Chapter 5
Main finding, Discussion and Conclusion

5.1 Chapter Overview

This chapter provides a summary of the research results, as well as discussion of their implications before drawing the work to a close. It includes a consideration of the research limitations as well as opportunities for future expansion and adaption of the research. The chapter begins by revisiting the research aims set out in Chapter 1, and uses these as a basis to summarise the results, report findings, and discuss whether these objectives were achieved throughout the process of the research. The second part of this chapter focuses on the research limitations and how these form opportunities for future work. Finally, the discussion then places the research into its wider context to provide perspective, and present a final conclusion to the work.

5.2 Key findings

The first part of this chapter summarises and concludes the research by presenting the key findings according to the aim and objectives introduced in Chapter 1. The main aim of this research was to understand school safety attitudes in Thailand and then design a new and effective approach to school safety via a knowledge management and lean thinking framework. This overall aim was designed to increase value to school customers and reduce the costs and waste associated with school safety. There were seven main objectives, which came from the overall aim. Each of these objectives is now considered based on the results generated throughout the research.

5.2.1 Key Findings: Parental Attitude Towards School Safety

One of the main objectives aimed to investigate, characterize, and understand parental attitudes toward school safety in Thailand.

Overall, the research discovered that parents in Thailand consider school safety as a very important issue. Survey results in Chapter 4 from

five schools in northern Thailand showed that of 540 parents, the majority classified school safety as either very important or important. This result alone has significant implications for school safety in Thailand, which was shown in Chapters 1 and 2 to be relatively low priority for Thailand's education policies and this relatively low priority has resulted in a laissez-faire attitude, meaning schools are left to create their own safety policies and processes.

This has critical implications for schools, which must approach safety against a backdrop of budgetary constraints and a demand for rising academic standards. The results in Chapter 4 also illustrated that parental attitude varies considerably between different school types. This means that some Thai schools must approach safety more rigorously than others in order to meet the needs of parents. Results from this thesis showed that in particular, parents from private schools considered safety as more important than parents from government schools. This suggests private schools must pay attention to school safety to remain attractive to parents. In addition, the questionnaire results revealed that primary school parents consider safety as a more important issue than secondary school parents. This is corroborated by the related school safety literature, and suggests primary schools must take safety seriously to satisfy parents. In summary, the results from this objective mean that in Thailand, private primary school parents consider school safety more important when compared to other school types and must therefore address school safety to maintain parental satisfaction and thus competitiveness.

Within this context of parental attitude toward school safety, the research discovered that the majority of parents consider their schools as requiring improvements to safety. These improvements require time, money and management, hence the need for the second objective in this research and the resulting understanding of explicit school safety costs, processes, management and waste.

5.2.2 Key Findings: School Safety Process

Key results for school safety process came from UML activity diagrams, financial data, accident records and a school hazard assessment. The methodology behind these data collection instruments is explained in Chapter 3, while the results were presented in Chapter 4.

The UML diagrams clearly mapped the key explicit safety processes in the school, which were:

- Ensuring students' safety from morning until evening
- Safety budgeting and planning
- Safety compliance
- Safety monitoring
- Responding to the safety-related needs and suggestions of parents

Of these five processes, Chapter 4 highlighted three as requiring the most significant management input, and there were chosen as an area of focus. Responding to the needs and suggestions of parents as well as safety compliance and safety monitoring represented the most significant management inputs and were selected for the solve phase of the research.

Financial data showed an average of 3.2% of the school budget spent on safety, and a relatively small number of accidents over 3 semesters.

Results from this objective showed that in terms of responding to the needs of parents, the case study was swamped with safety suggestions. The number of suggestions from parents corroborates the results from objective one, which illustrate how important parents consider school safety to be. However, the number of suggestions requires significant management input and affect the school's budget, hence the need for the AHP decision support system presented in this research.

The school hazard assessment echoed parents' attitudes and opinions toward safety and demonstrated that despite school management effort and appropriate safety processes, hazards remained in the school as well as addressing explicit safety processes, the tacit aspects of school safety have a significant impact on the overall safety of the school. The results of objective four were therefore related to these tacit aspects (non-visible) of school safety.

5.2.3 Key Findings: Leadership, Knowledge Sharing And Culture

The third research objective is inextricably linked to the second, and the key rationale behind this objective was to assess the current leadership, knowledge sharing and culture related to safety at the case study school, or in other words, the tacit, invisible aspects of school safety.

Chapters 3 and 4 described the key data collection instruments of Rapid Process Improvement Workshops (RPIWs) to address the tacit aspects of school safety. Chapter 4 presented key results from three RPIWs and showed a statistically significant difference (at the 99% confidence interval) between safety awareness, lean awareness and knowledge sharing attitude after the RPIWs. The RPIWs highlighted the current leadership, knowledge sharing and culture of school safety at the case study, and captured knowledge which could be utilized to improve school safety.

5.2.4 Key Findings: A Lean Approach To School Safety

This objective was central to achieving the overall aim of the research, and utilized knowledge management and lean thinking to design and implement a new approach to managing school safety at the case study school. The focus of this objective was on safety processes, or explicit aspects of school safety rather than the tacit aspects.

One of the key research outputs was the lean value stream maps (VSMs), which were presented in Chapter 4 and show an overall improvement in the school's safety related processes. In particular, the number of value added steps increased by almost 39% overall, thus delivering more value to parents and reducing waste. There was also an overall reduction in the number of steps involved in safety processes, by 22 (53% reduction). For each of the three areas where VSM was utilised, there were significant improvements. However, the key strength of this lean thinking knowledge management approach is that it considers more than metrics. In fact, Chapters 1 and 2 highlighted the danger and fallacy of relying on numeric information or statistics to assess school safety. The next objective therefore moved beyond these lean metrics to synergise the tacit and explicit aspects of school safety via knowledge management.

5.2.5 Key Findings: Improving Behaviour And Attitude Towards Safety

After the focus on explicit processes, the next objective focused on the utilization of knowledge management and lean thinking to adjust staff attitude and behaviour towards safety and related knowledge sharing. While objective four focused on the explicit processes, this objective was centred on people, and the tacit aspects of safety.

There were three main rapid process improvement workshops (RPIWs), which were delivered to staff and teachers in the school alongside the application of lean tools to the explicit processes. Pretests, posttests and long-term posttests indicate statistically significant differences before and after the RPIWs, thus indicating that the focus on tacit safety processes was also effective. Paired t-test results show that there was a statistically significant difference (at the 95% CI) between the pre and post tests regarding aspects of leadership, knowledge sharing and school safety. In the control group, there were no statistically significant differences between the pretest and posttest, thus showing that the focus on tacit aspects of school safety was effective, as shown by these statistically significant differences between the pretest, posttest and long-term post test. The CEDAC diagram and fishbone analysis also served to capture tacit knowledge from staff and utilize them in the improvement of school safety management. The results from the CEDAC and fishbone analysis were linked to the RPIWs and the overall improvement in school safety management.

5.2.6 Key Findings: The AHP Model

This objective is linked to the previous five, but with a strong focus on creating a decision support system (DSS) to manage the school safety suggestions given to the school by parents. The objective was to design and implement a new safety suggestion DSS based on the principles of knowledge management and lean thinking.

Such a DSS was created using the analytical hierarchy process (AHP). The DSS followed the precepts of lean tools by standardizing and sorting the decision making process with regard to parents' safety suggestions. The result was a coefficient of variation of 11%, based on inputs on safety suggestions from 10 staff. This variation is in contrast to no set decision criteria prior to the implementation of the AHP model. The relatively low coefficient of variation represents a way to sort and standardize in alignment with the 5S lean tool. The AHP also feeds the improvements in the lean value stream mapping by cutting down on decision making time as well as the lead time prior to making decisions.

5.2.7 Key Findings: Evaluation

The final research objective was to evaluate the new approach to school safety through stakeholder analysis and statistical analysis of the

pretest and posttest research results. All stakeholders reported an improvement in the approach to school safety. School leadership noticed the streamlined processes arising from the lean tools, which cut down on the manpower and costs associated with school safety. Parents noticed the improved knowledge sharing about safety, and the improved speed regarding the school's safety communication. Staff and teachers were more aware of school safety and thus felt empowered to make a difference to the school's safety. Overall, results show that the new approach is both effective and sustainable.

5.2.8 Knowledge Creation

The concept and methodology of this research highlighted the importance of tacit and explicit dimensions of knowledge. This work has contributed significantly to understanding the tacit and explicit aspects of school safety, but has also created new knowledge regarding school safety. This section thus concludes the work, but taking the perspective of new knowledge creation. The knowledge creating theory of Nonaka and Takeuchi (1995) is now used to show how this research produced new knowledge in the various dimensions of knowledge creation, and does so using the SECI model.

5.2.9 Analysing New Knowledge Creation Via the SECI Model

The SECI (socialization, externalization, combination, internalization) model of organizational knowledge creation was introduced by Nonaka (1994) and subsequently developed (e.g. Nonaka et al., 1995; Nonaka et al., 2000; Gourlay, 2003). A key disadvantage of the SECI model is that it was developed with Japanese companies in mind, and with a heavy focus on tacit knowledge due to the tradition of Japanese employees remaining with companies for life. The school and education environment of this research is also heavily dependent on tacit knowledge and members of teaching and administrative staff often remain with the school or in the education sector for life, thus developing considerable tacit knowledge. Figure 5.1 illustrates the SECI model of knowledge creation and subsequently discusses and concludes how this research created new knowledge according to the key aspects of SECI.

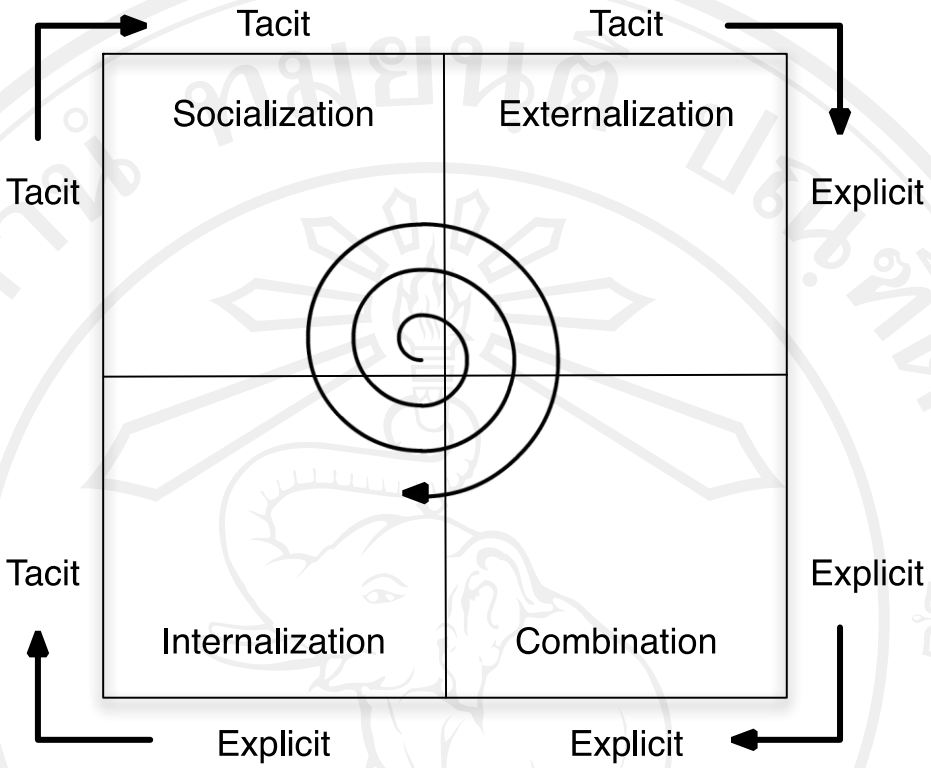

Figure 5.1 The SECI model of knowledge dimensions used to analyse new knowledge creation (adapted from Nonaka and Takeuchi, 1995).

As shown in Figure 5.1, there are four key modes of knowledge conversion, which lead to knowledge creation. These are as follows:

1. Tacit to tacit
2. Tacit to explicit
3. Explicit to explicit
4. Explicit to tacit

Each of these key modes of knowledge conversion and creation are now discussed according to the results from the lean thinking approach to school safety.

5.2.9.1 Tacit to Tacit (Socialization)

In terms of tacit to tacit knowledge conversion and creation, there are two key aspects which have been developed in the research. Firstly, the conversion of tacit safety knowledge from parents to teachers, and from teachers to parents. Secondly, the creation of school safety knowledge arising from the conversion of tacit to tacit knowledge between schoolteachers.

In terms of parents to teachers, the new lean approach to school safety has encouraged dialogue between parents and teachers and thus developed the tacit to tacit conversion of knowledge. Such knowledge is later converted into explicit dimensions via the school safety suggestion system and AHP model.

The socialization and conversion of tacit to tacit safety knowledge also occurs between teachers at the school. The RPIW which was set up to encourage knowledge sharing is the main driver of knowledge creation in terms of tacit to tacit knowledge transfer between teachers. The next stage in the creation of school safety knowledge can be understood from the perspective of tacit to explicit knowledge transfer (externalization).

5.2.9.2 Tacit to Explicit (Externalization)

Externalization is the process of converting tacit to explicit knowledge. The main way in which this research converted tacit to explicit knowledge was from parents' and teachers' safety suggestions, which were input and assessed through the AHP tool. Parental tacit knowledge was converted to explicit knowledge when their suggestions about school safety were captured and assessed by the AHP model. The AHP model thus creates new knowledge in the form of parental safety suggestions, which may or may not be successful. Whether the safety suggestions from parents or teachers are successful is secondary at this stage – the key point is that the AHP model and lean process for dealing with school safety suggestions enables tacit knowledge to be converted into explicit safety knowledge. Once this transformation of safety knowledge has occurred, the next step of knowledge transfer and creation relates to the combination of knowledge.

5.2.9.3 Explicit to Explicit (Combination)

The combination of different explicit knowledge to create new knowledge is often described as the simplest form of knowledge creation. In this research such conversion took place when the explicit knowledge in the AHP model was practically implemented in the school. In essence, the successful suggestions were due to a combination of explicit knowledge types. The combination of the explicit knowledge from the AHP model with either practical changes to school safety or embodied knowledge in the form of rules is a common result of explicit knowledge combination. The whole spiral of knowledge creation can be sketched out thus far, and includes knowledge sharing and socialization in the form of tacit to tacit knowledge conversion. This is then captured and externalized via the AHP and lean school safety suggestion system. Such explicit knowledge is then combined if the AHP and managers deem the knowledge to be useful to school safety suggestions. The combination involves practical implementation of suggestions or the embodiment of the knowledge in the form of rules or regulations. The final stage involves internalization.

5.2.9.4 Explicit to Tacit (Internalization)

The final stage of knowledge creation in the SECI model relates to using and learning explicit knowledge, which then becomes internalized and the user of the knowledge then modifies his/her behavior. In terms of school safety knowledge, the new suggestions which are implemented in the form of practical changes to safety or rules mean that the behavior of all school stakeholders is adjusted based on this new knowledge. The adjustment in behavior is then a breeding ground for further tacit knowledge, which is then transformed via the first process of socialization. This continuous process is represented by the spiral of knowledge creation and is particularly important for school safety, which is continuously changing and being adjusted based on the school safety suggestions and how tacit knowledge is created and transformed though the SECI process. There is a continuous transfer of knowledge between parents, teachers and management at the school which directly affects safety suggestions and implementation. The AHP model is thus primarily a method to externalize tacit knowledge and assess its value to the school before it is combined and internalized as new school safety behavior. This SECI model and knowledge creation in school safety feeds the originality and novelty of this research.

5.3 Research Novelty and Originality

This new multi-criteria knowledge management approach offers significant benefits, which are associated with the new lean knowledge management approach to school safety. In Chapter 4, the balanced scorecard analysis indicates how school safety feeds all the key business perspectives of the school and also shows how the new lean knowledge management approach contributes significantly to each of these perspectives. The research novelty and originality can be summarised as follows:

- The new synergistic approach between knowledge management and lean thinking is new
- Lean thinking has not been applied to school safety before now, and thus this research makes a novel and original contribution to the literature
- The Analytical Hierarchy Process Model (AHP) has not been applied to school safety and thus also represents a novel and original contribution

These key research novelties and originality are now discussed in more detail to highlight and clarify the contribution made by this thesis.

- **The new synergistic approach between Knowledge Management and lean thinking**

  The research was framed and underpinned by knowledge management and lean thinking. While each of these concepts are not new in themselves, the way in which they were combined synergistically represents originality. The knowledge for school safety was initially separated into two main parts, firstly, the visible (explicit) knowledge of school safety and secondly, the invisible (tacit) knowledge of school safety. For the visible (explicit) school safety knowledge, the solution focuses on lean thinking while for the invisible (tacit) knowledge of school safety, the solution focuses on knowledge sharing.

  Lean thinking and its tools were utilised for the explicit (visible) processes in the school related to safety. Knowledge management was applied to the tacit (enabling) factors contributing to school safety. Lean thinking and knowledge management were then applied in synergy to the problems of school safety. The enabling (tacit) factors are bigger and more difficult issues to address in terms of school safety and therefore knowledge management and lean thinking were applied in synergy to comprehensively address all issues of school safety. Knowledge management presented the central methodological theory on which this research was based. This

effective combination of knowledge management and lean thinking represents a key research novelty.

- **A new application of lean thinking**

As noted above, knowledge management was applied to the tacit and invisible aspects of safety in the school, for example, the tacit knowledge teachers and staff hold about school safety, or the school's culture or leadership. In contrast, lean thinking was mainly applied to explicit processes in the school. The literature review has already introduced and described lean thinking as a process reengineering methodology, which has been successfully applied to a number of organisations operating in different sectors: for example, healthcare, industrial and manufacturing sectors. However, the research showed that lean thinking also had potential to be effectively used within schools. This research has demonstrated this effectiveness and proven the efficacy of using lean thinking in a school environment. Lean thinking has been used as a process reengineering methodology to enhance the processes related to school safety, and has been applied in conjunction with the other more tacit aspects of school safety. Lean thinking is therefore applied to the school to meet the requirements of school safety against the common context of a constrained budget. Lean is therefore about the explicit, visible processes related to safety, while KM acts as the foundation of the research and focuses on the tacit factors associated with school safety. The application of lean thinking to the school environment has built on some hypothetical and theoretical research to demonstrate that lean can indeed be applied to school environments.

- **The Analytical Hierarchy Process Model (AHP)**

The analytic hierarchy process (AHP) breaks down a complex problem into a multiple hierarchical structure in order to aid in making decisions. The complexity and frequency in which decisions are made by individuals and organizations means that AHP has become a well-known and well-considered method in reducing the complexity associated with making decisions. One of the key problems in this research was related to the sheer number of safety suggestions given to the school by parents. Each suggestion was then assessed, and a decision was made whether to implement or reject the suggestion. Making decisions about the school safety suggestions and choosing which to select and which to reject is a complex task, and fits the multi criteria domain of AHP. In this research, the AHP model was used in a novel way to reduce the complexity of

decision making when dealing with parental safety suggestions. AHP also enabled the decision making process to be sorted and standardized. By sorting safety suggestions and standardizing the process used in making decisions, the AHP model was therefore part of the lean methodology as it reduced complexity and improved efficiency.

A key aspect of the research was related to managing the large number of safety suggestions that the school collected from parents. Prior to the implementation of the AHP model, making decisions about whether to implement or reject the suggestions contributed much to the amount of waste and non-value added time related to school safety. The novelty of the AHP model can therefore be summarised as follows:

- The AHP model provides a standardized way to approach school safety suggestions.
- The number of processes associated with safety suggestions and the related processing time, were reduced significantly by using the AHP model.
- The AHP model provides an effective solution to dealing with significant numbers of safety suggestions.

5.4 Research Generalizations

Key generalizations from the research lie in the potential of applying the approach to other schools within Thailand, and potentially beyond. The method outlined in this thesis could be applied to other schools, where the safety processes and tacit aspects of safety could be investigated and improved using the techniques described in this thesis. It is also important to note that one of the key generalizations from this thesis is the importance that should be placed on managing school safety and the process of adjusting school safety rather than the safety itself. The lean approach also encourages continuous improvement, and the method presented in this thesis can be continuously improved and adjusted to meet the needs of schools wishing to effectively manage their safety. In Thailand, school safety is often overlooked (see Chapters 1 and 2), and therefore the primary generalization from this work is that it provides a process/framework for managing school safety.

5.5 Research Limitations

Despite the success of the results, and potential for generalization of the lean thinking knowledge management approach, there are a variety of research limitations. These are outlined below, before considering how they feed future research opportunities.

- **The approach was only applied to one school**
  The lean thinking knowledge management approach was designed, implemented and tested at only one school. While there is no reason to suggest that this school is not representative of other similar schools in Thailand, application of the model in the future may require adjustment to fit the particular school circumstances. The case study was also a private primary school, and to apply such an approach to secondary schools, or government schools would require adjustment.

- **The model was designed and tested in only one area of Thailand**
  Chapter 2 explained how school safety is geographically diverse, and therefore the testing and application of the model is specific to the safety issues affecting the school in northern Thailand. As with the first research limitation, the model would require adjustment to the local school safety context in order to be useful.

- **Time limitations**
  The data for this model was collected over three semesters and implemented for one semester. While this provided a useful timeframe for the research, longer testing and evaluation might help to improve the approach even further, and would fit with the lean tenets of continuous improvement.

- **Parents' perception and understanding of safety research**
  There is a danger that involving parents in such research may adversely affect their perception of the school's safety and have a counterproductive effect on the school's safety. The method aimed to minimize such perceptions by explaining to parents the rationale behind the research. In addition, any perception related school safety surveys or other data collection methodologies are likely to be short rather than long term.

- **Adapting Lean concepts from manufacturing to school is challenging**
  Lean thinking originated in physical manufacturing and may not be well suited to office and service based processes. While this could be used as an argument against lean, there is a significant amount of literature which suggests lean is suitable for application to all types of organization. In addition, the positive results from the research in this thesis suggest that lean is indeed suitable for application to the education sector.

- **Not all schools would be able to devote the appropriate resources**
  While the long-term goal of the lean thinking knowledge management approach is to cut cost, waste and bureaucracy, it still requires time and effort to implement, particularly at the beginning of the program. For government schools in Thailand, it could be especially difficult to apply this approach; this is despite the fact that by implementing the approach, money/resources could be saved in the long-term.

The six key research limitations provide a clear context for future research directions.

5.6 Future Research Directions

There are a variety of directions where the research could be taken in the future. These are described in turn below.

- **Expand to other schools across Thailand**
  The first opportunity for future research is to build on the results and apply the model to other schools across Thailand. This could include other types of school (government schools, secondary schools) and possibly other education institutions.

- **Possibility of expanding to other countries**
  As well as applying the model elsewhere in Thailand, the approach could be used in schools based in other countries. Chapter 2 has already shown that while school safety literature is diverse, many schools have issues with how to manage safety, especially in terms of the cost and waste associated with safety.

- **Assess over longer timescales**
  One of the research limitations relates to the relatively short period of testing and implementation, but this also forms the basis of future research potential, where the model can be implemented and tested at longer time scales as well as benefitting from continuous improvement and adjustment.

- **Attempt to link accidents and safety statistics**
  Running the research over longer time scales would provide an opportunity to link the safety program with accident records. While Chapters 1 and 2 have illustrated the fallacy of safety statistics, over longer time periods these statistics become more useful. If the model was implemented over longer timescales the possibility of utilizing lean six sigma as a statistical analysis emerges.

- **Attempt to link safety and finance data**
  Linking safety data and school finance data more closely would enable a cost-benefit analysis to be performed and provide an accurate reflection of the cost-savings provided by the lean knowledge management approach. While some analysis of cost-savings has already been performed in Chapter 4 (i.e. percentage of budget spent on school safety before and after lean implementation), it needs to be conducted over longer timescales to provide clear information as to any cost-saving. Future research should therefore focus on monitoring the lean approach and comparing it with historical financial data to see if the cost-saving pattern is as expected and whether it continues over longer timescales.

- **Link to several schools**
  One of the most interesting possibilities for future research is to link data from several schools to create a larger database of school safety data. This could then be used to modify the approach and adapt the models (e.g. AHP).

5.7 Final Conclusion, Key Recommendations and Wider Perspective

School safety is a global issue, driven by a natural parental instinct to protect their children, and the moral duty adults have in safeguarding children during their formative years. Conclusions from this research suggest that addressing school safety is not necessarily one of accident numbers or cost, but more importantly, a

question of how to effectively manage school safety. The proposed lean knowledge management approach can effectively tackle the issues of managing school safety, and while the issue of school safety varies internationally, and even more so at regional and local scales, effective safety management could help to reduce this variability. Even in more developed countries, school safety is an issue of considerable debate, and most often in relation to juggling an already stretched budget in order to address pressing issues of safety. Lean thinking has been used in a variety of settings to effectively tackle issues of cost, inefficiency and waste, but so far has not extended to educational management. The results in this thesis have generated a set of key recommendations for improving school safety management using the lean thinking knowledge management approach. These are:

- The lean thinking approach to school safety has shown significant potential and should be tested and applied to other schools both to improve parental satisfaction with safety, but also to provide schools with a suitable framework to manage safety.

- Safety is a key marketing tool, particularly for private schools, and more so for primary schools than secondary. The lean thinking knowledge management approach can add value to safety processes and should be leveraged to increase parental (customer) satisfaction, which can help the school become more competitive.

- Safety is not necessarily a management burden and does not have to detract from other important aspects of the school and its management (e.g. academic achievement). The lean thinking knowledge management approach can reduce the management burden associated with safety.

- The synergy of lean thinking and knowledge management offers a comprehensive and useful framework to assess the current situation of safety in schools and work to improve it. The focus on tacit and explicit aspects of safety is an effective way to consider school safety as well as methods to improve it.

- Developing economies should embrace, not ignore school safety. Lean thinking and knowledge management can enable them to do so by addressing their fears relating to cost, bureaucracy and waste. Although school safety is not mandated in these developing economies, the increased competition between schools and the increase in affordable private schools means that school safety is required for schools wishing to remain competitive.

- Education trails the business sector by a wide margin and schools should learn from efficient and effective industry and service sectors to improve the service given to parents and students. Knowledge management and lean thinking provides at least a starting point for this to happen.
- The lean thinking knowledge management approach raises awareness about safety related processes, and shows that to master a school's safety is firmly in the domain of the school's leadership and management.

The key novelty of this thesis has been to tackle both the explicit and tacit aspects of safety via the synergy of lean thinking and knowledge management. The results should help to reduce assertions that managing school safety is bureaucratic, wasteful and adds little value to the school as an organization. The main conjecture from the research results thus indicates that the lean knowledge management approach might be an effective way to address issues of safety not just in educational settings within Thailand, but wherever cost, bureaucracy, waste, and inefficiency plague management processes.