Prioritization of Six-Sigma project selection

A resource-based view and institutional norms perspective

Dotun Adebanjo
Business School, University of Greenwich, London, UK
Premaratne Samaranayake
School of Business, Western Sydney University, Penrith, Australia
Fereshteh Mafakheri
Faculty of Engineering and Computer Science, Concordia University, Montreal, Canada, and
Tritos Laosirihongthong
Department of Industrial Engineering, Thammasat University, Pathumtanee, Thailand

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Abstract

Purpose – With increasing choice from a range of programs, improvement project selection within broader supply chain context and resource constraints has become a major research challenge. The purpose of this paper is to investigate the different criteria for selecting Six-Sigma (SS) projects based on previous studies. The study is supported by two grounded theories: resource-based view and institutional norms. The criteria include: first, business drivers for improvement and the common performance metrics deployed; second, the organization's stakeholders needs; and third, process owner's needs.

Design/methodology/approach – To determine the relative importance of influencing factors, opinions were collected from 30 experienced practitioners including SS champions/master black-belts, company directors, consultants, and process owners through a series of interviews in small, medium, and large organizations including multi-national organizations. The evaluation of criteria is based on analytical hierarchy process.

Findings – The results show that impact on customer, financial impacts, and impact on operational goals are the most significant factors in selecting SS improvement project.

Originality/value – This study is a first attempt to determine the relative weight among SS project selection criteria, which help the practitioner to allocate their limited resources in implementing SS project.

Keywords Quality improvement, Analytic hierarchy process (AHP), Business excellence, Project selection, Resource-based view, Six-Sigma (SS), Institutional norms

Paper type Research paper

1. Introduction

Performance improvement is an integral part of overall business strategy for many organizations across service and manufacturing focussed industries. Various improvement programs such as Six-Sigma (SS), Total Quality Management, and Lean involve a number of philosophies and methods such as BPR, statistical process/quality control, quality circles, ISO9001 PDCA, and just in time. In this context, continuous improvement has become a major element of strategy formulation in organizations across a range of

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industry sectors. It aims to provide improvements across a range of functional areas with the focus on both internal and external performance measures. Among various improvement methods, SS is well-established and one of the most recognized continuous improvement methods. Many companies including General Electric (Pande *et al.*, 2000), Texas Instruments, Honeywell, and Johnson and Johnson (Kwak and Anbari, 2006) have successfully implemented this method. SS takes a holistic and multi-dimensional systems approach toward understanding and providing solutions for problems, and thus develops close links between organizational competitiveness, customer satisfaction, and continual improvement. By implementing SS, companies could achieve breakthrough improvement (Juran, 1988) with a dramatic impact, not only on financial benefits, but also customer satisfaction, and operational capability (Harry and Schroeder, 2000).

To implement SS successfully, companies need to ensure that an appropriate organizational strategy, structure, process architecture (Hammer, 1999), and culture has been well-established (Cronemyr *et al.*, 2014; Krueger *et al.*, 2014). These include leadership, the linkages among SS and business objectives and customer needs, and capability of members in the supply chain. It is also important to note that selecting the right SS project and providing adequate resources (finance, time, human, and technology) are other enablers in implementing this technique (Kumar *et al.*, 2009). However, a number of studies have investigated how to achieve the expected outcomes of SS program. These studies have identified the following: the importance of the SS project selection process (Kumar *et al.*, 2009), having clear objectives for targeting improvement efforts (Kornfeld and Kara, 2011), the need for alignment to the strategic goals of the organization (Kendrick and Saaty, 2007), and selection of appropriate method for SS project selection (Kazemi *et al.*, 2012). Organizations typically have limited resources to be dedicated to a wide range of potential improvement projects. Such resources would typically include time, finance, and human resources. It is not conceivably possible to address all potential areas for improvement at any one particular time or over a period of time and therefore, there is a need to be selective in application of SS projects. Consequently, there is a need to prioritize which potential SS projects would be availed of the resources within the organization. However, there is currently very little understanding of the relative importance of the various criteria for SS project selection. The implication is that SS project selection is not necessarily being carried out based on the comparison of multiple organizational factors or an understanding of multiple theoretical perspectives. In this study, two organizational behavior theories are considered through a broader spectrum of SS project selection criteria, associated with financial impact; impacts on customer, operational goals, employees, customers, suppliers; as well as technical and resource feasibility. Therefore, it is important to propose this study which uses analytical hierarchy process (AHP) to rank and compare SS selection criteria. Consequently, this study seeks to understand the perceptions of SS practitioners about the relative importance of criteria for project selection. The study is based on the experiences of organizations in Thailand.

Sandholm and Sorqvist (2002) and Bilgen and Sen (2012) suggested that the prioritization and selection of projects for product/process evaluation and improvement is critical to successful SS implementation. Antony and Banuelas (2002) cited project prioritization and selection as one of the key ingredients of SS program implementation which if it is not done properly will lead to delays and frustration. However, previous studies only quantify experience using selected uni-dimensional measures (Easton and Rosenzweig, 2012). In addition, most of the criteria for project selection are based on

either random choice without justification or a theoretical perspective such as resource-based view (RBV), institutional, and network theory (Auh and Menguc, 2006). Thus, this study addresses this gap in understanding the criteria for SS project selection. The study draws from RBV and institutional theory and links project selection criteria to the strategic objectives of the organization. The structure of the paper is as follows: a literature review on key areas of continuous improvement, project selection criteria from RBV and institutional theory perspective is presented and followed by research methodology, findings, discussion, and conclusion.

2. Literature review

In recent times, continuous improvement initiatives have gained increased popularity in many industry sectors across the globe (Tickle *et al.*, 2015). This has led to increased level of research activity/investigations with a range of studies on various aspects of improvement strategies and their supporting projects. These studies indicate that there are a number of improvement methods being adopted across a range of industries for gaining competitive advantage through the identification of resources and capabilities (de Wilk *et al.*, 2003), assessment of motivation for the adoption of SS (Henderson and Evans, 2000; Moosa and Sajid, 2010; Braunscheidel *et al.*, 2011), and collaboration and partnerships developed with suppliers and evolving relations with customers (De Toni and Tonchia, 2003). In addition, supplier selection is also considered to be a key improvement factor (Chan *et al.*, 2008).

The primary reasons why organizations adopt improvement methods such as SS are to improve performance in key areas such as quality, cost, flexibility, and customer service levels (Thawani, 2004; Karim *et al.*, 2010). In this regard, SS and other improvement methods and philosophies are being adopted across a range of industry sectors with a varying degree of success from both internal and external performance perspectives (Arif-Uz-Zaman and Ashan, 2014). Adoption of such approaches and methods for continuous improvement and their varying levels of success have led many researchers to investigate the selection of improvement methods, for providing the best outcomes such as cost reduction (Bilgen and Sen, 2012), improved efficiency (Banuelas *et al.*, 2005), and return on investment (Swink and Jacobs, 2012). This study focussed on SS which was defined by Pande *et al.* (2000) as follows:

> A comprehensive and flexible system for achieving, sustaining, and maximizing business success. Six-Sigma is uniquely driven by close understanding of customer needs, disciplined used of facts, data, and statistical analysis, and diligent attention to managing, improving, and reinventing business processes.

The importance of studying SS partly lies in its uniqueness among other improvement methods. According to Shafer and Moeller (2012) there are theoretical differences between SS and other improvement methodologies and Parast (2011) argued that the advantage of SS lay in its ability to underpin cross-organization problem solving by enabling a suitable organizational context. Jin *et al.* (2011) suggested that the ability of SS to incorporate statistical tools in problem solving gave it an advantage over other problem-solving tools. However, for all the advantages it can bring to an organization, the implementation of SS is also an expensive and disruptive endeavor. This is because it typically involves major changes to organizational activities as well as the responsibility for these activities (Jacobs *et al.*, 2015).

Given the potential disruption that implementation of SS can cause as well as the significant investment required for such implementation, it is important that

organizations make every effort to ensure its success. There is common acknowledgment that selection of the right project is important to SS success (Kwak and Anbari, 2006). The following section examines previous studies that have examined SS project selection but does not describe the fundamental nature of SS as such description is widely available in extant literature (e.g. Tjahjono *et al.*, 2010; Kwak and Anbari, 2006).

2.1 SS project selection

The selection of projects within a SS program has been described as an important concern for organizations irrespective of whether they are new to the initiative or not (Ray and Das, 2010). According to Padhy and Sahu (2011), the ability to successfully deploy a SS initiative is commonly linked with the selection of the right project and they went further to analyze the importance of making the right choices. They argued that organizations have limited resources and there is an imperative to achieve multiple objectives and maximum business impact within the constraints of such resources. The implication, therefore, is that poor selection of projects can result in expending scarce resources on projects that deliver limited benefits.

Given the importance of the acknowledged link between SS project selection and success, various studies have attempted to address project selection from different perspectives. These include, using analytical methods (Kumar *et al.*, 2007; Kendrick and Saaty, 2007; Yang and Hsieh, 2009; Buyukozkan and Ozturkcan, 2010; Bilgen and Sen, 2012), case studies of implementation of SS in different industries (Motwani *et al.*, 2004; McAdam and Lafferty, 2004) and analyses of SS implementation from a theoretical perspective such as RBV and institutional theory (Braunscheidel *et al.*, 2011; de Wilk *et al.*, 2003; De Toni and Tonchia, 2003). However, many of these studies are limited to selection criteria that are based on singular theoretical perspective or performance perspective. They, therefore lack a focus on the multiple objective dimensions that Padhy and Sahu (2011) suggested are important to project selection.

Thus, there is a need for research on SS project selection based on multiple performance perspectives and theoretical underpinnings. This is because, in practice, organizations are unlikely to only consider one performance perspective when evaluating potential projects. Essentially, different potential projects could lead to improvements in different dimensions of performance and organizations will consider these different dimensions of performance before deciding which projects to prioritize. Thus current project selection approaches are limited because they do not consider influencing factors from a broad perspective.

2.2 SS project selection criteria: RBV and institutional theory perspective

The adoption of organizational theory in understanding SS success was strongly advocated by McAdam and Hazlett (2010) when they suggested that although there were many studies on SS, the link between theory and practice had not been consistently examined. Aside from the study of McAdam and Hazlett (2010) which considered SS from the theoretical perspective of absorptive capacity, Linderman *et al.* (2003) concluded that goal theory is one of the theories for understanding the SS phenomenon. Other studies that have examined SS from a theoretical perspective include studies by Krueger *et al.* (2014) which considered a grounded theory approach to analyzing SS, and Braunscheidel *et al.* (2011) which examined SS adoption from an institutional theory perspective. However, this study examines SS project selection

from a different theoretical perspective by arguing that RBV theory can be applied and used for the purpose of sustaining competitive advantage within the context of SS, while institutional theory can be used to better understand the firm's motivations for selecting projects. The application of such theoretical perspectives to SS project selection is lacking in industry despite the acknowledged importance of project selection and the suggested importance of linking theory to practice (McAdam and Hazlett, 2010).

Table I summarizes the link between decision-making criteria for SS project selection and the two identified theoretical perspectives and also describes the two theories. Table II provides a justification and description of the project selection criteria used in this study. Six criteria are identified, which are project feasibility, financial impacts, impacts on employees, impact on operational goals, impact on customers, and impact on suppliers, respectively. The first three criteria are linked with RBV theory because feasibility and financial impacts have a direct link with the resource efficiency and financial benefits of SS projects while employees are a core resource for the implementation and success of SS projects. The importance of financial impacts and

Organizational theory	Descriptions of theory	SS project selection criteria
RBV	RBV theory has emerged as one of the theoretical perspectives used to explain persistency in inter-firm performance differences (Barney and Griffin, 1992). It is important to note companies have collections of unique resources and capabilities that are valuable, rare, inimitable, and non-substitutable. These lead company to be able to achieve a sustainable competitive advantage and increase the capabilities. Resources could be tangible and intangible assets that are either owned or controlled by a firm, whereas capabilities refer to its ability to exploit and combine resources through operational routines in order to achieve its objectives (Amabile *et al.*, 1996). In order to make the right decision in selecting SS project, this study examines how much the project impact to company's resources, which include technology, financial, and human factor	Feasibility financial impacts Impact on employees
Institutional Theory	Institutional theory suggests that adoption of operational routines is an institutional process subject to the influence of three pressures or forces – coercive (refers the influence of regulatory authorities to influence conformity), mimetic (refers to the pressure to "mimic" more successful competitors in the industry, and normative (refers to market forces usually typified by pressure from customers). It has been argued that normative pressures typically move along the supply chain from customers to suppliers with the customer usually wielding the power (DiMaggio and Powell, 1983). Consequently, some companies may use the leverage of institutional pressures to improve performance while others may seemingly adopt practices to conform to expectations of the market or regulation. In this study, main factors that force company to select the right SS project are: an inquiry made by key and potential customers, benchmarking of operational performances with key competitors, and enhancing supplier's capabilities to sure that the overall performance will be achieved along the entire supply chain	Impact on operational goals Impact on customers Impact on suppliers

Table I.
Justification of SS project selection criteria reflecting the applicability of RBV and institutional theory

Main goal	Criteria	Factors	Description/classification
Prioritization of SS project selection	Feasibility	Technical feasibility	Closely aligned to the feasibility of the project which is one of the five business drivers for prioritizing business process improvement projects (Kendrick and Saaty, 2007)
	Financial Impact	Availability of appropriate resources	Identified as one of the most important strategies for extending the market share, through process and reliability improvement and eliminating the cost of poor quality (Saghaei and Didehkhani, 2011)
	Impact on customer	Cost reduction	Impact on customer and associated factors are directly related to reaching business excellence and competitive competencies which are recognized as main aims of implementing SS projects (Saghaei and Didehkhani, 2011)
	Impact on operational goals	Revenue generation	Direct relationships between effects of management practices on internal process quality and product quality performance and their effects on operational performance and business performance (Brady and Allen, 2006)
	Impact on employees	Customer satisfaction	Closely aligned to the human resources perspective of the balanced scorecard which is one of the five business drivers for prioritizing business process improvement projects (Kendrick and Saaty, 2007)
	Impact on supplier	New business	Globalization and inter-organizational linkages is enabling diffusion of SS throughout the supply chain including suppliers (van der Wiele *et al.*, 2010). The ability of a supplier to link Six-Sigma efforts to customers is important to success (De Carvalho *et al.*, 2014)
		Reduction in cycle time	
		Improved compliance and controls	
		Attract/retain	
		Improved skills and knowledge	
		Mutual benefits	
		Improved capability	

Table II.
Six-Sigma project selection criteria and factors

impacts on employees as a result of SS implementation have been identified by studies which include those by De Carvalho *et al.* (2014), Tjahjono *et al.* (2010), and Padhy and Sahu (2011).

From the perspective of institutional theory, impact on operational goals, impact on customers, and impact on suppliers are important and relevant as these are objectives that could influence the selection of projects and which are attributable to institutional forces. The importance of suppliers, customers, and operational goals in SS implementation and success have been identified by a number of studies including Ray and Das (2010), van der Wiele *et al.* (2010), and Wu *et al.* (2012).

3. Research methodology

This study extends the study of Kendrick and Saaty (2007) by considering two organizational theories – RBV and institutional theory to identify decision-making criteria in SS project selection. The research methodology consisted of two stages. In the first stage, six decision-making criteria, which consist of 12 sub-criteria were identified and prioritized by using AHP. In the second stage, semi-structured interviews were carried out to provide deeper insight into the findings from the first stage.

The AHP proposed by Saaty (1977) is a multiple-criteria decision technique that is capable of combining qualitative and quantitative information in evaluating decision alternatives. It consists of three parts: the hierarchy structure, the pair wise comparisons matrix, and calculating the priorities (through the synthesis of normalized priority weights). Since this study examines multiple decision-making criteria consisting of qualitative and quantitative data, AHP was an appropriate research method. Figure 1 presents the hierarchy structure of SS project selection. Based on the view that most decision makers are not able to handle many factors associated with complex problems (David and Saaty, 2007; Chan *et al.*, 2008), the problem of SS selection, subject to many factors, is broken down into more manageable sub-problems. As such, the SS project selection considered here has three levels of hierarchy: the main goal, criteria, and sub-criteria. At the top level, prioritization of SS selection is set as the main goal, followed by six criteria at the second level of hierarchy. Each criterion of the second level is represented by two factors at the third level of hierarchy.

To construct the pair wise comparison matrices, a panel of 30 practitioners were selected based on their experience. They have been involved in SS projects as master black-belt, back-belt, process owners, green-belts in 30 Lean SS listed good practice companies awarded by Technology Promotion Association (TPA; Thailand-Japan) (www.tpa.or.th). They were either middle or top managers in manufacturing organizations. Table III presents the details of the practitioners who provided input

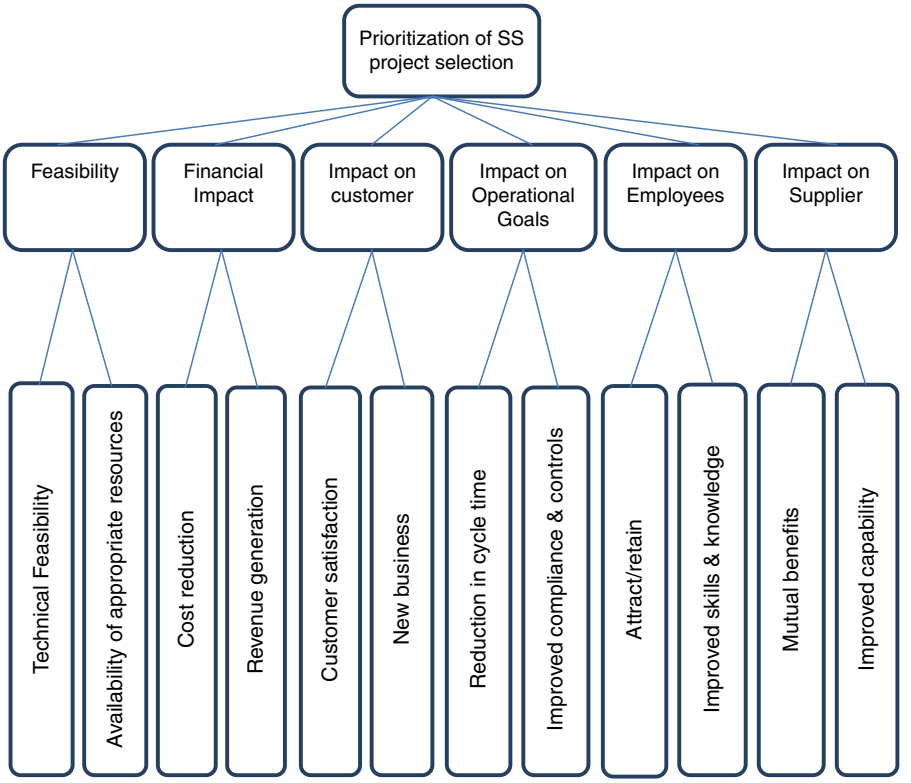

Figure 1.
Hierarchy structure of SS project selection

No.	Section/department	Position	Experience	Types of industry
1	Design and Engineering	Engineer	1Y7M	Home Appliance
2	Design and Engineering	Senior engineer	8Y7M	Electronics
3	Optical Supply Chain	Engineer	7Y	Communication devices
4	Product Development	Engineer	3Y4M	Telecommunications
5	Facility Department	Engineer	2Y6M	Automotive
6	Marketing and Sales	Engineer	6Y	Automotive
7	Engineering	Engineer	5Y9M	Electronics
8	Mechanical Assembly	QA	5Y8M	Electronics
9	Mechanical Assembly	QC	5Y2M	Electronics
10	Quality System	QMR/EMR	10Y	Automotive
11	Draught Beer and Service	Department MGR	8Y	Beverage
12	Production	Engineer	3Y	Electronics
13	Product	Product engineer	7Y	Automotive
14	Planning	Production control	2Y10M	Electronics
15	Production	Production engineer	7Y10M	Electronics
16	Quality control	QC	3Y6M	Automotive
17	Process Engineer	Process engineer	10Y	Electronics
18	Marketing Department	Sales executive	3Y	Automotive
19	Operations Department	Engineer	3Y	Electronics
20	Manufacturing Engineering	Process engineer	3Y3M	Electronics
21	Customer service	Engineer	4M	Automotive
22	Middle Process Section (FPC)	Engineer	4Y	Electronics
23	Quality Management System	Senior engineer II	3Y3M	Electronics
24	Production Department	Section manager	15Y5M	Cement
25	Product Quality Engineer	Engineer	3Y	Electronics
26	Production Control Section	Engineer	9Y10M	Electronics
27	Business Development	Operations manager	9Y	Agriculture
28	System Development	Engineer	2Y8M	Communication devices
29	New Product Introduction	Engineer	8Y	Electronics
30	Regional Production Control	Engineer	6Y	Automotive

Table III.
Qualification of practitioners who carried AHP

for this study. All practitioners were interviewed personally in order to determine the relative weight across six criteria and 12 sub-criteria of SS project selection by using Expert Choice Software. First the relative importance of each criterion with respect to goal was obtained. Next the relative importance of sub-criteria with respect to immediate higher level criteria was obtained. The final weights of each sub-criterion with respect to goal are obtained through the synthesis of normalized priority weights. The acceptable level of inconsistency index among practitioners was 0.10 or less (Bilgen and Sen, 2012).

In the second stage, 14 semi-structured interviews were conducted in five organizations to better understand how SS project was selected based on the research findings from first stage (McAdam and Lafferty, 2004; Su and Chou, 2008). These companies include two Golden Award winners, one Silver Award winner, and two Bronze Award winners given by TPA in 2013. The interviewees were from different management levels or were professional SS practitioners and included project team leaders, senior executives, and master black-belts (Table IV). The experiences of the interviewees in hands-on implementation of SS project(s) made them appropriate candidates to provide the rich detail required by the study.

Furthermore, in order to obtain information from multiple perspectives and consequently, enable triangulation (Yin, 2009), interviews were also conducted with

Company (interviewees)	Nationality	Industry	Experience (in implementing SS (years))
Company A (master black-belt, black-belt, process owner)	Japanese	IC chips	6
Company B (mfg div director, master black-belt)	Thai	Automotive parts	4
Company C (master black-belt, project mgr, consultant)	American	Automotive parts	10
Company D (country mgr, black-belt, green-belt)	Japanese	Electrical appliances	8
Company E (vice president, master black-belt, consultant)	European	Electrical appliances	7

Table IV. Company profiles – semi-structured interviews

suppliers and professional consultants with experience and involvement in SS projects. Each interview lasted between 30 minutes and an hour. Interviewees also provided some documented data obtained from their experience in implementing SS project(s) to support their viewpoints. The primary focus of the interviews was to understand the perceptions of the interviewees on whether the criteria/sub-criteria were suitable or applicable to their organizations in determining whether a SS project should be selected, and how and why do these criteria/sub-criteria influence the success of SS project(s)?

Interviews were conducted in 2014 with five multi-national companies with manufacturing plant(s) in Bangkok, Ayutthaya, and Patumtanee, Thailand. Besides the face-to-face interviews, secondary information from company archives was examined to supplement the study. The details of the interview participants are presented in (Table IV). Among the five companies, company A (the Japanese-owned company) produces IC chips. Companies B and C manufacture automotive parts/components and supply to Japanese and American automaker, respectively. Companies D and E are tier-I suppliers of American and European consumer electrical appliances (i.e. refrigerator, television, air-conditioner, and washing machine).

4. Findings

4.1 Findings from AHP analysis

Figures 2 and 3 present the relative weight among six criteria and 12 sub-criteria for SS project selection (stage 1). The results indicate that impact on customer (0.443), financial benefits (0.21), and achieving operational goals (0.173) are the prominent criteria in justifying which SS project should be selected. Together, these three criteria account for more than 80 percent of the weighting for prioritization of SS project selection. In contrast, the other three criteria, project feasibility (0.082), impact on employees (0.057), and impact on suppliers (0.034) account for less than 20 percent of the weighting. The very distinct differences between these two sets of criteria indicate that SS project selection is primarily performance driven. Customer outcomes, financial outcomes, and operational outcomes are important dimensions of output performance for many organizations. It can be argued that these dimensions have a significant direct impact on the results achieved by an organization, and consequently, its level of success. On the other hand, project feasibility, employees and suppliers can be argued to be more representative of enablers of success rather than dimensions of output performance.

From a theoretical perspective, institutional theory represented by impact on customers, impact on operational goals, and impact on suppliers is the more dominant theory accounting for almost two-thirds of the weighting for selection of SS project. On the other hand, RBV, represented by project feasibility, financial impacts, and impact on employees accounts for only one-third of the overall weighting importance. However, within this classification, financial impacts is particularly prominent and this suggests, that when it comes to resources related to SS, financial resources are seen as being pre-eminent.

Within the impact on customer category, increasing customer satisfaction (0.344) is the most prominent sub-criteria in contrast to new business (0.069) while cost reduction (0.163) is the most important sub-criteria in the financial impact category in contrast to revenue generation (0.086). Within the impact on operational goals category, improved compliance and controls (0.134) is seen as more important than reduction in cycle time (0.031). The implications of these prioritizations are clear – the second level drivers of SS project selection are retention of current customers by improving compliance and control while also reducing cost. This is in stark contrast to using SS to drive new business and improve top-line performance by increasing revenue. At the other end of the scale, the least important of the 12 sub-criteria were, improved capability of

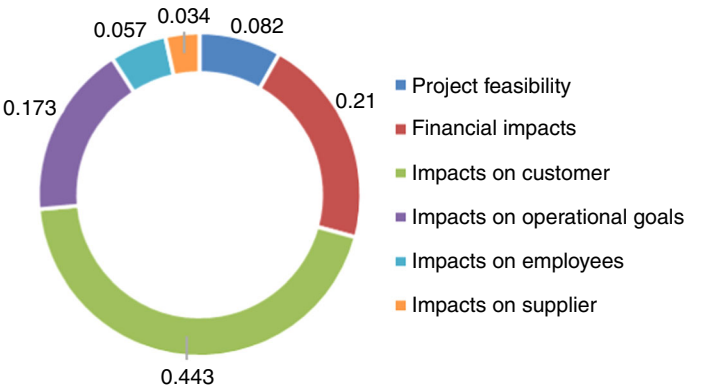

Figure 2.
The relative weights among six criteria for SS project selection (inconsistency index = 0.09)

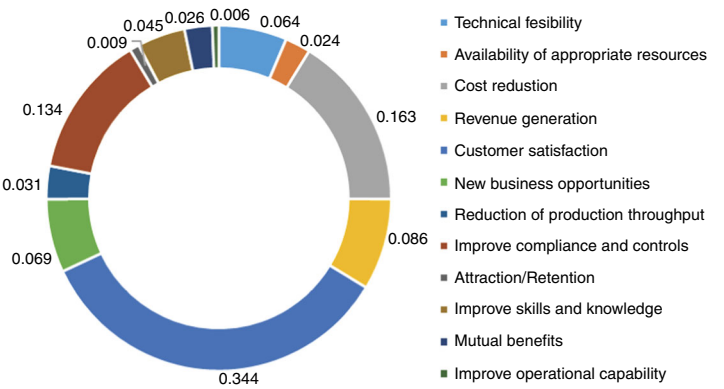

Figure 3.
The relative weights among 12 sub-criteria for SS project selection (inconsistency index = 0.04)

suppliers (0.006), attraction and retention of employees (0.009), and availability of appropriate resources (0.024). The suggestion, therefore, is that these sub-criteria are not important considerations when it comes to SS project selection.

4.2 Findings from the structured interviews

Findings from the structured interviews are presented in this section. In many ways they support the findings from AHP analysis. In particular, the importance of the customer is indicated above all others. According to the executive from company A:

> Our key customers always request us to implement breakthrough improvement program including SS project(s) because they expect to receive the superior products with the minimal cost of production. They (customers) also consider how much achievement (i.e. customer satisfaction level, cost saving, and production yield) we can commit before and after implementing SS as one of order-winner criteria.

This statement suggests that customers are key drivers of the need to consider initiatives such as SS. Perhaps, more importantly, it suggests that customers are seeking achievement of certain objectives such as customer satisfaction and cost saving. This concurs with the findings from the AHP analysis which suggests that customer satisfaction and cost reduction are seen as more important than new business and revenue generation. The implication, therefore, is that not only are customers important drivers of improvement initiatives such as SS, they are also increasingly responsible for determining the objectives that such initiatives should achieve. From the theoretical perspective, the reason why institutional theory is more dominant is customer pressure. A similar view was expressed by company C which has been very successful in implementing SS and was a winner of "Supplier Achievement Program (in 2011, 2012, and 2013)" – recognition from their key customer which is an American automaker. The company's approach to SS project selection was expressed as follows:

> From our five years' experience in implementing SS, we do agree that the most important stage is "project selection". If you or your team decide which project(s)/area(s) of improvement should be selected correctly, 95 per cent achievement will be guaranteed. In our company, we consider two main reason, which are: (i) impact on our major customers (key accounts), and (ii) how much we gain in term of monetary (i.e. cost saving, increasing of sales) and non-monetary (i.e. productivity indexes, customer satisfaction level). Finally, technical feasibility will be carried out among project team members to ensure that we are able to close all selected project(s) within timeframe given by customers.

This view by company C indicates that the key criteria they consider relate to the three most important criteria identified in the AHP analysis – customers, financial impacts, and operational goals. However, it is important to note that the company also identifies technical feasibility as an important enabler of success. Company E, however, examined project selection from a different perspective. The senior executive for company E, based on his experience in implementing SS as a professional consultant (ten years as ASQ certified master black-belt) and project leader (five years as vice president of operations), summarized his concerns on how much benefit the company gains from implementing SS program in terms of human capital as follows:

> As both external consultant and full-time senior executive, I do believe that one of the most influential decision making criteria in SS project selection is how much your human capital assets will be enhanced. As we know, SS project requires high-skill and knowledgeable team who can think, analyse, and suggest all potential opportunities for improvement logically.

Therefore, impact of selected SS project in term of knowledge (technical and non-technical) and skill (problem-solving) development need to be considered before selecting the right project.

This perspective therefore suggests that impact on employees should be seen as important. However, this is not the perspective of the majority of experts, based on the findings from AHP analysis. Table V presents further quotations from the structured interviews related to all six selection criteria considered in this study.

5. Discussion

This study makes an important contribution to knowledge by investigating SS project selection and examining a combination of organizational and theoretical viewpoints. It is also a unique study that examines the topic from two theoretical perspectives (institutional theory and RBV). Furthermore, these two theoretical perspectives are

Criteria	Observations (company)
Customer satisfaction	"Major customers always push us to implement breakthrough improvement initiative on annual basis" (A, B, and C)
	"Efforts in implementing SS way is one of the supplier evaluation criteria" (A and E)
	"Voice of the customer, a common feature of process improvement projects" (D)
Cost reduction	"The main objective in selecting SS project is how much cost can be reduced" (A, D, and E)
	"Specified sets of KPIs (including cost reduction) to search and implement process improvements" (A and C)
Improve compliance and control/cycle time reduction	"Our SS project team frequently apply this initiative to re-design operations process" (D)
	"SS project leader created to act as change agents and to spread breakthrough improvement culture" (B and E)
Technical feasibility and availability of appropriate resources	"Selection of highly motivated employees as trainees"
	"Professional consultants are very important for the successful of SS project" (A, C, and E)
	"Experts in a specific area (i.e. IT, Engineering Design) frequently included in SS project team" (B and C)
Improve skills and knowledge/job retention	"The high level of counter measures in implementing SS project leads to improve skills and knowledge of our project team (i.e. SPC, FMEA, Mistake-proofing, and mathematical modelling)" (B, C, and D)
	"Front-line employees trained to work on improved processes by process" (A and E)
	"Well defined paths for professional development of full-time SS project team members" (B and E)
Revenue generation	"New major customer always ask for SS implementing plan or some example of susses stories as a part of supplier selection criteria" (A, D, and E)
	"Special emphasis placed on data/information to incorporate trade-offs of functional goals in the interest of organizational performance" (B, D, and E)
New business opportunity	"Implementing SS project is one of order-winner for major customer(s)" (C and E)
	"SS implementing plan need to be submitted to customer(s) in order to maintain the business contract" (D and E)
Mutual benefits/ improve capability of supplier	"Use of SS projects to target specific process improvement goals for all of our existing suppliers" (A, B, and E)
	"Selection of highly capable suppliers as our long-term business partners" (B, D, and E)

Table V.
Criteria for SS project selection – findings from interviews

contrasted in order to understand any differences in their impact on SS project selection. Therefore, this study makes an original contribution to understand the selection and prioritization of SS projects. While previous studies (e.g. Kwak and Anbari, 2006; Miguel and de Carvalho, 2014) have suggested that project selection is important for SS and also identified a range of potential criteria for selection (e.g. De Carvalho *et al.*, 2014; Bilgen and Sen, 2012; Grima *et al.*, 2014), this study has set out to prioritize the importance of different criteria while also considering the theoretical drivers that underpin selection. The findings suggest that the selection criteria can be classified into two. The first category relates to performance outcomes and is represented by impact on customer, financial impact, and impact on operational goals.

This category is dominant and accounts for an importance weighing of more than 80 percent. However, closer analysis of these criteria combined with findings from the interview provides a number of interesting insights. First, customers are dominant in the need to implement improvement initiatives such as SS and, second, customers, to some extent, specify the expected objectives of such implementation (e.g. cost reduction). Third, SS project selection is primarily driven by the need to retain customers and reduce costs as opposed to seeking new business and increasing revenue. This is an important finding as it suggests that while businesses typically seek to get new customers and increase their income stream, these are not seen as the most important drivers of SS projects. Rather, companies that implement SS are more likely to seek to gain financially by eliminating waste via cost reduction rather than top-line growth.

The second category of criteria comprises project feasibility, impact on employees, and impact on suppliers. Together, these criteria account for less than 20 percent of selection weighting importance and this study has classified them as enablers. In many ways, the low weights attributed to these criteria come as an unexpected outcome. In particular, the almost negligible importance of attracting and retaining employees is surprising given the criticality of trained SS black and green-belts to the implementation of SS projects and the amount of time, resource, and training required to achieve this status. This caveat was expressed in the interviews by the executive from company E who insisted that employee skills should be an important consideration in SS project selection. The low importance given to impact on employees concurs with the finding by De Carvalho *et al.* (2014) that linking "SS to human resources" is not very important. However, other studies such as Buch and Tolentino (2006) and Tjahjono *et al.* (2010) identified the centrality of employees and their skills to SS success. Therefore, there is still a lack consensus about the relationship between SS project selection and the impact on employees.

The results also show that impact on suppliers, which included gaining mutual benefits with and enhancing capability of supplier is the least important criterion. Given that suppliers and their inputs count as significant contributors to the organization's "transformation tasks," their role was expected to be high but was not. The findings contrast with the findings of Van de Wiele *et al.* (2010) and De Carvalho *et al.* (2014) that SS implementation impacts strongly on suppliers. The findings indicate that from the institutional theory point of view, the impact on customers is much more important than the impact on suppliers. Therefore this study finds that with respect to SS project selection, companies are much more concerned about how the project will impact customers than how it impact suppliers, even though suppliers are important contributors to the processes of an organization.

5.1 Sensitivity analysis

To observe whether variations in the decision criteria would change the final weights of criteria in SS project prioritization, a sensitivity analysis was performed. It is especially important in this study since the weights for criteria and sub-criteria are obtained based on experts' judgments. First, the change in the feasibility weight was observed. Figure 4 presents how the final weights varied with respect to the change in the feasibility. By increasing the feasibility weight, the technical feasibility still is more important than availability of appropriate resources. By increasing the financial impact weight (Figure 5), cost reduction is still more important than revenue generation. For the other four criteria, impact on customer, impact on operational goals, impact on employees, and impact on the supplier, the changes in final weights do not change the priority of sub-criteria. Figures 6-9 present these results, respectively. Finally, the overall performance of the sensitivity analysis is presented in (Figure 10). Customer satisfaction is the most important factor in prioritizing SS project selection. The conclusion, therefore is that the findings from AHP analysis provide a robust indication of importance of selection criteria for SS prioritization.

6. Conclusions

The selection of the right project has been widely acknowledged as an important factor in the success of SS initiatives. Given that selection of such projects can be influenced by different criteria, this study set out to identify if some selection criteria are considered to be more important than others. The study found that impact on customers, financial impact, and impact on operational goals were the most important selection criteria. In contrast, project feasibility, impact on employees, and impact on suppliers were all seen as significantly less important criteria in SS project selection. The study also found that SS project selection is primarily driven by the need to retain customers and reduce costs rather than attain new customers and grow revenue.

The study has important practical and academic implications. From an industrial perspective, there are implications for drivers of implementation of SS projects.

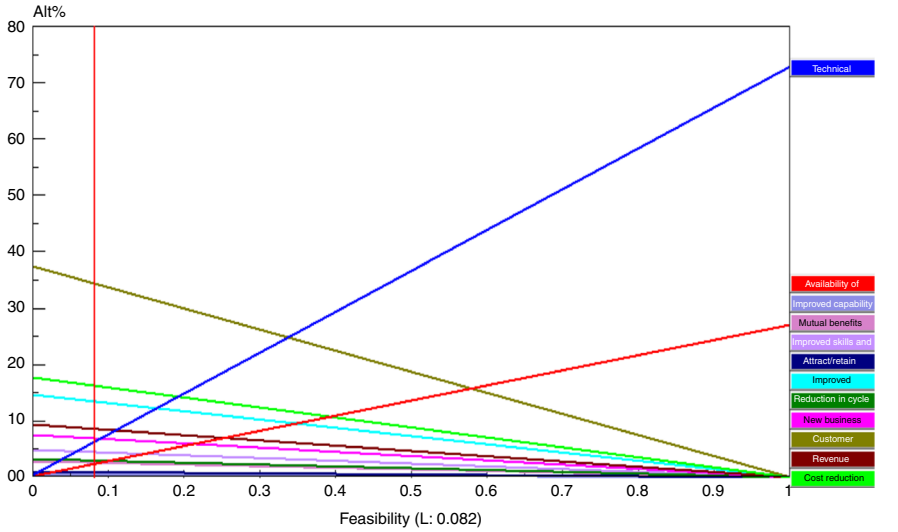

Figure 4.
Sensitivity analysis of final priorities when feasibility weight is varied

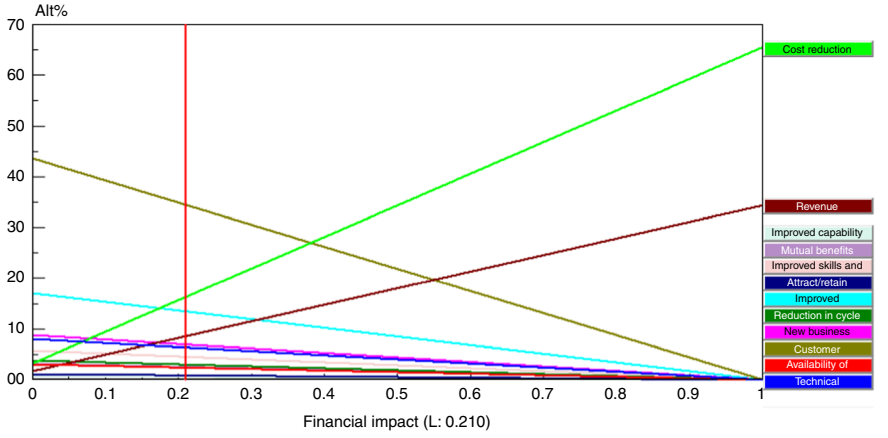

Figure 5.
Sensitivity analysis of final priorities when financial impact weight is varied

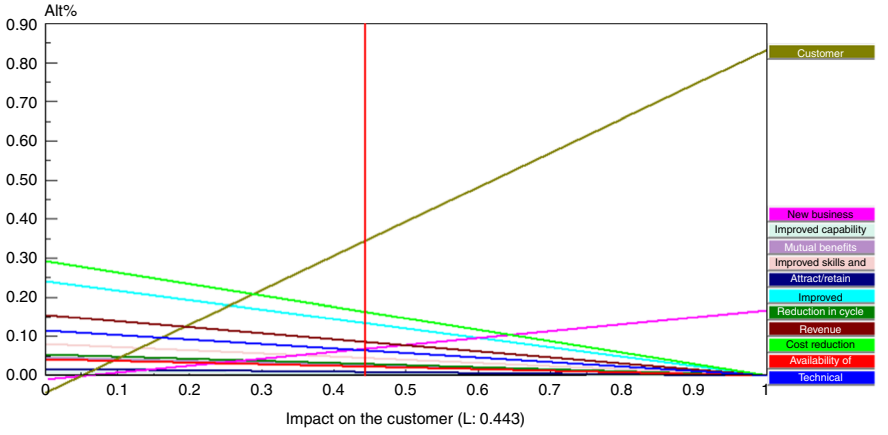

Figure 6.
Sensitivity analysis of final priorities when impact on customer weight is varied

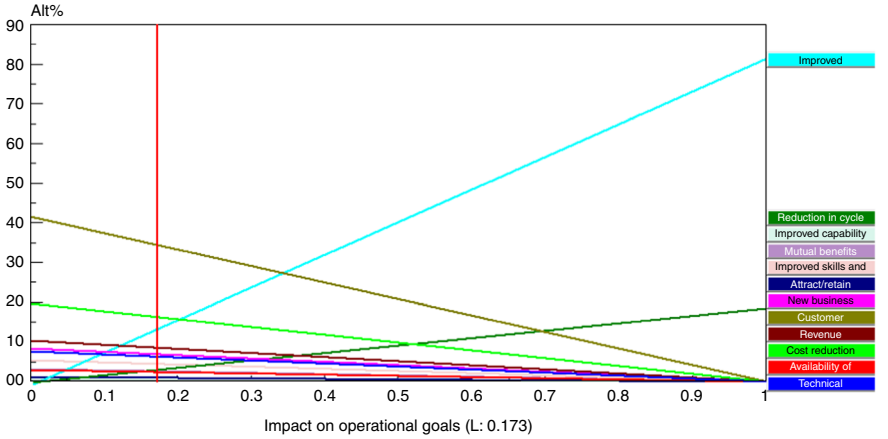

Figure 7.
Sensitivity analysis of final priorities when impact on oprational goals weight is varied

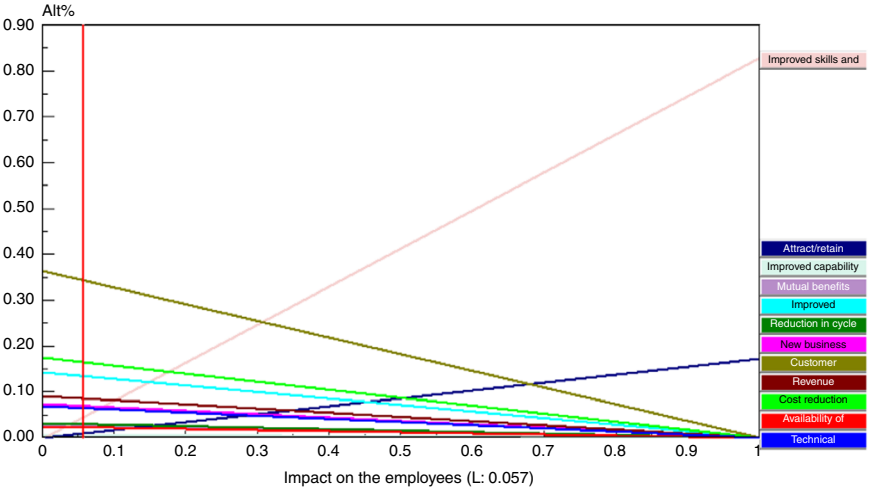

Figure 8.
Sensitivity analysis of final priorities when impact on employees weight is varied

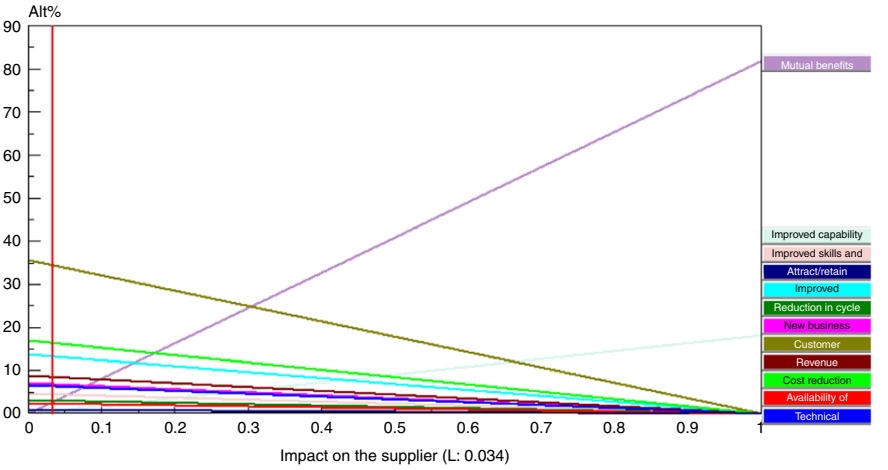

Figure 9.
Sensitivity analysis of final priorities when impact on supplier weight is varied

Organizations need to be aware of the different drivers and potential outcomes that relate to SS implementation. Therefore, when faced with a range of potential improvement projects, there is a need to understand the primary driver and outcomes of each potential project and prioritize selection based on the objectives of the organization (e.g. customer satisfaction). In particular, the finding suggests that organizations need to heed the voice of the customer when it comes to SS project selection. They also need to, simultaneously understand how the project will deliver financial and non-financial benefits to the organization. However, at present, in the drive to satisfy customers, organizations may be failing to adequately attain benefits related to new customers and revenue growth. Therefore, in the selection of SS projects, organizations should seek a better balance between the defensive strategy of customer satisfaction/retention and the offensive strategy of customer growth. In addition, more attention should be given to the impacts on employees and suppliers as these are major contributors to organizational success.

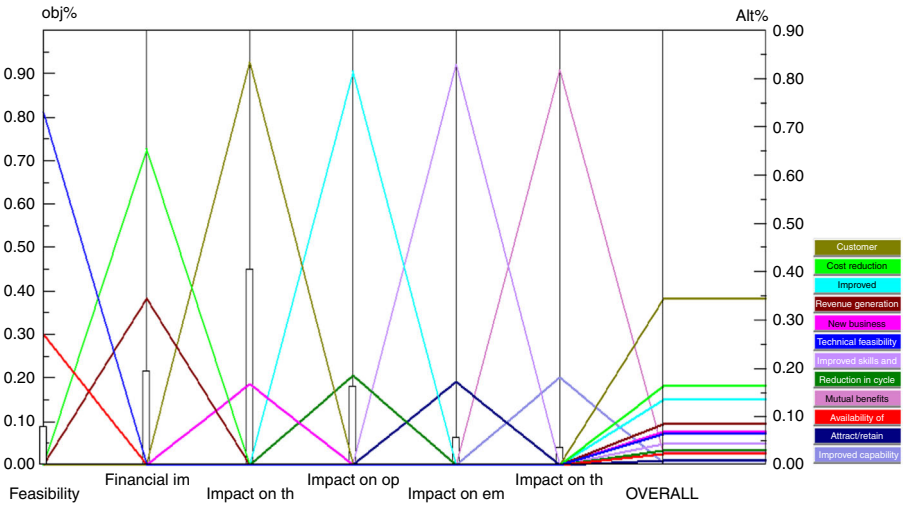

Figure 10.
Overall performance of sensitivity analysis of final weigh priorities

From an academic perspective, the study has implications for the application of theory to SS selection projects. It suggests that there are multiple theoretical drivers for SS selection (e.g. institutional theory, RBV) but that there are significant differences in the importance and influence of these theoretical drivers. This implies that the relationship between theory and SS project selection is not simplistic and needs to be further examined. In particular, given the high levels of skills required for SS certification and the resources necessary for such certification, the relationship between employee retention and skills and SS project selection and success requires further investigation. In addition, given the indicated low importance given to impact on suppliers, there needs to be better understanding of how SS projects affects suppliers and the strategies and approaches that they adopt to compensate for disruptive changes.

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About the authors

Dotun Adebanjo is a Professor in supply chain management at the University of Greenwich. He previously spent several years at the Leatherhead Food International as a researcher, consultant, and trainer to the food industry. Before joining the Business School at the University of Greenwich, he was a senior lecturer at the University of Liverpool Management School. His research interests are in supply chain management, quality management, and the application of new and emerging technology to the delivery of efficient inter-organizational relationships. He has written a book on customer satisfaction and has published his research in several journals and also presented his research at leading international conferences.

Premaratne Samaranayake is a Senior Lecturer at the University of Western Sydney, Australia. He has around 25 years of teaching and research experience and has published a number of papers in top-ranked international journals such as *International Journal of Production Research*, *Supply Chain Management: An International Journal*, *International Journal of Operations and Production Management*, and *European Journal of Operational Research*. His areas of expertise include supply chain management, production planning, business process

management, and enterprise resource planning. He is currently engaged in research collaboration with industry and has successfully completed a number of research projects in recent times.

Fereshteh Mafakheri is currently teaching at the Faculty of Engineering and Computer Science (ENCS) at the Concordia University. She received her PhD in quantitative methods from the HEC (University of Montreal) in 2011. Prior to moving to Concordia, Fereshteh was a Senior Lecturer at the Department of Systems Management and Strategy at the University of Greenwich, London, UK. Dr Mafakheri's research interests evolve around the applications of operational research approaches in production and operations management and sustainability. Fereshteh's work has been published and cited in several top-tier journals.

Tritos Laosirihongthong is an Associate Professor at the Industrial Engineering Department, Faculty of Engineering, Thammasat University, Thailand. His research interests are in supply chain management and international operations strategy. He works actively with a range of organizations in Thailand, Vietnam, and Australia. During 2007-2008, he was appointing by ASEAN Secretariat as the ASEAN Automotive Technical Specialist for the AusAID ASEAN SME Automotive project. Dr Laosirihongthong has published his research in leading journals including *Production Planning and Control*, *International Journal of Production Research*, *Supply Chain Management: An International Journal*, *Technovation*. Tritos Laosirihongthong is the corresponding author and can be contacted at: ltritos@engr.tu.ac.th