
Total quality management elements and risk resilience at the operational level

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Abstract: The complex and systematic methods of risk management are not always suitable for addressing the risks in the operational level and the activities performed by blue-collar workers. This study is focused on such risks and how they could be mitigated without employing complex mathematical risk management approaches, which can be difficult to implement at the shop-floor level. In fact, the literature review here conducted revealed a significant gap in the research on risk management at this level. The central stage of the study was a field survey, which was focused on the potentials of total quality management (TQM) to address low-level activity risks. The findings confirm an interrelation between TQM and risk management, and they also reveal that trust and integrity are the most effective elements of TQM that can help to mitigate risks related to the blue-collar workers' activity.

Keywords: risk management; risk resilience; TQM; total quality management; BCWs; blue-collar workers; shop-floor risks; resilience engineering; operation management; operational risks.

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1 Introduction

Continuous improvement and quality management methods are commonly employed by manufacturing companies to sustain their business, but uncertainty and risks affect production activities, and they can be severe threats to achieving their goals. It is common practice in project-based firms to classify risk levels into four categories (project level, function level, portfolio level, and enterprise level)(Arena et al.,2013) and devise risk management plans at the strategic or middle management levels, in which the mitigating measures can be identified by means of mathematical models and are usually carried out by decision makers with a specific area of authority. However, some risks can affect activities at the operational level where blue-collar workers (BCWs) are involved; in such contexts, complex mathematical approaches are not always suitable for solving problems, as their use may require high amounts of data and specific expertise.

The literature review conducted in the present study shows that the existing risk management methods are suitable for the project or portfolio level, but there is scarce reference to methods for shop-floor risk management. This is a significant gap in the risk management body of knowledge. As a matter of fact, this study aims to offer a contribution to address this methodological gap. In order to devise an effective risk

management plan at the operational level, a first question can be posed: what are the most significant risks for BCWs? This paper presents an investigation that has been conducted to identify what kinds of risk are associated with operational activities. A second question involves the methodological aspect of risk management at that level. It has been observed that total quality management (TQM) is grounded on the concept of continuous improvement, which encompasses the whole organisation. Therefore, from the TQM perspective, each individual worker is an essential part of the overall production process of the company and contributes to building the resilience of the working environment. Subsequently, the second question addressed in this paper is: does TQM have the potential for supporting risk management in the activities performed by BCWs? To sum up, this study aims to investigate the potential positive effects of TQM on risk management at the shop-floor level. In the following sections, two methodological stages will be illustrated: a literature review aimed at identifying the most important risks at the operational level, and a field survey of the potentials of TQM on risk management and resilience. The results of the literature review and survey will be reported and discussed in the light of the connection between TQM elements and potentials of risk management.

2 Methodology

In order to address the research questions, this study consists of two main stages: a literature review and a field survey.

2.1 Literature review

The first stage was aimed at surveying other studies that propose a solution for risk assessment regarding BCWs and/or investigate the use of TQM for risk management at the operational level. To this aim, the literature review includes three sections: the first identifies the key TQM elements, the second lists the risks connected with operational activities and the third collects the papers that are relevant to the research questions. Two databases were utilised for the survey: Scopus and Google Scholar. The advanced search feature of Google Scholar was used without exclusion criteria and limits on the publication year, authors and affiliations, and combining keywords. The results were sorted according to their relevance and the first 20 papers were examined. The advanced search query of Scopus was also used to find studies about the investigated topics. This feature allowed us to combine keywords with operators such as AND and OR. There were no exclusion criteria and all source types and subject areas were included in the search query. The search included a combined field that explored abstracts, keywords and paper titles.

In order to identify the key TQM elements, the keywords of the query search were combinations of words from two lists. The first list contained 'TQM' and 'Total Quality Management' and the second list included 'elements', 'factors', and 'pillars'. The body of knowledge in TQM is clearly structured and the elements are well defined in the literature. As for risk management, the keywords were combinations of two lists. The first list included 'risk' OR 'threat', and the second list 'Low*level work' OR 'Low*level activit*' OR 'blue*collar' OR 'shop*level work' OR 'shop*level activit*'.

Only 12 papers indexed in SCOPUS emerged from this research, which shows a possible gap in the present literature.

To limit the following examination of papers, only papers written in English were selected. Subsequently, a group of TQM principal elements was selected from the literature by the authors, and the types of risks at the operational level that are associated with the TQM elements were extracted.

2.2 *The survey*

The second stage of the study was focused on the main goal, namely the investigation of the potentials of TQM to manage risk in the activities performed by BCWs at the shop-floor level. The first step of this stage was to identify and classify the key elements of TQM and the types of risks that could influence the objectives of BCW activities. Some case studies show that operational risks are addressed by project, operations or plant managers as they are primarily held accountable for the impacts of risks on the objectives, even if the BCWs are directly involved. In many production environments, in fact, BCWs have a limited participation in management and they do not have the authority to make decisions about the best strategy for addressing risk. To answer the second question of this study, we propose to investigate the potentials of TQM and its positive effect on risk management at the shop-floor level.

A survey was designed and administered by means of a questionnaire to practitioners, managers or consultants, of several companies. The questionnaire was semi-structured: the questions required the interviewee to grade the existing risks at the operational level, the importance of each risk regarding TQM elements and the potentials of TQM in managing them; finally, some questions concerned the respondents' organisation. The questionnaire also included some open-end questions about the interviewees' personal idea about the mitigating effects on risks of the implementation of quality programs or tools carried out by their company. Face validity has been established to improve the validity of the questionnaire. The questionnaire was implemented in SurveyMonkey® and the link to the questionnaire was distributed through email; the link was open for 37 days and 30 responses were collected during the period. Taking part in the survey was voluntary and it took about 10 min –according to SurveyMonkey® report and analyses – to be completed.

The face validity was considered by using standard samples and similar surveys, which are available in SurveyMonkey® sample collection. The first 10 answers were separated to test the reliability of the questionnaire and compared with the remaining 20. The 30 respondents belong to different production and service sectors: 44.83% work in project-based businesses, 24.14% in manufacturing companies and 31.03% in service companies. 13.79% of the respondents work in companies with less than 50 employees, 31.03% in companies with between 50 and 249 employees and 55.17% in companies with at least 250 employees. The field survey targeted only managers and consultants. BCWs were not interviewed as it had been difficult to reach a significant sample of BCWs having a sufficient knowledge of concepts like risk, risk management and TQM, which were key aspects of the study.

3 Results

3.1 Results of the literature review

3.1.1 TQM elements

Powell claimed that the basic concept of TQM can be traced back to 1949 (Powell, 1995), but its role in quality management became relevant in the mid-1980s (Martínez-Lorente et al., 1998). TQM is an approach that considers the entire process of production or service, so it could be a potential tool for an integrated risk management in the entire operations (Creech, 1994; Houston and Dockstader, 1988; Mar Fuentes-Fuentes et al., 2004). The survey of the literature produced a list of categories of TQM elements according to their essential aspects (Table 1). In order to address the problem of uncertainty and risk in operational activities, an integrated approach is required. This approach should not exclude any of the components of the process at that level in the company. In short, to tackle the risks in low-level activities, every individual, who plays a role in achieving the company's goal by carrying out an activity, is important. However, all individual parts work as a team in the process that produces and delivers an organisation's value proposition (goods or service). The process perspective, underlined in TQM, is also suitable for addressing the risks at the operational level. The TQM elements, listed in Table 1, are mostly associated with both BCWs and managers, and connections can be found between some of them. For example, 'Trust' can be the result of the interplay of two other elements in the list: 'Ethics' and 'Integrity'; trust should be established between all members of the organisation since a trustworthy work environment can produce more reliable decisions and build a resilient work environment. In the remaining of the paper, the potentials of TQM will be investigated as a strategic solution for risk management at this level.

Table 1 TQM elements

<i>Category of TQM elements</i>	<i>Sub elements of TQM</i>
Foundation	1 Ethics
	2 Integrity
	3 Trust
Framework	Communication
Practical measures	1 Training
	2 Teamwork
	3 Leadership
Supportive element	Recognition

3.1.2 Risk in operational level activities

A general rule for success in any activity includes predicting the problems and finding effective solutions. However, in every scheduled operation or project, the effects of future risky events become more important because they can present themselves as threats or opportunities (Snyder, 2014). In addition, a plan to manage risks and its consequences are required (Pritchard and PMP, 2014). In this situation, before making any decision, it is critical to identify the risks, their roots (Kasap and Kaymak, 2007) and

consequences; so managers need to use risk management models to address risks as a way to optimise the operation or project performance (Aghazadeh Ardebili et al., 2017). As far as low-level activities are concerned, while several kinds of risk can affect them, using the existing models and risk management tools can be problematic because of the quantitative and probabilistic assessments that they employ (McNeil et al., 2015; Raz and Michael, 2001), the complexity of uncertainty and the embedded challenges of risk management (Beck, 1992, Kajüter, 2007, Arena et al., 2009, Miller, 2009). For instance, Arena et al. (2013) suggested a new method for risk management, but they considered risk management as an activity carried out just by company managers at the middle or high levels of the organisation; indeed, they argue: ‘risk management has always been high on managers’ agendas’. These studies seem then to confirm that the existing risk management tools are more suited for highly skilled managers than for operatives who, on the other hand, are directly affected by the consequences of uncertainty. Indeed, these risks could adversely affect the safety of the workers, the production process and the quality of the final product or service. Table 2 illustrates the risk categories that could affect the BCW activity according to the examined literature.

Table 2 Risk categories relevant for the operational level

<i>Risk category</i>	<i>Description</i>
Strategic risks	Intellectual property risk
Operational risks	Process risks, product failure risk, maintenance risks, infrastructure risks, quality risks, production shortfall risks
Organisational behaviour risks	Working culture, relation risks, and ethic risk
Human resource risks	Employee reputation risks, employee liability risks, law compliance risk, talent management risks, employee skills, staff size
Logistic risks	Any risk related to logistics that is related to workers
Safety risks	Personal protection, housekeeping
External effects risks	Force majeure risks include environmental, war and terrorism risks, social risks include strikes

3.1.3 *The relation between TQM elements and low-level activities risk*

A systematic literature review was conducted to find the relation between the TQM elements and low-level activities risks. The SCOPUS database was selected and the following search query was used:

TITLE-ABS-KEY (“risk” OR “Threat”) AND (“TQM” AND “Total Quality Management”)

The search produced 699 documents. Three screenings were performed to select the full papers to be analysed in detail. The first screening filtered out the papers that did not consider at least one of the TQM elements of Table 1. It is worth noting that none of the reviewed studies took into consideration ‘Ethics’. Figure 1 shows the focus of the papers and the interrelation between the TQM elements in different studies. 111 papers were selected in this stage.

Figure 1 Interrelation between subject area and TQM elements (see online version for colours)

SUBJECT AREA	Count of TQM elements							Count of Sector (Subject Area)
	Recognition	Leadership	Training	Communication	Trust	Integrity	Ethics	
Customer				1	1			1
Decision Making		1	1	1				3
Government Study	1	2	2				1	4
Information Management		1		2			1	3
ISO (The International Organization for Standardization)	1	1	2		2	1		6
Leadership	1	4						4
Process Improvement		3	3					6
Project Management *		2	1	2				3
Quality Management	1	3	5	4	4	2	1	17
R&D		1						1
Risk Management	2	1	2	3				8
Safety Management	2	2	6	5				11
Service Quality	2	12	11	11	10	1	1	31
Small and medium-sized enterprises			2					2
Strategic Management	1	4		1				6
Supply Chain	2	1	1	1				5
Grand Total	13	38	36	31	17	4	4	111

The second screening employed inclusion criteria. The selection aimed to include the papers that used a risk management model or a part of it, such as risk identification, analysis, response or monitoring. The screening revealed that none of the papers investigated the concept of ‘Integrity’ from the risk management viewpoint. 24 papers were selected in this stage.

The third screening stage was based on the contents of the abstract, introduction and conclusion of the 24 papers. This stage was meant to find the TQM methods that consider risk management, and the case studies on risk management that consider TQM elements. After screening the documents, 8 papers were selected for the full paper examination to individuate the relation between TQM elements and risk in low-level activities. The selected papers are reported in Table 3. All papers are compatible with the aim of the present study for risk identification, and no new risk typology was identified that could be added to the list in Table 2. Seven out of eight papers in Table 3 were published in the last decade, suggesting that the integration of risk management and TQM is a novel avenue of research that shows a growing interest.

3.2 Results of the survey

Figure 2 illustrates the importance, as an average on a 1–10 point scale and according to the interviewees, of the seven major risk categories related to the blue-collar workers’ activities. Operational risks have the most important relationship with BCWs with score 5.14 (Figure 2), and organisational behaviour risks, human resource risks and safety risks are also significant.

Table 3 Selected papers for full study

Tsotetsi and Mugova	Investigating the efficiency and effectiveness of project execution in a South African project based organisation	2018	<i>Proceedings of the International Conference on Industrial Engineering and Operations Management</i>
Zeinalnezhad et al.	Identification of performance evaluation indicators for health, safety, environment, and ergonomics management systems	2018	<i>Chemical Engineering Transactions</i>
Soltanizadeh et al.	Business strategy, enterprise risk management and organisational performance	2016	<i>Management Research Review</i>
Boyle et al.	Safety implications of standardised continuous quality improvement programs in community pharmacy	2013	<i>Journal of Pharmacy Practice</i>
Ho and Liao	The use of failure mode and effects analysis to construct an effective disposal and prevention mechanism for infectious hospital waste	2011	<i>Waste Management</i>
Szczepańska and Urbaniak	Evaluation of the Effects of Quality Management System Improvement	2011	<i>Foundations of Management</i>
Borgelt and Falk	Untangling leadership and management: The first step to ensuring quality attainment in organisations	2008	<i>ICQR 2007 – Proceedings of the 5th International Conference on Quality and Reliability</i>
Saunders	Managing quality and risk	1995	<i>Journal of Occupational Health and Safety – Australia and New Zealand</i>

Figure 2 The importance of the risks of BCWs activities (see online version for colours)

Table 4 shows the importance ('weight') of each risk category with respect to the TQM elements. The respondents were asked to indicate the importance of the elements of TQM in the first column as a means to address the types of risk in the first row at the blue-collar level, according to their experience in the company. A five-level

Likert Scale (1, ‘not at all important’ to 5, ‘extremely important’) was used for this part of survey.

Table 4 Weights of the TQM elements with respect to risk categories

<i>TQM Elements ("The 8 Crucial TQM Elements for TQM's Success – You Must Know", 2016)</i>	<i>Risks</i>							<i>Rank</i>
	<i>Strategic risks</i>	<i>Operational risks</i>	<i>Organisational behaviour risks</i>	<i>Human resource risks</i>	<i>Logistic risks</i>	<i>Safety risks</i>	<i>External effects risks</i>	
Integrity	3.07	3.41	3.65	4.00	2.58	3.42	2.52	4.06
Trust	3.04	3.70	3.88	3.83	2.79	3.33	2.43	4.08
Ethics	2.96	3.12	3.83	3.82	2.82	3.27	2.50	4.05
Training	2.50	3.77	3.36	3.65	3.09	3.91	2.91	4.04
Leadership	3.35	3.32	3.25	3.50	2.77	3.50	2.67	4.03
Recognition	3.00	3.44	3.33	3.32	2.86	3.14	2.76	4.02
Teamwork	2.80	3.48	3.54	3.52	2.78	3.27	2.59	4.05
Communication	3.33	3.80	3.63	3.73	3.36	3.59	3.33	4.00

Table 5 tabulates the assessments related to the question ‘To what extent the TQM tools are effective to manage risks at the operative level?’ according to the respondents’ experience. 81.48% of the investigated companies commonly use a risk management plan and 29.63% use TQM tools or programs. The operational level risks are significantly important because 72.41% of the companies have suffered deviations from their goals as a consequence of risks at the operative level (low risk resilience); further, 96.43% of the respondents experienced that continuous improvement programs had been beneficial in managing risks at the operational level. The answers to open-end questions reveal that not only quality tools and continuous improvement but also risk management methods affect the final quality of the product or service. It is worth noting that one respondent asserted that ‘some risks could be translated into opportunities.’

Table 5 TQM tool potentials to manage risk at the operational level

<i>TQM tools</i>	<i>Seven basic quality tool</i>	<i>FMEA</i>	<i>Flowcharts</i>	<i>Quality circles</i>	<i>Poka-yoke</i>	<i>Six Sigma</i>	<i>Taguchi methods</i>	<i>Quality function deployment, QFD</i>	<i>Systematic analysis and improvement of work processes</i>
Score	3.32	3.19	3.43	3.04	3.12	3.18	2.79	3.30	3.89

4 Discussion

The investigated literature confirms that the effective execution of the projects and operations is related with quality issues and uncertainty management plans. Some case studies highlighted the interrelation between quality issues and risk management (Tsetetsi and Mugova, 2018). Tsetetsi and Mugova investigated a company that faced problems at project level. The study identified lack of skills and training programs as the underlying reasons for cost increase due to monitoring and controlling issues, risk management and control of the outsourced activities and subcontractors. Since training is one of the elements of TQM, this suggests an actual connection between TQM practices and risk management.

Health, Safety, Environment and Ergonomics Management Systems (HSEEMS) is a multidisciplinary approach, which is implemented as a risk-based strategy toward sustainability. HSEEMS is a useful approach for practitioners to enhance the quality and mitigate sustainability problems in a supply chain. Zeinalnezhad et al. argue that risk analysis is one of the eight acknowledged criteria that enhance the quality and effectiveness of the HSEEMS implementation (Zeinalnezhad et al., 2018). On the other hand, Soltanizadeh et al. investigated organisational performance from the wider perspective of business strategy and leadership (Soltanizadeh et al., 2016). They conclude that organisational performance is significantly influenced by enterprise risk management. Boyle et al. examined standardised continuous quality improvement programs combined with web-based technologies to enable quality-related events (Boyle et al., 2013). They suggest that such programs can receive substantial benefits from the implementation of risk management in the quality improvement process. Their study was focused on communication, staff competence and education, and highlighted the relation between training/communication and risk management. Other case studies are focused on employing risk management tools to improve the quality system. Ho and Liao used Failure Mode and Effects Analysis (FMEA) to improve quality of medical care in health institutions (Ho and Liao, 2011). The study was focused on waste management: in such context, the authors emphasise that training on waste classification and risk to the medical staff is beneficial to hazardous waste management and disposal.

Other studies confirm the relation between quality and risk management, accentuating the prominent role of quality management systems. For example, according to Szczepańska and Urbaniak risk management is an effect of the improvement of the quality management system (Szczepańska and Urbaniak, 2011). This paper, alongside one by Borgerlt and Falk and one by Saunders, studies quality management and management tools and emphasises the importance of leadership; all these authors highlight that the effective use of management tools and the achievement of quality standards depend on leadership and management (Borgerlt and Falk, 2007; Saunders, 1995). It is noteworthy that Saunders specifically discusses the similarities between TQM and risk management.

The study here presented is a first attempt to investigate the risks at the operational (i.e., BCW) level and the role that TQM can have in addressing them. Indeed, the results of the field survey seem to confirm the important role of TQM in that direction. According to the results of this study (Figure 2), operational risks, organisational behaviour risks, safety risks and human resource risks are the most important risks. Some of the interviewed practitioners highlighted that unforeseen events pertaining to these categories affected processes, quality and maintenance and, consequently, reduced their

company's performance. On the other hand, all of the issues related to human resources, including behavioural, safety, knowledge talent and skills, are worth to consider.

The total rank in Table 4 shows that 'Trust' is the most important element of TQM for addressing risks at the operational level; this seems to suggest that a team can favour risk resilience if there are constant collaboration and trust among the team members. In fact, the results displayed in Table 4 show that team work alongside collaboration and trust could be generally effective at managing all categories of risk. On the other hand, the table shows that some elements of TQM could be more effective than others in addressing specific risk categories. Communication can address operational risks, logistic risks, and external effect risks simultaneously. Binding all factors of the working process together and strengthening the relationship of the employees with the element of quality is effective in improving risk management and resilience. Providing an inspirational vision for the employees and ensuring a clear guidance could address the strategic risks. Obviously, training could play an important role in risk management, especially for safety risks, and the rank of this element proves the fact. Finally upholding values/virtues such as honesty, justice and sincerity (the constitutive elements of 'integrity') could tackle organisational behaviour risks and favour a resilient work environment.

According to the respondents, almost all of the TQM tools have a good potential to address risks at the operational level (Table 5). Systematic analysis and improvement of work processes (SAIWP) and flow charts have the highest potentials. The flowcharts aim to communicate how a process works and SAIWP has a process-focused vision as well; this may suggest that considering the whole activities of a company as a process from the senior management to BCWs could be beneficial to manage the risks connected to the workers' activities.

5 Conclusion

The present study pointed out that there is limited research on risk management tools for BCWs' activities. More specifically, the literature review revealed a scarcity of studies on the identification of risks in low-level activities. In this respect, the study shows that operational risks and organisational behaviour risks are the most important at the operational level. Most of the literature highlights the relation between quality management and risk management, and several papers emphasise the importance of training and leadership for risk management. Nevertheless, there are not specific studies that have investigated the relationship between risk management and the concepts of 'ethics' and 'integrity', which are key elements of TQM and seem to be related to work environment resilience.

The field survey of this study confirmed an interrelation between TQM and risk management. The results of the survey, which place 'trust' in the first position of importance, contrasts with the results of the literature review, which stressed the role of training and leadership more than other factors. This could depend on the fact that the respondents were mainly senior and middle project managers, where trust plays a key role. Conversely, it could depend on the benefits of trust that they experienced, thus leading them to conclude that trust can also have a prominent effect on risk management at the shop-floor level.

The fact that all the respondents were at least middle managers is the main limitation of the survey. In many cases, they could possibly overlook the impact of risk at shop-

floor level, favouring risk management programs at higher levels. Therefore, a deeper investigation should involve line managers at the very least. Additional empirical research should then be conducted, targeting the shop-floor workers and comparing the results obtained with those presented here.

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