

## **Developing a capability model of Six Sigma implementation: a comparative study of CSF of Six Sigma implementation between manufacturing and service sectors in Uzbekistan**

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**Timur Niyazmetov\***

Faculty of Management and Information Technology,  
UCSI University,  
1, Jalan Menara Gading, UCSI Heights,  
Kuala Lumpur 56000, Malaysia  
E-mail: timur\_niyazmetov@mail.ru  
\*Corresponding author

**Kay Hooi Keoy**

Centre of Excellence for Research, Value Innovation and  
Entrepreneurship (CERVIE),  
Faculty of Management and Information Technology,  
UCSI University,  
1, Jalan Menara Gading, UCSI Heights,  
Kuala Lumpur 56000, Malaysia  
E-mail: keoykh@ucsi.edu.my

**Abstract:** This research is intended to carry out a comparative study between key success factors of Six Sigma implementation in manufacturing and service companies in Uzbekistan and develop a capability model of Six Sigma implementation. In the intense competitive environment with customer demanding higher quality products and services, companies look for ways to improve their operational performance to respond to customer expectations. There has been a significant increase in the application of Six Sigma in industry over the past decade. Success stories of organisations that implemented Six Sigma and reaped huge benefits are generating a rising interest of many CEOs and organisations. Organisations need to have a Road Map (a capability model) for Six Sigma implementation before embarking on Six Sigma programmes. Data were collected from a sample of 107 companies in Uzbekistan selected at a random. The research findings showed that key success factors of Six Sigma implementation differ between manufacturing and service companies. Top management factor had been shown to have insignificant impact on success of Six Sigma implementation.

**Keywords:** TQM; total quality management; Six Sigma; key success factors.

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**Biographical notes:** Timur Niyazmetov holds MBA from UCSI University Malaysia. Presently, he holds the position of Sales and Operations Manager at 'East Project Team' LLC Uzbekistan. The company is engaged in export and import business worldwide. Prior to joining 'East Project Team' LLC, he worked at the Ministry of Finance of the Republic of Uzbekistan. His research interests lie in the area of leadership, operations management, business strategy, marketing, e-business, total quality management, finance and entrepreneurship.

Kay Hooi Keoy is working presently as an Associate Professor and he is the Director for the Centre of Excellence for Research, Value Innovation and Entrepreneurship (CERVIE) at UCSI University Malaysia. He also holds the post of Associate Professor at the Faculty of Hospitality and Management (FoHM), Sarawak campus, leading research in the area of eco-hospitality and initiating post-graduate courses. Prior to joining UCSI University in December 2009, he was the Chief Executive Officer at Business Support International Services (BSIS) Sdn Bhd, an IT Business Solution Company based in Cyberjaya, a subsidiary company for Zairi Institute Ltd., UK. The company acts as a catalyst for human capital development, entrepreneurship and business transformation. He is an experienced academician and researcher with over six years of teaching and research experience based in UK (2006–2009). His research interests include operation management, e-business, business performance, entrepreneurship, total quality management to more recently, focusing on green research such as a Green University Framework and Eco-Hospitality.

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## 1 Introduction

As competition becomes more intense, customers demand higher quality products and services, firms look for ways to improve their operational performance to respond to customer expectations (Hammer, 2002). In this setting of intense rivalry among existing competitors and in the pursuit of improved operational performance and satisfied customers, Six Sigma was developed by Motorola in 1987 and targeted an aggressive goal of 3.4 defects per million opportunities (DPMO) (Harry and Schroeder, 2000) and had been recognised as a systematic and structured methodology that attempts to improve processes by eliminating the root causes of defects through focusing on customer needs. There has been a significant increase in the application of Six Sigma in industry over the past decade.

Hammer (2002) reports that in 2002 at least 25% of Fortune 200 companies claimed that they have the Six Sigma programme. However, the implementation of Six Sigma has produced mixed results. While such companies as General Electric (GE) and Motorola report huge savings reflected in their respective net incomes from Six Sigma initiatives (Pande et al., 2000), critics of Six Sigma argue that many quality initiatives (e.g. Six Sigma) will fail because of the intense competitiveness. For example, in 1999, GE spent over half a billion in Six Sigma projects and received over two billion in benefits for the fiscal year (Pande et al., 2000). Six Sigma is the highly statistical quality improvement technique intended to significantly cut costs and rework, eliminate waste, improve business processes and reduce business cycle time (Lloréns-Montes and Molina, 2006).

The major goal of any company is to maximise its shareholders' wealth, which is achievable through improving the firm's long-term business performance. Thus, to improve long-term business performance, the company should ensure its survival in today's growing competitive market environment, i.e. market environment where 'customers are always demanding high quality products and services offered to them' (Gijo and Rao, 2005, p.721). Therefore, to satisfy the customer company should successfully reach the objective of overall quality improvement, namely the improvement of efficiency, quality and productivity (Harry, 1998; Harry and Schroeder, 2000; Pande et al., 2000).

Six Sigma has saved billions of dollars in reduced costs, eliminated waste, rework and reduced business cycles time and significantly increased revenues and profits for famous world corporations. For instance, Ford added ~\$52 million to the bottom line in year 2000, and near \$300 million in 2001; and obtained waste elimination savings of more than \$350 million in year 2002 (Motorola, Inc., 1994–2010). Many organisations worldwide have implemented Six Sigma and achieved remarkable improvements in their market share, customer satisfaction, reliability and performance of products and services, with impressive financial savings (Harry and Schroeder, 2000).

In the intense competitive environment with customer demanding higher quality products and services, companies look for ways to improve their operational performance to respond to customer expectations. There has been a significant increase in the application of Six Sigma in industry over the past decade. Success stories of organisations that implemented Six Sigma and reaped huge benefits are generating a rising interest of many CEOs and organisations. However, there is no pattern for systematic and structured Six Sigma implementation to guide the companies in their Six Sigma effort. Organisations need to have a Road Map (a capability model) for Six Sigma implementation before embarking on Six Sigma programmes. Therefore, this research sets out to develop a capability model of Six Sigma implementation.

Many companies across the globe are beginning to realise the full implications and results of Six Sigma and as a consequence list of companies implementing Six Sigma is growing longer, despite the cost and resources needed for Six Sigma deployment (Green, 2006; Lloréns-Montes and Molina, 2006). Six Sigma has generated a significant interest from many CEO's and in many countries of the world and in many organisations.

Yet despite, Six Sigma delivers significant return on investment and is important in improving firm's performance and particularly the bottom line there is a lack of Six Sigma being acknowledged in Uzbekistan. There are several reasons of Six Sigma not being acknowledged and extensively implemented in firms incorporated in Uzbekistan. The bustling industrial Uzbekistan territory encompasses a vast amount of small and medium firms, most of which do not have separation of ownership and control; hence significantly different from US public company model. Implementing Six Sigma initiative in such small firms is not so simple, since HR training can represent a significant burden for the limited budget of such firms, and the management is not so willing to pool employees from the day-to-day operations as organisational structures are extremely lean and most of the employees represent key roles and have no substitutes. Moreover, any type of organisational change is often perceived as a threat by organisational culture. Therefore, the scope of this research is to carry out a comparative study between key success factors of Six Sigma implementation in manufacturing and service companies incorporated in Uzbekistan to develop a capability model (Road Map) of Six Sigma implementation.

Nonthaleerak and Hendry (2008) in their research pointed out that there is a lack of empirical evidence concerned with critical success factors (CSFs) of Six Sigma implementation, however, at the same time, the latter authors note that all empirical researches that were conducted were limited within a single case study. Furthermore, even comparative studies intended to empirically test the CSFs of Six Sigma implementation followed the single case study strategy, however focusing on different Six Sigma projects nevertheless limited within the scope of a single organisation. Consequently, the significance of this research is justified in terms of conducting by the researcher a comparative study of Six Sigma CSFs between a sample of manufacturing and service companies in Uzbekistan.

## **2 Literature review**

Total quality management (TQM) is a philosophy or an approach to management that stresses a systematic, integrated and consistent perspective involving everyone and everything and intended to significantly improve quality and other business performances of the organisation (Zairi, 2005). TQM is a management philosophy originated in the 1950s and has gradually become more popular since the early 1980s (Brun, 2010). 'Total quality is a description of the culture, attitude and organisation of a company striving to provide customers with products and services satisfying their needs' (Brun, 2010, p.2). Thus, TQM is a management approach focused on quality and customer satisfaction.

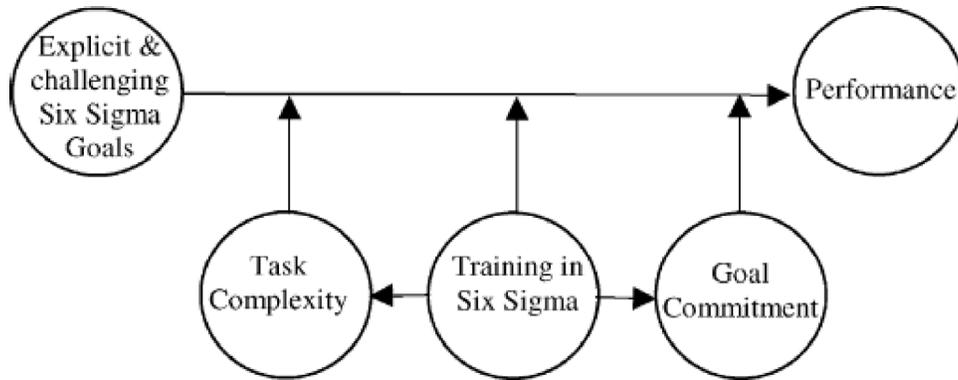
TQM seeks to improve communication and coordination between all departments (from marketing to finance, to design, engineering, manufacturing, customer service, etc.) to focus on customer satisfaction. TQM views a firm as a collection of processes, arguing that a firm must seek ways to continuously improve these processes by utilizing knowledge and experience of every employee of a firm. The fundamental principles encompassed in and characterising TQM in its most general conception are (Hashmi, 2006 cited by Brun, 2010):

- management commitment: in TQM, management should be the driver of change
- employee empowerment, through training, measurement and recognition (for both the teams and individuals), and teamwork
- fact-based decision-making tools
- focus on customer
- continuous improvement.

Linderman et al. (2003) point out that academic research in Six Sigma is lagging behind its practice in the industry. While empirical research is needed to fill the gap between the theory and the practice of Six Sigma, few studies have been carried out to understand the underlying causes of success of Six Sigma projects. Yet different theoretical frameworks have been devised and research carried out to understand the implementation of Six Sigma. Linderman et al. (2003) developed propositions and models concerned with the impact of specified challenging Six Sigma goals on Six Sigma programmes' success (Figure 1).

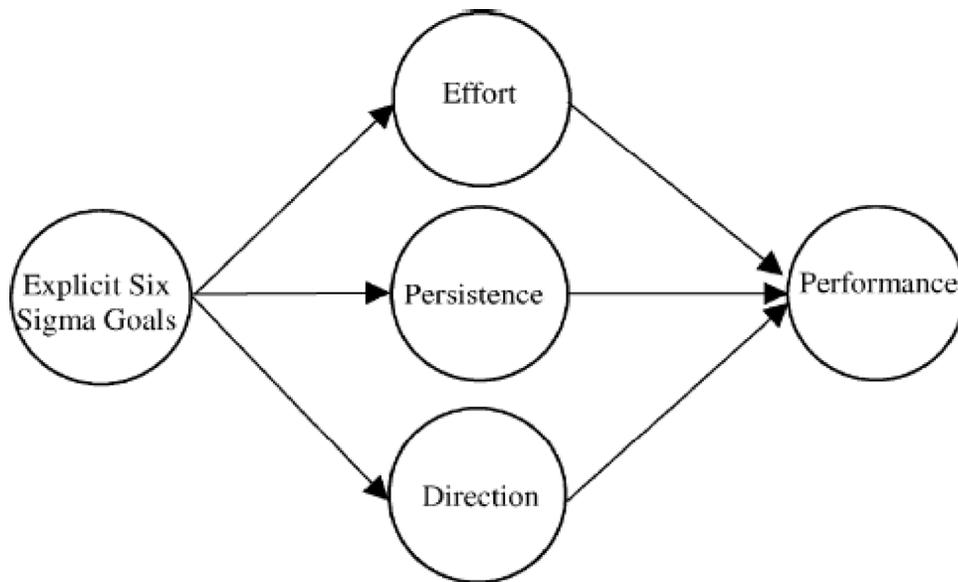
Propositions developed by Linderman et al. (2003, p.196) suggest that ‘Six Sigma projects that employ specific challenging goals result in a greater magnitude of improvement than projects that do not employ specific challenging goals’. Moreover, Linderman et al. (2003) proposed a model with mediating variables concerned with the impact of specific Six Sigma goals on Six Sigma projects’ success (Figure 2).

**Figure 1** Explicit Six Sigma goals and performance



Source: Linderman et al. (2003).

**Figure 2** Mediating variables between Six Sigma goals and performance



Source: Linderman et al. (2003).

The above-mentioned model demonstrates that specific Six Sigma goals impact mediating variables, namely effort, persistence and direction, which in turn affect success of Six Sigma projects as expressed in the following propositions offered by Linderman et al. (2003, pp.199–200):

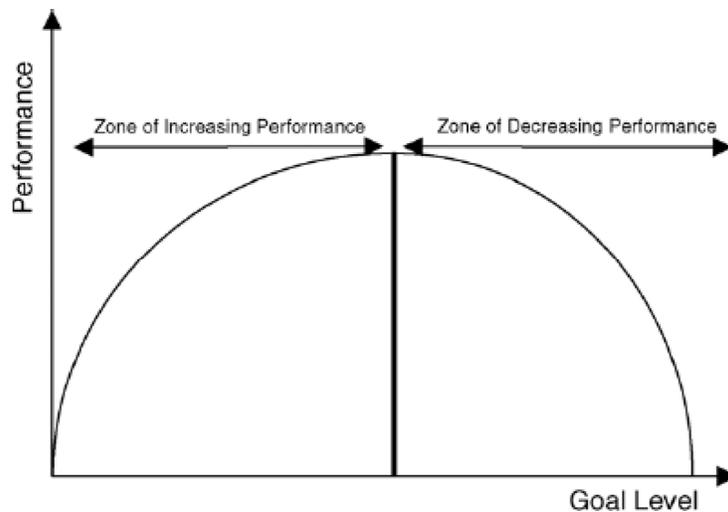
- specific Six Sigma goals result in more team member effort than vague goals
- specific Six Sigma goals result in more team member persistence than vague goals
- specific Six Sigma goals increase team member direction on activities to accomplish improvement objectives than do-best goals.

However, it is worthwhile to note that when Six Sigma goals become excessively challenging, performance actually declines (Linderman et al., 2006) (Figure 3).

The link between the degree of difficulty of Six Sigma goals and performance is evident, i.e. difficult goals result in greater expenditure of effort, which in turn increases performance to the point of diminishing returns.

Despite Six Sigma concept is actively discussed in existing literature, there is lack of theoretical explanation concerned with the patterns and principles of successful implementation of Six Sigma quality improvement programmes, which are not empirically tested. The researcher suggests that such situation is due to the fact that Six Sigma was initially developed as highly statistical quality improvement technique in manufacturing bays of Motorola in the mid-1980s. Later, Six Sigma concept was developed in Six Sigma Academy and considerable number of famous companies successfully implemented it in the USA, Europe and Asia, such as Sony, Nokia, Toshiba, Samsung, General Motors, GE, IBM, etc. These vast corporations have made significant gains concerned with implementation of Six Sigma, for instance Samsung saved \$40 million during the first six month of Six Sigma introduction. The latter and the fact that most of the Six Sigma pioneers and practitioners developed the Six Sigma concept within their particular industry, rather than in universities (Lloréns-Montes and Molina, 2006).

**Figure 3** Goal level and point of diminishing returns



Source: Linderman et al. (2006).

### 3 Theoretical framework and rationale

The researcher suggests that the most comprehensive list of success factors was articulated by Zairi (2005), Deming (1986), Juran (1993), Lloréns-Montes and Molina (2006) and other researchers in TQM and Six Sigma field. These CSFs are top management factor, inclusive of corporate strategy, management leadership, fact-based decision-making, cross-functional project teamwork, reward schemes and explicit and challenging goals; and organisational characteristics factor, inclusive of customer focus, firm internal constraints, organisational culture, continuous training and learning, Six Sigma role structure and company size (Tables 1 and 2).

**Table 1** Identification of top management CSFs

<i>CSF</i>	<i>Definition</i>	<i>Variable</i>	<i>Definition</i>	<i>References</i>
Top management factor	Factor that concerned with managerial issue and is critical for Six Sigma successful implementation	Corporate strategy	Corporate strategy	Gijo and Rao (2005), Morgan (2005), Lee and Choi (2006), De Mast (2006), Dedhia (2005), Coronado and Antony (2002), Nonthaleerak and Hendry (2008), Ramirez and Loney (1993), Deming (1986), Juran (1993), Saraph et al. (1989), Black and Porter (1996), Zairi (2005)
		Fact-based decision-making	Management based on the pure fact, but not on the sixth feel	Morgan (2005), De Mast (2006)
		Management leadership	CEO's and top management commitment to quality programmes, aimed not to merely find and record failures, but to remove the causes of failure, thus improving the performance of people, machines, quality and output	Lloréns-Montes and Molina (2006), Green (2006), Morgan (2005), Lee and Choi (2006), Dedhia (2005), Coronado and Antony (2002), Nonthaleerak and Hendry (2008), Saraph et al. (1989), Ramirez and Loney (1993), Black and Porter (1996), Deming (1986), Juran (1993), Zairi (2005)
		Cross-functional project teamwork	Linking together by top management traditional functions and blurring functional boundaries to integrate all players across the organisation to work together as a team towards greater accomplishment in the organisation's quality performance	Lloréns-Montes and Molina (2006), Green (2006), Lee and Choi (2006), Dedhia (2005), Knowles et al. (2004) cited by Nonthaleerak and Hendry (2008), Black and Porter (1996), Deming (1986), Juran (1993), Zairi (2005)
		Rewards schemes	Mechanism of awarding direct financial and other non-financial rewards to the employees for the achievement of the goals	Lloréns-Montes and Molina (2006), Lee and Choi (2006), Dedhia (2005), Zairi (2005)
		Explicit and challenging goals	Goals can play effective role in quality management	White and Locke (1981), Linderman et al. (2003)

**Table 2** Identification of organisational characteristics CSFs

<i>CSF</i>	<i>Definition</i>	<i>Variable</i>	<i>Definition</i>	<i>References</i>
Organisational characteristics factor	Factor that concerned with organisational issues and is critical for Six Sigma successful implementation	Customer focus	Building customer-driven quality in the organisation by aligning corporate strategy to the customers' requirements, i.e. constant focus on satisfying customers and measuring their satisfaction	Lloréns-Montes and Molina (2006), Green (2006), Morgan (2005), De Mast (2006), Dedhia (2005), Coronado and Antony (2002), Ramirez and Loney (1993), Black and Porter (1996), Deming (1986), Juran (1988) cited by Zairi (2005), Saraph et al. (1989), Zairi (2005)
		Firm internal constraints	Financial, HR and system constraints	Lloréns-Montes and Molina (2006), Green (2006), Gijo and Rao (2005), Dedhia (2005), Nonthaleerak and Hendry (2008)
		Organisational culture	Organisational culture is the sum of collective beliefs, knowledge, attitudes of mind and customs to which people are exposed and which distinguishes one organisation from another	
		Continuous training and learning	A strategy which ensures ongoing training and education, and acquisition of the entire organisation's personnel (including CEOs) new knowledge, skills and abilities which are explicitly linked to implementation to achieve maximum effectiveness	Lloréns-Montes and Molina (2006), Green (2006), Morgan (2005), Lee and Choi (2006), Dedhia (2005), Coronado and Antony (2002), Saraph et al. (1989), Ramirez and Loney (1993), Black and Porter (1996), Deming (1986), Juran (1974) cited by Zairi (2005)
		Six Sigma role structure	Six Sigma role structure is a hierarchical coordination mechanism of work for quality improvement across multiple organisational levels	Henderson and Evans (2000), Zu et al. (2008), Schroeder et al. (2008)
		Company size	A set of company's characteristics that constitute its size value (e.g. annual revenue, number of employees, etc.)	Nonthaleerak and Hendry (2008)

The researcher has identified research that had been conducted in Thailand and intended to investigate key success factors of Six Sigma implementation and disclose the differences between Six Sigma implementation in manufacturing and service industry.

Despite the latter, as pointed out by the authors, ‘the main research limitation is in the number of companies studied and the restriction to companies located in Thailand. In addition, the research is exploratory and future research is needed to look at the issues raised in depth’ (Nonthaleerak and Hendry, 2008, p.279).

#### **4 Top management factor**

Top management factor is concerned with managerial issues of Six Sigma implementation and is critical for programs success. Top management includes six variables, which are management leadership, corporate strategy, fact-based decision-making, cross-functional project teamwork, reward schemes and explicit and challenging goals.

##### *4.1 Management leadership*

Leadership is highly important because Six Sigma implementation effort should be carried out by CEOs or top management executives (e.g. Motorola, Inc., GE). The value of top management commitment to and involvement in Six Sigma is supported by Gopal (2008), who found that one reason Six Sigma implementation failed in many companies was due to the lack of commitment from management, i.e. top management simply pushed Six Sigma programmes out to employees and did not become involved in the implementation process. Furthermore, there must be support and commitment from the top management executives to successfully implement Six Sigma (Coronado and Antony, 2002; Lloréns-Montes and Molina, 2006). According to Harry and Linsenmann (2007), the CEO of DuPont committed complete management support for implementing Six Sigma programmes and ensured that management acquired knowledge about Six Sigma methodology by requiring managers to become Green Belt certified. At DuPont, the Six Sigma programme was not a mere methodology aimed at achieving results, but a management culture (Chakravorty, 2009).

##### *4.2 Corporate strategy*

Corporate strategy can be defined as a long-term plan for achieving corporate goals. To achieve success, companies should align Six Sigma programmes with corporate strategy (Black and Porter, 1996; Deming, 1986; Juran, 1993; Zairi, 2005). Furthermore, Six Sigma as a quality improvement programme should be integrated into corporate strategy to successfully achieving all the potential outcomes of Six Sigma. This notion is supported by Cheng (2007) who argues that firms should implement Six Sigma initiatives via integrating them with their business strategy.

‘Six Sigma cannot be treated as yet another stand-alone activity’ (Antony and Banuelas, 2002, p.23). Six Sigma requires adherence to a whole philosophy rather than a mere usage of few tools, techniques and statistic methods of quality improvement (Antony and Banuelas, 2002). Pande et al. (2000) argue that firm implementing Six Sigma programme needs to be clear as to how Six Sigma projects and other activities link to customers, core processes and competitiveness.

Since the ultimate goal of every firm is to make profits, Six Sigma projects make business processes profitable while attacking process variability which leads costs

associated with defects in processes. In every single Six Sigma project, the link between the project objectives and the business strategy should be identified (Antony and Banuelas, 2002). This coincides with the Six Sigma implementation model developed by Chakravorty (2009) and emphasising the importance of strategic analysis, which is to be market/customer-driven to be undertaken before launching the Six Sigma project.

Six Sigma organisations develop formal mechanisms to select Six Sigma projects (Schroeder et al., 2008). According to Schroeder et al. (2008), these mechanisms, often called *project hoppers*, involve top management to filter out Six Sigma projects that do not have strategic or financial implications (Carnell, 2003; Kelly, 2002).

#### *4.3 Fact-based decision-making*

In research by Schroeder et al. (2008) carried out in companies implementing Six Sigma, one of the interviewees shared the adage 'In God we trust, all else bring data'. This adage emphasises that decision-making within Six Sigma projects is based purely on facts. Data-driven approach to decision-making promotes dialog in Six Sigma project teams based on expertise and data (facts) rather than positional authority and domination (Eisenhardt et al., 1997). Therefore, data-driven approach to Six Sigma projects allows for more effective exploration of the problems and their root cause identification.

#### *4.4 Cross-functional project teamwork*

Teamwork is an essential element of successful TQM implementation which breaks down functional and cross-functional barriers in the organisation. 'One step by 100 persons is better than 100 steps by one person' (Japan cited in Clemmer, 1990 cited by Zairi, 2005). It is obvious from this statement that teamwork significantly improves the problem-solving activities in the organisation; especially cross-functional project teams that blur functional boundaries between departments; thus, allowing team members to develop communication and facilitates exchange of knowledge and skills. Furthermore, teamwork allows more focus on the task given or problem identified; enhance work, for team members help each other in overcoming barriers; synergic response to challenges, i.e. complementary knowledge and skills of a team enables to respond synergistically to challenges and Finally, teams enable flexibility in assembling, refocusing and disbanding (Tan, 1997 cited by Zairi, 2005).

#### *4.5 Reward schemes*

In 1976, Jensen introduced agency theory which stressed that in principle-agent relationships agent will always act in his own interests, thus, agency problem aroused, a problem of inducing agents to act in the best interest of principal. Reward schemes and reinforcement may be one of the hardest parts of successfully institutionalising a Six Sigma programme (Quality Council of Indiana, 2007). This implies that Black Belts (BBs) and Green Belts must have positive career paths to encourage the best candidates and to commit to their extensive training and development required. It is worthwhile noting that when BB skills and knowledge are in demand due to the immense popularity and wide-spread adoption of Six Sigma (Chakravorty, 2009), it is important to recognise and reward the accomplishments of BB specialists by tangible and intangible means.

Moreover, other improvement team members must be recognised for their contribution to performance improvements.

#### *4.6 Explicit and challenging goals*

Research in goal theory shows a strong relationship between goal setting and performance. White and Locke (1981) studied a multinational company and found that goal setting correlated with performance for managers, clerical workers and professionals. Many studies also show a positive relationship between goal difficulty and performance. For example, research by Locke (1967) showed that the performance of subjects with challenging goals were 250% higher than those with easy goals. Goals can play effective role in quality management. Linderman et al. (2003) suggests that Six Sigma projects with specific and challenging goals result in a greater magnitude of improvement than projects that do not employ specific challenging goals.

### **5 Organisational characteristics factor**

Organisational characteristics factor deals with organisational issues in implementing Six Sigma and is important for successful Six Sigma implementation. Organisational characteristics include six variables: organisational culture, customer focus, firm internal constraints, continuous training and learning, company size and Six Sigma role structure.

#### *5.1 Organisational culture*

The importance of organisational culture as a CSF in Six Sigma initiative success is reflected in the culture hindering effects on organisational changes and is supported by Schroeder et al. (2008 cited by Zu et al., 2010), who pointed out for the need of research investigating the question of internal fit in Six Sigma implementation, i.e. what types of firms can successfully adopt Six Sigma and what changes in culture and structure may be required. An appropriate organisational culture is widely regarded a necessity for successful implementation of TQM (Buch and Rivers, 2001; Lagrosen, 2003; Lewis, 1996; Prajogo and McDermott, 2005) and Six Sigma (Antony and Banuelas, 2002; Cheng, 2007; Kwak and Anbari, 2006). However, while the impact of organisational culture on TQM has been extensively studied in the literature, little research has been done to examine the implementation of Six Sigma relative to culture, despite the recognised importance of organisational culture for Six Sigma programmes adoption and deployment (Antony, 2004 cited by Zu et al., 2010).

#### *5.2 Customer focus*

Linderman et al. (2003) defined Six Sigma as an organised and systematic method for strategic process improvement and new product and service development aimed to make dramatic reductions in customer defined defect rates. This definition stresses the importance of customer focused Six Sigma initiative, i.e. improvements and defect reductions must be based on the customer's definition of a defect. Therefore, a key step in any Six Sigma improvement effort is determining exactly what the customer requires and then defining defects in terms of their 'critical to quality' parameters (Linderman

et al., 2003). In fact, the baseline and desired process sigma measure levels are defined based on customer requirements. As a result, customer requirements help to establish Six Sigma project goals, which significantly affect performance (White and Locke, 1981) and direct improvement efforts of Six Sigma teams (Linderman et al., 2003).

### *5.3 Firm internal constraints*

Successful implementation of both TQM and Six Sigma requires having sufficient resources, i.e. financial, system and human resources. Some authors point out that to have full-time BB in the organisation, it might need a considerable amount of cash to be paid (Green, 2006; Lloréns-Montes and Molina, 2006). Furthermore, the management should precisely determine which employees to assign a project team and which to assign to Green Belt and BB positions. Also, the organisation must have adequate system resources to successfully implement Six Sigma.

### *5.4 Continuous training and learning*

Continuous training and learning is considered in both TQM and Six Sigma literature because companies personnel acquires new knowledge, skills and abilities that can be designed in such a way that they can be implemented right away to a particular field of work, thus, improving the quality (Zairi, 2005). The role of training, in the successful implementation of Six Sigma, is fundamental (Quality Council of Indiana, 2007). Needed skills and knowledge for improvements cannot be developed without continuous training and learning.

### *5.5 Company size*

Company size according to Nonthaleerak and Hendry (2008) can play a considerable role in successful implementation of Six Sigma concept. The reasons mostly lie in the field of economies of scale and availability of resources to organisations. The research conducted by Nonthaleerak and Hendry (2008) in nine Thai companies showed that except other reasons the company size (e.g. number of employees) played a negative role in Six Sigma implementation, i.e. small companies had insignificant results.

### *5.6 Six Sigma role structure*

With assigning quality improvement specialist to take different levels of roles and responsibilities in leading the improvement efforts, the organisation builds a Six Sigma role structure for quality improvement. In the Six Sigma role structure, there is a hierarchical coordination mechanism of work for quality improvement across multiple organisational levels (Zu et al., 2008). Thus, for example, senior executives serve as champions for making the organisation's strategic improvement plans and BB reporting to them lead Six Sigma projects and mentor Green Belts in problem solving. This mechanism of Six Sigma role structure helps to coordinate and control work across organisational levels to ensure that the tactical tasks match with the overall business strategy.

## 6 Performance outcome

### 6.1 Improved business performance

Improved business performance refers to the benefits organisation can reap upon success of Six Sigma projects. Pande et al. (2000) identified the following business successes that result from a Six Sigma initiative: cost reductions, market-share growth, defect reductions, culture changes, productivity improvements, customer relations improvements, product and service improvements, cycle-time reductions. Caulcutt (2001) indicates that Six Sigma reduces waste, increases customer satisfaction and improves processes with a considerable focus on financially measurable results (Table 3).

**Table 3** Identification of improved business performance factors

Improved business performance	Reduced manufacturing costs	Financial savings due to reduction in manufacturing cost and rework and elimination of waste in manufacturing process	Lloréns-Montes and Molina (2006), Lee and Choi (2006), Dedhia (2005)
	Increased market share	Acquisition of more market share due to customer satisfaction and cost reduction	Harry and Schroeder (2000)
	Increased financial outcomes	Increased revenues, profits, earnings per share, etc.	Harry and Schroeder (2000), Green (2006), Gijo and Rao (2005), Morgan (2005), Lee and Choi (2006)
	Defect free manufacturing	Defect free manufacturing implies the achievement of Six Sigma level of defects, i.e. 3.45 DPMO or 99.96%	Lloréns-Montes and Molina (2006), Linderman et al. (2003), Breyfogle et al. (2001), Pande and Hollp (2002), Dedhia (2005)
	Reduced business cycle time	The reduction in business processes time	Lloréns-Montes and Molina (2006), Dedhia (2005)
	Increased customer satisfaction	Increased levels of customer loyalty and retention	Lloréns-Montes and Molina (2006), Harry and Schroeder (2000)
	Knowledge acquisition through continuous training and learning	Acquisition of new knowledge, skills and abilities which explicitly linked to practical implementation	Lloréns-Montes and Molina (2006)
	Improved cross-departmental communication	Blurring of functional boundaries and cross-functional teamwork, thus improving cross-departmental communication	Lloréns-Montes and Molina (2006), Morgan (2005)

### *6.2 Reduced manufacturing costs*

Reduced manufacturing costs are financial savings due to reduction in manufacturing cost and rework and elimination of waste in manufacturing process (Dedhia, 2005; Lloréns-Montes and Molina, 2006). There are many examples of worldwide famous companies who achieved significant reduction in manufacturing costs (e.g. Motorola, Inc., GE, etc.).

### *6.3 Increased market share*

Increased market share refers to the acquisition of more market share due to increased customer satisfaction and cost reduction (Harry and Schroeder, 2000). Harry (1998) argues that Six Sigma is a method with a potential to increase market share and profitability.

### *6.4 Defect free manufacturing*

Defect free manufacturing is the major goal of Six Sigma, i.e. manufacturing with defect rate at Six Sigma level, particularly 3.4 DPMO, or 99.96% defect free manufacturing (Dedhia, 2005; Breyfogle et al., 2001; Linderman et al., 2003; Lloréns-Montes and Molina, 2006; Pande and Holpp, 2002). Motorola originally developed Six Sigma in 1987 and targeted an aggressive goal of 3.4 DPMO (ppm defects) (Barney, 2002b; Folaron, 2003 cited by Schroeder et al., 2008).

### *6.5 Reduced business cycle time*

The reduction in business cycle time implies that a company will perform its business operations with less time consumed and as a result will have more free capacities which in turn enable more output available (Dedhia, 2005; Lloréns-Montes and Molina, 2006).

### *6.6 Increased customer satisfaction*

Increased customer satisfaction assumes increased levels of customer loyalty and retention. Both TQM and Six Sigma acknowledge these outcomes of customer focused quality improvement programmes (Dedhia, 2005; Harry and Schroeder, 2000; Lee and Choi, 2006; Linderman et al., 2003; Lloréns-Montes and Molina, 2006; Zairi, 2005).

### *6.7 Knowledge acquisition through continuous training and learning*

Knowledge acquisition through continuous training and learning implies acquisition of new knowledge, skills and abilities which explicitly linked to practical implementation. Teamwork, cross-functional project teamwork, and continuous training and learning facilitate to the knowledge and skills acquisition (Lloréns-Montes and Molina, 2006).

### *6.8 Improved cross-departmental communication*

Improved cross-departmental communications assumes blurring of functional boundaries and cross-functional teamwork, thus improving cross-departmental communication

(Lloréns-Montes and Molina, 2006; Morgan, 2005; Zairi, 2005). Since Six Sigma employs multifunctional teams, communication challenges often occur between diverse organisational members, who may have different interpretative schemes and organisational sub-culture that can hinder understanding. Six Sigma improves communication, particularly communication between organisation functional areas. Institutionalising Six Sigma creates a common language and method, i.e. define–measure–analyse–implement–control (DMAIC) for solving problems (Schroeder et al., 2008). This common language helps to overcome barriers created by diverse interpretative schemes.

## **7 Research objectives**

‘Research objectives – clear, specific statements that identify what the researcher wishes to accomplish as a result of doing the research’ (Saunders et al., 2009, p.600). This research has set up research objectives as followed:

- *RO1*: To identify in existing academic literature the key success factors of Six Sigma implementation that will be adopted in the research.
- *RO2*: To develop a theoretical model of Six Sigma implementation based on key success factors identified in the academic literature.
- *RO3*: To test the model to identify ‘true’ key success factors of Six Sigma implementation.
- *RO4*: To compare key success factors of Six Sigma implementation between manufacturing and service sectors of the economy of Uzbekistan.
- *RO5*: To evaluate the readiness of manufacturing and service companies in Uzbekistan to adopt Six Sigma.
- *RO6*: To develop and propose a capability model of Six Sigma implementation in manufacturing and service companies.
- *RO7*: To present findings and propose recommendations.

### *7.1 Target population*

The full set of cases from which a sample is taken is called the population (Saunders et al., 2009). In this research purpose, the researcher has identified a specific target population: manufacturing and service companies incorporated in Uzbekistan. The researcher has drawn a sample for this research from this target population using probability sampling technique, particularly stratified random sampling.

### *7.2 Sampling frame and sampling locations*

The sampling frame for any probability sample is a complete list of all the cases in the population from which a particular research sample will be drawn (Saunders et al., 2009). In this research project the sampling frame used by researcher is the reference book ‘GOLDEN PAGES’, which is a list companies incorporated in Uzbekistan and estimated

to include 20,000 (Golden Pages, 2010) firms. Therefore, this research project is concerned with the population, i.e. full set of cases of 3,000 firms. This includes both manufacturing and service companies incorporated in Uzbekistan.

### *7.3 Sampling elements*

A sampling element is an individual case or individual unit from the target population. This is the individual unit about which data will be collected. In this research, the sampling elements are manufacturing and service companies incorporated in Uzbekistan.

### *7.4 Sampling techniques*

This research has used probability sampling, particularly stratified random sampling technique. Stratified random sampling technique will be used to draw a sample of firms from the target population in Uzbekistan, which will be sent the questionnaire.

Stratified random sampling technique is a modification of random sampling in which the population is divided into two or more relevant and significant strata based on one or a number of attributes. Attribute is referred to as the stratification variable (or variables) should be representative of the discrete characteristic (or characteristics) for which the researcher wants to ensure correct representation within the sample. However, deVaus (2002 cited by Saunders et al., 2009) points out that in some instances, the sampling frame will already be divided into strata. In effect, the sampling frame is divided into a number of subsets (Saunders et al., 2009). A random sample is then drawn from each of the strata using either simple random or systematic sampling technique. When dividing the population into a series of relevant strata, the sample is more likely to be representative, as the researcher can ensure that each of the strata is represented proportionately within a particular research sample (Saunders et al., 2009). Overall, stratified random sampling technique takes the following pattern (Saunders et al., 2009):

- 1 choose the stratification variable or variables
- 2 divide the sampling frame into the discrete strata
- 3 number each of the cases within each stratum with a unique number, i.e. the first case is numbered 0, the second 1, etc.
- 4 select research sample using either simple random or systematic sampling technique.

The stratification variable in this research project is the type of industry in which the firm is engaged, i.e. either manufacturing or service. Therefore, the sampling frame will be divided into two discrete strata, which are manufacturing and service industry. Then each case within each stratum will be numbered – first case is 0, second 1, etc. After numbers were assigned to each case the researcher will use systematic sampling technique to select the sample of firms.

### 7.5 *Questionnaire design*

Dillman (2007 cited by Saunders et al., 2009) distinguishes between three types of data variable that can be collected through questionnaire:

- opinion
- behaviour
- attribute.

Saunders et al. (2009) argues that such division is important because it will influence the wording of the questions. Opinion variables record how respondents feel about something or what they think or believe is true or false. In contrast, data collected on behaviour and attributes reflect concrete experience of respondents and their characteristics. Behavioural variables contain data on what respondents' practices or plans. While, attribute variables contain data on respondents characteristics. Attributes are things a respondent possesses (Dillman cited by Saunders et al., 2009). Attribute variables are used to explore how opinions and behaviours differ between respondents as well to check that the data collected are representative of the total population (Saunders et al., 2009).

The questionnaire in this research is designed to collect data on all three variables, i.e. opinion variables will collect data on opinion of companies not practicing Six Sigma regarding the CSFs of Six Sigma success. Behavioural variables will collect data on current practices of firms carrying out Six Sigma projects. Finally, attribute variables will record respondent firms characteristics, such as company size and annual revenue, whether BBs are full- or part-time specialists, which valuable information for the purpose of this research.

This questionnaire is using several types of questions, namely rating questions and list questions. It is worthwhile to note that two questions were adopted from other researches, particularly question 4 and 7 in section 'E' from Nonthaleerak and Hendry (2008) and Saunders et al. (2009), respectively. Question 4 is concerned with measuring company size through the number of employees as classified by Nonthaleerak and Hendry (2008): small (10–49), medium (50–250) and large (more than 250). Question 7 is concerned with defining the position of respondent in a company.

Rating questions are often used to collect opinion data. Rating questions most frequently use the Likert-style rating scale in which the respondent is asked how strongly she or he agrees or disagrees with a statement or series of statements, usually on a four-, five-, six- or seven-point rating scale. This questionnaire uses five-point Likert-style rating scale question (where 1 = disagree, 2 = tend to disagree, 3 = neutral, 4 = tend to agree and 5 = agree) to collect data on both opinion and behavioural variables from respondents.

### 7.6 *Pilot study*

Pilot study refers to a small-scale study to test the questionnaire or interview checklist to test the logistics and gather information prior to a larger study to improve questionnaire's or interview's quality and efficiency. Prior to administering the questionnaire to collect data, it should be pilot tested. The purpose of the pilot test is to refine the questionnaire so that respondents will have no problems in answering the questions and there will be no problems in recoding the data (Saunders et al., 2009).

The researcher conducted pilot study of the questionnaire by distributing it to a non-probability sample of 20 manufacturing and service companies. Pilot study participants indicated that questions about current organisations’ Six Sigma practices are not feasible because organisations simply do not practice Six Sigma programmes. Therefore, the researcher has eliminated sections D and E of the questionnaire, which collected data on behaviour variables.

7.7 Hypotheses proposition

Two main hypotheses are proposed to be tested in this framework, namely (Figures 4 and 5):

*H1: Top management has a positive impact on the improved business performance when implementing Six Sigma.*

*H2: Organisational characteristics have a positive impact on the improved business performance when implementing Six Sigma.*

Figure 4 Conceptual framework (see online version for colours)

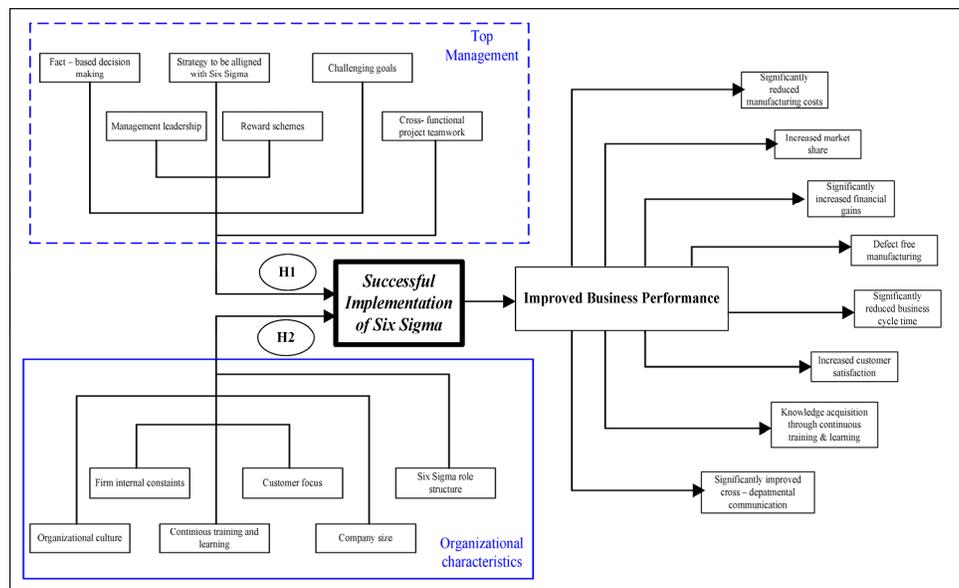
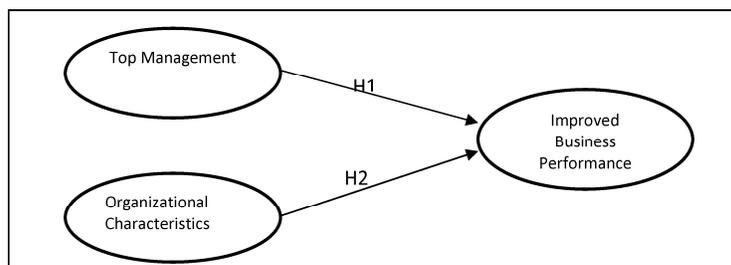


Figure 5 Hypotheses proposition



## 8 Research methodology

### 8.1 Data analysis and results

#### 8.1.1 Respondents' profile

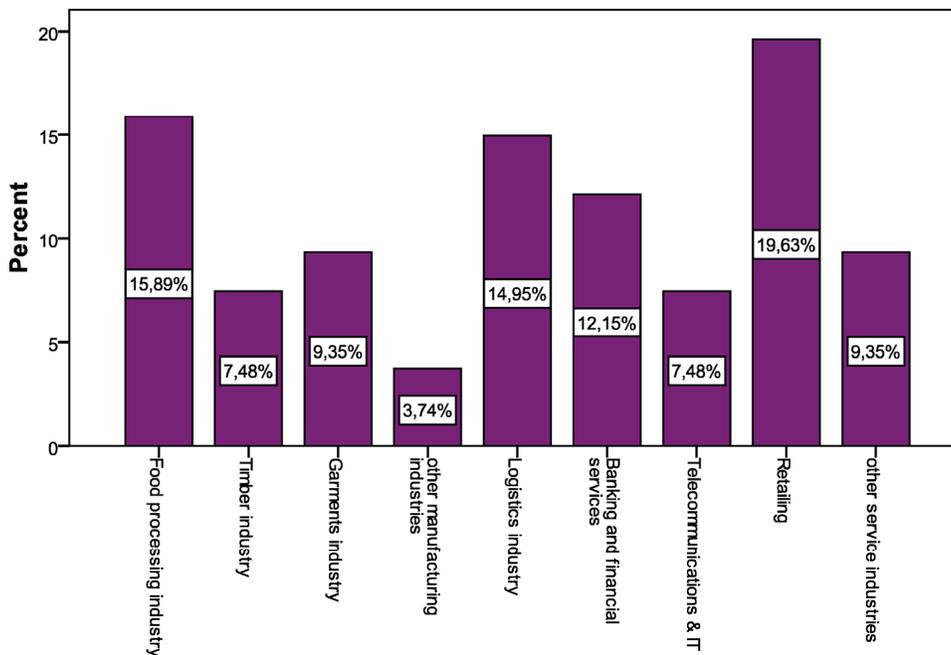
This research was carried out in 107 companies involved in manufacturing and service sectors of economy in Uzbekistan. Out of these 107 companies, 40 companies are engaged in manufacturing and 67 are in service sector. This proportion is illustrated by the frequency table below (Table 4).

The research showed that these 107 companies participate in various industries, such as food processing industry, banking and financial services, telecommunications and IT, retailing, timber industry, logistics and garments industry. As Figure 6 shows, the largest industries within this research are retailing (19.63%), food processing (15.89%), logistics (14.95%) and banking and financial services (12.15%). The remaining industries roughly share the same size of about 8–9% of companies surveyed.

**Table 4** Company's sector of economy

		Frequency	%	Valid %	Cumulative %
Valid	Manufacturing industry	40	37.4	37.4	37.4
	Service industry	67	62.6	62.6	100.0
	Total	107	100.0	100.0	

**Figure 6** Company's industry (see online version for colours)



### 8.1.2 Scale measurement

'Reliability refers to the extent to which your data collection techniques or analysis procedures will yield consistent findings' (Saunders et al., 2009, p.156). The reliability of a scale is a measure of the correlation between scores on the scale and the hypothetical 'true' value (Norušis, 2005). In this research, Cronbach's alpha is used to measure the reliability of the scale. It worth remembering that usually good scales have Cronbach's alpha larger than 0.8 (Norušis, 2005). Furthermore, because in this research scale tapping into several dimensions of the same construct, namely top management, organisational characteristics and improved business performance dimensions, the researcher had measured Cronbach's alpha values on these three factors. Table 5 reveals the Cronbach's alpha values for 'top management' factor, 'organisational characteristics' factor and 'improved business performance' factor.

### 8.2 Multiple linear regression

Multiple linear regression statistics enables to assess the strength of a cause-and-effect relationship between a numerical dependent variable (DV) and two or more independent variables. Below is the multiple linear regression statistics for the proposed theoretical model (Tables 6–8).

**Table 5** Cronbach's alpha

<i>Factors</i>	<i>Cronbach's alpha</i>	<i>No. of items</i>
Top management	0.816	6
Organisational characteristics	0.822	6
Improved business performance	0.869	8

**Table 6** Model summary

<i>Model</i>	<i>R</i>	<i>R<sup>2</sup></i>	<i>Adjusted R<sup>2</sup></i>	<i>SE of the estimate</i>
1	0.547 <sup>a</sup>	0.299	0.285	4.23114

<sup>a</sup>*Predictors*: (constant), organisational characteristics, top management.

**Table 7** ANOVA<sup>a</sup>

<i>Model</i>		<i>Sum of squares</i>	<i>df</i>	<i>Mean square</i>	<i>F</i>	<i>Significance</i>
1	Regression	793,535	2	396,767	22,163	0,000 <sup>b</sup>
	Residual	1,861,867	104	17,903		
	Total	2,655,402	106			

<sup>a</sup>*DV*: business performance.

<sup>b</sup>*Predictors*: (constant), organisational characteristics, top management.

**Table 8** Coefficients<sup>a</sup>

<i>Model</i>		<i>Unstandardised coefficients</i>		<i>Standardised coefficients</i>	<i>t</i>	<i>Significance</i>
		<i>Beta</i>	<i>SE</i>	<i>Beta</i>		
1	(Constant)	11.560	3.198		3.614	0.000
	Top management	0.121	0.107	0.103	1.135	0.259
	Organisational characteristics	0.724	0.132	0.495	5.466	0.000

<sup>a</sup>DV: business performance.

The  $R$  square ( $R^2$ ) is 0.299 (Table 6), meaning that ~29.9% of the variability of business performance is accounted for by the variables in the theoretical model. Therefore, the adjusted  $R^2$  indicates that about 28.5% of the variability of business performance is accounted for by the model, even after taking into account the number of predictor variables in the model. Adjusted  $R^2$  value of 0.285 is quite good given that within business and management research, it is rare to obtain a coefficient above 0.8 (Saunders et al., 2009).

The observed significance level is less than 0.0005 (Table 7), i.e. the results are statistically significant the researcher accepted hypotheses H1 and H2. Because the significance level is less than alpha; therefore, the model with two variables (top management and organisational characteristics) significantly predicted the DV (business performance).

The beta coefficients are the path coefficients leading to business performance: 0.103 from top management and 0.495 from organisational characteristics (Table 8). However, path from top management to business performance has insignificant impact:  $p > 0.05$ .

Such research findings show that in Uzbekistan setting companies should emphasise organisational characteristics factor, which has significant impact on a company's business performance:  $p < 0.05$ . On the other hand, top management factor despite being largely emphasised in a host of TQM and Six Sigma, researches and literature showed to have an insignificant impact on company's business performance in the perceptions of the respondents. Beyond respondents' perceptions such research finding may be attributable to two reasons: either the sample size is too small or the existing sample is not large enough to be representative of the population.

Many researches, studies and literature highlighted that top management leadership in TQM and Six Sigma programmes implementation, Six Sigma projects alignment with corporate strategy and strategic prioritisation of Six Sigma projects, fact-based decision-making (use of DMAIC), employee reward schemes and explicit and challenging goals are key factors for both TQM and Six Sigma successful implementation (Antony and Banuelas, 2002; Black and Porter, 1996; Brun, 2010; Carnell, 2003; Chakravorty, 2009; Cheng, 2007; Coronado and Antony, 2002; Dedhia, 2005; De Mast, 2006; Deming, 1986; Eisenhardt et al., 1997; Gijo and Rao, 2005; Gopal, 2008; Green, 2006; Harry and Linsenmann, 2007; Henderson and Evans, 2000; Japan cited in Clemmer, 1990 cited by Zairi, 2005; Juran, 1993; Kelly, 2002; Knowles et al., 2004 cited by Nonthaleerak and Hendry, 2008; Lee and Choi, 2006; Lloréns-Montes and Molina, 2006; Morgan, 2005; Nonthaleerak and Hendry, 2008; Ramirez and Loney, 1993; Saraph et al., 1989; Schroeder et al., 2008; Zairi, 2005).

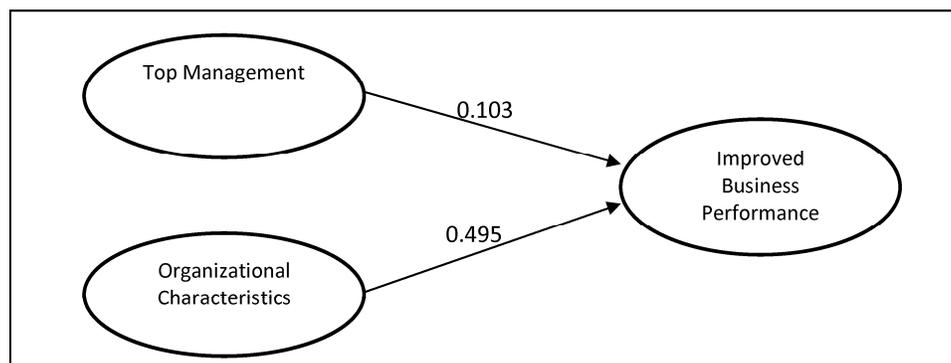
Based on this host of researches and literature, the researcher has concluded that top management factor has significant impact on success of TQM and Six Sigma programmes implementation. Despite that beta coefficients show top management factor has insignificant impact on company's business performance, the researcher suggests that this is a result of respondents' perceptions rather than top managements 'true' insignificance as such.

Therefore, although, *the observed statistical significance level for top management factor is:  $p > 0.05$ , the researcher has accepted the testable hypothesis H1*, i.e. top management has a significant impact on company's business performance (Figure 7). After all, as was noted by Norušis (2005, p.118) "... statistical significance is overrated, too often, it's a poor substitute for careful thought, common sense, and good research practices."

### 8.3 Significance of the research

Nonthaleerak and Hendry (2008) in their research pointed out that there is a lack of empirical evidence concerned with CSFs of Six Sigma implementation; however, at the same time, the latter authors note that all empirical researches that were conducted was limited within a single case study. Furthermore, even comparative studies indented to empirically test the CSFs of Six Sigma implementation followed the single case study strategy, however focusing on different Six Sigma projects nevertheless limited within the scope of a single organisation. Consequently, the significance of this research is justified in terms of conducting by the researcher a comparative study of Six Sigma CSFs between a sample of manufacturing and service companies in Uzbekistan.

**Figure 7** Regression results for hypothesis H1 and H2



#### 8.4 *Limitation of the research*

It is clear that this research project has limitations because there is no perfect study. Limitations of this study are mostly stem from sampling design used. When applying probability sampling, the researcher must identify a suitable sampling frame, which is based on research question(s) and objectives. It is important to ensure that research sampling frame is as complete, accurate and up to date as possible. It is worthwhile to note that sampling frame, which was identified by the researcher as firms registered in Golden Pages is incomplete, which is a limitation of this study. Saunders et al. (2009) argues that an incomplete or inaccurate sampling frame means that some cases will have been excluded and so it will be impossible for every case in the population to have a chance of selection. Therefore, the sample may not be representative of the total population and generalisability of findings will be questioned. Furthermore, despite top management factor was emphasised as key ingredient for successful Six Sigma implementation by a host of research in Six Sigma field, this research's findings showed that top management has insignificant impact on business performance. Such findings may be caused by two factors: either the sample size is too small or the existing sample is not large enough to be representative of the population. Thus, findings generalisability, i.e. findings practical applicability to other settings, is a main limitation faced by this research project.

#### 8.5 *Proposed future research*

Despite the limitation discussed, this research contributes to empirical research in the field of Six Sigma. The findings of this research suggest that companies have to emphasise organisational characteristics factor to attain to reap the full benefits of Six Sigma implementation. Top management factor despite being stressed in a host of research and literature on both TQM and Six Sigma had been shown to have insignificant impact on success of Six Sigma programmes implementation. Further research in Six Sigma field may investigate in deep the impact of top management factor on success of Six Sigma implementation. *Another area of desired research is to test the proposed research capability model (Road Map) of Six Sigma implementation.*

Another area of suggested research may be to study more closely the impact of explicit and challenging goals, and cross-functional project teamwork on success of Six Sigma implementation. Contrary to research findings of Nonthaleerak and Hendry (2008), which showed that company size plays considerable role in success of Six Sigma implementation, i.e. small companies obtained insignificant benefits, findings of this research proved the opposite – company size showed to be not significant factor in success of Six Sigma programmes implementation. Because the amount of benefits from Six Sigma implementation is mainly attributable to the economies of scale and is not related to company size as such but the size of a given company market share. This implies that although a company's size may be small in terms of number of employees as classified by Nonthaleerak and Hendry (2008), the company may have big market share and still benefit largely from Six Sigma implementation. Therefore, future research may focus on scrutinising the impact of firm size classified as a given company's market share on the company's ability to reap the full benefits of Six Sigma implementation.

## 9 Conclusion

Six Sigma is becoming increasingly popular in various industries and organisations across the globe. Success stories of organisations that implemented Six Sigma and reaped huge benefits are generating a rising interest of many CEOs and organisations. However, there is no pattern for systematic and structured Six Sigma implementation to guide the companies in their Six Sigma effort. Organisations need to have a Road Map (a capability model) for Six Sigma implementation before embarking on Six Sigma programmes. This research had developed and proposed a capability model of Six Sigma implementation.

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