

## Original Research Article

### **SERVANT LEADERSHIP, KNOWLEDGE MANAGEMENT, AND FRUGAL INNOVATION IN CHINESE SPORTS MANUFACTURING INDUSTRY: THE MODERATING ROLE OF TECHNOLOGY TURBULENCE AND INNOVATION CAPABILITIES**

#### **ABSTRACT**

Frugal innovation is an emerging term, and since the last decade, many studies have been focusing on this type of innovation. Therefore, this research has also directed attention towards frugal innovation. First of all, it studied the effect of servant leadership on knowledge management and then the relationship between knowledge management and frugal innovation was measured. Moreover, the relationship described above was examined by moderating the role of innovation capabilities and technology turbulence. The data were collected from Sports equipment manufacturing companies of China, and to analyze the data, AMOS was used. The results highlighted a positive relationship between servant leadership and knowledge management, and this management has a significant and positive relation with frugal innovation. In addition, the technology turbulence and innovation capabilities can strengthen the relationship between knowledge management and frugal innovation. Despite highlighting the broad areas and developing a comprehensive model, this research has several limitations which are future directions for further studies. This research focused on sports equipment manufacturing companies, and future studies can highlight the perspective of other companies. In addition, the entrepreneurial orientation can be considered as mediating variable as it can be affected by knowledge management and affect frugal innovation.

**Keywords:** Frugal Innovation; Innovation Capabilities; Servant Leadership; Sports; Technology Turbulence.

## INTRODUCTION

In terms of the business and academic world, the idea of leadership has great importance. The previous leadership studies have not given much attention to a leadership role and solely focused on individual employee performance. Numerous scholars have only discussed the role of leadership as a mentor, coach, and facilitator (Galbraith & Cohen, 1995; Gardner, 1983; Kouzes & Posner, 1995; Senge, 1990). Subsequently, individual employees are considered an essential source of generating and sharing information. Therefore, various scholars in this field area have indicated that an effective leadership style must be people-oriented instead of tasks (Bryant, 2003; Politis, 2001, 2003; Williams, 2003). According to Pfeffer (1998a, p.394), a people-centred strategy is "an important source of competitive advantage because it is difficult to imitate, unlike technology, cost or new product development". Bass (2000) described servant leadership as the leadership that emphasizes subordinates' learning, growth, and sovereignty. Many researchers have pointed out culture and leadership as the root cause of frustration in most knowledge management programs (Davenport & Prusak, 1998; DeLong & Fahey, 2000; Galbraith & Cohen, 1995; Gardner, 1983; Senge, 1990). Similarly, several researchers highlighting leadership indicated servant leadership as the most effective leadership approach for knowledge-based organizations (Blanchard & Hodges, 2002; Covey, 2002; Senge, 2002; Spears & Lawrence, 2002; Wheatley, 2004). Therefore, the leader plays an enthusiastic role in any knowledge management program. According to Wenger (2004, p. 2), "the role of the professional manager is not to manage knowledge directly, but to enable practitioners to do so". Thus, the leader's responsibility is to encourage employees to create and share useful knowledge that defines the significance of a successful knowledge management program. Thus, we can say that leadership is solely responsible for successfully implementing knowledge-friendly cultures in organizations.

Bryant (2003) explained that a leaders' role is essential for an effective knowledge management program. It is important to understand that leaders shape an organization's culture by setting standards to motivate employees and their knowledge management behaviours. Therefore, an effective leadership approach is essential to take advantage of competitors by successfully influencing employees' behaviour through the management and sharing of knowledge at every

level of the organization. Darroch and McNaughton (2002) argued that the ultimate purpose of knowledge management is to create or locate knowledge, manage the flow of knowledge, and ensure efficient use of knowledge to reap long-term organizational benefits. Alike, Gloet and Terziovski (2004) explained knowledge management as the general framework of specific experiences, awareness, and expertise that develop new organizational capabilities, lead to superior organizational performance, encourage operational innovation, and enhance customer value. Hence, we can say that innovation results from effective knowledge management, enabling organizations to surpass their competitors and achieve organizational goals successfully. Therefore, this study aimed to describe the role of servant leadership in effective knowledge management, which ultimately leads to organizational innovations.

Researchers working on innovation have defined innovation as implementing modern knowledge and philosophies to improve the in-house business structures and policies to produce customer-oriented goods that can provide superior customer satisfaction. In view of Gloet and Terziovski (2004), innovation is the idea of employing new findings and procedures that brings better results, products, and improved internal policies. For that reason, organizations need to have an innovative business approach to stay ahead of competitors for long-term business survival. However, due to rapidly changing consumer needs, extensive competitive pressure, and speedy technological advances, the concept of innovation has become a major challenge for organizations (Cavusgil et al., 2003). Moreover, the availability of extensive and diverse knowledge has further complicated the way for organizations to adopt and manage a successful innovation strategy (Adams and Lamont, 2003; Cardinal et al., 2001; Darroch and McNaughton, 2002; Pyka, 2002; Shani et al., 2003). It is necessary to understand that innovation results from available information and knowledge. Therefore, to develop and implement a successful innovation strategy, it is necessary to find and adopt the right information and knowledge. Thus, this study aims to examine the impact of knowledge management on frugal innovation.

The term frugal innovation has gained considerable attention from practitioners in emerging and advanced economies (Agarwal and Brem, 2017; Agarwal et al., 2017; Crisp, 2014; Lim and Fujimoto, 2019; Melkas et al., 2019; Pisoni et al., 2018). Zeschky et al. (2011) highlighted that frugal innovation can be well-described as a cost-cutting and uniform approach to satisfy the expectations of low-income customers and provide innovative and inexpensive solutions to

promote structural improvements within their communities (Karnani, 2007). Numerous scholars in their study have described frugal innovation as social innovation which promotes the manufacturing of inexpensive products and services to fulfil the needs of low-income societies (Chataway et al., 2014; Lorentzen, 2010; Murray et al., 2010). Nevertheless, many scholars argue that it is necessary to identify what kind of knowledge would be more appropriate for a particular innovation (Dost et al., 2016; Subramaniam and Venkatraman, 2001; Subramaniam and Youndt, 2005; Tsai and Ghoshal, 1998). Furthermore, it can be observed that the democratic behaviour of innovation has eliminated the role of financed corporations and government research laboratories in developing new ideas for the manufacturing of the best products and services to meet societal needs (King and Lakhani, 2013).

Many researchers have revealed that knowledge generally originated from inside and outside the organizational boundaries (Kessler et al., 2000; Menon and Pfeffer, 2003). Therefore, organizations need to implement effective managerial and operational approaches that promote the flow of knowledge at all levels to achieve maximum results (Alavi and Leidner, 2001; Natalicchio et al., 2017). Moreover, the moderate behaviour of technology turbulences and innovation capabilities has an intensity of K.M. on F.I. (Dost et al., 2019; AlMulhim, 2021; Iqbal, Ahmad, & Halim 2021). Besides, organizations are usually surprised by the technology turbulences because rapid technological advancement sometimes appears as a blessing and a curse (Meyer, 1982; Dost et al., 2019; Song and Montoya-Weiss, 2001). A firm may fail to meet the rapidly changing technological environment. Consequently, once useful assets become a liability if no longer useful to meet the modern-day requirements (Reed and DeFillippi, 1990; Song and Montoya-Weiss, 2001). Thus, while competing in a turbulent environment, managers' foremost responsibility is to reduce the risk and uncertainty (Calantone et al., 2003). However, organizations that are well aware of the environmental turbulences reap high benefits for F.I. by utilizing internal and external knowledge sources. Tamer Cavusgil et al. (2003) explained innovation is essential for the long-term survival of an organization. Lin (2007) has argued that firms must continuously improve and innovate to meet modern-day environmental challenges. Likewise, a more adaptive organizational culture also successfully implements new innovative capabilities (Lawson and Samson 2001; V.U., 2020). Thus, this study aims to investigate the effect of servant leadership on knowledge management and further the impact of knowledge management on frugal innovation. Additionally, the current study also examines how the

moderation of technology turbulences and innovation capabilities weaken or strengthen the effect of K.M. on frugal innovation in Chinese sports equipment manufacturing companies.

## **LITERATURE REVIEW**

### **Servant Leadership and Knowledge Management**

Knowledge is power, a famous phrase that means knowledge is the ultimate tool that any other power cannot beat. From the organizational perspective, knowledge is also a key element that enables organizations to have an advantage over competitors and support a sustainable organizational environment. In the recent economic environment, the productive utilization of knowledge is the key to effective economic performance. Scholars have recognized leadership and organizational culture as the key elements that affect the knowledge-management practices in an organization. Thus, servant leadership has been recognized as the future leadership approach that significantly leads to organizational success among the various leadership practices. The primary purpose of servant leaders is to promote and strengthen the relationship between followers in order to support the organizational culture and achieve organizational goals. This helps servant leaders to successfully implement knowledge management practices by shaping followers' desire to use and share knowledge at all levels of the organization. Many scholars have recognized servant leadership as an approach to future leadership (Spears, 2004; Correia de Sousa & Dierendonck, 2010; Guillaume, Honeycutt & Cleveland, 2012). According to Guillaume et al. (2012), there is a dire need for a leadership approach that can meet the challenges of the new world, the world of a knowledge-based economy.

Greenleaf (1977) and Spears (2004) defined servant leaders as those who thrive by supporting others and include all the concerned authorities while making a decision. Helping others is the main characteristic of servant leaders that motivate employees to give their best in achieving organizational objectives (Northhouse, 2010). Ngcamu and Sunyani (2011) consider that leaders affect the employees' perception of knowledge-management strategies. Therefore, leaders should develop a culture that stimulates employee's knowledge behaviour and ensures maximum access to employee knowledge. Likewise, it has been observed that employees' knowledge-sharing behaviour is more dependent on management support (Connelly and Kelloway 2003). Thus, the role of leadership in shaping employees' knowledge-management behaviour is essential. As a result, we can say that leadership alone is responsible for fostering strong ethical relationships

among employees and adopting knowledge management practices. Fundamentally, knowledge management results from the creation, sharing, and exploitation of knowledge that enables leaders to improve internal organizational processes, innovation, better communication, and support employees' growth and development (Heirdani et al., 2011). Subsequently, servant leadership promotes a strong, trusting relationship among employees and involves all concerned parties (top management & other employees) in the decision-making process by providing a platform to share their ideas confidently (Baker & Baker, 2001).

Baker and Baker (2001) also revealed that knowledge results from employee interactions and trust in each other. They explain that a higher level of trust and interaction among employees leads to higher and more sincere knowledge sharing. In this regard, a group of scholars has reported that leadership is essential in promoting a knowledge-sharing culture (Lee, Gillespie, Mann, and Wearing, 2010). Therefore, scholars highly rate the servant leadership style as this approach enable leaders to support their followers by empowering them and respecting their opinions while making organizational decisions (Greenleaf, 19977; Spears, 1998; Thomson, 2010). As a result, we can say that Servant leadership is the most appropriate leadership approach, which facilitates knowledge-sharing by creating a knowledge-management environment by empowering followers and making them realize that their opinions are useful to the organization (Dehaven, 2008). Based on the above discussion, we can hypothesize that:

*H<sub>1</sub>: Servant leadership has a positive relationship with knowledge management*

### **Knowledge Management and Frugal Innovation**

Nowadays, it is considered that K.M. led the organization to increase innovativeness and responsiveness and have a competitive advantage over competitors. Therefore, it is essential for organizations to successfully implement knowledge-management programs to improve and innovate internal operations and organizational products (Eslami and Lakemond, 2016; Mousavizadeh et al., (2015. According to Salmador and Bueno (2007), organizational learning and innovativeness are highly dependent on the creation and transmission of knowledge. Many researchers revealed that knowledge creation, knowledge sharing, knowledge application, knowledge storage, and acquisition significantly influence the innovativeness of an organization (Andreeva and Kianto, 2011; Lee et al., 2013; Chen et al., 2010). Thus, K.M. allows organizations to utilize this knowledge for the greater benefit of the organization. For example,

efficient internal operations, innovative products, services, processes, and higher customer satisfaction (Huang and Li, 2009). The idea of K.M. has gained considerable attention due to the positive change it brings to the organization. For example, increasing employees' creativity, generating innovative ideas, improving internal processes, and innovative organizational products (Darroch, 2005).

Donate and Sanchez de Pablo (2015) highlighted that knowledge management significantly mediates the effect of knowledge-oriented leadership on product innovation. Moreover, Lee et al. (2013) experimentally prove the significance of K.M. on the organization's technological innovation. It is essential to understand that the main purpose of K.M. is to improve the firm's innovation capacity. In this regard, Darroch and McNaughton (2002) stated that K.M. is positively associated with the innovative performance of the organization. Additionally, many researchers have argued that R&D also leads to K.M. and K.M. fundamentally results in new ideas and innovation (e.g., Capon, Farley, Lehman, & Hulbert, 1992; Zahra & Bogner, 1999). Similarly, many other scholars highlight a positive relationship between the acquisition of market knowledge or knowledge from employees and innovation (Li & Calantone, 1998; Lynn, Reilly, & Akgun, 2000). Based on the above discussion, we can say that innovativeness is essential for organizations to dominate the market and achieve organizational objectives (Zack et al., 2009). We found two general categories of innovation in literature, namely conventional innovation and frugal innovation (Basu et al., 2013; Weyrauch & Herstatt, 2017). However, this study only discusses the importance of "frugal innovation" from the organizational perspective. In recent times, the term frugal innovation has gained considerable attention. The term primarily provides an opportunity for non-affluent customers to purchase and consume products at affordable prices to fulfil needs in an emerging market. Besides, there is no certain definition of frugal innovation. However, the ultimate goal of frugal innovation is to facilitate non-affluent customers of an emerging market by producing cheap products and services to meet their needs (Hart and Christensen 2002; Prahalad and Hart 2002; Wooldridge 2010; Soni and Krishnan 2014).

The significance of frugal innovation has also been recognized in developed markets and is usually known as reverse innovation (Govindarajan and Trimble 2012; Immelt et al. 2009; von Zedtwitz et al. 2015). According to Rao (2013), there are various examples of frugal innovation

that we can observe, including the Tata Nano (Ray and Ray 2011; Tiwari and Herstatt 2014) and handheld, pocket-sized ultrasound devices being the most common (Govindarajan and Trimble 2012). Based on a number of earlier studies, we can say that there is a positive relationship between frugal innovation and knowledge management. As described by Fischer et al. (2020), knowledge sharing is positively associated with frugal innovation. Similarly, Dost et al. (2019) also reported an effective relationship between knowledge management and frugal innovation. In this regard, Lei, Gui, and Le (2021) defined K.M. as the result of effective leadership that leads to frugal innovation. Besides, in view of Niroumand et al. (2021), frugal innovation results from human capital and human-based knowledge management. Based on these arguments, we hypothesized that:

*H<sub>2</sub>: There is a positive relationship between K.M. and frugal innovation.*

### **Technological Turbulence as Moderator**

Turbulence in the market is often described as changing customer preferences, composition, and market trends. However, technological turbulence is a different concept that leads to an entire up-gradation of manufacturing and delivery processes of goods and services (Kohli and Jaworski, 1990; Ngamkroekjoti and Speece, 2008). It is generally argued that market turbulence is the result of technological turbulence. In view of Lichtenthaler (2009), technological turbulence appears as the most challenging task for organizations when dealing with market turbulence and competitors' rivalry. According to Jaworski and Kohli (1993, p. 57), technological turbulence is defined as "the rate of technological change in an industry" (Jaworski and Kohli, 1993, p. 57). As a result, we can say that technological turbulence leads to entrepreneurial opportunities, highlighting the technological gap and modern market trends for an organization (Hall and Rosson, 2006).

An unstable or turbulent environment results from unexpected market and technological changes that highlight the risks and uncertainties for the industry due to the turbulent environment. However, it is found that innovative companies are more affected by unstable environments and rapid technological advances that are constantly revolutionizing the business world. Besides, it also allows innovative companies to improve internal processes and change the traditional way of conducting business to think differently and creatively. In consideration of Li et al. (2019), technological turbulences enable organizations to explore new knowledge, new relationships,

improve companies' innovativeness, and new causality systems. Additionally, due to technological turbulences, existing technologies become obsolete, resulting in a lower competitive advantage and reducing the life cycle of existing products (Zhou et al., 2005). Therefore, organizations need to successfully deal with technological turbulences through continuous improvement and innovation. According to Lichtenthaler (2009), market and technological awareness are necessary for organizational due to their higher impact on a company's innovativeness. Thus, we can say that a turbulent environment has increased the firm's potential for innovation and encouraged the adoption of new technologies using knowledge sources to maximize the impact of frugal innovation (Miller, 1987). Therefore, we made the following hypothesis:

*H<sub>3</sub>. The moderation of technology turbulence will strengthen the impact of knowledge management on frugal innovation*

### **Innovative Capabilities as Moderator**

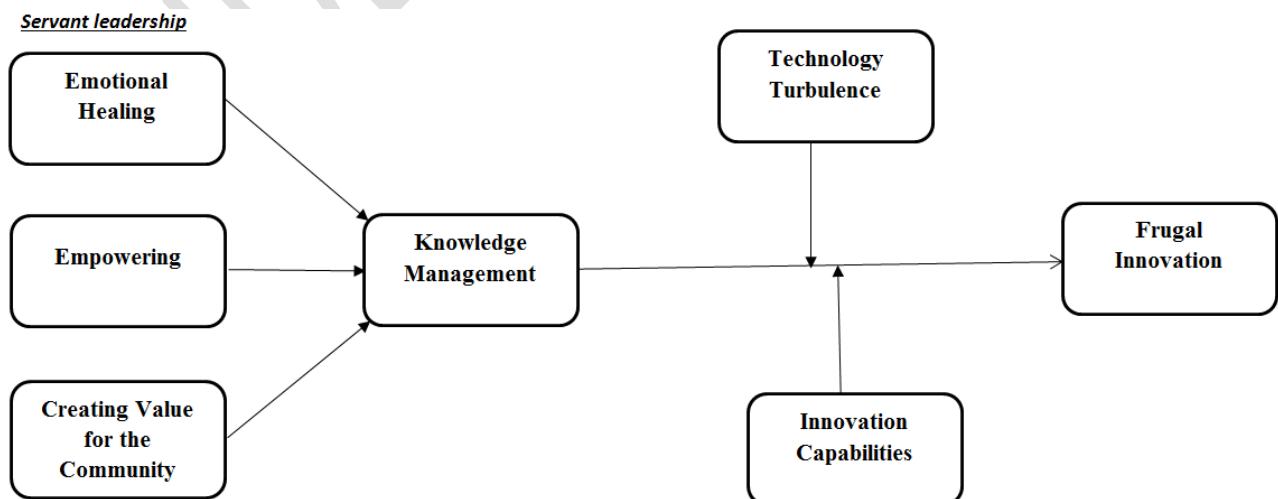
Lawson and Samson (2001, p. 384) defined innovation capability as "the ability to continuously transform knowledge and ideas into new products, processes, and systems for the benefit of the firm and its stakeholders". They further explain innovation capability as a technical trend that highlights the essential arrangements for the success of innovative activities. From the organizational perspective, innovation capability is often described as a distinctive feature of a firm that provides the firm with a reasonable advantage over its competitors (Fidel et al., 2018). However, it is not easy for firms to maintain a competitive advantage in this rapidly changing business world. Therefore, extraordinary efforts are required to deal with environmental instabilities for the long-term survival of the organizations, and firms must have a flexible culture to adapt to changes according to the change in the environment (Teece et al., 2016). Furthermore, numerous scholars have defined innovation capabilities as the combination of marketing, product, and process innovation capabilities (e.g., Camison & VillarLopez, 2014; Nwachukwu, Chladkova, & Olatunji, 2018). According to Camison & Villar-Lopez (2014), product innovation is an organization's ability to utilize its resources efficiently to offer unique and improved products for greater customer satisfaction. Similarly, many scholars have described process innovation as the flexibility in a company's culture to adapt to environmental

changes to improve internal processes and achieve lower production costs that lead to higher organizational performance (Damanpour, Walker, & Avellaneda 2009; Damanpour, 2010).

The companies that lack innovation capabilities face various challenges, including low, competitive advantage as the foremost (Goncalves, 2019). For that reason, an organization's efforts towards frugal innovation, globalization, diffusion of advanced technology, and knowledge creation will certainly improve internal processes, develop innovative products, and give organizations an edge over other firms (AlMulhim, 2017; Sheng, 2019). It is argued that an organization's innovation capabilities boost the impact of knowledge management on frugal innovation (Dost et al., 2019). Thus, we conclude that innovation capabilities are essential to developing a successful relationship between knowledge management and frugal innovation (AlMulhim, 2021). Therefore, we also hypothesized that:

*H<sub>4</sub>: The moderation of innovation capabilities will strengthen the impact of knowledge management on frugal innovation.*

On the basis of the discussion given above, the following framework was developed for this research (see figure 1). The relationship of multi-dimensional concept of servant leadership (i.e. emotional healing, empowering and creating value for the community) was examined with knowledge management. Further, the relationship of this management was examined with frugal innovation. Moreover, technology turbulence and innovation capabilities were considered as moderators between knowledge management and frugal innovation.



*Figure-1: Conceptual Framework*

## **METHODOLOGY**

The study focus is to investigate the impact of servant leadership on knowledge management. Moreover, the current study investigates the effect of knowledge management on frugal innovation. Furthermore, the study also examines the moderating effect of innovation capabilities and technological turbulence in the relationship of K.M. and frugal innovation.

A questionnaire-based survey was used to measure the conceptual model (figure-1) and hypothesized relationships by targeting China's sports equipment manufacturing industry. The understudy industry is contributing a lot to overall country revenue generation as it was 34.7\$ in 2019, which was 5.5% higher than in 2018. In the last five years (2016-2020), the average annual revenue growth rate sports equipment manufacturing industry is 5.6%, and almost 50% of the total revenue is from exports (Li, Liu, Fu, & Feng, 2020). The study was carried out in five more famous territories for sports manufacturing, including Shanghai, Zhejiang, Jiangsu, Fujian, and Guangdong.

The data were collected from December 2020 to March 2021, using hand distribution of survey questionnaires. Before collecting data, special permissions were obtained from top human resource management of target companies with the commitment of data confidentiality. Overall, 950 questionnaires were distributed among the employee of target companies, from which 571 responses were returned. Out of 571, 24 responses were excluded from the final data analysis because of inadequate information. Hence, the obtained response rate was 58% (N=547).

### **Research Instrument**

To measure the conceptual model, a questionnaire was developed, and items were adopted from past valid studies. The construct of servant leadership was measured with a 12-items

measurement scale developed by Liden et al. (2008), including three major dimensions, creating value for the community, emotional healing, and empowering. The construct of knowledge management was measured with a 5-item scale adapted from the study of Chen and Huang (2007). A 5-item measurement scale from the study of (Calantone et al., 2003) was used to measure the construct of technology turbulence. The construct of innovation capabilities was measured using a 12-items measurement scale, adopted from the study of Tutar, Nart, and Bingöl (2015). A 5-item measurement scale was used to measure the construct of frugal innovation, which was also adopted from the study of (Weyrauch and Herstatt, 2017). All items were measured using a 5-point Likert scale (where 5=strongly agree, 1= strongly disagree).

### Analysis Strategy

The collected data were analyzed using a 3-steps approach. In the first phase of data analysis, descriptive statistics, correlation, reliability, validity, and exploratory factor analysis (EFA) were conducted using SPSS-26. In the second step, confirmatory factor analysis (CFA) and SEM was performed through AMOS-24. Instead of using Smart PLs, AMOS was used because of large sample size. Moreover, SEM done by AMOS or Smart PLs provides almost similar results. In the third phase, the moderation effects were determined using Hayes Process Macro.

## 4. Results

### 4.1 Descriptive and Correlation Analysis

Results of descriptive statistics and correlations are presented in table-1. The results reveal that all mean values are higher than 3, which indicate the agreement of respondents. Moreover, correlation results demonstrate significant and positive correlations among all study variables. These positive and significant results are consistent with our hypothesized relationships.

*Table-1: Descriptive Statistics & Correlation Analysis*

<i>Variables</i>	<i>Mean</i>	<i>SD</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>
<b>1- Servant Leadership</b>	4.24	0.58	1				
<b>2- KM</b>	4.00	0.72	.315**	1			
<b>3- Technology Turbulence</b>	3.72	0.94	.270**	.531**	1		
<b>4- Innovation Capabilities</b>	4.09	0.61	.462**	.486**	.531**	1	
<b>5- Frugal Innovation</b>	4.07	0.64	.257**	.368**	.452**	.469**	1

\*\**. Correlation is significant at the 0.01 level (2-tailed).*

## 4.2. Reliability and Validity

Internal consistency of the data within constructs is measured using Cronbach's alpha values. According to Hulin, Netemeyer, and Cudeck (2001), the Cronbach's Alpha values of 0.6 - 0.7 indicate good reliability, and values higher than 0.7 is a very good level of reliability. As shown in table-2, the alpha values are ranged between 0.87 to 0.95, which show excellent reliability. The validity was tested using the value of average variance extracted (AVE) and composite reliability (C.R.). According to Fornell and Larker (1981) and Bagozzi and Yi (1988), the values higher than 0.50 for AVE and higher than 0.70 for C.R. confirm convergent validity. The study results show AVE values from 0.62 to 0.73, and C.R. values ranged from 0.89 to 0.97. Furthermore, the results of EFA indicate excellent factor loadings of all items that are ranged between 0.74 to 0.89.

*Table-2: Exploratory factor analysis, reliability, and validity*

<b>Constructs</b>	<b>Items</b>	<b>Loadings</b>	<b>Cronbach's Alpha</b>	<b>AVE</b>	<b>CR</b>
<b>Servant Leadership</b>	<b>SL1</b>	0.754	0.94	0.67	0.96
	<b>SL2</b>	0.797			
	<b>SL3</b>	0.823			
	<b>SL4</b>	0.817			
	<b>SL5</b>	0.793			
	<b>SL6</b>	0.789			
	<b>SL7</b>	0.759			
	<b>SL8</b>	0.856			
	<b>SL9</b>	0.855			
	<b>SL10</b>	0.871			
	<b>SL11</b>	0.859			
	<b>SL12</b>	0.867			
<b>Knowledge Management</b>	<b>KM1</b>	0.812	0.90	0.71	0.92
	<b>KM2</b>	0.844			
	<b>KM3</b>	0.848			

	<b>KM4</b>	0.847			
	<b>KM5</b>	0.855			
<b>Technology Turbulence</b>	<b>TT1</b>	0.836	0.91	0.73	0.93
	<b>TT2</b>	0.852			
	<b>TT3</b>	0.883			
	<b>TT4</b>	0.886			
	<b>TT5</b>	0.827			
<b>Innovation Capabilities</b>	<b>IC1</b>	0.830	0.95	0.71	0.97
	<b>IC2</b>	0.840			
	<b>IC3</b>	0.844			
	<b>IC4</b>	0.849			
	<b>IC5</b>	0.833			
	<b>IC6</b>	0.846			
	<b>IC7</b>	0.810			
	<b>IC8</b>	0.850			
	<b>IC9</b>	0.846			
	<b>IC10</b>	0.863			
	<b>IC11</b>	0.864			
	<b>IC12</b>	0.866			
<b>Frugal Innovation</b>	<b>FI1</b>	0.739	0.87	0.62	0.89
	<b>FI2</b>	0.786			
	<b>FI3</b>	0.801			
	<b>FI4</b>	0.842			
	<b>FI5</b>	0.764			

*N=547; AVE= average variance extracted; CR= composite reliability*

#### **4.2. Confirmatory Factor Analysis (CFA)**

CFA can be used to check hypothesized models and yields assessments of the goodness of fit. CFA results are presented in table-3 and interpreted using the goodness of fit standards ( $X^2/df < 3.00$ ; CFI  $\geq .96$ , RMSEA  $\leq .06$  and SRMR  $\leq .10$ ) as recommended by Hu and Bentler (1999). The

results for initial 5-factor default model indicate poor model fit ( $X^2/df=3.41$ ; NFI=0.89; CFI=0.92, RMSEA=.13 and SRMR=.09), and after correlating various items within constructs, excellent model fitness was achieved as 5-factor revised model ( $X^2/df=1.74$ ; NFI=0.95; CFI=0.98, RMSEA=.06 and SRMR=.05).

*Table-3: Measurement Models*

Model	$X^2/df$	NFI	CFI	RMSEA	SRMR
5-Factor Baseline	3.414	0.89	0.92	0.13	0.09
5-Factor Revised	1.742	0.95	0.98	0.06	0.05

*NFI = normed fit index; CFI = comparative fit index; SRMR = standardized root-mean-square residual; RMSEA = root-mean-square error of approximation. N =547*

### 4.3. Test of Hypotheses

#### 4.3.1. Direct Effect

Results of direct effects are shown in table-4. Standardized path coefficients indicate that servant leadership has a positive and significant effect on knowledge management ( $\beta=0.316$ ,  $p<.001$ ), which results in acceptance of our first hypothesized relationship H1. Moreover, results also reveal the significant and positive influence of knowledge management on frugal innovation ( $\beta=0.369$ ,  $p<.001$ ), therefore, our second hypothesized relationship (H2) is also accepted.

*Table-4: Path Coefficients*

Relationships	Path Coefficients	T-Value	P-Value
<b>Servant Leadership → Knowledge Management</b>	0.316	6.882	<.001
<b>Knowledge Management → Frugal Innovation</b>	0.369	10.943	<.001

#### 4.3.2. Moderation Effect

The moderation effect of innovation capabilities between the relationship of knowledge management and frugal innovation is shown in table-5 and figure-2. The results indicated that the positive relationship between knowledge management and frugal innovation in the presence of innovation capabilities gets stronger in the presence of innovation capabilities. When there is low K.M. with low innovation capabilities, there are low frugal innovations ( $\beta=0.191$ ,  $p<.01$ ).

On the other hand, with higher knowledge management and higher innovation capabilities, there will be higher frugal innovation ( $\beta=0.489$ ,  $p<.001$ ) as shown in table-5 and moderation graph figure-2. Therefore, hypothesized relationship (H3) is accepted.

Table-6 and figure-3 show significant interaction of technological turbulence as a moderator between the relationship of knowledge management and frugal innovation. Results prove that when there is high technological advancement in the industry, it will boost innovations. The results indicate that there will be low frugal innovations when there is low knowledge management and low technology turbulence ( $\beta=0.231$ ,  $p<.001$ ). However, the frugal innovation will also be higher with increased technological advancement and high knowledge management ( $\beta=0.395$ ,  $p<.001$ ). The mod graph (figure-3) indicates that even at low knowledge management with the interaction of low technological turbulence, the innovation is high, and with a higher presence of technology turbulence, the frugal innovations will also be higher. As a result, our hypothesized relationship H4 is also accepted and well supported by data results.

Table-5: Conditional effects of the K.M. at values of the moderator (Innovation Capabilities)

	$\beta$	p	95% CI	
One SD below mean	0.191	<0.01	0.089	0.335
At the mean	0.314	<0.001	0.206	0.421
One SD above mean	0.489	<0.001	0.317	0.657

CI = Confidence Interval

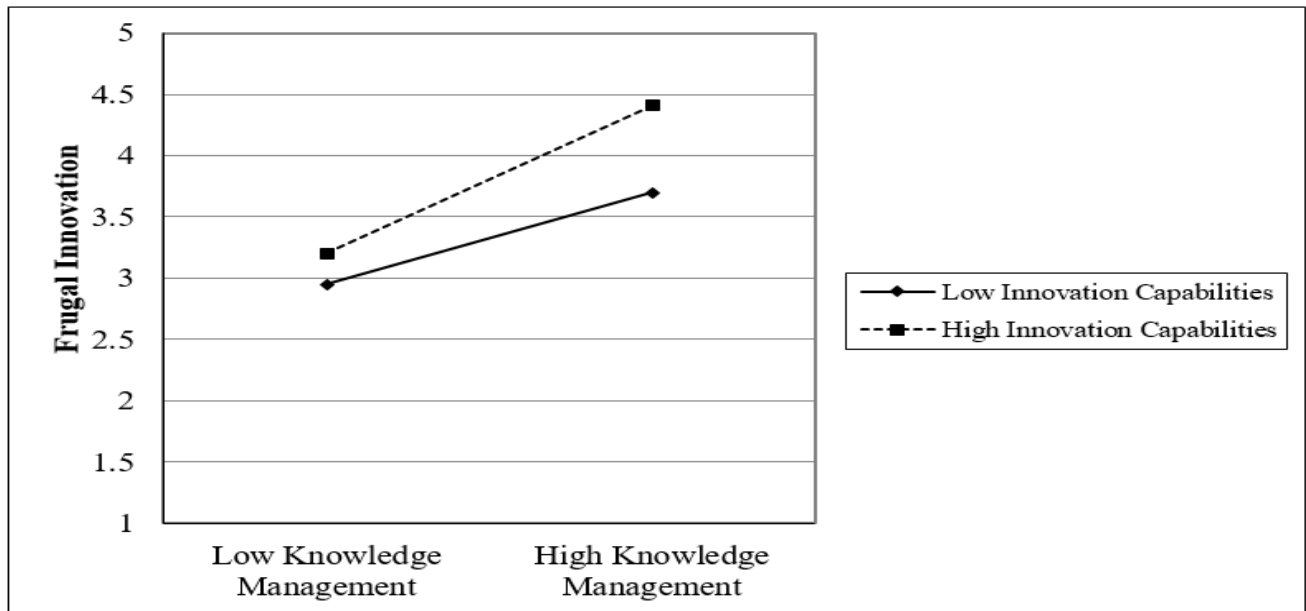


Figure-2: Mod Graph (I.C.)

Table-6: Conditional effects of the K.M. at values of the moderator (Technology Turbulence)

	$\beta$	p	95% CI	
One SD below mean	0.231	<0.001	0.187	0.387
At the mean	0.271	<0.001	0.218	0.403
One SD above mean	0.395	<0.001	0.243	0.516

CI = Confidence Interval

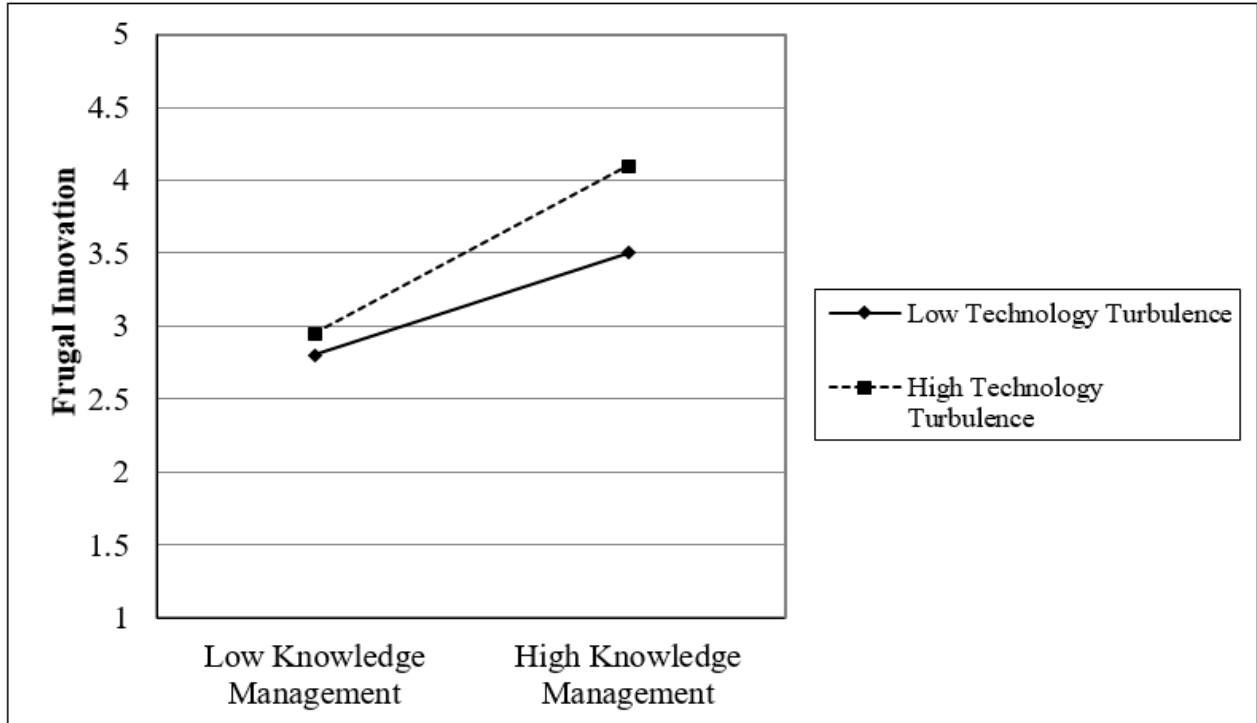


Figure-3: Mod Graph (T.T.)

## 5. DISCUSSION

In this era of technology and globalization, the importance of knowledge is emerging in organizations. The business processes are now becoming more complex or diverse, and manual labour is replaced by informational work necessitating a high degree of competence and experience. There is no substitute for skills and knowledge possessed by individuals because these two things are precious for companies. Similarly, in the new economics of this world, besides land, nature, workforce and capital resources, knowledge and innovation also became essential drivers of production (Sedziuviene & Vveinhardt, 2010). In addition, there is a dire

need for product or process innovation in this turbulent environment (Massa & Testa, 2004), and this innovation is supported by knowledge management which also generates new ideas and enhances the thinking power of organizations (Parlby & Taylor, 2000). Many types of innovation and their link with performance have been analyzed by several researchers (Kalyar, Shafique, & Ahmad, 2019), but a type of innovation, termed frugal innovation, has been given more consideration by researchers these days (Dost et al., 2019). Similarly, this research also directed the attention towards frugal innovation by highlighting the relationship between knowledge management and frugal innovation. Before measuring this relationship, it was also analyzed that how Servant leadership effect knowledge management because its the least researched area in leadership studies. Servant leadership comprises emotional healing, empowering and creating value for the community. These all three dimensions of servant leadership affect the knowledge management strategies. This research also investigated the moderating role of technology turbulence and innovation capabilities between the relationship of knowledge management and frugal innovation. The results have demonstrated the relevance of studying Servant leadership dimensions and knowledge management from the perspective of Chinese sports equipment manufacturing companies. In multiple ways, the results extended the available literature on servant leadership, knowledge management, technology turbulence, innovation capabilities and frugal innovation.

The study formulated three hypotheses, and the first hypothesis of the study, H1, predicted that servant leadership has a positive impact on knowledge management. Servant leadership is based on emotional healing, empowering and creating value for the community. The positive relationship between servant leadership and knowledge management highlight that servant leadership can improve the knowledge management approach and strategies within Chinese sports equipment manufacturing companies. This result also supported the findings of Dehaven (2008), who explained servant leadership as an essential leadership approach that helps in knowledge sharing by creating a knowledge management environment by empowering followers and enabling them to realize the importance of their useful opinions in the organization. In addition, many studies claimed servant leadership as an approach to future leadership (Guillaume, Honeycutt & Cleveland, 2012; Correia de Sousa & Dierendonck, 2010). Therefore, the results of H1 confirmed that among several types of leadership, servant leadership is one that can enhance the knowledge management practices within organizations.

The second hypothesis of this research was developed to highlight the relationship between knowledge management practices and frugal innovation. Knowledge management is a broad domain (Irma, 2001) and many studies linked it with different types of innovations. The positive relationship between knowledge management and frugal innovation highlight that the implication of knowledge management with the organization can enhance the frugal innovation or enable the organizations to develop frugal innovation. Like other manufacturing units, the sports equipment manufacturing companies should also adopt frugal innovation with the help of knowledge management practices to efficiently reach their goals. Effective information can help the small business to achieve external knowledge (Luamba, 2019), and this knowledge, with the help of internal knowledge, can affect frugal innovation (Dost et al., 2019). The results of this hypothesis supported the previous literature. According to Lei et al. (2021), knowledge management is the result of effective leadership, which leads to frugal innovation. This leadership is not other than servant leadership. Frugal innovation is the ultimate outcome of human-based knowledge management (Niroumand et al., 2021). Thus, the results of the second hypothesis confirmed that the most effective type of management that can lead to innovation is knowledge management. The most effective type of innovation is frugal innovation.

H3, predicted that technology turbulence moderates the relationship between knowledge management and frugal innovation. This turbulence will either strengthen the relationship or weaken it, but according to results of research, it was found that technology turbulence will strengthen the impact of knowledge management on frugal innovation. Many studies use environment and market turbulence as potential moderators (Rhee et al., 2020; Wardi et al., 2018), but technology turbulence is more rarely used but recommended by many studies. Therefore, this research considered it and also found it a potential moderator because technological awareness is in dire need of organizations to enhance their innovative abilities (Lichtenthaler, 2009). Moreover, the turbulence in technology affects the efficiency of existing technologies and even reduces existing products' life cycle (Zhou et al., 2005). Thus, organizations should carefully deal with this type of turbulence for their continuous improvement and innovation (AlMulhim, 2021). The hypothesis H4 aimed to predict that innovation capabilities mediate the relationship between knowledge management and frugal innovation. Innovation capability is also a potential moderator and recommended or explained by many studies, like Dost et al. (2019), highlighted that innovation capabilities could moderate the

relationship between knowledge sources and frugal innovation. Similarly, Sen and Egelohoff (2000) also highlighted that these capabilities predict organizational innovation. Thus, the results of this hypothesis explained that innovation capabilities could strengthen the relationship between knowledge management and frugal innovation. The findings of this hypothesis are in line with many previous types of research on knowledge and innovation (Salter et al., 2014).

## **6. IMPLICATIONS**

This research is based on a broad area of knowledge management and innovation, and it has deeply analyzed the literature and gathered much empirical evidence to highlight significant implications. Theoretically, this research has comprehensively explained the relationship between servant leadership and knowledge management. Moreover, the relationship of knowledge management was analyzed with frugal innovation. Thus, this research expanded the literature on frugal innovation, knowledge management, servant leadership, technology turbulence and innovation capabilities. For organizations, it's very essential to know the factors which can ultimately lead them to innovate or enhance their innovation. Therefore, this research has directed the attention towards different strategies that can help organisations to innovate. Apart from other studies, this research is unique as previous studies focused on frugal innovation based on sources of knowledge (Dost et al., 2019; AlMulhim, 2021) and ignored the overall perspective of knowledge management and servant leadership. The two moderations were analyzed in this study, including technology turbulence and innovation capabilities. Thus, adding abundant literature on all variables under study has provided significant results and theoretical justifications.

The methodological contributions of this research originate from a unique way of analyzing the data gathered from sports equipment manufacturing companies of China. It developed the questionnaire by adopting the items used by previous studies and analyzed the data by using AMOS. Many previous studies used different approaches for developing questionnaires, like some developed by responses generated by interviews and others developed their own questionnaire. Thus, this research used the most common practice of adopting the items of different studies. Moreover, the study was quantitative and focused on the positivism approach and questionnaire or moderation analysis techniques that future studies can use. The researchers can use the complete scale developed by this research or change it according to their need of

context. Innovation is essentially required in sports equipment manufacturing companies (Brata et al., 2009), so the owners or managers working in these companies can use this research as a guideline for developing effective strategies and training their employees. In addition, the researchers can quote the findings of this research as a reference while studying frugal innovation, servant leadership, innovation capabilities or technology turbulence.

This research has focused on different broad areas, including innovation, knowledge management and servant leadership. Thus, besides other implications, it has provided many practical implications. It has directed the attention of managers and owners of sports equipment manufacturing companies towards the concept of servant leadership, knowledge management and frugal innovation. Therefore, it can have great importance in the development of sports equipment manufacturing companies of China or other emerging countries. Knowledge management and servant leadership are critical factors in the development of any organization, and this research has focused on measuring the effect of servant leadership on knowledge management practices. Moreover, it aimed to highlight this knowledge management can further leads to frugal innovation. The findings or results of the research could help the managers in developing effective leadership for doing efficient knowledge management practices that could help in innovation. Thus, by understanding the value of servant leadership, knowledge management and frugal innovation, the managers can use the innovation capabilities and understand the technological turbulence for making their organizations innovative. In developing or emerging countries, like China, and there is a trend of frugal products because people of such countries prefer to purchase affordable products. Similarly, the majority of sports equipment is very costly and out of reach for many customers. Thus, the frugal product or frugally innovative equipment can attract more customers.

## **7. LIMITATIONS**

This research has highlighted the broader areas and provided extensive implications, but still, it's not without limitations. These limitations can be addressed in future studies, and a few of the limitations with future recommendations are provided below:

### **7.1. More studies on Frugal Innovation**

In developing and emerging countries, there is an emerging trend of frugal products due to the limited purchasing power of customers. Many studies focused on different dimensions/ types of knowledge or knowledge management with innovation, but only a few focused on frugal innovation. Similarly, this research has directed the attention towards this important type of innovation, but still more studies are required on frugal innovation and especially within the sports equipment manufacturing industry.

### **7.2. Inclusion of other key variables:**

This research highlighted many potential variables which can affect frugal innovation, but still many variables, including information share intention, social capital, market turbulence and entrepreneurial orientation, can be used in future studies to develop a new and comprehensive model.

### **7.3. Similar studies in a cross-cultural context**

There is great importance of culture in developing attitude or generating perception towards the things (Nayal et al., 2021) processes or phenomenon. This research has focused on China, and it can be replicated in the context of other emerging or developing countries to generalize the findings. Moreover, a similar model can be used to conduct research on developed countries or compare the findings of developed countries.

### **7.4. Industrial Change**

The comprehensive model used by this research is generic in nature and can be applied or studied from the perspective of other industries or industries. This research was based on the perspective of sports equipment manufacturing companies, and future research can use any other industry like I.T. products manufacturing companies. Moreover, the future study can be generalized to SMEs or MNCs.

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