

ACKNOWLEDGMENTS

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REFERENCES


ATTACHMENT

Figure 1. Structural Equation Modeling for the Study Model

Prepared by researchers.