Development of a framework for utilising Lean Six Sigma's intangible impacts in creating organisational innovation climate

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Abstract

Purpose – The purpose of this paper is to develop a framework that illustrates the role of Lean Six Sigma (LSS) in creating organisational innovation climate by investigating the relationship between LSS's intangible impacts and organisational innovation climate factors.

Design/methodology/approach – A self-administrated survey questionnaire was distributed among 145 public sector officials to get their opinions on the relationship between various observable elements of LSS's intangible impacts and organisational innovation climate factors, where a response rate of 73.8% was achieved. The collected data was demographically, descriptively, and statistically analysed. Accordingly, a house-of-pillars-based framework that illustrates the role of LSS's intangible impacts in creating innovation climate in an organisation was developed.

Findings – Results from this study indicated that LSS's intangible impacts on organisational structure and hierarchy, culture, change adaptability, utilisation of staff, and staff's behavioural aspects are positively related to many of organisational innovation climate factors such as trust and openness, challenge and involvement, support for ideas, and freedom and autonomy.

Research limitations/implications – The findings of this study are based on the data collected from public sector organisations in the UAE and are supported by relevant literature. However, this study can provide useful guidance for further research for the generalisation of the results to wider scopes in terms of sectors and geographical domains.

Practical implications – The findings of this study will provide UAE public sector officials with a clear roadmap on how to utilise LSS for promoting innovation and fostering its implementation in practice. This study will also encourage professionals in public sectors to integrate LSS into their innovation strategies to enhance organisational innovativeness and improve service quality.

Originality – It is one of the first studies that explores LSS's intangible impacts and assesses their relationship with organisational innovation climate factors. Hence, this study offers valuable insights for both academics and practitioners and is expected to lay a foundation for a better understanding of how LSS's intangible impacts can be utilized in creating organisational innovation climate.

Keywords Lean Six Sigma, Intangible impacts of Lean Six Sigma, Innovation, Innovation climate, Organisational innovation climate, Empirical study

Paper Type Research Paper

1. Introduction

The cut-throat, uncertain, dynamic, and competitive market environments with globalisation pressures make the need for producing innovative and high-quality products a top priority (Gorodnichenko *et al.*, 2008). Not only companies have been impacted by globalisation, but also countries in terms of their trade balances (Badar *et al.*, 2012). Global businesses are challenged by rapid changes of customer demands, which need to be responded as quickly as possible. To deal with such challenges, organisations are needed to adopt an emergent strategy that provides increased flexibility.

Lean Six Sigma (LSS) is an integration of Lean and Six Sigma process improvement methods used around the world. While Lean focuses on reduction in waste and flow time between process steps (Bader *et al.*, 2020), Six Sigma focuses on optimizing processes (Taylor *et al.*, 2015). LSS is considered as one of the most powerful techniques widely used by business owners and organisational professionals to improve customer satisfaction and profitability. LSS technique is a combination of hard and soft systems philosophy used to enhance business performance and ensure process effectiveness and efficiency. Moreover, it focuses on the cultural aspects of the organisations, and considered as a scientific and statistical approach for eliminating defects and reducing costs of poor quality (Tsironis and Psychogios, 2016). Furthermore, LSS not only has its tangible impacts over increasing productivity and reducing wastes and costs, but it is also found to have intangible impacts over enhancing organisational culture and change adaptability, as well as achieving a more efficient utilisation of staff and influencing some of their behavioural aspects. It is also considered as one of the important tools that helps organisations to be innovative, achieve competitive advantage, and maintain market position (Delgado *et al.*, 2010).

Organisational innovation can be defined as an ability to generate and adopt new ideas or behaviours that helps in enhancing overall productivity and improving business performance (Jia *et al.*, 2018). From an organisational structure perspective, organisational innovation refers to the degree of centralisation that influences the flow of new ideas or behaviours, as well as the assignment of tasks among organisational members and the way of decision-making. From a process perspective, organisational innovation is related to the processes followed for developing and implementing ideas such as its learning processes. Organisational innovation climate is shaped on different factors such as trust and openness, challenge and involvement, time and space for ideas, support for ideas, freedom and autonomy, conflicts, debate, risk taking, playfulness and humour (Tidd and Bessant, 2013).

It is argued that LSS can be used as a base for promoting innovation (Byrne *et al.*, 2007). In a study by Panat *et al.* (2014), LSS was applied to drive innovation in research and development environments. Li *et al.* (2019) used LSS to improve service process in higher education. In fact, LSS stimulates the creative thinking needed for incremental innovation throughout the different stages of the Define, Measure, Analyse, Improve and Control (DMAIC) process (Hoerl and Gardner, 2010). Antony *et al.* (2019) studied the relationship between LSS with innovation and organisational learning. De Freitas and Costa (2017) used the LSS as a methodology for continuous improvement and to identify which impacts may need to be achieved primarily to enhance a more sustainable management in organisations. LSS and innovation have always been among the tools that continuously receive considerable amount of attention in both research and practice. This implies their capability and effectiveness in helping organisations to achieve the desired improvement and performance targets, and the interesting research insights they offer for academics and researchers. However, only a few articles in literature has discussed the role of LSS in creating organisational innovation climate, especially in the public sector organisations, by investigating the relationship between LSS's intangible impacts and organisational innovation climate factors.

This study aims to develop a framework that illustrates the role of LSS in creating organisational innovation climate by investigating the relationship between LSS's intangible impacts and organisational innovation climate factors. The rest of the article is organised as follows: Section 2 provides a literature review on the application of LSS in the public sector organisations, and the relationship between LSS and innovation. In addition, it highlights the research gaps and limitations in this area. Section 3 proposes

the conceptual model and the research hypotheses, while the research design and methodology are explained in Section 4, highlighting the survey design and sampling procedure. Survey analysis and findings are presented in Section 5. In Section 6, the proposed framework is presented highlighting its components and implications. Useful discussions and possible research implications are illustrated in Section 7. This research is concluded in Section 8, along with mentioning the future research directions.

2. Literature review

2.1 LSS in the public sector

The public sector is a key contributor to the development of any country and a main driver of its economy. Delivering quality services while maintaining cost, efficiency, and targets remains a challenge that the public sector organisations strive to achieve and continuously look for ways to better serve the public at an affordable cost (Flynn, 2007). A number of research works were published to check if LSS's success in profit-based sectors can still be of relevance to the public sector organisations whose ultimate objectives are meeting customer requirements and enhancing process efficiency that can be achieved by using tools such as LSS.

An overview of the evolution of LSS highlighting its current state and future was provided in a research article by Antony *et al.* (2017). It was highlighted that LSS helped the public sector organisations reduce costs, better understand customer quality requirements, enhance process efficiency, and transform organisational culture to be continuous-improvement-based. Furthermore, it was also found that the approach of LSS triggers creative thinking and hence it provides opportunities for incremental innovation and enhances organisational innovation capabilities. The existence of a supportive organisational culture and a learning environment are keys for LSS to have a positive impact on innovation. In a research article by De Mast *et al.* (2021), it was found that the implementation of quality management systems such as SS in a European engineering company requires both radical transformation and incremental change efforts that tackle organisational structure and business practices followed in the organisation. Antony *et al.* (2017) questioned whether LSS for the public sector organisational is a myth or reality. While LSS can be applied in the context of the public sector because of its ability to reduce operational costs and achieve customer satisfaction, the relevance of LSS and the benefits it can bring to the public sector lack solid evidence. Hence, there is a need for conducting research to validate and prove the effectiveness of LSS when applied in the public sector processes. Walter and Paladini (2019), who looked into the application of LSS in Brazil, found that most of LSS published research comes from the industrial sector. Yet, the authors expect LSS to move towards the service sector being an area of huge potential for the deployment of LSS especially after the gains the LSS proved to achieve in manufacturing sectors. The authors also highlighted the need for assessing the impacts of LSS on organisational performance and other related aspects. Singh and Rathi (2019) reviewed several articles on LSS applications, in terms of benefits achieved and challenges encountered, in various industrial sectors. LSS application was found an effective business strategy in service sectors such as financial, healthcare, and education as it helped in enhancing operational efficiency by cutting costs and achieving customer satisfaction by improving the service quality. Yet, the deployment of LSS in the mentioned sectors is challenged by several factors such as the lack of resources, both financial and non-financial, and lack of leadership support. In a content analysis paper by Rodgers *et al.* (2019) addressing the change in LSS research patterns, it was interestingly reported that it is quite difficult to replace LSS with a new tool as it is a dynamic technique that will continue to evolve as it did previously. Furthermore, researchers are currently

open to the idea of integrating the concept of LSS with some other methodologies such as innovation and sustainability.

The use of LSS in improving higher education service processes was explored by Laux and Antony (2019). Such processes involve high levels of human interactions and are mainly driven by human behaviour, which makes them complex to deal with, especially in case of any improvement is required, and hard to predict as well. Applying LSS in service processes must take into consideration the difference between process-based and knowledge-based processes as it determines the complexity level of LSS project and hence, the required resources. Management understanding of LSS philosophy and commitment in terms of allocating resources needed for implementing and establishing a supporting organisational culture are crucial to ensure the success of LSS projects. Furthermore, Laux and Antony (2019) highlighted the importance of organisational culture and communication across the organisation for the success of LSS deployment in higher education. Davidson *et al.* (2020) conducted a literature review on LSS frameworks in higher education. It was found that most of the frameworks were designed for the purpose of ensuring and measuring compliance where the aspects related to continuous improvement were found to be lacking. To further elaborate, issues related to improving teaching and learning were not addressed much and it was mainly the administrative and other processes that involve interaction with students that the frameworks have focused on. Similarly, Antony *et al.* (2018) explored the implementation of LSS in UK higher education institutes and concluded that most applications were related to support services such as human resources and finance but not teaching services. A case study on the implementation of LSS in Irish higher education institutes to improve services such as finance and registration was conducted by O'Reilly *et al.* (2019), where LSS was found to be an effective tool to empower staff and make them process-oriented rather than task-oriented. That led to a considerable reduction in cycle time and process errors. Although there was a wide range of applications and successful implementations of LSS in higher education which clearly proves the capability of LSS to enhance process efficiency, lack of management support and understanding of LSS tools remain among the main challenges that are hindering the popularity of LSS in this sector specially when it comes to addressing issues related to academic services such as teaching methods and quality.

The application of LSS in Malaysian hospitals was explored by Ahmed *et al.* (2018) where it was found that LSS is a tool that helps in combining operational activities with strategic activities which ultimately drives the quality and organisational performance to the highest levels. Trakulsunti *et al.* (2021) proposed a roadmap for the implementation of LSS in UK hospitals. It consists of three main phases that start with recognising the need for change and having a clear vision and strategy that tend to be aligned with institutional vision and strategy. That requires management commitment for the allocation of the necessary resources required for LSS project initialisation and implementation. As a result, a continuous improvement culture can be promoted by the knowledge and skills the staff gained throughout the implementation journey. It is evident that the more sustainable impact categories of LSS are those related to organisational culture and staff work behaviors.

Rodger *et al.* (2019) investigated the drivers for implementing LSS in UK policing sector which were found to be overlapping in terms of their strict and ambitious directions to achieve public satisfaction and involvement in streamlining services and enhancing quality. However, it was reported that there is a need to ensure organisational readiness for the adoption and implementation of such tools being part of the ongoing debate on the applicability of LSS in the public sector and the sustainability of its impacts in the long

term. In another research by Antony *et al.* (2018), the organisational impacts of LSS in policing services in Scotland were investigated whereby the relevance of LSS to the public sector, and policing services in specific, was further validated. The study clearly highlighted that LSS has a positive impact on staff as it empowers them to be a main contributor in the improvement process and that leads to a smoother implementation process for LSS tools and more sustainable results.

In a literature review by Fletcher (2018), LSS applications in the public sector municipalities, in terms of the level of awareness and implementation opportunities, were investigated. A number of public sector officials were interviewed, and it was found that LSS is receiving a considerable amount of attention and interest by the public sector organisations as it helps in enhancing the efficiency of processes by eliminating different aspects of government waste, reducing cost, and improving the service quality. Furthermore, it was also found that the application of LSS helped in improving the organisational culture by promoting continuous quality improvement. Null *et al.* (2019) investigated the application of LSS in program management being one the of potential areas for LSS applications as the ultimate objective of program managers is to continuously improve the program's quality and speed and achieve other financial benefits. The study examined LSS's financial benefits and percentage of improvement taking into consideration project scope, phase, and functional area. The relationship between the application of LSS and financial benefits as well as the percentage of improvement were both found to be partially supported taking into consideration the phase and functional aspect unlike the scope which was found to be not much relevant. An application of LSS in consumer banking was discussed by Sunder *et al.* (2019), being an area within service industry where LSS applications have not received much attention. Banking processes are known to be harsh in terms of the need to meet targets and Key Performance Indicators (KPIs) as that is directly related to customer impression of the bank's services and would help the bank to strengthen its brand name and enhance profitability. LSS was found highly relevant to the context of improving banking processes where a number of both tangible and intangible benefits were achieved. The authors highlighted the need to further understand LSS from the perspectives of human and organisational culture. It is also very important, and to ensure the success of LSS deployment in banking operations, that LSS should be perceived as a mindset and a working approach and not to be applied on a project-based approach. In fact, Rodgers and Antony (2019) mentioned that there is a need to further investigate the role of organisational culture in the deployment of continuous improvement programs such as LSS. Murmura *et al.* (2021) conducted a case study on the implementation of LSS to improve and stabilise procurement process in an Italian company. Aside from the improvements that were achieved in some important KPIs related to lead time and suppliers' relationship with the management, it was found that LSS helped the concerned team members improve their skills, gain new knowledge, and become more aware of what contributes to the efficiency of the delivery process. LSS philosophy provided them with an innovative way to tackle the inefficiencies they were facing. It also led to high levels of employee motivation and promoted a continuous improvement culture. LSS requires top management buy-in and a change in the mindset in order to successfully and smoothly adopt and implement its various tools and concepts. The need for organisations to comply with environmental sustainability aspects must be aligned with other organisational performance measures and hence Ruben (2018) proposed a framework for integrating environmental insights into LSS frameworks so both operational and environmental considerations can be achieved and met.

Table 1 below provides a summary of the articles reviewed above on the relevance of LSS to the public sector:

Table 1. Summary of research on LSS in the public sector

Reference	Scope of the study
Antony *et al.* (2017)	LSS research trends and impacts of LSS on public sector organisations
De Mast *et al.* (2021)	Implementation process of SS and what it requires in terms of change
Antony *et al.* (2017)	Investigation of the applicability of LSS in public sector
Walter and Paladini (2019)	Adoption of LSS principles by public sector organisations in Brazil
Singh and Rathi (2019)	Review on LSS applications and effectiveness in service sector
Rodgers *et al.* (2019)	Change in LSS research patterns and the possibility of integrating LSS with tools such as innovation
Laux and Antony (2019)	LSS applications in higher education processes
Davidson *et al.* (2020)	Frameworks for LSS applications in higher education
Antony *et al.* (2018)	LSS applications in UK higher education processes related to support services
O'Reilly *et al.* (2019)	Case study on the implementation of LSS in Irish higher education institutes and the impact it had on employee empowerment
Ahmed *et al.* (2018)	Exploration of the application of LSS in Malaysian hospitals
Trakulsunti *et al.* (2021)	Roadmap for the implementation of LSS in UK hospitals
Rodger *et al.* (2019)	Investigation of the relevance of LSS concept to UK policing sector
Antony *et al.* (2018)	Organisational impacts of LSS in Scotland policing services
Fletcher (2018)	LSS awareness level and implementation opportunities in public sector municipalities
Null *et al.* (2019)	The applicability of LSS in program management
Sunder M. *et al.* (2019)	Improving consumer banking processes using LSS
Rodgers and Antony (2019)	The importance of organisational culture in the implementation of LSS
Murmura *et al.* (2021)	Application of LSS to improve procurement process in an Italian company
Ruben (2018)	Integration of environmental sustainability within LSS frameworks

The relevance and the presence of LSS in the public sector as a tool used for enhancing process efficiency and meeting customer requirements is undoubtful and evident from the wide range of its applications in various public sector processes, as well as its proven benefits and value-adding outcomes. Aside from its well-known impacts, it is interesting to find that LSS is closely related to other organisational performance measures, that are either required for its implementation or areas that it impacts, such as culture and innovation capacity. This presents a promising research area that this paper contributes to.

2.2 LSS and innovation

The review of previous research efforts on the relationship between LSS and innovation revealed several insightful findings that were the motivation behind conducting this research. For example, Garcia-Porres *et al.* (2008) used LSS to achieve process innovation in the health sector in Mexico, and Polk (2011) introduced a model that enables organisations to use LSS as a tool to expedite the adoption of innovation opportunities. LSS was also found to be used as one of the effective tools for driving innovation in research and development environments as it provides researchers with the time needed to generate innovative ideas by better utilisation of their time and avoid spending it on non-value-added activities (Panat *et al.*, 2014). Antony *et al.* (2016) found that the features of LSS such as process management, project selection, and mentorship influence various innovation types, and Hoerl and Gardner (2010), and Antony *et al.* (2017) supported the same observation. Parast (2011) found that LSS encourages creativity that drives incremental innovation. Nascimento *et al.* (2019) explored synergies between Lean production and Six Sigma (SS) to propose a LSS framework for continuous and incremental improvement and to support operations management needs. Chennupati *et al.* (2012) proposed a model that illustrates how the DMAIC process ignites innovation in an organisation.

In fact, integrating LSS concepts with an innovation agenda helps companies to achieve breakthrough innovations (Johnstone *et al.*, 2011). Authors such as Knapp (2015), Pakdil and Leonard (2015), Boyle *et al.* (2011), and Amar (2012) mentioned that LSS requires an organisational culture that emphasises group work, flexibility, and openness, which are the same as for innovation. Rejikumar *et al.* (2020) implied that various factors such as data quality, technology readiness, knowledge management and performance efficiency lead to the adoption of new techniques in an LSS environment, which also enables the organisational managers to enhance the deployment of LSS in a better manner. Alkunsol *et al.* (2019) studied the strong relationships between LSS variables and business performance. A conceptual framework was proposed by Yusr *et al.* (2011) based on which SS was found to have an indirect impact on innovation through organisational absorptive capacity. Sony and Naik (2012) found that SS, through organisational learning and knowledge sharing, enhances innovation. In another research by He *et al.* (2015), it was found that some of SS's critical components such as its focus on achieving specific improvement goals and its structured procedure build an organisational atmosphere that supports innovation.

Ratnayake and Isoherranen (2017) proposed a comprehensive framework that can be used to disseminate Lean knowledge to enhance innovation excellence in academic and industrial fields. The use of Lean principles in Information Technology (IT) helped in a smoother communication of innovative ideas through supporting learning behaviours (Gong and Janseen, 2014). In healthcare projects, Lean changed organisational structure to support innovation (Abuhejleh *et al.*, 2016). Nicoletti (2015) proposed a method for improving and optimising innovation processes using Lean and Digitise Innovation. Cuc

and Tripa (2007) highlighted that successful integration of LSS and innovation principles, leadership commitment and enthusiasm towards innovation is actually of high importance, while innovation vision should be based on both customer input and organisational capabilities. LSS can do more than merely process improvement; it can be used as a base for promoting innovation. Companies such as Caterpillar and ScottishPower implemented LSS methodologies to achieve innovation, and this generated advantages in terms of both their business performance and many other organisational performance aspects (Byrne *et al.*, 2007). One of the techniques used to design an SS implementation framework is innovation-based approach, which is referred to as the diffusion of innovation theory. Success of the adoption of an innovation is subject to its value to the organisation, applicability, the party responsible for taking its adoption decision, the way it is diffused and communicated, and the organisational cultural system (Amar and Davis, 2008).

A summary of the above-mentioned articles that focuses on the relationship between LSS and innovation is provided in Table 2.

Table 2. Summary of research on the relationship between LSS and innovation

Reference	**Scope of the study**
Garcia-Porres *et al.* (2008)	Process innovation using LSS.
Polk (2011)	A model to expedite the adoption of innovation opportunities using LSS.
Panat *et al.* (2014)	Application of LSS tools in driving innovation.
Antony *et al.* (2016)	Influencing process, product, and service innovation types by LSS's features.
Hoerl and Gardner (2010)	LSS stimulates creative thinking that is required for incremental innovation.
Antony *et al.* (2017)	LSS is related to incremental innovation and innovation capabilities.
Parast (2011) and Lizarelli *et al.* (2019)	SS addresses incremental innovation efforts.
Chennupati *et al.* (2012)	A model that proposes DMAIC as a source for innovation.
Johnstone *et al.* (2011) and Soheil (2018)	Achieving innovation while meeting LSS principles through organisational culture.
Knapp (2015)	LSS requires the same organisational culture as innovation.
Pakdil and Leonard (2015)	Lean requires a culture that is heavily based on innovative thinking.
Boyle *et al.* (2011)	Innovative organisational climate is preferable for Lean implementation.
Amar and Davis (2008) and Amar (2012)	Diffusion of innovation theory is an innovation-based SS implementation framework.
Yusr *et al.* (2011)	A conceptual framework that illustrates the relationship between SS tools and organisational innovation.

Alharthi and Aziz (2018)	A theoretical framework, which illustrates the relationship of LSS in crisis management and innovation.
Sony and Naik (2012)	SS is positively related to innovation through its impact on organisational learning.
He *et al.* (2015) and Strong (2018)	SS's critical components are related to organisational innovation.
Ratnayake and Isoherranen (2017)	A comprehensive framework that unifies Lean knowledge across various innovation types.
Gong and Janseen (2014) and Haerizadeh and Sunder (2019)	The application of Lean supports a smooth communication of innovative ideas through learning behaviors and knowledge resources.
Abuhejleh *et al.* (2016) and Salah (2019)	Adoption of Lean results in a cultural change that promotes innovation.
Nicoletti (2015)	Digitising the innovation process and redesigning it to achieve Lean results.
Cuc and Tripa (2007)	Requirements for integrating LSS and innovation principles.
Byrne *et al.* (2007)	Using LSS as a base for promoting innovation.

It is found from previous research that the relationship between LSS and innovation is either from the aspect of LSS's direct impact on innovation or its organisational culture requirements that are found to be similar as of innovation. Moreover, a number of studies focused on the critical components and the basic principles of LSS to support various aspects of innovation. Furthermore, many of the studies discussed the relationship between LSS and innovation from the aspect of some mediating variables such as creative thinking, organisational learning, and knowledge management. LSS was looked into as a separated tool, either Lean or SS, and only particular types of innovation such as process and incremental innovation were considered.

Nabhani and Shokri (2009) highlighted some of LSS's intangible impacts such as improving job satisfaction among shop floor employees due to the better flow of goods, which made the execution of tasks easier. The authors also questioned whether LSS is related to employee satisfaction and other related aspects, as well as organisational learning. Sunder M. *et al.* (2018) mentioned that there is a need to validate and better understand the attributes of LSS's various intangible impacts. Recently, Alblooshi and Shamsuzzaman (2020) proposed a conceptual model that illustrates the relationship between LSS's intangible impacts and organisational innovation climate factors by a number of propositions. However, their model neither formulated or validated quantitatively any hypotheses on the propositions, nor developed a framework that enables practitioners and academics to visualise the relationship between LSS's intangible impacts and organisational innovation climate factors and hence, utilise them for organisational development purposes. Thus, the current study works to fill up these gaps. The contributions of this study are summarized as follows: (i) formulating the relationship between LSS's intangible impacts and organisational innovation climate factors by a number of hypotheses based on comprehensive theoretical analysis, (ii) testing and validating the defined hypotheses quantitatively based on the data collected

from a self-administrated survey questionnaire, (iii) developing a house-of-pillars-based framework that illustrates the role of LSS's intangible impacts in creating innovation climate in an organisation.

3. Conceptual model and propositions

The first construct (i.e. LSS's intangible impacts) of the proposed conceptual model was developed by conducting a comprehensive literature review. More than 200 articles published in 41 journals on LSS applications and its impacts in various sectors were initially identified, and then filtered to exclude non-relevant articles as well as articles from conference proceedings, website, and other grey literature (interested readers are referred to Alblooshi *et al.*, 2020). In addition, in-depth interviews were conducted with several LSS experts to verify the collected information about the intangible impact of LSS applications. In order to determine the required number of interviews, the purposive sampling approach and saturation principle were adopted (Rosenthal, 2016). Accordingly, a total of 6 interviews were conducted with international and local professionals and academics to gather their opinions on the intangible impacts of LSS applications.

Furthermore, organisational innovation climate factors as proposed by Tidd and Bessant (2013) were referred to develop the proposed model's second construct. It is found that the factors identified by Tidd and Bessant (2013) provide a broad and comprehensive view of what contributes to shape an innovative organisational climate, and hence they are being used as a reference for organisational innovation climate in this research. Some previous studies, such as Abdelrazek and Alharbi (2017) assessed technological innovation climate using the factors proposed by Tidd and Bessant (2013). Similarly, Ferreira *et al.* (2015) and Zain and Kassim (2012) cited the same factors in their research on organisational innovation and performance.

Finally, based on the literature and the expert's opinions, the conceptual model was developed to illustrate the relationship between LSS's intangible impacts and organisational innovation climate factors (Alblooshi and Shamsuzzaman, 2020) as shown in Figure 1.

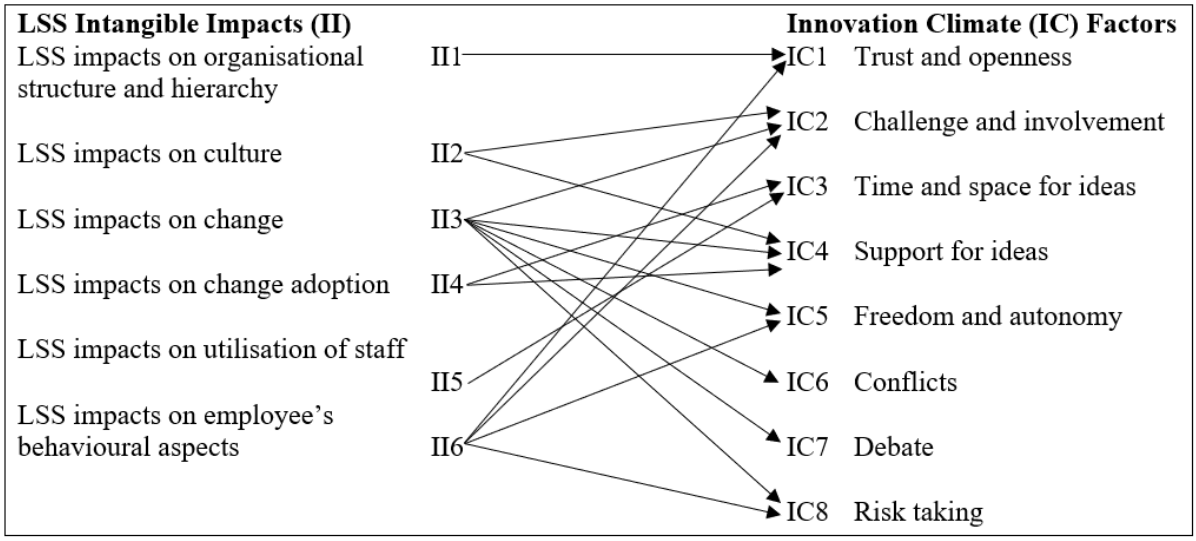

Figure 1. A conceptual model (Source: Alblooshi and Shamsuzzaman, 2020)

3.1 Constructs names and operational definitions

As illustrated in Figure 1, the conceptual model has l constructs (LSS's intangible impacts and organisational innovation climate factors) that are of an independent nature, but one drives and influences the other. The theoretical concepts of each of the two constructs are transformed to a number of observable and measurable elements, where each construct is operationally defined by specifying its observable elements. As the constructs have multiple dimensions, more than one observable elements are used (Forza, 2002).

3.1.1 Construct A

LSS's intangible impacts, denoted by II, are operationally defined as LSS's impacts that are neither direct financial impacts nor direct marketing impacts and are referred to as soft impacts as they are hard to be measured due to their intangibility nature. LSS intangible impacts can be categorized into organisation related impacts and individual related impacts, covering the dimensions mentioned below each with its list of observable elements:

1. Impact on organisational structure and hierarchy (II1)
    a. Promote organisational structure to be of less hierarchal levels (II1a)
    b. Facilitate ease of communication between functional departments (II1b)
    c. Foster collaboration between functional departments (II1c)
2. Impact on organisational culture (II2)
    a. Foster learning and knowledge sharing (II2a)
3. Impact on change adoption (II3)
    a. Increase readiness for change and easing its adaptability (II3a)
4. Impact on innovation (II4)
    a. Increase innovation adaptability (II4a)
5. Impact on utilisation of staff (II5)
    a. Eliminate the need for additional hires (II5a)
    b. Free up employee's time (II5b)
6. Impact on employee's behavioural aspects (II6)
    a. Empower employees (II6a)
    b. Increase trust in management (II6b)
    c. Improve employee morale, engagement, and motivation (II6c)
    d. Improve job performance and satisfaction (II6d)

3.1.2 Construct B

Innovation climate factors, denoted by IC, represent the level of support and encouragement that an organisation provides for the generation and treatment of new ideas (Alas *et al.*, 2012). It is employee's perception of organisational norms and believes related to implementation of innovation (Pundt, 2015). It covers the following dimensions, each with its list of observable elements (Tidd and Bessant, 2013):

1. Trust and openness (IC1)
    a. Employees are self-confident and trust each other (IC1a)
    b. Employees openly communicate and share ideas with each other (IC1b)
2. Involvement and challenge (IC2)
    a. Employees are self-motivated (IC2a)
    b. Employees are involved in their organisation operation and strategy (IC2b)
3. Time and space for ideas (IC3)
    a. Employees find it possible from a time and space perspective to develop, test, and implement new ideas (IC3a)
4. Support for ideas (IC4)

    a. Employees put forward more new ideas (IC4a)
    b. New ideas are listened to, well treated, and not ignored (IC4b)
5. Freedom and autonomy (IC5)
    a. Employees can independently define their work approach (IC5a)
    b. Employees face less restrictions and rules to go through (IC5b)
6. Conflicts (IC6)
    a. Employees are open to consider other opinions (IC6a)
7. Debate (IC7)
    a. Employees are open to discuss and exchange opposing ideas and beliefs (IC7a)
8. Risk taking (IC8)
    a. Employees are encouraged to explore new opportunities (IC8a)
    b. Employees are more willing to deal with uncertainty (IC8b)

3.2 Definition of the propositions

The above-mentioned constructs are independent and LSS intangible impacts are expected to positively influence organisational innovation climate factors as illustrated in Figure 1. The propositions are defined as follows:

P1: *Impact of LSS on organisational structure and hierarchy (II1) is positively related to trust and openness (IC1)*

P2: *Impact of LSS on organisational culture (II2) is positively related to challenge and involvement (IC2), and support for ideas (IC4)*

P3: *Impact of LSS on change adoption (II3) is positively related to challenge and involvement (IC2), support for ideas (IC4), freedom and autonomy (IC5), conflicts (IC6), debate (IC7), and risk taking (IC8)*

P4: *Impact of LSS on innovation adaptability (II4) is positively related to time and space for ideas (IC3), and support for ideas (IC4)*

P5: *Impact of LSS on utilisation of staff (II5) is positively related to time and space for ideas (IC3)*

P6: *Impact of LSS on employee's behavioural aspects (II6) like job satisfaction and performance as well as employee morale, engagement, and motivation is positively related to trust and openness (IC1), challenge and involvement (IC2), freedom and autonomy (IC5), and risk taking (IC8)*

3.3 Explanation of the propositions

LSS impacts organisational structure and hierarchy and makes the knowledge sharing and communication between functional departments easier and smoother. That, as a result, positively influences the openness of individuals to new ideas and the trust between them. LSS also creates a continuous improvement culture that fosters generation of new ideas and organisational learning and is positively correlated to the innovation climate factors such as challenge and involvement, and support for ideas. In addition, LSS increases organisational flexibility and makes it readier to adopt to change. That helps in supporting new ideas and providing staff with the freedom and autonomy required for dealing with change. LSS challenges employees to change their work-related habits and practices and

encourages them to take a certain level of risk that is usually associated with adoption of new ideas. It also encourages constructive debate and conflicts that lead to better ideas. LSS is found to trigger innovation and result in a culture and work environment that support innovation. For example, the DMAIC approach provides staff with the time and space for generating new ideas specially in the Define, and Improve stages, and that will require a financial and non-financial support. LSS helps in more efficient utilisation of the manpower, and as a result employee's time usually wasted on non-value adding activities can be used for generating new ideas. Furthermore, LSS empowers employees, regardless of their level, to participate and contribute to the decision-making process and put forward their ideas. That enhances trust between employees and management, and highly involves employees in organisational operation and strategy. It allows staff to take risk as they are provided with the freedom to do so. LSS impacts on employee's behavioural aspects like job satisfaction and performance as well as employee morale, engagement, and motivation are positively related to trust and openness, challenge and involvement, risk taking, and freedom and autonomy.

Given the model's constructs (A and B) and their respective dimensions and observable elements, each proposed proposition is tested using a number of hypothesis statement that relate each of the observable elements of a particular LSS's intangible impact (e.g. II1a, II1b, and II1c are the observable elements of the LSS's intangible impact II1 in P1) with the observable elements of the organisational innovation climate factor(s) (which are IC1a and IC1b under organisational innovation climate factor IC1 in P1). The hypothesis statements tested as part of the six propositions (P1, …, P6) are defined in Table 3.

Table 3. Research propositions and corresponding hypothesis statements

Proposition	Hypothesis Statement #	Hypothesis Statement
P1	1	An organisational structure of less hierarchal levels makes employees self-confident and trust each other
	2	An organisational structure of less hierarchal levels eases it for employees to openly communicate and share ideas with each other
	3	An organisation where communication between functional departments is easy makes employees self-confident and trust each other
	4	An organisation where communication between functional departments is easy enables the employees to openly communicate and share ideas with each other
	5	An organisation of high collaboration between functional departments makes employees self-confident and trust each other
	6	An organisation of high collaboration between functional departments eases it for employees to openly communicate and share ideas with each other
P2	1	An organisation of fast learning and easy knowledge sharing makes employees self-motivated
	2	An organisation of fast learning and easy knowledge sharing makes employees highly involved in their organisation operation and strategy
	3	An organisation of fast learning and easy knowledge sharing encourages employees to put forward more new ideas
	4	An organisation of fast learning and easy knowledge sharing treats new ideas well and doesn't ignore them
P3	1	An organisation that is readier for change and can easily adapt to it makes employees self-motivated
	2	An organisation that is readier for change and can easily adapt to it makes employees highly involved in their organisation operation and strategy
	3	An organisation that is readier for change and can easily adapt to it eases it for employees to put forward more new ideas
	4	An organisation that is readier for change and can easily adapt to it treats new ideas well and doesn't ignore them
	5	An organisation that is readier for change and can easily adapt to it makes employees able to independently define their work approach
	6	An organisation that is readier for change and can easily adapt to it makes employees face less restrictions and rules to go through
	7	An organisation that is readier for change and can easily adapt to it makes employees open to consider other opinions
	8	An organisation that is readier for change and can easily adapt to it makes employees open to discuss and exchange opposing ideas and beliefs
	9	An organisation that is readier for change and can easily adapt to it encourages employees to explore new opportunities
	10	An organisation that is readier for change and can easily adapt to it makes employees more willing to deal with uncertainty
P4	1	An organisation of high innovation adaptability allows the time and space needed for employees to develop new ideas, test and implement them
	2	An organisation of high innovation adaptability enables employees to put forward more new ideas
	3	An organisation of high innovation adaptability treats new ideas well and doesn't ignore them
P5	1	An organisation that eliminates the need for additional hires allows the time and the space needed for staff to develop, test, and implement new ideas
	2	An organisation that is able to free up employees' time allows the time and the space needed for them to develop, test, and implement new ideas
P6	1	An organisation that empowers its employees makes them self-confident and trust each other
	2	An organisation that empowers its employees enables them to openly communicate and share ideas with each other
	3	An organisation that empowers its employees makes them self-motivated
	4	An organisation that empowers its employees makes them highly involved in their organisation operation and strategy
	5	An organisation that empowers its employees makes them able to independently define their work approach
	6	An organisation that empowers its employees makes them face less restrictions and rules to go through
	7	An organisation that empowers its employees encourages them to explore new opportunities
	8	An organisation that empowers its employees makes them more willing to deal with uncertainty
	9	An organisation of high level of trust in management makes employees self-confident and trust each other
	10	An organisation of high level of trust in management allows employees to openly communicate and share ideas with each other

4. Research design and methodology

4.1 Overview of the research method

In this research, the proposed model is to be tested and validated, thus a confirmatory survey research approach is adopted, as the intention is to test the propositioned relationships between LSS's intangible impacts and organisational innovation climate factors. The rationale behind choosing surveys is the quantitative nature of this research that requires collecting information about the frequency of occurrence of participant's beliefs, judgments, experiences, and opinions on the impact that LSS has on organisational innovation climate factors. In addition, collecting data using surveys makes it easier and quicker to reach to a large number of people. Moreover, survey sampling approach allows the generalisation of the results to larger populations (Rowley, 2014). Furthermore, survey results can be statistically analysed, and therefore, meaningful conclusions can be drawn (Chauvel and Despres, 2002).

4.2 The Survey – design and implementation

Survey design covers all the activities that precede data collection. It starts with an identification of the type of information required, which is based on the research hypotheses and purpose, formulation and review of its questions, implementation, and finally analysis and interpretation of the results (Smartt and Ferreira, 2013). The survey design process and the steps followed in this research are illustrated in Figure 2.

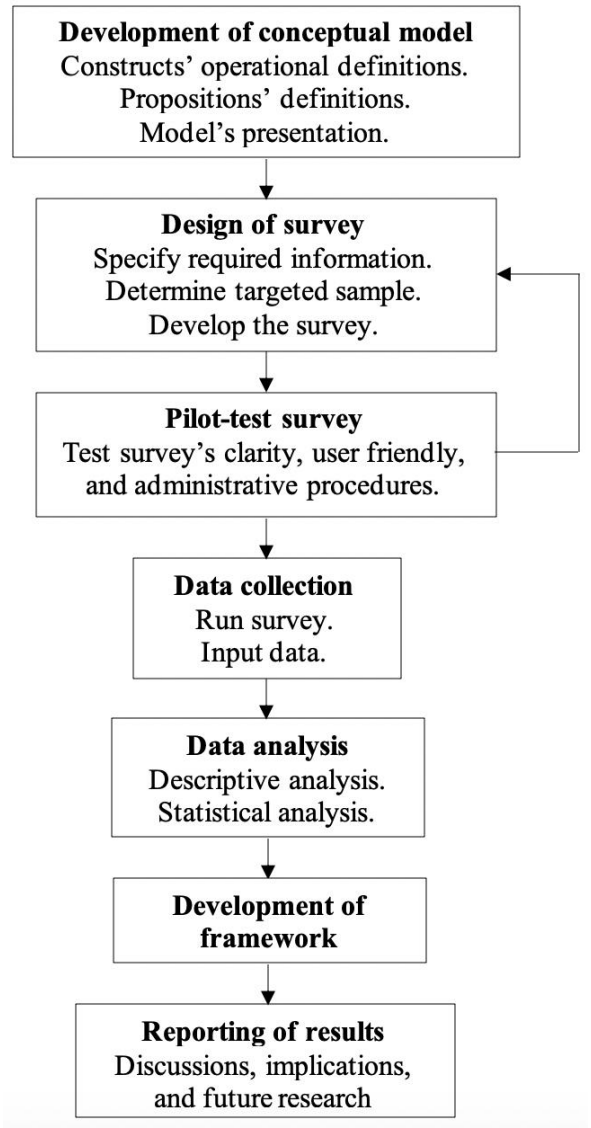

Figure 2. Survey design and research steps

4.2.1 Sampling method and procedure

In this research, the population frame is determined based on industry classification. Accordingly, the public sector organisations in the UAE were targeted, where innovation is mandated in the operational and strategic plans in meeting country's innovation agenda and strategic objectives. In terms of sample design and as the survey targets obtaining information from only certain groups, non-probabilistic sampling type is followed. Furthermore, the sampling method followed in this research adopted a purposive approach targeting experts and experienced professionals in the field of innovation as well as snowball approach where the selected individuals in the purposive approach are asked to nominate and contact other potential participants. That sampling procedure was also based on convenience approach targeting accessible organisations and social networks (Rowley, 2014). It is worth highlighting that 88% of survey-based operations management research does not rely on probabilistic sampling approach (Forza, 2002).

In this research, the survey targeted 145 public sector officials in the UAE. They come from various industries within the public sector with an in-depth or at least a workable knowledge on LSS and/or other quality management and improvement tools. They were carefully selected by the UAE government, for their proven record of serving

the public and future foresight skills, to represent their entities and participate in an intensive public sector innovation program that targeted developing an innovative culture in government entities and building capacities to promote that. The interviewees successfully completed the program prior to participating in this research, whereby they delivered innovative solutions for some of the issues their entities were facing by going through the full cycle of innovation implementation starting from the ideation phase to the phase of delivering an executable project. With the exposure the interviewees had to both quality and innovation, they were found to be able to better understand and accurately assess the impact of LSS on organisational innovation. The number of responses received was 107 out of 145 (73.8%), which meets minimum sample representative size at a 5% margin of error (Yamane 1967). It is worth noting that Flynn *et al.* (1990) mentioned that a response rate greater than 50% should be achieved in any operations management research, while Malhotra and Grover (1998) emphasized that the response rate should be at least 20%.

Before conducting the survey, it was tested in a pilot study with academic researchers and industry professionals to get feedback on the clarity of its questions and the instructions. Based on the outcome of the pilot study, some minor revisions related to the wording of the questions and their structures and presentations were made to ease the administration of the survey. In terms of survey's development, and distribution and analysis, the following tools were used: web survey software "SurveyMonkey," and specialized data entry survey software "Statistical Package for Social Sciences (SPSS)". Such tools ensure providing participants with the privacy needed for answering sensitive types of questions, as they do not involve face-to-face meeting with the researcher (Mierzwa *et al.*, 2016).

4.2.2 Survey development

The overall survey was designed in a way to ease and encourage participants to respond, where an introduction is provided to set the context, clarify research objective, and encourage participants to respond. Readers may refer to Alblooshi (2020: PhD Thesis) for more details. Information on data protection and survey anonymity was also provided to ensure that participants do not have any concerns in this regard (Silva *et al.*, 2017). The participants were contacted in advance to ensure their commitment to complete the survey. A follow up mechanism was in place by sending participants an email after 2 weeks from distributing the survey to thank those who filled it and remind those who did not to fill it, followed by a final reminder after four weeks. Furthermore, participants were approached individually and through their networks c to ensure they respond to the survey. It is also worth to mention that the survey was kept live for considerable amount of time to achieve the highest possible response rate.

The questions of the survey were specific and of closed type with a number of options to select from, which made it easier and quicker for the participant to respond, and for the researcher, to code and analyse. The double barrelled, leading, loaded, and biased questions were avoided. Demographic questions related to participant's age, gender, job role, educational qualification, work experience, and industry type were kept for the last as some participants get sensitive to answer such type of questions. Questions of same theme were grouped and clustered to ensure a proper and clear survey design (Rowley, 2014). For example, core questions were grouped according to research hypotheses (Silva *et al.*, 2017). Accordingly, the survey was designed to have the following parts:

1. Part 1 - Introduction and Instructions: Participants were greeted and briefed on the objective of the survey highlighting the expected completion time and mentioning that the survey was confidential and totally anonymous.

2. Part 2 - Core questions: To test each proposition's hypothesis statements and assess its different aspects, participants were asked to indicate the level of agreement with the hypothesis statements that were derived to relate the observable elements of the various dimensions of LSS's intangible impacts with the observable elements of organisational innovation climate's dimensions as per the six propositions (see section 3.2).
3. Part 3 - Demographic questions: Participants were asked about their age, gender, educational qualifications, years of work experience, service sector type of their organisation, and their job roles and function.
4. Part 4 - Conclusion and thanks: To thank participants for their contribution and ask them to contact survey's administrators in case they wish to receive a copy of the survey's results.

The answering scale should be carefully selected to ensure that the participants can easily respond to the questions and the responses can easily be analysed. Accordingly, categorical scale is selected for demographic questions for which answering options are descriptive, and ordinal scale is selected for core questions that require participants to provide rank order responses (Rowley, 2014). Hence, answering options provided for demographic questions are of multiple-choice nature, that is to select one item from a list of given options. For core questions, five-point Likert scale is used where participants are asked to indicate the level of their agreement or disagreement with a particular statement (Forza, 2002). Furthermore, forced answering is used to eliminate nonresponse error, and therefore, increase completion rate (Albaum *et al.*, 2014). For the purpose of ensuring consistency of the scales used for responding to the survey questions given the nature of the constructs being studied, the following scaling techniques were used:

1. Multiple choice options for demographic related questions
2. Likert-like scale: one to five scales (1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly Agree), and (1 = unimportant; 2 = of little importance; 3 = moderately important; 4 = important; and 5 = very important)

5. Survey analysis and findings

Before proceeding to data analysis, the collected survey data were checked if they are completed with no missing data, and then entered into the data analysis software.

5.1 Reliability test

Reliability of the data refers to how dependent, stable, predictable, and consistent is the measurement. It can be measured differently using test-rested method, alternative form methods, split halves methods, and internal consistency method (Forza, 2002). In this research, Cronbach's α is used to measure the internal consistency, where the measure is very reliable if $\alpha \geq 0.8$ and has a satisfactory construct validity if $\alpha > 0.6$ (Nunnally, 1978). The results of the reliability test performed with the help of the SPSS software show Cronbach's α values of 0.90, 0.93, 0.93, 0.86, 0.60, and 0.97 for items related to each of the propositions 1, 2, 3, 4, 5, and 6, respectively. Accordingly, it can be concluded that the measure is reliable and of a very good construct validity level for all propositions.

5.2 Profile of participant's demographics

The objective of this section is to familiarise the reader with the selected sample and provide more details about the participants and how they were distributed with respect to various demographic aspects. Participant's demographics profile is presented showing their age range, gender, educational qualification, number of years of work experience, type of their organisations, and function of their current job role (see Table 4).

Table 4. Participants' demographic profile

Demographics	Response	(%)
Age range (X, years)		
$X \leq 20$	0	0
$21 \geq X \geq 30$	0	0
$31 \geq X \geq 40$	79	73.8
$41 \geq X \geq 50$	25	23.4
$51 \geq X \geq 60$	3	2.8
$X \geq 60$	0	0
Total	107	100
Gender		
Male	52	48.6
Female	55	51.4
Total	107	100
Educational qualification		
High school	1	0.9
Undergraduate (Diploma, Higher Diploma, Bachelor)	27	25.2
Graduate (Master, PhD)	79	73.9
Total	107	100
Years of work experience (Y, years)		
$Y \leq 5$	7	6.5
$6 \geq Y \geq 10$	25	23.4
$11 \geq Y \geq 20$	63	58.9
$Y \geq 21$	12	11.2
Total	107	100
Organisation's service sector type		
Cabinet Affairs and The Future	9	8.4
Education	11	10.3
Health and Prevention	8	7.5
Energy and Industry	15	14
Human Resources and Emiratization	3	2.8
Community Development	4	3.7
Infrastructure Development	11	10.3
Defense Affairs	0	0
Interior Affairs	5	4.7
Foreign Affairs and International Cooperation	3	2.8
Justice	1	0.9
Tolerance	0	0.
Culture and Knowledge Development	1	0.9
Climate Change and Environment	1	0.9
Financial Affairs	11	10.3
Economy	4	3.7
IT and communication	5	4.7
Advanced sciences	1	0.9
Food Security	1	0.9
Artificial intelligence	0	0
Youth Affairs	0	0
Other	13	12.1
Total	107	100
Function of current job role		
Strategy and shaping the future	15	14
Organisational excellence	12	11.2
Quality management and control	8	7.5
Innovation management	25	23.4
Other	47	43.9
Total	107	100

Several interesting insights can be revealed from the participant's demographics as shown in Table 4. The observations on the participant's age profile, being mainly from a middle age group that is 31-40 years old, is in line with their years of work experience where majority of them have 11-20 years of work experience. That shows the level of exposure and experience the participants have with respect to organisational behaviour and operations related matters. In addition, the educational qualification level of the participants, being mainly graduate degrees and undergraduate degrees as minimum, implies that participants to this research survey have a certain level of understanding and knowledge that make their contribution value adding. In terms of participant's

organisations, the findings reveal that they are from a wide range of the public sector organisations in the UAE such as education, energy and industry, health and prevention, and infrastructure development. As a result, the representativeness of the sample being studied in this research is high and hence helps generalising the results. The findings on the functions of participant's current job roles indicate that they do not necessarily have an innovation related job role. Hence, innovation professionals are distributed among organisation's various functions to act as agents to help enhance the organisational innovation culture and support various innovation initiatives.

5.3 Descriptive analysis of the responses on the hypothesis statements

The purpose of the descriptive analysis of the responses obtained from the survey is to check the pattern and distribution of the data collected and look for any useful insights and meaningful observations that can further support the proposed relationships between LSS's intangible impacts and organisational innovation climate factors being tested and validated in this research. The minimum-maximum range, mean, and standard deviation values of each propositioned hypothesis statement are calculated and presented in Table 5 (see columns under descriptive statistics). The mean value of the responses received for the hypothesis statements ranges from 3.140 to 4.407, with total score ranging from 1 to 5. It is noted that all hypothesis statements have mean values on the higher side of the total score.

Table 5. Hypothesis test results

Proposition	Hypothesis Statement #	Descriptive Statistics				Inferential Statistics			
		Minimum	Maximum	Mean	SD	Kurtosis	Skewness	*t*-value	*p*-value
P1	1	1	5	3.935	0.827	2.141	-1.112	11.686	< .00001
	2	1	5	4.065	0.893	1.775	-1.183	12.340	< .00001
	3	1	5	4.112	0.839	2.076	-1.094	13.708	< .00001
	4	1	5	4.131	0.848	2.288	-1.202	13.799	< .00001
	5	1	5	4.178	0.850	2.472	-1.301	14.327	< .00001
	6	1	5	4.215	0.880	1.796	-1.199	14.284	< .00001
P2	1	1	5	4.159	0.859	2.479	-1.314	13.948	< .00001
	2	1	5	4.065	0.847	1.942	-1.075	13.012	< .00001
	3	1	5	4.103	0.835	2.420	-1.188	13.665	< .00001
	4	1	5	4.075	0.809	2.551	-1.118	13.740	< .00001
P3	1	2	5	3.949	0.666	0.340	-0.346	14.741	< .00001
	2	2	5	4.056	0.649	0.874	-0.476	16.829	< .00001
	3	2	5	4.093	0.701	0.806	-0.696	16.139	< .00001
	4	2	5	4.154	0.695	-0.250	-0.464	17.178	< .00001
	5	1	5	3.832	0.841	2.149	-1.029	10.231	< .00001
	6	2	5	3.977	0.805	-0.128	-0.545	12.549	< .00001
	7	2	5	4.037	0.703	0.070	-0.405	15.269	< .00001
	8	2	5	4.005	0.705	-0.006	-0.345	14.732	< .00001
	9	2	5	4.093	0.694	0.923	-0.666	16.296	< .00001
	10	2	5	3.995	0.732	0.941	-0.720	14.071	< .00001
P4	1	1	5	4.252	0.766	2.166	-1.108	16.913	< .00001
	2	2	5	4.308	0.654	0.442	-0.699	20.698	< .00001
	3	2	5	4.304	0.672	0.229	-0.697	20.066	< .00001
P5	1	1	5	3.140	0.980	-0.454	-0.004	1.479	.071052
	2	1	5	3.855	0.890	1.323	-0.859	9.936	< .00001
P6	1	2	5	4.407	0.680	1.512	-1.142	21.385	< .00001
	2	2	5	4.336	0.640	0.584	-0.711	21.608	< .00001
	3	2	5	4.313	0.650	0.423	-0.664	20.902	< .00001
	4	2	5	4.252	0.667	0.183	-0.581	19.416	< .00001
	5	2	5	4.224	0.705	-0.235	-0.553	17.975	< .00001
	6	2	5	4.178	0.681	0.672	-0.671	17.893	< .00001
	7	2	5	4.276	0.656	0.274	-0.574	20.116	< .00001
	8	2	5	4.117	0.735	-0.131	-0.505	15.714	< .00001
	9	2	5	4.224	0.740	0.611	-0.813	17.103	< .00001
	10	2	5	4.196	0.785	0.454	-0.854	15.756	< .00001
	11	2	5	4.126	0.753	0.171	-0.593	15.478	< .00001
	12	2	5	4.154	0.751	0.300	-0.697	15.908	< .00001
	13	2	5	4.098	0.772	-0.101	-0.571	14.709	< .00001
	14	2	5	4.075	0.776	0.182	-0.670	14.319	< .00001
	15	2	5	4.103	0.716	0.596	-0.645	15.928	< .00001
	16	1	5	3.977	0.772	1.262	-0.735	13.084	< .00001
	17	2	5	4.294	0.680	0.966	-0.822	19.698	< .00001
	18	2	5	4.280	0.677	1.034	-0.851	19.562	< .00001
	19	2	5	4.248	0.688	0.737	-0.754	18.756	< .00001
	20	2	5	4.224	0.705	0.470	-0.718	17.975	< .00001
	21	1	5	4.159	0.848	1.039	-0.996	14.129	< .00001
	22	2	5	4.098	0.845	-0.192	-0.685	13.440	< .00001
	23	2	5	4.271	0.778	1.386	-1.175	16.902	< .00001
	24	2	5	4.051	0.801	0.462	-0.789	13.582	< .00001
	25	1	5	3.995	0.851	1.508	-1.155	12.100	< .00001
	26	2	5	4.042	0.816	0.235	-0.709	13.212	< .00001
	27	2	5	4.201	0.827	0.374	-0.934	15.028	< .00001
	28	2	5	4.187	0.769	0.191	-0.763	15.956	< .00001
	29	2	5	4.112	0.793	-0.275	-0.565	14.508	< .00001
	30	2	5	4.033	0.802	-0.224	-0.514	13.324	< .00001
	31	2	5	4.070	0.702	0.694	-0.671	15.770	< .00001
	32	2	5	4.107	0.774	0.319	-0.710	14.799	< .00001

Kurtosis standard error: 0.237; Skewness standard error: 0.474

5.4 *Hypothesis testing results*

In order to utilize the Likert scale data obtained from the questionnaire as interval data, it was decided to test the normality of the data (Scheepers and Storm, 2019). As shown in

Table 5 (see columns under inferential statistics), data under each hypothesis statement could be considered as normally distributed as the Skewness and Kurtosis are between -2.58 to +2.58 (Scheepers and Storm, 2019). After confirming the normality of the data, parametric tests such as *t*-tests were applied on the survey's findings related to each hypothesis statement to determine whether there are relationships between the observable elements of a concerned LSS's intangible impact and the observable elements of the organisational innovation climate factor (Alsyouf *et al*., 2021; Fidan and Ozturk, 2015; Ogunbiyi *et al.*, 2014). Participants were asked to express their level of agreement/disagreement about each hypothesis statement using a 5-point Likert scale as explained in Section 4.2.2. Accordingly, the following hypothesis was formulated for each hypothesis statement (Alsyouf *et al*., 2021):

$$P_i = \begin{cases} H_0^j : \mu = 3, \quad i = 1,...,6 \\ H_1^j : \mu > 3, \quad \forall i,\ j = 1,...,s;\ s = \text{no. of hypothesis statement} \end{cases}$$

where, μ is the mean value of the responses obtained for *j*th hypothesis statement under *i*th proposition. The implication is that if the mean response is significantly greater than the mean value 3 of the Likert scale, then the majority of the participants are in agreement with regard to the proposed relationship between the observable elements of a LSS's intangible impact and organisational innovation climate factor(s). The resulting *p*-values suggest rejecting all null hypotheses (*p*-values < 0.00001) except for hypothesis statement 1 under proposition 5 where the null hypothesis is found not to be rejected (*p*-value = 0.071052). In short, all the hypothesis statements proposed for testing each of the six propositions are supported, with an exception for hypothesis statement 1 under proposition 5. The rejection of supporting hypothesis statement 1 under proposition 5, that relates the elimination of additional hires with provision of time and space for new idea generation, is somehow logical and expected. Eliminating the need for additional hires as LSS suggests, may not necessarily provide staff with a room for innovative thinking as they may simply get engaged with other work-related activities that takeaway the time and space privilege required for innovation.

6. A framework illustrating the role of LSS's intangible impacts in creating innovation climate

A framework is a combination of tools, enablers, concepts, indicators, and other components that affect each other in organising and structuring information to meet a certain purpose and create a total outcome. It should have a clear direction, a well-defined purpose, and a measurement approach. It can be visualised as a picture frame that focuses on what is taking place within the frame, or as a building frame where components are being locked into their proper positions. For developing a framework, there are four main elements to be identified: the purpose and need for developing the framework, its value and expected benefits and outcomes, the context of its application, and the mechanism of its execution (Yadav *et al.,* 2017).

Given the conceptual model in Section 3, that the propositions of which relate LSS's intangible impacts (organisational behaviour related (II1, II2, II3, and II4) and individual's behaviour related (II5 and II6)) with organisational innovation climate factors (IC1, IC2, IC3, IC4, IC5, IC6, IC7, and IC8), which were found supported in this study, a framework is developed to illustrate the utilisation of LSS's intangible impacts in creating innovation climate in an organisation. Built on Amar and Davis's (2010) framework, which was found to comply with all of Roger's criteria for the Diffusion of

Innovation Theory (DOI) as highlighted by Amar (2012), and represented by a house of pillars, the framework is developed and illustrated in Figure 3.

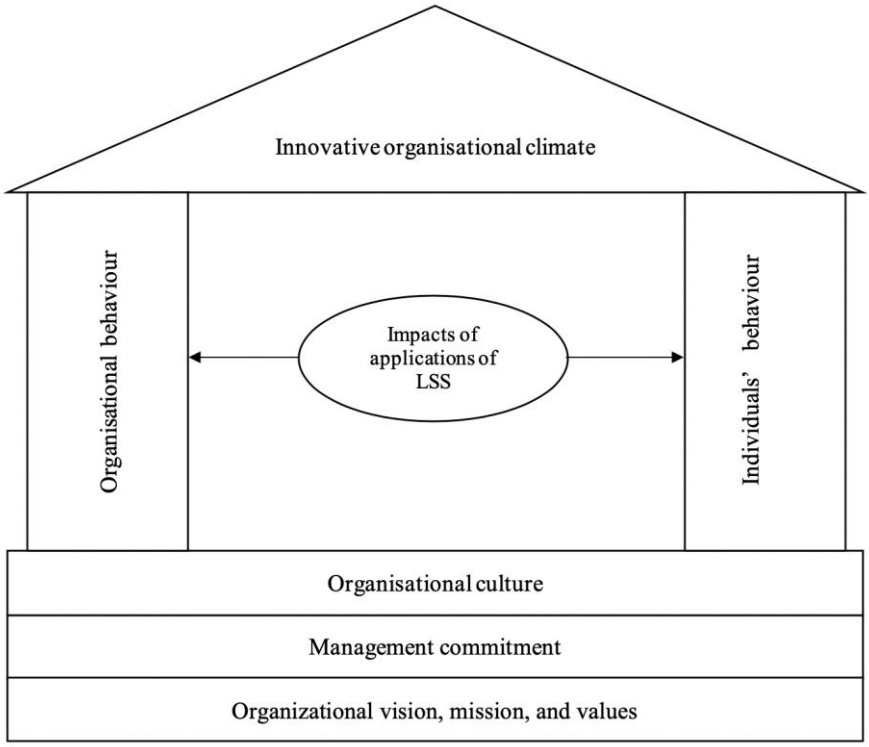

Figure 3. A framework for utilising LSS's intangible impacts in creating organisational innovation climate

Management commitment and organisational culture are driven by organisational vision, mission, and values that set a direction for the operations of an organisation. Being the most important requirements for the successful implementation of both LSS and innovation, management commitment and organisational culture represents the bases of the framework that govern its effectiveness and ensure its applicability. Hence, the implementation of LSS requires a supportive organisational culture and a management that believe in its value and outcomes for the organisation, and accordingly provide required financial and non-financial support. The propositioned and validated intangible impacts of LSS on organisational behaviours (structure and hierarchy, culture, change adaptability, and innovation) and individual's behaviours (staff utilisation and behavioural aspects) are represented by the pillars of the framework. Further, the said intangible impacts of LSS support and foster an innovative organisational climate as represented by the roof of the proposed framework by influencing the aspects related to trust and openness, challenge and involvement, support for ideas, freedom and autonomy, conflicts, debates, and risk taking. It is worth highlighting that organisational culture in the bases of this framework refers to the existing organisational culture, whereas the cultural aspect of organisational behaviour represents the impact of LSS on the organisational culture that is more of knowledge and learning based.

In addition to illustrating the relationship between LSS's intangible impacts and organisational innovation climate factors, this framework provides organisational professionals and practitioners with a roadmap that help them visualise and better understand how LSS impacts organisational innovation climate. Hence, they can utilise the tools of LSS projects for creating or strengthening the various elements of their organisational innovation climates. This framework can be used as a promotion tool when

seeking management buy-in for LSS projects as it explains how LSS can go beyond its well-known market and financial benefits. It can also be used during the pursue of LSS projects as it helps staff relate the changes they experience at an organisational or individual level as part of LSS implementation with the innovative behaviours that contribute to organisational innovation at a larger scale. In terms of its implementation, consideration should be given to the context and field of application to both ensure a full utilisation and gain maximum benefits. This framework may also imply that organisations that implement LSS has an advantage with regard to their organisational innovation climate, because of the influence of the intangible impacts of LSS, compared to those that do not implement LSS who may still invest in or seek other ways for enhancing their innovation climate.

7. Discussions, research, and practical implications

7.1 Discussion

The results obtained from this study can be interpreted as follows:

1. Impact of LSS on organisational structure and hierarchy is positively related to trust and openness. This result implies that LSS, by changing organisational structure to be flatter and of less hierarchal levels, makes employees self-confident, trust each other, and hence, they comfortably put forward, share, and discuss ideas where no bad intentions or unethical behaviours exist. That is also supported by eliminating barriers between functional departments as LSS results in higher levels of openness, communication, collaboration, and coordination between business units.
2. Impact of LSS on organisational culture is positively related to challenge and involvement and support for ideas. LSS emphasizes an organisational culture where problem solving mindset is encouraged and where everyone feels enthusiastic, committed, and responsible to solve issues that hinder organisational growth and as a result enhance productivity and improve efficiency. Such work behaviours approach makes the organisation dynamic and flexible in terms of acquiring knowledge, from either external or internal sources, and diffusing it across the organisation easily. It also helps in better and fast utilisation of existing knowledge to deal with any complexities and obstacles associated with organisational performance. Hence, LSS makes employees extrinsically and intrinsically motivated and fully engaged in the various organisational activities at both operational and strategic levels. That is expressed by having employees confident in proposing their ideas to improve work methods and practices as they find the organisation supports creative thinking and establishes mechanisms to adopt new ideas and benefit from them.
3. Impact of LSS on change adoption is positively related to challenge and involvement, support for ideas, freedom and autonomy, conflicts, debate, and risk taking. It is found that LSS enhances organisational preparedness for change; that is achieved by making more willing and flexibility to apply necessary changes to its structures, strategies, and operations as per internal and external conditions. So LSS makes it easier for an organisational to adjust its processes to be in line with surrounding environments and meet global and local trends. Such impact is found to make employees feel energetic and own the processes and hence they spare no efforts in improving them. They put their recommendations and suggestions for the required enhancements and improvements and find that they are taken seriously, looked into, and considered. Employees enjoy autonomy and are not

micromanaged, where they also find that organisational rules are supportive. They engage in constructive arguments that help them in having a holistic overview of the matters being discussed and consider all points of view. LSS, and as it is a change initiative, makes the organisation risk tolerant and futuristic.

4. Impact of LSS on change adaptability is positively related to time and space for ideas and support for ideas. LSS approaches target either improving existing processes or introducing new processes that are efficient in terms of resource utilisation and effective in terms of their outcomes, which are referred to as incremental and radical innovations, respectively. It makes the organisation more innovative and readier to adopt various innovation types by providing employees with the support needed in terms of working hours, venues, and facilities for thinking innovatively. Such opportunities make employees encouraged to release their creativity and unleash innovative ideas as they are well processed and utilized.
5. Impact of LSS on utilisation of staff is positively related to time and space for ideas. LSS helps employees to well utilize and organise their working hours so that they can get free time to think differently and spend the free time on innovative activities. However, elimination of additional staff may not be helpful in creating innovative climate.
6. Impact of LSS on employee's behavioural aspects like job satisfaction and performance as well as employee morale, engagement, and motivation are positively related to trust and openness, challenge and involvement, freedom and autonomy, and risk taking. LSS creates an organisational atmosphere where employees are given opportunities and their capabilities are believed in to carry out more than what they are expected to do and beyond their day-to-day activities. This leads to establishing a strong relationship between employees and management that is based on mutual understanding, respect, and trust. Employees are highly concerned with their performance and focused on their productivity. They behave ethically, act morally, and achieve high levels of job satisfaction and stability. Such environments enhance employee's self-confidence and make them exchange ideas and knowledge. Employees in an organisation of such characteristics are empowered and deeply involved in their organisation's operations where they freely define the methods of the tasks they execute, as they are abided by less rules and regulations, and direct their thinking towards future.

7.2 Research implications

This research is one of the first studies that explores LSS's intangible impacts and assesses their relationship with organisational innovation climate factors, where very little research can be found. Thus, this study helps to improve the understanding of how LSS influences organisational behaviour and the way it operates and functions, as well as individual's behaviours and the way they interact and deal with each other within the organisation. Moreover, the results of this study have many theoretical and practical implications for both academics and professionals. From a theoretical point of view, the results of this study support and provide clear evidence on the existence of LSS's intangible impacts on various organisational and individual aspects as reported previously by Sunder M. *et al.* (2018) and Nabhani and Shokri (2009). Furthermore, the research not only adds to the existing body of research on the relationship between LSS and innovation, but also supports the argument made by researchers such as Garcia-Porres *et al.* (2008), Polk (2011), Panat *et al.* (2014), Antony *et al.* (2016), Parast (2011), He *et al.* (2015), and Abuhejleh *et al.* (2016) on the positive nature of this relationship. In fact, the

findings of this research indicate how powerful LSS is and that how it can exceed its well-known financial and market related benefits by impacting the organisational innovation climate. Hence, the research results help in strengthening the profile of the LSS and introducing new areas for its application.

Academics can use this research as a starting point to motivate students to further investigate the intangible impacts of LSS and explore other impact categories that were not paid enough attention and investigated thoroughly. This will unleash new research areas and will open new promising horizons for LSS research. The link that has been established between LSS's intangible impacts and organisational innovation climate factors is unique and first of its kind. This will encourage students and researchers to look for other areas and aspects that can be linked in a similar way.

7.3 Practical implications

This research will help to demonstrate the benefits of LSS tools so that professionals may better utilize them for enhancing the various aspects of organisational performance. The findings of this research are expected to provide practitioners with insights on what influences organisational climate and will help them better understand its innovativeness and the factors that shape it. The public sector officials can use the outcomes of this research to provide justification for the financial and non-financial resources required for LSS projects that will not only benefit the organisation by enhancing its innovativeness, but also improve public satisfaction by providing better quality services. That will eventually result in a higher recognition of LSS tools which will ultimately resolve many inefficiencies in the public sector services and result in enhancing the quality of life of the public being served.

As for UAE public sector, the findings of this research and the house of pillars framework introduced to illustrate the role of LSS in creating an innovative organisational climate, will provide UAE public sector officials with a clear roadmap on how to utilise LSS for promoting innovation and fostering its implementation. Innovation is one of the main pillars of the UAE national agenda, and nowadays public sector organisations strive to be innovative and take the lead regionally and globally. LSS, being a tool that proved its applicability in a wide range of public sector organisations, is of relevance to many UAE public institutions such as universities, hospitals, banks, courts, and police. Hence, this research presents LSS as a powerful innovation tool that can be used by many public sector organisations to enhance their innovativeness and improve service quality.

8. Conclusions and future research

This research aimed to empirically investigate the influence of LSS's intangible impacts on organisational innovation climate factors based on a self-administrated survey. Based on the results of the study, it can be concluded that LSS, in addition to its market and financial related benefits, can be used as an effective tool to enhance organisational innovation and its intangible impacts influence on organisational innovation climate factors. LSS was found to considerably impact organisational structure and hierarchy by making it flatter, organisational culture by making it knowledge and learning based, organisational change adaptability by enhancing its willingness to accept and adopt it, and organisational innovation by making it more innovative in its processes. LSS was also found to enhance the utilisation of staff efficiently and effectively, and employee's behavioural aspects as well by having employees more productive and moral. Such impacts of LSS influence the trust between employees and management, make employees more engaged and involved, and provide them with the support required to express and pursue their new ideas. They also encourage constructive debates that lead to

consideration of various points of views and being risk tolerant. Hence, that will help in a better utilisation of employees and enable them to define their works approaches in an effective way and behave morally. Collectively, LSS influences various factors within the organisational innovation climate. Such conclusion not only supports the argument made by a number of scholars on the positive relationship between LSS and innovation, but it also adds to the existing body of research by its unique and new research approach and the insights it provides for the practitioners and academics on utilisation of LSS tools.

However, the presented research suffers from several limitations. For example, the survey of this research was limited to the public sector organisations in the UAE, which may limit the generalisation of the results to wider scopes in terms of industries and geographical coverages. Another limitation of this research is that the data was collected at a single point in time, which may not allow dynamic causal inferences. Hence, it is recommended to consider revisiting the content of the model's constructs, LSS's intangible impacts and their relationships with organisational innovation climate factors to ensure their comprehensiveness and inclusion by conducting survey considering experts from both public and private sectors over geographical domains. Future studies to be carried out to closely investigate the factors that govern the relationships as discussed in this research. Future research may further test the research hypotheses to determine the extent to which the various aspects of LSS and organisational innovation are related.

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