Risk determinants of Small and Medium-sized Manufacturing Enterprises (SMEs)- an empirical investigation in New Zealand

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ABSTRACT
Small and Medium-Sized Manufacturing Enterprises (SMEs) continuously encounter daily internal and external disturbances to their operations that detract from their business performance. Among these disturbances some are likely to create risks to the organization in terms of loss of; production, manufacturing capability, human resource, market share and, of course, economic losses. These are referred to as 'risk determinant' in this research. To deal with these risk determinants effectively, SMEs need a systematic method of approach to identify and treat their potential effects along with an appropriate set of tools. In order to achieve this, first of all a strategic approach is required to identify

typical risk determinants and their linkage with potential risks. In that context, the authors conducted an empirical investigation with an exploratory questionnaire survey with 155 SMEs, which was subsequently followed by five in-depth case studies, in New Zealand. This paper describes a methodology to identify risk determinants and presents a set of identified risk determinants based on the findings from the empirical investigation.

Keywords: Resources, Strategy, Strategy formulation, Performance measurement and management, Operational risk management, Small business.

BACKGROUND

In the current business arena, manufacturing industries are under tremendous pressure due to the free market economy, rapid technological development and continuous changes in customer demands. In this context, they face vigorous competition with respect to quality, cost and time to market. To cope with these business trends, the demands on modern manufacturing systems have required; *increased flexibility, higher quality standards* and *higher innovative capacities* (Monica & John 1999). These demands emphasize the need for high levels of overall system reliability that include the reliability of all human elements, machines, equipment, material handling systems and other value adding processes and management functions throughout the manufacturing system. To keep the system performance consistent, an integrated harmonious approach to man, machine, process and management is vital, which in practice, is rarely achieved. Irrespective of the availability of modern technology and techniques, most manufacturing organizations still face undesirable events and unwanted setbacks such as machine breakdowns, material shortages, accidents and absenteeism that make the system unreliable and inconsistent (Toulouse 2002; Mitala & Pennathurb 2004; Monostori, Szelka & Kadar 1998). In essence, the smooth running of a Small or Medium-sized Manufacturing Enterprise (SME) presents a significant challenge irrespective of the technological and human resources it may have at its disposal. Every organization faces undesirable events and unwanted setbacks (internal and external) in its day to day operations. In our research, we choose the word 'disturbance' to represent any of these undesirable events and setbacks. The definition of a disturbance adopted for our research is "*an undesirable or unplanned event that causes the deviation of system performance in such a way that it incurs a loss*". As a disturbance creates undesirable consequences that are obviously detrimental to a businesses performance, we finally refer a disturbance as 'risk determinant' on basis of its dynamic presence in the system and its consequential negative impact on business performance. Disturbances are linked to undesirable consequences which may result from either normal circumstances, abnormal circumstances or improbable circumstances. Whatever the sources of disturbances, the consequences resulting from them could be; difficulties to continue work, decreased productivity, reduced production rate, increased defective products, unplanned rework, delayed delivery to market, unexpected downtime, human loss, etc. In practice, any of these consequences will result in financial loss. The combined effect of different disturbances could effectively cripple a SMEs business performance which may ultimately put it at risk of complete failure. The risks can be categorized into three groups such as Operational, Occupational and

Economic. The first group involves the loss of production and loss of production capability which includes productivity losses, quality related losses, interrelated activity losses and damage to assets. The second group comprises of the risks to the workforce related to health and safety. While the third group encompasses business risks associated with the financial penalties resulting from either of first two categories as well as compensation claims and damage to reputation. While dealing with risks, the term "hazard" automatically comes into the scenario and thus, the definition of a hazard can play an important role when dealing with risks in the industrial context. A hazard is a condition that can cause harm, injury, death, or damage to or loss of equipment (Bahr 1997). Hazards can exist without anything failing. There are four types of hazards namely *catastrophic* (death or serious personnel injury or loss of system), *critical* (severe injury or loss of valuable equipment), *minor* (minor injury or minor system damage) and *negligible* (no resulting injury or system damage). While examining the definitions of a hazard, it can be noticed that a hazard ultimately represents a situation or condition that has the potential to harm people, property or the environment. However, a question now presents itself, that if there is no chance to harm any of these three elements (people, property, environment), can we classify the situation as a hazard? For an example, the absence of a key machine operator may have no impact on these three elements, but it has the potential to develop financial risk to the organization in terms of loss of production. The impact might be severe for a small business if the absence is prolonged. There might be some debate as to whether absenteeism should be included in the hazard category or not, but most people would agree to recognize it as a potential disturbance which could have serious consequences for a SME. Disturbances can be seen from different perspectives and can also be described with various words such as disruptions, failures, errors, defects, losses and waste. However, all potential disturbances and their consequential losses should be considered in the risk management of SMEs because they can be both time-consuming and costly. We believe that this type of disturbance should be studied under the umbrella of risk management. Consequently, while studying risk management in SMEs, we prefer to use the term 'disturbance' instead of hazard. According to our definition therefore, a disturbance represents all types of hazards as well as any other unwanted setbacks that can produce uncertainty or a loss for an organization.

SMEs are viewed as a source of flexibility and innovation, and make a significant contribution to economies of any country, both in terms of the number of SMEs and the proportion of the labour force employed by these organizations. In this connection, the significance of the SME sector in New Zealand has been increasing, with further opportunities presented by globalisation and technological development (Ministry of Economic Development 2004). New Zealand is a small nation state of 3.7 million people, ethnically diverse, with a strong culture of self-help and independence underpinning business development. New Zealand's size means that by international standards its small businesses are very small but are the dominant sector in terms of employment, organizational structure, and social and economic cohesion. A recent report on SMEs states that in the context of policy consideration, the characteristics of small size businesses should typically include personal ownership and management,

few specialist managerial staff, and not being part of a larger business enterprise (Ministry of Economic Development 2003). Small and Medium Sized Manufacturing Enterprises (SMEs), in New Zealand, typically exhibit these characteristics, and it is in this context that our research has been designed to deal with companies with employment in the range of 10-100 employees.

Small businesses are perceived as high risk ventures and the entry and exit rate supports this perception (Zacharakis, Meyer & DeCastro 1999). Business failure is often caused by a lack of knowledge, misplaced overconfidence, lack of financial performance strategies and a lack of internal management planning (Hartcher, Allan and Scott 2003). In spite of high failure rates however, small businesses continue to be an essential component of the economy of any country as they account for a significant percentage of all entities and collectively employ large numbers of the workforce. Generally, SMEs depend on financial factors such as profit or sales when considering business risks (Waring & Glendon 1998). But, monetary factors alone may ignore many issues affecting the long term reputation of the SME and its staff. A recent research study has suggested that risk management is less well developed within SMEs where the strong "enterprise culture" sometimes mitigates against managing risks in a professional structured way (Virdi 2005). This attitude persists within SMEs despite evidence that businesses that adopt risk management strategies are more likely to survive and grow. Research by Zacharakis et al. (1999) identifies some reasons for failures of small businesses that include both internal and external causes. The internal causes of failure included, poor management, lack of risk management planning and a failure to adopt a risk limit threshold. The external causes included Government policies, the liability of small size, competition from larger businesses, wars, natural disasters and general economic downturns. It was also found that 'overconfidence' could often drive small business operators to devalue the importance of fundamental risk assessment that ultimately caused their failure. Although there are some other causes for failure that are highlighted in this section, our research is not intended to investigate the reasons behind the absolute failures of SMEs. Rather, it deals with identifying the potential risks existing in operating SMEs within their current infrastructures so that they can avoid potential failures by implementing a strategic risk management approach. Because manufacturing involves a complicated mix of people, systems, processes, and equipment, an effective research strategy should be multidisciplinary in its approach to establishing a risk management framework. Because of some specific limitations which include, inadequate infrastructure, limited managerial and technical expertise, lack of financial and intellectual resources to generate substantial technological developments and change, weak information networks to locate and recognize information and knowledge that is especially relevant to them, and low investment in research and development may keep SMEs away from adopting a positive approach towards strategic risk management (Islam MA, Tedford JD & Haemmerle E 2006). It is also noted that major accidents and emergencies rarely occur in SMEs although small losses, near misses, unsafe acts, and unsafe conditions are common occurrences. Problems, failures and mistakes as well incorrect or ineffective actions are very likely occurrences in the daily business of SMEs and for this reason, in

practice, minor incidents and near misses are worth analyzing since in slightly different circumstances the consequences could have been serious. By monitoring even small problems and analyzing their underlying causes, it might be possible to discover causes for serious problems and hazards. Therefore, no disturbance should be overlooked or should be allowed to happen again.

Over the years many publications on risk management have appeared in literature. Most of them, however, have focused on particular industries such as nuclear, aviation, space exploration, chemical processing and other areas where the consequence of a system breakdown is considered severe or catastrophic for human beings or the environment, and/or where the potential financial loss is significant (Strupczewski 2003; Milan 2000; Seastroma, Peercy, Johnson, Sotnicov & Brukhanov 2004; Khan & Abbasi 1998). Research on risk and risk management in other areas, including financial sectors, medical science, transportation and construction engineering; have also significantly expanded with time. In contrast to this, lower priority has been given to the management of risk in the SME sector where the risks have been considered to be less catastrophic and where most studies have concentrated solely on the risks associated with safety and occupational health. The precautionary practices such as OSH and other safety related programmes should, if properly implemented and practiced, ensure better health and working environments inside organizations. They do not, however, ensure the smooth running of the organization or minimize its risks operationally, technically and/or financially.

While studying risk identification and risk analysis, most investigations start with hazard identification within the system and emphasise the critical components/factors that produce or could produce failure or harmful consequences for humans, assets or the environment. In this context, various techniques such as HAZOP studies, FMEA, FMECA, HACCP, FTA, ETA, 'What If' analysis and Checklist are popular (Khan & Abbassi 1998; Tixier, Dusserre, Salvi & Gaston 2002). All techniques focus on the main hazard sources. These techniques help to divide a complex system into smaller and more manageable nodes for study. While any of the techniques can produce a thorough list of important system failures, causes, consequences and controls, none lend themselves to rigorous risk acceptability analysis. Furthermore, none of the techniques are necessarily effective in identifying and prioritising the risks associated with multifaceted criteria. None of the above mentioned methods alone will be applicable for the identification of the root causes of many disturbances or for analysing their consequences, because of their complex nature. For example, a disturbance such as 'tool shortage' could be rooted in; erroneous planning of stock, misuse by the operator, unexpected breakage, or incorrect selection of tool for the particular task. Thus, the origin of the disturbance could either be strategic, operational or technical. This means that a detailed analysis of a particular disturbance is required to establish a suitable risk handling procedure. The extensive literature review provides an impression that though a substantial amount of research has been done regarding the failure rate of SMEs and regarding the typical reasons behind the failures, no study, to the best of the authors' knowledge, addresses the issues concerning the preconditions of the failures or the potential

risk indicators to the operational functions of SMEs, which are linked to the ultimate failures. Thus, there appears to be a gap in the literature regarding operational risk management of SMEs. In this connection, this study was conducted to explore the answers of two research questions; i) what are the typical risk determinants of SMEs? and ii) how are they linked to operational, occupational and economic risks?

This paper builds upon a study undertaken by the authors as a part of an ongoing research effort to verify and modify the theoretical model developed by them (Islam et al. 2006). The focus of this paper is to highlight typical risk determinants of SMEs that need to be considered in developing an integrated risk management approach which should includes strategic, operational, occupational, financial and technology-oriented risks. It presents a set of identified potential risk determinants on the basis of an empirical investigation in New Zealand.
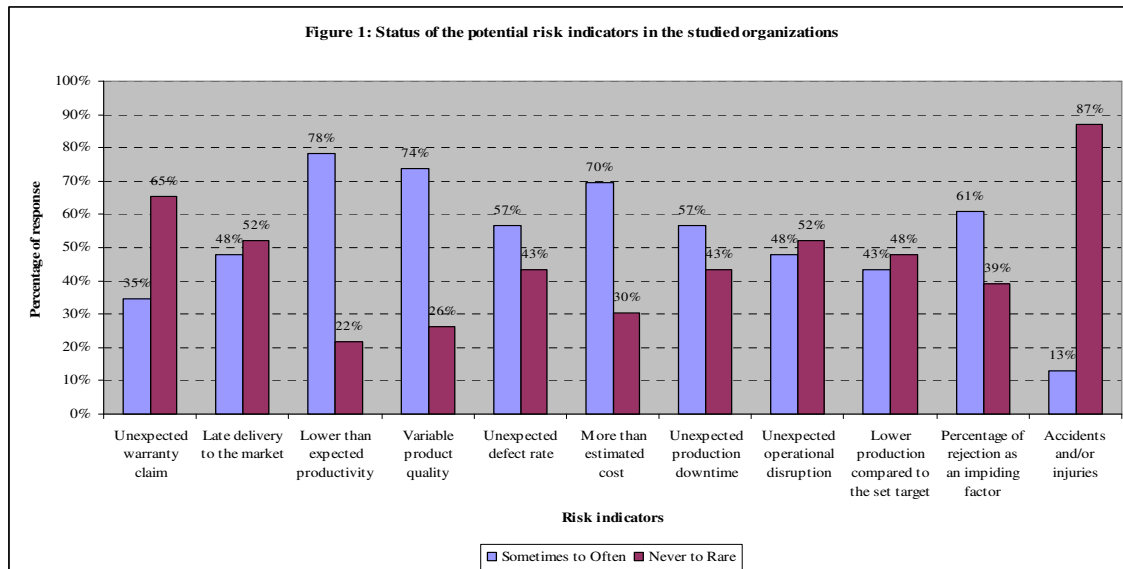
RESEARCH METHODOLOGY AND SAMPLE

We choose an empirical investigation as it put special consideration of the affiliated research on way to develop a strategic risk management framework in terms of operational and organizational context (Islam et al. 2006; Mills et. al 1995; Pettigrew, Whipp & Rosenfeld 1989). For the empirical investigation, standard questionnaires were developed and verified by a panel of academic experts and finally by a focus group in a Pilot survey. To avoid superficial risks from a survey research, the authors developed separated questionnaires for three respondents (one for Top management, another for Middle management and the other for Frontline management) for each organization to have supportable perceptions and interpretations on some common events (Bowman & Ambrosini 1997). The questionnaires were strategically designed to explore the risk determinants (potential disturbances at first place) and risk indicators (detrimental parameters of business performance) related to existing mechanisms and practices in the studied organizations. The focal points of the questionnaire were i) production related activities associated with risks ii) quality and reliability related issues of both human and assets including health an safety iii) major activities in a supply chain networks (in and out) and finally iv) strategic issues related to managing risks.

There were two phases in the data collection process of the mail survey and follow up the results. Questionnaires were sent to 55 manufacturing SMEs (to 165 management personnel) in Phase I and 105 companies (to 315 management personnel) in Phase II. The respondents were given one month to return the completed questionnaires. Three weeks were allocated for telephoning and personal interviewing to acquire more respondents to the questionnaire. Altogether 82 usable responses from top to front-line management of 32 responding SMEs has been received and analyzed. The overall response rate is about 18% which is found satisfactory and representative though past experience indicates that mail survey response rates are often low and appear to be declining among small business populations (Dennis, 2003). However, apart from the mail survey, subsequent in-depth case studies, based on observations, document reviews and face to face interviews with key staff (including key actors who shape firms' operations strategy, e.g. Senior executives) from each of 5
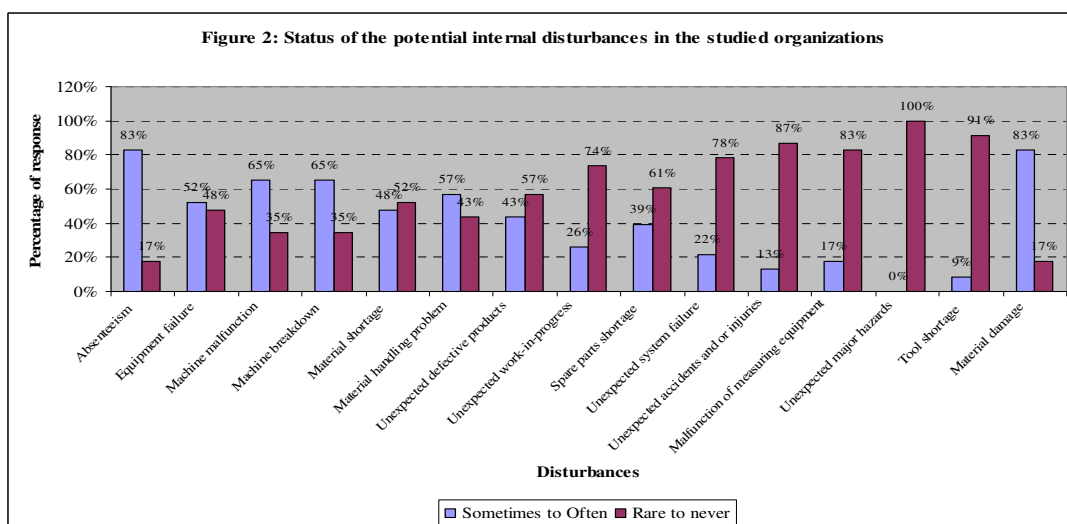
organizations which participated in mail survey, have also been conducted to verify the findings from the mail survey. We choose the case studies as 'a case study is an empirical inquiry that investigates a contemporary phenomenon within some real-life context and a case study methodology involving multiple source of data could provide the fullest understanding of the phenomenon and improve validity of research implication through triangulation'(Yin 1994). The case studies were conducted for six months. The leading researcher engaged himself for developing deeper understanding of the existing strategies and underlying practices in relation to the findings from the mail survey. The type of industries that participated in the mail survey and in the case studies included *Metal-based product manufacturing, Paper and plastic based product manufacturing, Wood and furniture manufacturing* and *Textile and apparel manufacturing*.

KEY FINDINGS AND ANALYSIS

Majority of the findings from the mail survey are strongly supported by the case studies and some are supported partially. However, this paper presents the findings from the exploratory study that are strongly supported by the findings from case studies. Key findings are discussed in this section. The study reveals that about 32% of the organizations are dissatisfied with existing 'net profit' (of which 10% are very dissatisfied) and about 40% are dissatisfied with 'business growth' (of which 10% are very dissatisfied). On the other hand, 68% organizations are satisfied with existing net profit while 60% of them are satisfied with business growth (of which 9% of the organizations are very satisfied with both net profit and business growth). The study also finds that 30% of the organizations consider the existing 'employee turnover rate' as a substantial impeding factor for the business operation from a considerable amount to great extent, when 43% of them indicate the impediment regarding this as a little amount. 26% of the organizations indicate the impediment with employee turnover rate as negligible. Previous researches overwhelmingly indicate that effective employee management and other strategic measures can lead to a competitive advantage in the form of a motivated workforce, improved operational and business performance reducing employee turnover rate and improving productivity (Richard OC & Johnson NB 2001; Batt R 2002; Macduffie JP 1995). Therefore, we could interpret that 'dissatisfaction level with net profit' and 'dissatisfaction level of business growth' (business plan is assumed to be realistic) and 'significant employee turnover rate' could be the results of inappropriate/inadequate strategic allocation and utilization of resources and they might be treated as primary indicators of potential problems within existing business settings. These are surely linked to operational risks of direct or indirect losses due to failures in systems, processes and people or from external factors. So, these are considered as 'risk indicator' for this study. Along with these three, a set of risk indictors in terms of operational, occupational and economic losses are identified from the study. Figure 1 shows the relative position of some risk indicators on the basis of their comparative presence (distribution level) in the system. In identifying some driving factors (disturbances) for these risk indicators, a thorough investigation was performed during the study.

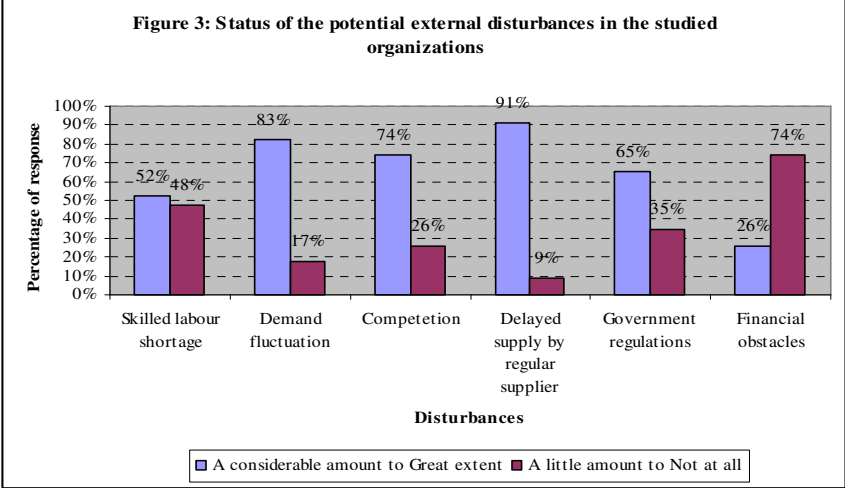Figure 1: Status of the potential risk indicators in the studied organizations

The study identified a number of notable internal and external disturbances linked to the risk indicators, which are summarized in Figure 2 and 3 respectively. Among the internal disturbances, *absenteeism, material damage, machine malfunction, machine breakdown and material handling disruption* are found to be most significant disturbances, while *unexpected major hazards, unexpected accidents/injuries and tool shortage* are found to be the least significant ones and the others are found to be in between, from most to least significant. Among the external disturbances, *delayed supply by the regular supplier* and *demand fluctuation* are found to be most significant, while *financial obstacle* is found to be the least significant disturbance. However, despite minimal appearance of least significant disturbances compared to others, they are considered for further analysis as a rare occurrence disturbance might have sever consequence (for example, fire hazard).

Figure 2: Status of the potential internal disturbances in the studied organizations

Therefore, all disturbances presented in Figure 2 and 3 are considered for further analysis in identifying risk determinants based on their correlation with risk indicators. The analysis included some statistical methods of non-parametric testing such as *Friedman test, Wilcoxon signed ranks test* and *Spearman Correlation Coefficient tests* (Perry 2004) at two significant levels; (i) α =0.01 (99%

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confidence levels) and (ii) $\alpha = 0.05$ (95% confidence levels). The first test (Friedman test- for related samples) result confirms that at least one pair of the frequencies of disturbances were significantly different at significant level of 0.01 (*$p < 0.01$), which means all disturbances are not from the same distribution and they need to be treated differently. Subsequent test (Paired comparison with Wilcoxon signed ranks test, T statistic) results show the relative distributions

Figure 3: Status of the potential external disturbances in the studied organizations

of the disturbances, which are applied to give relative scores for the disturbances. The internal and external disturbances are summarized in the second columns of Table 1 and 2 respectively. The final test results (based on Spearman Correlation Coefficient, r_s) confirm the correlation between disturbances and risk indicators. Based on the positive correlation with a number of risk indicators, scoring is performed. The highest scorer is correlated with maximum number of risk indicators, while the lowest scorer is correlated with minimum number of risk indicators. Based on the relative scores, the disturbances are summarized in the third columns of Table 1 and 2 accordingly showing their

Table 2:Potential risk determinants (external)

relative ranking based on the total scores. Note that the disturbances (e.g. Tool breakage) that are not correlated at all with any of the risk indicators are excluded from the risk determinant identification technique and are not presented in this paper. However, the identified disturbances presented in Table

	Scores of the disturbances based on the distributions of the level of impediments on business (I) (6= highest score, 1= lowest score)	Scores of the disturbances based on their positive correlation with the risk indicators (C) (6= highest score, 1= lowest score)	Total score (I X C)	Final ranking of the risk determinants (1=most important & 6=least important)
Delayed supply by the suppliers	6	4	24	1
Demand fluctuation	4.5	3	13.5	2
Competition	4.5	2	9	4
Government regulations	2	5	10	3
Skilled labour shortage	3	1	3	6
Financial obstacle	1	6	6	5

1 and 2 need to be dealt strategically to reduce operational, occupational and business risks of SMEs.

Table 1: Potential risk determinants (internal)				
	Scores of the disturbances based on the distribution of the frequency of occurrence (F) (15= highest score, 1= lowest score)	Scores of the disturbances based on their positive correlation with the risk indicators (C) (15= highest score, 1= lowest score)	Total score (F X C)	Final ranks of the risk determinants (1=most important & 15=least important)
Absenteeism	15	15	225	1
Material damage	14	14	196	2
Machine malfunctions	13	8	104	5
Material shortage	12	12	144	3
Equipment failure	11	4	44	8
Material handling problem	9.5	11	104.5	4
Machine breakdown	9.5	9	85.5	6
Unexpected defective product	8	6	48	7
Spare parts shortage	7	3	21	11
Unexpected system failure	5	7	35	9
Unexpected accidents or injuries	5	5	25	10
Unexpected work-in-progress	5	2	10	14
Malfunctions of measuring equipment	3	1	3	15
Unexpected major hazard	2	10	20	12
Tool shortage	1	13	13	13

It is relevant to note that the relative ranking of the identified disturbances would vary from organization to organization based on the organizational business settings including strategic measures and practices. Moreover, while developing strategic plan and appropriate measures an organization might add a few more disturbances to the identified set or delete some from the set based on the

organization's business criteria, resources availability and its vulnerability. However, an organization could easily find the methodology for the risk identification (described in this paper) significantly applicable irrespective of its business settings and finally it could utilize the set of identified disturbances for benchmarking.

CONCLUSIONS

From the empirical investigation, it was found that most SMEs encounter some potential disturbances that put the organization at risk with respect to production and business operations. It is

worthwhile to note from other findings of the study that the majority of SMEs do not have systematic risk management strategies in place. The case studies consolidated the findings that the majority of SMEs have standard Hazard Identification Forms that comply with the requirements of the Health and Safety in Employment Act and Regulations in New Zealand (for e.g., Avery 1993). However, their application concerning hazards is limited to health and safety issue only and their implementation also varies significantly from organization to organization. The current practice in SMEs appears to only record injury related information, while 'near misses', are generally not recorded at all, even though the form contains such a clause. As a whole, the safety culture within SMEs demands further attention. Digging down to the root causes of disturbances and their related origins are not practiced to any great extent, and where they are practiced, the flow of information tends to miss many of the relevant parties. Day to day incident reporting, which is not related to health hazards, is almost absent. In addition, the existing disturbance handling systems in the organizations in terms of data collection, information processing, information sharing and decision making are found relatively weak and very informal. Concerning the identification of external disturbances, most SMEs do not have assessment criteria in place to measure the consequences, nor have enough information regarding the root causes of those disturbances. It was also found that the use of Benchmarking within SMEs is extremely rare. However, the purpose of the study reported here, has been to answer the following research questions; what are the typical disturbances encountered by SMEs? and what risks do these disturbances cause? Further study is required to answer other questions; how should SMEs deal with these disturbances in the light of the risks they pose? and finally, how should SMEs manage the risks caused by these disturbances more effectively? The follow-up study to link the identified risk determinants, their root causes and strategic management approach to reduce risks is underway by the authors. In conclusion, research findings presented in this paper will, hopefully, enable the development of a body of knowledge on good practices in risk management associated with disturbances that may be useful for both management professionals in SMEs as well as researchers in the field of risk management.

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