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Towards a Theory of Operational Excellence

Professor Pauline Found¹

Professor of Lean Operations Management

Business School, University of Buckingham, Hunter St, Buckingham, UK. MK18 1EG

Email: pauline.found@buckingham.ac.uk

Mr Andrew Lahy

DPhil Student

Business School, University of Buckingham, Hunter St, Buckingham, UK. MK18 1EG

Email: andylahy@gmail.com

Dr Sharon Williams

Health Foundation Improvement Science Fellow,

College of Human and Health Sciences, Swansea University, Swansea, UK.

Email: Sharon.j.williams@swansea.ac.uk

Dr Qing Hu

Lecturer at Department of Business Administration

Zhejiang Institute of Administration, Zhejiang, China

Email: huqing0402@hotmail.com

Dr Robert Mason

Senior Lecturer in Logistics

Cardiff Business School, Cardiff University, CF10 3EU

Email: Masonrj@cardiff.ac.uk

¹ Corresponding Author

Abstract:

The term Operational Excellence is widely applied to businesses but the meaning is ill-defined and is often used as a desired goal. This paper provides a comprehensive review of Operational Excellence and starts to address the criticism of its lack of theoretical foundation. The aim of this conceptual paper is to clarify the meaning of Operational Excellence and to identify the underpinning theories and laws, or rules that guide it. Based on the synthesis of the literature using the term 'Operational Excellence' writings are reviewed against five criteria for a good theory. Our findings show there has been considerable research into identifying common practices and regularities of Operational Excellence but currently there is no single underlying theory of Operational Excellence that meets the criteria for a good theory. From our analysis of the literature we provide some recommendations to address the gaps found. Further research is required to develop a more robust theory of Operational Excellence that will serve to facilitate learning and innovation in next generation management thinking. Future study is also required to identify research that has been carried out that has tested the laws identified in this study. Ideas and input from practitioners would also be required to develop the theory and underpinning laws.

Keywords: Operational Excellence, Continuous Improvement, Lean, TQM, Six Sigma, Theory Development, Underpinning Laws

Introduction

The purpose of this paper is to review the term Operational Excellence with the aim of clarifying its meaning and identifying the underpinning theories and laws, or rules, that guide it.

The term ‘Operational Excellence’ has become almost universal across a range of organisational functions and research fields. Early writings on excellence focused on understanding the lessons learned from the US’s best-run companies, which were documented in Peters and Waterman’s (1982) best-seller *In Search of Excellence*. The most significant lesson was reported as the McKinsey 7S framework which combined 3Ss relating to organisational hardware (strategy, systems and structure) referred to as the ‘hard triangle’ typically seen in Western organisations with the ‘soft square’ of 4Ss related to the organisational software (style, staff, skills and shared values) that was predominant in Eastern organisations. More recently it has been argued that Operational Excellence should not be seen as an approach to promote change, but rather to provide tools and a framework to enable for people in the organisation to operationalise it (Carvalho et al., (2017).

The objective of this paper is to review existing literature on the topic of Operational Excellence with the aim of establishing the underpinning theories and rules that help to improve organisational performance through learning and innovation. A systematic literature review method is applied to review the term from a holistic perspective.

A theoretical framework provided by Schmenner and Swink (1998) is used to assess if a theory of Operational Excellence already exists. The literature is reviewed with the aim of testing if Operational Excellence stands up to the five tests of a good theory, proposed by Schmenner and Swink (1998). Namely,

- 1) *The phenomenon for which explanation is sought should be clearly defined. This clarity is enhanced by unambiguous measures.*
- 2) *The description of the phenomenon will likely centre on some observed regularities that have been derived either logically or empirically*
- 3) *There should be one or more precise statements of these regularities (laws). Mathematical statements of the laws will naturally help the precision*
- 4) *The theory should indicate a mechanism.... that explains why the laws work as they do and how, and in which ways, the laws may be subject to limitations*
- 5) *The more powerful the theory, the more likely it will unify various laws and generate predictions or implications that can be tested with data.*

The outcome of the assessment of ‘Operational Excellence’ against the above criteria is presented in the main body of this paper. To begin, the paper begins with an overview of the methodology of the systematic literature review applied here.

Systematic Literature review of Operational Excellence

Machi and McEvoy (2009, p. 4) define the systematic literature review as “a written document that presents a logical argued case founded on a comprehensive of the current state of knowledge about a topic of study” The six steps in the process are:

1. Select a topic (specifies and frames)
2. Search the literature (explores and catalogues)

3. Develop the argument (organises and forms)
4. Survey the literature (documents and discovers)
5. Critique the literature (advocates and defines)
6. Write the review (address the topic)

The above framework is used as a basis to present the findings from the systematic literature review on continuous improvement.

Exploring the literature on Operational Excellence.

To obtain a broad perspective on the literature available on the topic, an initial search was carried out on the broader term ‘Operational Excellence’ using Google Scholar which returned 692,000 results. To explore whether there has really been a growth in use of the term ‘Operational Excellence’ in high-quality journals the number of articles in the International Journal of Operations and Production Management that have included the term since 1995 was identified, this is shown in figure 1. To further explore this, three databases were then searched: Emerald, EBSCO Discovery and Science Direct. The search criteria were first applied to each database and the number of peer-reviewed academic articles in each database was considered. A detailed review of these found that the papers in the EBSCO Discovery database were the most relevant for the topic, and hence the literature review focused on this database.

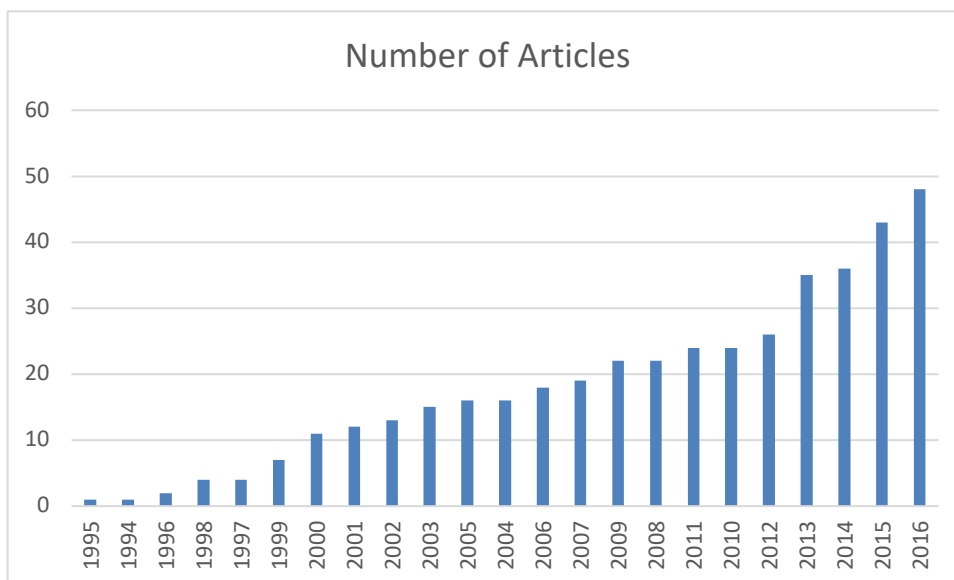


Fig 1: Published Articles on Operational Excellence in International Journal of Operations and Production Management since 1995

Firstly, a very high-level review of all available literature from the EBSCO Discovery database was considered. This returned 5022 documents of which 1050 were academic journals and conference papers. 819 of the academic journal and conference papers were peer-reviewed and to refine the search further the term ‘operational excellence’ was used as a keyword search of just the peer-reviewed academic journal and conference papers and the timescale of the last 35 years. The period 1983 – 2017 was used to ground the search within the contemporary management thinking timeframe since Peters and Waterman published *In Search of Excellence* (Peters and Waterman,

1982) which was influential in focusing management thinking to excel in all areas of the business but, importantly, in the operational effectiveness of the business. However, this paper recognizes that the concept is not new and has a long history but is conscious that it may have had different meanings to managers prior to the publication of *In Search of Excellence*. Previous literature on Excellence includes a comprehensive study of the evolution of Excellence (Dahlgaard-Park and Dahlgaard, 2007), an explanation of the characteristics of Excellence (Dahlgaard-Park, 2013, 2015) and a discussion on decoding the code of Excellence (Dahlgaard-Park, 2009). In addition, this paper specifically does not include the broader concept of Organisational Excellence (OE) or the models of Business Excellence (Dahlgaard-Park and Dahlgaard, 2004; Dahlgaard et al., 2013) that are outside the scope of this study, which focuses only on operations and Operational Excellence.

This refined search returned 33 peer-reviewed academic journal and conference papers that were considered in more detail against the criteria proposed by Schmenner and Swink (1998) to test whether a theory of operational excellence already exists. Before this however, the next section provides an overview of the historical development of Operational Excellence to provide a background to the later critique.

Development of the concept of Operational Excellence

According to Anninos (2007, citing Simaioforos, 2002) the word ‘*aristeia*’ (excellence) derives from ‘*aristos*’ which can be explained as AR= the flow of good that creates ISON which means stability. The Oxford English Dictionary defines excellence as ‘the quality of being outstanding (exceptionally good) or extremely good’ (OED on-line, 2017) whilst operational is from the verb ‘*operari*’ which is expending labour on an activity in which a business is involved. According to Hammer (2004 p. 85) the term operational excellence, or operational improvement, “refers to achieving high performance via existing modes of operation: ensuring that work is done as it ought to be to reduce errors, costs and delays but without fundamentally changing how that work gets accomplished”. Thus, it refers to being of the highest quality and performance in all operations of the business.

The origins of Operational Excellence can be traced to the seminal text of Treacy and Wiersema (1995) entitled “Discipline of Market Leaders which argues that organisations cannot succeed by trying to be all things to all people. As a result, they propose three distinct core disciplines that organisations can use to combine their operating model and value proposition. The three core disciplines are identified as operational excellence, product leadership and customer intimacy. Operational Excellence being described as the strategy for organisations striving to deliver a combination of quality, price and ease of purchase, and service, that no other organisation in their market, or industry, can match. The authors referred to Walmart as a company that epitomised Operational Excellence at that time.

Dahlgaard and Dahlgaard (1999; p. 465) later defined operational excellence using ‘the 4Ps’:

- excellent people, who establish
- excellent partnerships (with suppliers, customers and society) in order to achieve
- excellent processes (key business processes and management processes) to produce
- excellent products, which are able to delight the customers.

The first 'P' refers to importance of 'people', which aligned well total quality management and the knowledge that business excellence could not be achieved without the support from all employees. The second 'P' relates to partnership which referred to both internal (departments) and external (customers, suppliers and society) partnerships. The engagement of people and development of partnerships were aimed at improving the third 'P' (business processes) in order to deliver excellent products and services (the fourth 'P') to the customers

The more contemporary meaning of the term 'Operational Excellence' has its roots in the Lean movement, which is, in turn, rooted in the Toyota Production System (TPS). The term "Lean" was first introduced in 1988 by John Krafcik in the article, *Triumph of the Lean Production System*, which was published in the Sloan Management Review. Krafcik had been part of a team of researchers at MIT that were investigating the competitive advantage that Toyota had built up over western automobile manufacturers in the 1980s. The research findings were published in the book *The Machine that Changed the World* (1990) by Womack, Jones and Roos which became an international best seller, popularising the term Lean and winning the business book of the year 1992. There was nothing new about Lean production, but it had taken an exceptional engineer, Taiichi Ohno, to have challenged the status quo of mass manufacturing and integrated what he had seen as examples of the best practice manufacturing techniques into a cohesive production system.

Following the study at MIT, Womack and Jones (1996) argued that Lean tools and techniques could apply more widely to other industries and sectors outside of automotive and, if a set of guiding principles were followed, any organisation could also implement such a Lean system. As a result, in 1996 Womack and Jones published the book *Lean Thinking* that popularised Lean as a manufacturing production system applicable to any industry. The principles described in Lean Thinking are:

1. Specify value from the perspective of the customer
2. Identify the value stream
3. Make the value creating steps flow
4. At the pull of the customer
5. Strive for perfection

In the West, Lean is thought of as primarily a customer-focussed management system and the five Lean Principles, which are based on a study of Toyota in the 1980s, are generally still held to be true. This Western unitary perspective has not changed fundamentally in the last twenty years, despite many changes in the global economic situation and increasing concerns over the environmental impact of human activities.

In contrast, Japanese *monozukuri*, the art of making products, has become more pluralistic, building on a history and culture of coexistence of humans and nature. In 2005, the Japanese Ministry of Economy, Trade and Industry published a National Strategy for Monozukuri that viewed monozukuri from a socio-economic viewpoint with a vision for the 21st Century economic society that is responsive to the challenges imposed by the limitations of natural resources, the need to reduce the environmental impact and to plan for the post-2007 decline of labour resources. The strategy aims to decrease the burden on natural and labour resources. In consequence, a unitary customer-centric management system may not be sufficient for the 21st century. Corporate websites

for several major Japanese manufacturers suggest that they are following this strategy to achieve operational excellence.

Lean to Operational Excellence

The period 1987 to 1996 is described as a period of theory building in the evolution of Lean (Lamming 1993, 1996; Womack and Jones 1994; Karlsson and Åhlström 1996; Hines and Rich 1997) which was dominated by academic research. The publication of *Lean Thinking* (Womack and Jones 1996) preceded a wealth of practitioner-oriented publications including: Rother and Shook (1998), Spear and Bowen (1999), Liker (2004), and Bicheno and Holweg (2015). Additionally, there was a shift in empirical research from theory building with an emphasis on Lean tools towards theory testing and case study research to validate the models and concepts (Bhamu and Singh Sangwan 2014).

The last decade, however, has seen a shift from the term Lean in major organizations towards that of Continuous Improvement (CI) or Operational Excellence (Op Ex) a term made popular by the Shingo Institute at Utah State University to cover all improvement methodologies. This shift is consistent with the thinking of Richard Schonberger who, argues that management terms have a lifecycle approximating an 'S curve' and that 'Lean' had been in the ascendancy since 'JIT' had started to decline in the late 1980s but was now waning (2012). He puts this down to management fatigue, and suggests that the term Lean is undergoing a similar decline in 2010s to that of JIT in 1980s and that there is a 20-year lifecycle of management terms. He states that, whatever new term emerges, it should fundamentally include the element of time and responsiveness, explicitly mentioning Quick Response Manufacturing (Suri, 1998) as a core constituent.

The term 'Operational Excellence' was used by the Shingo Institute, as the qualification for the Shingo Prize, which builds on the work of Shigeo Shingo, an industrial engineer and one of the architects of Lean, particularly in the development of Single Minute Exchange of Die (SMED) that was fundamental to batch size reduction and flexibility. One of Shingo's important contributions was the recognition of the importance of the inter-relationship of the principles, systems and tools. So, in contrast to the argument that Lean has focused solely on tools (Seddon, 2005), Shingo and the concept of operational excellence taught the principles behind the tools, in five key paradigm shifts:

1. Focus on results and behaviours.
2. Behaviours flow from the principles that govern results.
3. Principles underlie the culture that supports the results long term.
4. Creating principle-based cultures requires alignment of the management system.
5. The tools of Lean, TQM, JIT, SS, etc. are *enablers* and should be used strategically, appropriately and cautiously to better drive ideal behaviour and excellent results.

Although not confined to the Shingo Institute, or indeed to the Shingo Model, Operational Excellence is becoming a business function of 21st century organizations with Operational Excellence (Op Ex) teams replacing the Lean teams of the early 2000s; yet Op Ex suffers from much the same criticisms of Lean (i.e. it is poorly defined, a theoretical and lacking a complete framework). The research on Op Ex, like Lean, is practice-led but without the exemplar of Toyota on which to base the concepts. However, as suggested in Shingo's fifth paradigm shift, Op Ex

includes all the business improvement methodologies and represents a convergence of Operations Management (OM) and Human Resource (HR) philosophies.

In the next sections, we will cover the criteria for a theory based on Schmenner and Swink (1997).

1. *The phenomenon for which explanation is sought should be clearly defined. This clarity is enhanced by unambiguous measures.*

Arguably, if the term is poorly defined from the outset, all subsequent elements of the theory will be imbued with ambiguity. One cannot expect unambiguous measures for something which is ambiguously defined.

Many definitions of Op Ex are based on Lean, TQM and Agile (Powell and Strandhagen, 2012) although most of the papers reviewed did not offer a definition and discussed Operational Excellence in terms of a journey, an aspiration, that goes beyond the application of Lean tools (Houck et al., 2012; Jayaram et al., 2014; Rusev and Salonitas, 2015). Within those that defined Op Ex there were those that stated it was related to customer value, although at lowest cost (Sulaiman et al., 2014; Zacharias et al., 2016) and others to a cost minimisation strategy (Wright, 2016) where an operational excellence strategy generates standardized products without the same level of product innovation business risk. There are, however, many authors that consider that excellence, as well as Lean, TQM and CI, are all firmly linked to organisational learning and transferring knowledge from west to east and east to west (Hermel and Ramis-Pujol, 2003; Calvo-Mora, et al., 2006; Dahlgaard and Dahlgaard-Park, 2007; Dahlgaard-Park, 2006).

Op Ex has been defined by the Institute for Operational Excellence (2012) as achieving a state where every employee can see the flow of value and fix that flow before it breaks down, whilst the Shingo Institute (2013, p. 9) as “a consequence of applying enterprise-wide practices based on principles classified in four dimensions: Culture, Continuous Process Improvement, Enterprise Alignment and Results”. Whilst not defining Op Ex several authors set it within Treacy and Wiersema’s (1993) typology of three strategies for superior customer value: product leadership, operational excellence and customer intimacy (Zacharias et al, 2016). These definitions are very broad but tend to focus on the enablers and principles rather than a precise definition of the constituents.

Hermel and Ramis-Pujol (2003) argue that a definition is unnecessary and would be counter to the principles of continuous change and the dynamic nature of excellence. Undoubtedly the critics of *In Search of Excellence* who point to the failure of many of the “Excellent” companies would point to the difficulties of sustaining excellence in a changing environment. This agrees with the findings of Samuel et al., (2016) who concluded that Lean is polymorphic, meaning different things to different people, and that it is this that has contributed to the longevity of the term.

The lack of definition does not preclude the development of measures and the relative nature of these measures which links to the understanding of excellence being ‘outstanding or exceptionally good’, relative to the sector. Brumme et al., (2015) discuss Hewlett-Packard, who redefined their mission to operational excellence with cost and dependability as the new critical measures. Houck

et al., (2012) discuss a Balanced Scorecard (Kaplan and Norton, 1996) approach to managing operational excellence and value in the forensics service.

2. *The description of the phenomenon will likely centre on some observed regularities that have been derived either logically or empirically.*

Despite the lack of an agreed definition of Op Ex, several articles have observed regularities and common themes around it, linking it to Lean and Continuous Improvement. There has been considerable research into identifying common practices and regularities of all the improvement methodologies. In some cases, the practices have been observed in specific organisations; the collection and practices used by Toyota for example, form the foundations for a grouping of quality improvement ideas which can be broadly classified under Lean. Similarly, the improvement practices observed and developed by Motorola classified as 6-Sigma. Other observed regularities or phenomenon of continuous improvement have been grouped under different titles, such as TQM, Agile or Systems Thinking and it is perhaps a reflection of the number of different groupings of continuous improvement methodologies, that there has also been significant research into comparing the differences, similarities and interconnectivity between them (Bendell, 2006; Dahlgaard and Dahlgaard-Park, 2006, Powell and Strandhagen, 2012).

In summary, it can be argued that some observed regularities around Op Ex have been derived, however it does appear that the regularities have already started to be fragmented under different headers (e.g Lean, 6-Sigma) and even when grouped under the wider term “continuous improvement authors have already begun to identify differences in certain sectors (e.g public or private) rather than looking for commonality across all sectors. Op Ex is an opportunity to unify this under a single concept.

3). *There should be one or more precise statements of these regularities (laws). Mathematical statements of the laws will naturally help the precision*

Schmenner and Swink (1997 p. 99) state that “as hypotheses are supported by more and more evidence, especially evidence of different kinds, they can often be organised into laws”. It appears that no authors have yet appeared to specifically define any fundamental laws of Operational Excellence.

Central to the concept of operational excellence is outperforming along the lines of operational performance, such as: increased customer satisfaction, improvement in quality, improvement in productivity, reduction in variation, reduction in lead-time, decreased inventory and increased operating profits, all of which are governed by laws with mathematical statements and measurements. In addition, there must be a basic direction and organisational desire for movement from a current state to an improved state, along the dimensions of value and time (Fig. 2) which is underpinned by continuous improvement, for which some laws have been defined, such as:

Law of the experience curve: This law states that over time, a process involving people will naturally improve as individuals become more experienced at carrying out the process. This law has been researched in more detail, by Zangwill & Kantor (1998) who propose a mathematical statement around this law, the Continuous Improvement Differential Equation (CIDE).

Law of contiguity and cumulative capabilities: This law, based on The Correlation-Based Law of Effect (Baum, 1973) which states that we can measure all consequences of interactions and activities on a common scale, called ‘value’. Taking this forward to explain the transition between lower-valued situations and higher-valued situation through feedback indicates that the more skills and ideas from different sources are brought together, the higher potential there is for new ideas for continuous improvement. This links the theory to learning, in that the more learning and knowledge is co-ordinated within the organisation, the more likely the improvements will be successful at achieving the specified objectives of value.

Law of focus: Operations that focus on a limited set of objectives will have more success in achieving these objectives than an organisation, or factory, with a wide range of objectives (based on Brumme et al., 2015). This law is a key factor in achieving excellence in operations in that it must be aimed at specified operational objectives and business goals.

Law of trade-offs: (Skinner, 1969) which states that a plant cannot excel in all competitive factors simultaneously. This is contested by Ferdows and De Meyer (1990) who consider that there is a hierarchy and a sequence to building cumulative manufacturing capability that mitigates the trade-offs.

Law of diminishing returns: This law indicates that continuous improvement and, according to Schonberger, management terms, will follow a typical S-curve shape. This explains that, initially, improvement activities may have a big impact on performance, but eventually as the performance is improved, it will become increasingly difficult to maintain the rate of improvement over time. This law is important as it indicates that the impact of operational improvements will not be linear, and organisations must recognise that, to sustain the movement towards operational excellence, new ideas and new approaches must be taken to start a new S-curve improvement. This links also to innovation, as this is the element that can trigger the start of a new S-curve of operational improvement.

Within operations there are many laws that govern flow, such as Little’s Law that describes the relationships between Work-in-Progress (WIP), Cycle Time (CT) and Throughput (T). See Hopp and Spearman (2001), and Hopp and Lovejoy (2013) for detailed description of the physics of operations in factories and healthcare.

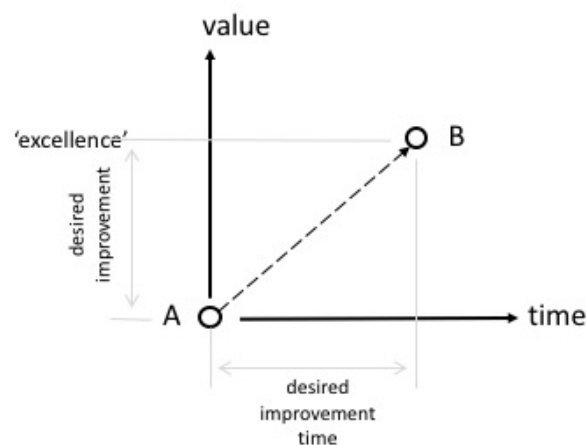


Figure 2: Fundamental Operational Improvement

4) *The theory should indicate a mechanism....that explains why the laws work as they do and how, and in which ways, the laws may be subject to limitations*

In the review of the papers, that we selected, no theories were proposed to explain Op Ex, although the underpinning concepts were firmly linked to Lean and, hence, to TPS, and CI. Schmenner (2012) and Samuel et al., (2016) consider that the underpinning theory of Lean is the Theory of Swift, even Flow. Flow is also the concept behind the definition of Op Ex from the Institute of Operational Excellence. Thus, we argue that this is also an underpinning theory of Op Ex, although this would only partially explain the principles.

Op Ex, as we have discussed is linked to high-performance and being outstandingly good. This infers that an organisation that aspires, or achieves, Op Ex is out-performing in its sector or, as Hammer (2004, p.85) states “achieving high performance via existing modes of operation”. Therefore, Op Ex is about pushing the frontiers. Schmenner and Swink (1998 p. 108 citing Samuelson, 1947) define a performance frontier as “maximum output that can be produced from a given set of inputs, given technical considerations”. The Theory of Performance Frontiers is consistent with data envelopment analysis (DEA) and considers that the maximum output for a given set of operating choices is the production frontier. In this paper, we suggest that Op Ex is achieved when the organisation is operating at, and changing, the production space through ‘betterment’ or laws of cumulative capabilities that move the asset frontier out and changes the shape to give a new operating frontier. At some point the improvement is subject to laws of diminishing returns and a new S-curve of technological innovation is needed to define a new operating space.

5) *The more powerful the theory, the more likely it will unify various laws and also generate predictions or implications that can be tested with data.*

As we have seen by the review of the literature, the term ‘Operational Excellence’ is growing in management thinking, yet, there is no unifying theory. This has led to a wide range of different definitions, models, methodologies and implementation approaches.

One model of Operational Excellence has been developed by Boston Scientific in Galway, Ireland (Found et al., 2017) that addresses some issues that managers of the company had identified over the last decade namely:

- There is a proliferation of models and concepts that go part way to describing Op Ex yet an absence of a single overarching transformation model that clearly identifies all of the necessary elements to implementing and sustaining operational excellence.
- There is an absence of clarity on the critical interdependence of the necessary elements of Op Ex.
- There is a tendency for over-reliance on consultants’ proprietary ‘big picture’ understanding and their tacit experiential knowledge.

It was apparent that no one model/method identified all the necessary elements of implementing and sustaining Op Ex. It also became apparent that the collective knowledge across a range of

separate models and methodologies could be distilled into a single unified Op Ex model that focused on the transformation of the organization’s vision into results (Fig. 3). This model focuses on the alignment of vision to deliver results through products and technologies, supplier and partner relationships, by utilizing and developing skills and capabilities to use an inter-related set of tools, systems with appropriate metrics and controls. This is all under-pinned by a culture and mind-set of improvement and driven by a strategy, set of business goals, under-pinned by values and principles on a foundation of leadership and change management. The model is dynamic as there are two CI feedback loops, the first to the strategy and goals and the second to the leadership and change. The whole is a systems approach to Operational Excellence.

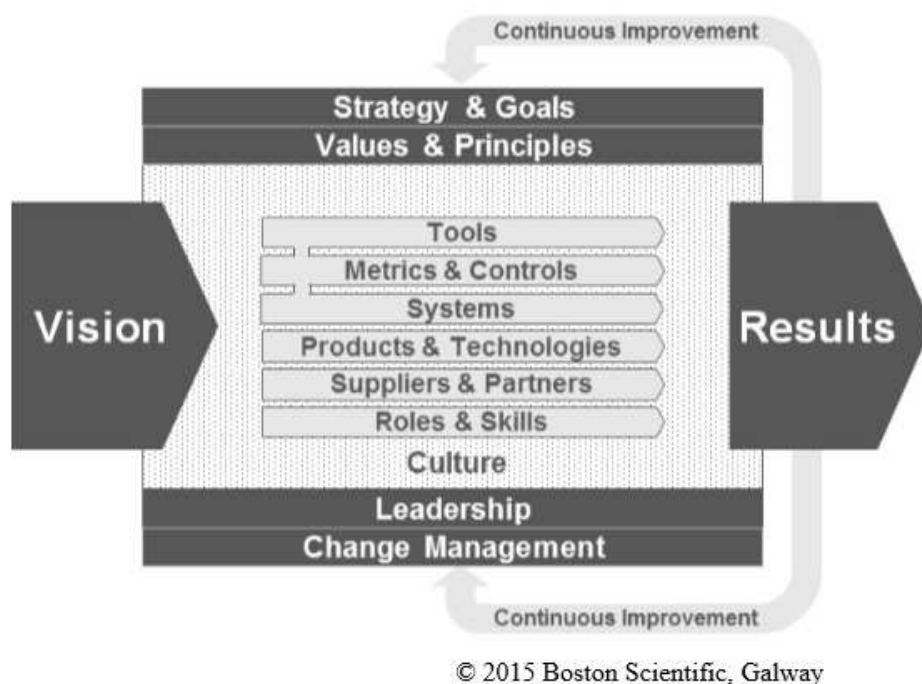


Figure 3. Boston Scientific Strategic Operational Excellence Model

Whilst the model does not, in itself, purport to represent a theory, it does have a strong underpinning theoretical base. The whole model is a system that is built on socio-technical systems theory that acknowledges that the transformation from vision to results is not possible without the full engagement, values and behaviours of skilled and trained people, a committed and capable leadership and a culture of problem solving, continuous improvement and change. However, the people within the organisation need to be supported by the technology, tools and techniques to make it possible, and these socio-technical elements have to work together in harmony. The theory of production frontiers and the theory of swift even flow is implicit in the continuous improvement feedback and quality tools, whilst the model is that of transformation from vision to results.

Conclusions

The aim of this paper was to review the term Operational Excellence and provide clarity in relation to its meaning and identifying the underpinning theories and laws that guide it. It is evident from

our review there is currently no commonly accepted definition or unifying theory of Op Ex but there exists many of the constituents that could be brought together to develop a theoretical approach.

Drawing on published work we have tracked the development of Op Ex and discussed the links with well-established approaches to operational improvement such as Lean Thinking, but we recognise that the time is important for the quality community to establish a set of underpinning theories to guide the future research to avoid the criticisms of the past and to get our research acknowledged fully by the academic and scientific community.

This point in time can be considered in many ways similar to that of the Leadership-Management debate where it is no longer sufficient to just 'manage' operations, it is also necessary to 'excel' in them through Quality, Continuous Improvement, Lean and Agile. In order to do this, we need to define the underpinning theories and theoretical frameworks that guide us.

Here we present one such model, a conceptual model developed as the Boston Scientific Strategic Operational Excellence Model, which provides a whole systems approach to Operational Excellence. To advance our knowledge in OpEx, this model requires further empirically testing with organisations from different industries and sectors. It needs each element to be broken down and explained in terms of the underpinning logic and laws that guide it. If this is possible, it would add to the body of knowledge and help practitioners to transform their business operations beyond Operations Management of the status quo towards one of Operational Excellence. It would also produce frameworks that could be taught in the classrooms, producing the next generation of managers with the skills and competencies required of industry. This progression in theory would also enable movement of boundaries and frontiers in order to meet the challenges and opportunities of Industry 4.0 and for organisations to remain competitive in the 21st Century.

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