# *How mind maps affect the practice of project management in SMEs*

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## Abstract

Increasingly, more companies and governments are turning to project management to deliver new products and transform internal processes. In turn, a mind map is a visual display of a person's thinking and a tool that can be used to improve thinking processes. Could the application of mind maps to project management improve project management practices? This research used case research to explore that question in selected SMEs. Four cases in Singapore were studied in an intervention exercise in each case in which the researcher trained and monitored a project team. A total of 33 interviews were conducted with project team members. Each team was observed in the exercise, and their use of mind maps during sessions was recorded. We found that, overall, mind maps are suitable as a project management tool for small and medium companies, to handle complexity and improve creativity and communications in most project management processes.

**Keywords:** project management, mind maps, case study, SME

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## Introduction

Project management as a formal discipline is relatively new (Shenhar & Dvir 2007). The establishment of the Project Management Institute in 1969 to serve the interest of project management practitioners was a milestone in the development and recognition of project management as a serious discipline. And now project management is being increasingly used by major companies.

In turn, mind mapping might help to advance project management's success rate (Brown & Hyer 2001; 2002). A mind map is a visual representation of a person's thinking (Buzan 2006). Research on whole brain thinking for project management suggested that mind mapping could provide the stimulus for both left and right brains in the process of project management. For example, Brown and Hyer (2002) suggested mind maps could be useful in project management, but their research touched on only some aspects, and was limited to a single case study of a pilot project of lean manufacturing during the planning stage. Thus, how mind maps could be used in project management is a relatively unexplored topic, especially in small and medium enterprises (SMEs) (Crawford & Pollack 2007; Turner et al. 2008).

This under-researched topic is important. Project management is poised to be one of the most promising jobs of the 21st century (Hoffman 2009; Gray & Erik 2000). Thus, in order to grow and attract leaders, projects must be the engines that power the enterprise and so leading projects will become one pathway to develop general management skills (Bowen et al. 1994). Moreover, group dynamics are key to how a project management team works, and mind maps could help with mapping an individual's and a team's state of mind, for example, by helping creativity and communications. But do they? Meanwhile, projects continue to fail. For example, 72 percent of all projects are unsuccessful in some way (Shenhar & Dvir 2007).

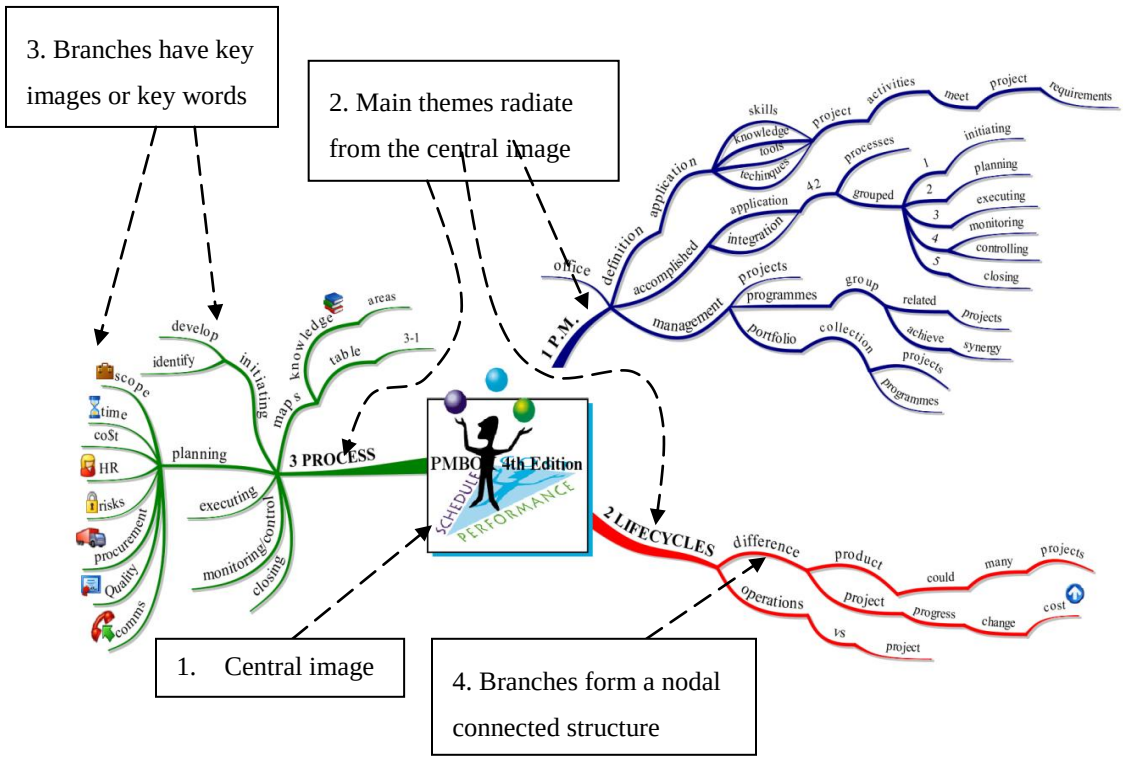
Given the successful application of mind mapping to a wide range of other activities and processes, the rising importance of project management and the under-researched potential

for mind maps to help in project management, this research addresses the problem: *How can mind maps affect the practise of project management in SMEs?* We argue that mind maps can have a useful role in SME project management in many ways, in most of its processes.

This report has several parts. The gaps in the literature about the topic are described, and four research issues to guide data collection and analysis are developed. Then the methodology of case research is justified and described. Next, the data is analysed. Finally, implications of the research are explored, and limitations and further research are presented.

Two core terms must be defined first. *Project management* is defined as the "application of knowledge, skills, tools and techniques to project activities to meet the project requirements" (Project Management Institute 2008, p. 6). Next, *mind maps* can be defined by four characteristics: a central image, main themes radiating from that central image, branches comprising one key image or key word, and these branches forming a connected nodal structure (Buzan 2006); an example with these four characteristics is provided in Figure 1.1. However, almost all prior research on mind maps does not adhere closely to these four characteristics of mind maps, making this research even more useful.

Figure 1 **Example of a mind map showing the four characteristics of mind maps**




Source: Mind map developed for this research, adapted from Project Management Institute (2008).

## Background Literature and Research Issues

Four research issues can be developed from the gaps in the literature about the research problem, to guide data collection and analysis. But first, that this research is delimited to SMEs has to be justified. Project management practices vary between companies of different sizes as well as companies of different industries (Crawford & Pollack 2007). There are differences between large and small companies' practise of project management (Turner et al. 2008). For example, SMEs may require a different set of project management tools, compared with large companies. Small companies tend to be more concerned with requirement definition and resource scheduling, so that planning remains informal and the company tends to focus on project control. In contrast, larger companies tend to use more

sophisticated tools. As well, fewer project management tools are used on small projects and these are generally the types of projects that small and medium sized companies are involved in. As well, due to the relative newness of project management as a form of management, SME leaders may not be familiar with the functions of a project manager and this lack of understanding by senior management is one of the reasons for project failures (Kerzner 2000).

In terms of project management skills, three areas constitute particular gaps for this research: creativity, managing complexity and project communications (Cavaleri & Reed 2007; Hildebrand 2007; Lundin 2007; Zielinski 2005). The changing business environment poses a challenge to the practise of project management. The demands of the market place have seen companies moving into increasingly complex projects for their clients. This transition is putting pressure on the traditional methodology developed for project management processes. That traditional methodology relies on linear thinking, well defined project life cycles phases, forms and checklists (Kerzner 2010a). What is needed for managing complex projects successfully are new methodologies and tools that are fluid and adaptive. Could mind maps be one of these new methodologies? That is, as projects become increasingly complex, the current set of tools available for project managers to handle complexity has been found wanting (Cicmil et al. 2009; Vidal & Marle 2008). Mind maps have helped manage complexities in business processes (Millen et al. 1997). But would this happen in an SME's project management? This question leads to the first research issue: *RI 1 How can mind maps help in managing complexity in an SME's projects?*

Another gap in the literature review is the lack of creativity in project management (Hildebrand 2007). The structured processes of project management may or may not be hindering creativity (Hildebrand 2007; Lundin 2007). But creativity is hailed as an important skill in many aspects of business operations (Buzan & Griffiths 2010; Green 2007; Hildebrand 2007; Swan & Pitta 2006). Indeed, mind maps have been useful for increasing creativity in both education as well as business processes, in areas such as brain storming, work breakdown structures and problem solving. But will mind maps actually help creativity

in project management in SMEs? Therefore the second research issue is: *RI 2 How can mind maps increase creativity in SME project management processes?*

Communications skills are among the soft skills lacking in project managers (Zielinski 2005). Yet mind maps have been found to be useful in communicating plans and visions (Buzan & Griffiths 2010). Could mind maps help communication in project management in this way? So the next research issue is: *RI 3 How can mind maps impact on SME project communications?*

Finally, the work processes of project management can be categorised into five major groups of initiating, planning, executing, monitoring and controlling, and closing (Project Management Institute 2008). The first process of initiating could not be covered in this research. Projects are initiated by management and the process of initiation could be lengthy, and sensitive business information might be divulged in the process; moreover, projects might be initiated but the start date might be delayed. But how mind maps could affect the other four processes could be explored for the first time. Therefore, the fourth and final research issue is: *RI 4 How can mind maps impact on SME project management processes?*

**Research setting: Singapore's economic and business environment.** The appropriate setting of this research was the developed country of Singapore. Singapore's economy is one of the most open and free economies in the world (Economic Development Board 2012). Singapore is an island state with a population of about 5.08 million and about 3.1 million workers. In 2011, it had a GDP of SGD300 billion (Ministry of Trade and Industry 2012). A small country with few natural resources, the government initially focused on its geographical advantage to develop Singapore's entrepot trade and shipping, and this focus led to growth in petrochemical and refining. But Singapore gradually diversified its economy to include banking and financial services, information and communications, and high value-added manufacturing such as semi-conductors and electronics. Currently there are about 160 000 enterprises in Singapore, of which about 99% are small and medium companies (Department of Statistics 2009). (In Singapore, a manufacturing SME has net fixed assets

investment of $15 million or less and a non-manufacturing SME has 200 or fewer employees Eng 2010). And note how Singapore's workers are well qualified for this research—the percentage of the population aged between 25 and 39 with secondary education and above is about 92% (Economic Development Board 2012). In brief, Singapore is an appropriate setting for this research about a developed economy.

## Research Methodology

The data about the research issues above could have been gathered in many ways. Because the area of study is under-researched, the research sought to develop some theory from the data gathered. Furthermore, because the research issues involved studying the complex process of project management (Anthes 2008; Burgess 2008), the interaction of mind maps on project management is likely to be a complex phenomenon. Thus the appropriate research method should be one where 'thick description' can be collected on the phenomenon of mind maps applied to project management. (A thick description "captures the thoughts, emotions, and web of social interactions" among participants within "their context" (Ponterotto 2006, p. 6).)

An appropriate methodology to collect this thick description was **case research** (Perry 1998; Stokes & Perry 2007; Yin 2009). In general, the case research methodology is preferred when 'how' and/or 'why' questions are being posed, when the researcher has little control over events, and when the focus of the research is on contemporary phenomenon within real life context (Yin 2009). Using the case research methodology for this research was justified against these three criteria. In brief, case research was suitable for this research.

The cases were carefully chosen to allow for replication logic across all the four cases; the axes of the replication logic were size of the company and its industry, as shown in Table 1. In other words, the cases were carefully chosen to build theory (and that theory will be summarised in Figure 2). Below, quotations are used to capture the respondents' insights. The quotations are linked to a case letter and respondent number; for example, A1 refers to

case A and interviewee 1. The numbers used for the interviewees indicate their position within the project team: project team leaders are coded as '1', the most experienced of other team members was coded as '2' and the least experienced team member as '3'. The one exception is in case A, where there were only two project members, the leader A1 and the other member A2. These codes aided the cross-case analyses in the next section.

Table 1 **Research design of cases based on two dimensions of literal and theoretical replication**

| **Type of industry** | **Small company** | **Medium company** |
|---|---|---|
| Information technology based | C (LLL, MMM) | C(LLL, MMM, MMM) |
| Non information technology based | C(LLL, MMM, MMM) | C(LLL,MMM,MMM) |
| Total | 2 cases<br>15 interviews | 2 cases<br>18 interviews |

Notes: C = represents one case

L = one interview with project leader

M = one interview with project member

Source: Developed for this research.

This case research methodology used three of case research's six possible sources of evidence: documentation, interviews, and direct observations; the other three sources of archival records, artefacts and participant observation were not available in this case research (Yin 2009). The three sources of evidence used were collected during an unusual *intervention exercise* in which the researcher trained and monitored project teams in the four cases. An intervention training session was conducted first, to introduce the project teams to the skills of mind mapping. Immediately following that training, the project teams started working on planning their own projects. The three intervention sessions were conducted at the company's premises and lasted about 1.5 hours. In each session, the documents with the mind maps created during the session were extracted and used as a source of evidence.

The second source of case research evidence was interviews. How many interviews were required? About 25 to 35 interviews are required to provide a reasonably credible picture for research of this nature (Stokes & Perry 2005). This research suitably incorporated 33 interviews; that is, a total of three interview sessions for each case were conducted for this research. The three interviews for each case were conducted at the pre-intervention stage, mid-project stage and after the project was closed, to provide different perspectives on the interviewee's experience. The team members with the most and least experience in project management were selected so that a balanced range of experience could be gathered. The interviews varied from 10 minutes to 30 minutes. These lengths were shorter than the typical duration of 60 to 90 minutes (Carson et al. 2001), because the interview questions were focussed and because each interviewee was interviewed three times. To improve the interviewing process, an interviewer's guide was developed to help provide good practices to the interview (Stokes & Perry 2007). An early version of that guide was used in the pilot interview, to allow the interviewer to practice using it and to further refine the guide. A draft of the transcript of the interview was also sent to the interviewees for their verification.

Directly observing the project team members at work provided the third source of evidence for the case research. Observation has widespread application in business and managerial research (Baker 2002) and so was a suitable source of data for this research. Because this case research is based on an area which is under-researched, a semi-structured observational technique was suitable. Four key issues were addressed. Firstly, the specific activity to be observed is the planning meeting of the project to be studied. In this planning session, observations were made about how the team used mind maps, how each member reacted to it, and how it affected the outcome of the planning session. The second issue was addressed by recording the observations with a video camera, supplemented by notes taken during the observation session. The words heard in the video recording were later transcribed. Thirdly, consistency was maintained by giving each of the four project teams the same instructions. Each team was told that immediately after the intervention training, the project team would be asked to spend some time to plan their project using mind maps. They were told that it

was not an exercise, but an actual planning process that would be video recorded for the purpose of the research.

The final issue of observation research addressed concerned relationship and control. The project teams were informed that the researcher would not interrupt them, because he was merely recording the event. They were also told that the researcher would not offer any assistance in their planning; the researcher maintained silence throughout the observation. Reliability and validity of direct observations can be enhanced by developing an observation schedule and guide that enables comparability between observations (Baker 2002). So an observation schedule and guide was developed and tested in the pilot research. The observation schedule focussed on recording facts and not interpretation, and recording as much detail as possible. Video recordings and transcripts of the video enabled multiple reviews and helped in improving accuracy of observation. The reliability issue was further addressed by collecting four sets of observation data from the four cases and having the four observations made on the same project management process of project planning.

In brief, this research was able to collect data from three of the six recommended sources of data: documentation, interviews and direct observations (Yin 2009).

Steps were taken to ensure the rights of the case research interviewees and to adhere to the ethical considerations of the Australian Institute of Business. The core principle followed was informed consent—consent for participation in this research was obtained from the interviewee during a telephone conversation or an email prior to the interview. At the beginning of each interview, the rights of the interviewees were stressed.

**Data Analysis**

Data was collected in the three forms described above. Then the data was analysed and reported in full in Toi (2012). Summary findings about each of the four research issues are discussed next.

**Research Issue 1: How can mind maps help in managing complexity in SME projects?**
Complexity is a large set of interdependent factors. How to handle it in the cases depended on the project involved. Case A was working on enhancing a website function for a client, case C was working on developing a new course, case B was developing brands for their clients, and case D was planning their company's annual dinner and dance.

At the mid-point of the project, two interviewees rated their project as high in complexity, two as medium and two as low in complexity. At the end of the project, while some of the interviewee's ratings changed, the proportion of the interviewees who felt that their projects were complex remained the same. In brief, at any time during the project time line, most of the interviewees felt that their projects were complex. The next discussion focuses on how the use of mind maps impacted that complexity.

At the mid-project stage, five interviewees said that mind maps helped them to manage project complexity while three said it did not and two were unsure. After the close of project, six interviewees said that mind maps helped, three said it did not help, while two were unsure. Each of these responses will be examined further.

In case A, both project team members felt that mind maps helped to manage the complexity of their project. After the project was over, the project leader estimated that it helped by 30% and he said that he could *'feel it'*. This view was different from his assessment at the mid-point of the project when he felt that it was not useful, because he was dealing with the spread sheet of data fields at that time.

In case B, the team had switched to different projects mid-way due to the client's needs. In the initial project, all three members of the project team felt that mind maps helped to manage complexity. For example, the project leader felt that mind maps helped by *'organising the different tasks and helps to ensure that nothing is forgotten'*. Subsequently, the other projects that two project members of case B went on to do were lower in complexity and therefore they felt that mind maps did not help in the area of complexity.

In case C, all three team members felt that mind maps helped to manage complexity. For example, the project leader felt that mind maps helped him to see the parts and the whole and their relationships. He also mentioned that designing a course that takes a course participant from basic knowledge to advance skills was challenging, but the mind map helped.

Case D did not use mind maps after the first planning session. Although the interviewees reported a significant level of complexity, they did not feel that mind maps helped because much of the work of their project was contracted out to an event organiser. At the final interview, D3 reflected that mind maps did help in managing complexity, but it did not help her to connect all the different viewpoints of the project team members.

There were no clear patterns of the impact of mind maps on complexity in terms of the level experience of the project member or the type of projects. But, overall, mind maps did generally impact project complexity in positive ways. In summary, common thread in the experiences of interviewees was that mind maps helped in the organisation of their thoughts, so that it was easier to see the parts and whole.

**Research Issue 2: How can mind maps increase creativity in SME project management processes?** The next research issue concerns creativity. Interviewees were asked about the importance of creativity to their project and how mind maps helped in creativity. This question was posed at both the mid- and end-points of the project.

At the mid-point of the projects, all interviewees except A2 felt that creativity was important to their projects. Four interviewees, C2, C3, D1 and D2, said that they did not use mind maps because of a lack of time or that they simply did not try it. Six of the interviewees who did try mind maps said that it helped them to be more creative. After the project was completed, nine interviewees said that creativity was important to their project. Out of the nine interviewees, the four who did not use mind maps for creativity were C2, D1, D2 and D3.

The four others, B1, B2, B3 and C1, said it helped them although C1 said that while he used mind maps, creativity did not *'show up in the mind map'*.

Next, consider the within-case impact of mind maps on creativity in project work. In case A, project leader A1 agreed that creativity was important to his project because he could see the programming pathways more clearly: *'It will help me because now when I see right, this one that you break into two logics ... over here break into another two logics. But at the end of the day they are going to 'workshop' (referring to a function in the software)'*. He further said that *'so basically this mind map can make me to think further away'*. However, in the later part of the project, he felt it was no longer important as he was focussed on trouble shooting and debugging the software. A2 felt that creativity was not critical from the beginning as the requirements were all given by the user and he simply had to execute it.

Case B's team members all felt that creativity was needed for their projects and all felt that mind maps had an impact on creativity. B1 said he got more ideas, B2 said she was able to get useful ideas and get it faster, while B3 experienced the increased ability to mix ideas and to let the words on the mind map '*guide*' her when she said in response to how she got a good idea for the project—*'words (on the mind map) kind of guide me to the idea'*. Case B is the most consistent team in terms of experiencing the impact of mind maps on creativity because they experienced it during the planning session of the first project and then on three other projects.

All team members of case C felt that creativity was important, but only C1 said that mind maps helped to increase creativity. C1 experienced it at mid-point of the project through brainstorming and being able to see the whole picture and relationships, he said, *'project wise in terms of brainstorming for ideas that's huge because you can see clearly the whole picture'*. Later on, after the close of the project, he felt that it did not show up in the mind map.

Case D's members all agreed that creativity was needed for their project. The project leader D1 did not use it personally, but felt that observing what some of his team members did, concluded that it should have helped them *'think through the linkages'*. D3 felt that it would help if the person is willing to think out of the box.

In summary, all interviewees except for A2 felt that creativity was an important skill for project management. At both stages of the projects, more than three quarters of the interviewees said that creativity was important. As to the impact of mind maps on creativity, it was experienced by more than half of the interviewees at the mid-point of the project and by about half of the interviewees after the close of the projects. Mind maps as a creativity tool was not consistently experienced by all the interviewees except for case B. Case B is a brand development and design company and hence the nature of their projects relies heavily on creativity. In brief, creativity is important in project management and a mind map can help somewhat in fostering it.

**Research Issue 3: How can mind maps impact on SME project communications?**
Interviewees were asked how mind maps impacted their communications within the project. The question was posed during the mid-point and at the end-point of the project.

At the mid-point of the project, two interviewees, A2 and C3, felt that mind maps impacted project communications. A2 said, *'First we are discussing this project and drawing this mind map. We know how to develop and how to handle this project. So I think this part is communicating'.* At the end point of the project, four other interviewees, B2, C1, C2 and D2, felt that mind maps did impact the project communications. B2 said, *'I can gather all the points which I want to speak to him (project leader) … after our conversation sometimes I realise I got points but I forgot to talk to him … now I can think more',* referring to her experience after using mind maps.

Overall, few interviewees at the mid-point of the project felt the impact of mind mapping on project communications, while some more interviewees experienced the impact after the

project ended. Most of those who said mind maps had an impact on project communications cited role clarity as the reason, and not a direct impact on communications itself. Furthermore, there was only one project leader, C1, who said that it impacted project communications. There were more interviewees from the medium companies who felt that project communications was impacted by mind maps. In conclusion, the impact of mind map on project communications would at best be described as limited, although its influence increased with the size of the company.

**Research Issue 4: How can mind maps impact on SME project management processes?**
Mind maps may affect the four project management process groups of planning, executing, monitoring and controlling, and closing. After the close of the project, interviewees were asked about the areas in the entire project management process that they felt had been impacted by mind maps. Mind maps most commonly impacted the **planning** process. The reason for the planning process being the most impacted could be due to the intervention training, when all of them had to plan for their projects using mind maps. However, cases A and B had continued to use mind maps in other projects and reported the same experience. In addition, case A and case C reported experiencing an impact in other areas of the project management process.

The next process group that felt the impact of mind maps was that of project **monitoring and controlling**. Many interviewees felt that the mind map was very useful in that process. A2 said that the mind map helped him *'check every stage of the programme';* C3 said she could *'zoom down'* on each area of the project and settle it before going on to the next areas. Finally, in terms of **executing** the project, both members of case A felt that the mind map was useful. In terms of using it for the process of project **closing**, although no one used it during this case research, C1 and B1 said that they would like to use mind maps during a project's closing, especially the evaluation and reflection aspects. B1said: *'If there is a way whereby I can use a mind map software to plan and then other people would also use it to reflect back what they have done and experience of things and as such that would be useful as well'.*

In summary, the impact of mind maps was felt mainly in the process group of *planning*, followed by *monitoring* and *executing*. No impact was felt in the process of *closing* because no one tried using it in that process group. There is no difference between the sizes of companies in terms of the process groups impacted by the use of mind maps. The interviewee's level of experience in project management did not affect the impact on the process groups.

**Conclusion about the research problem.** There is a lack of project management tools compared with the range of tools available for other forms of management, and there is a lack of tools for small projects in particular (Besner & Hobbs 2008). Mind mapping is not method-specific and hence versatile; is it possible to consider mind maps as an additional tool to current project management tools? So interviewees were asked at the end of the project if they would consider mind maps as a tool for project management. Furthermore, they were asked if they are likely to use mind maps in their next project. All interviewees agreed that mind maps can be considered as a tool for project management. D1, the project leader for case D (who did not use mind maps himself), agreed that it could be used as a project management tool because he had seen it being used by at least three of his project team members. The interviewees were also asked if they would be using it for their next project (except for D1 who was not asked that question); seven interviewees said yes, and three gave a qualified yes if the project was sufficiently big or complex. The response from the three interviewees who said that they will use mind maps only if the project is large enough or sufficiently complex, can be linked to their recognition that a mind map helps in managing project complexity. All three who gave these responses, C2, C3 and B2, had experienced the impact of mind maps on project complexity.

In summary, responses from interviewees on the suitability of mind maps as a project management tool shows that there were no major differences between small and medium companies in the acceptance of mind maps as a tool. There were also no differences in patterns of acceptance between the project leaders and project members. In brief, there was

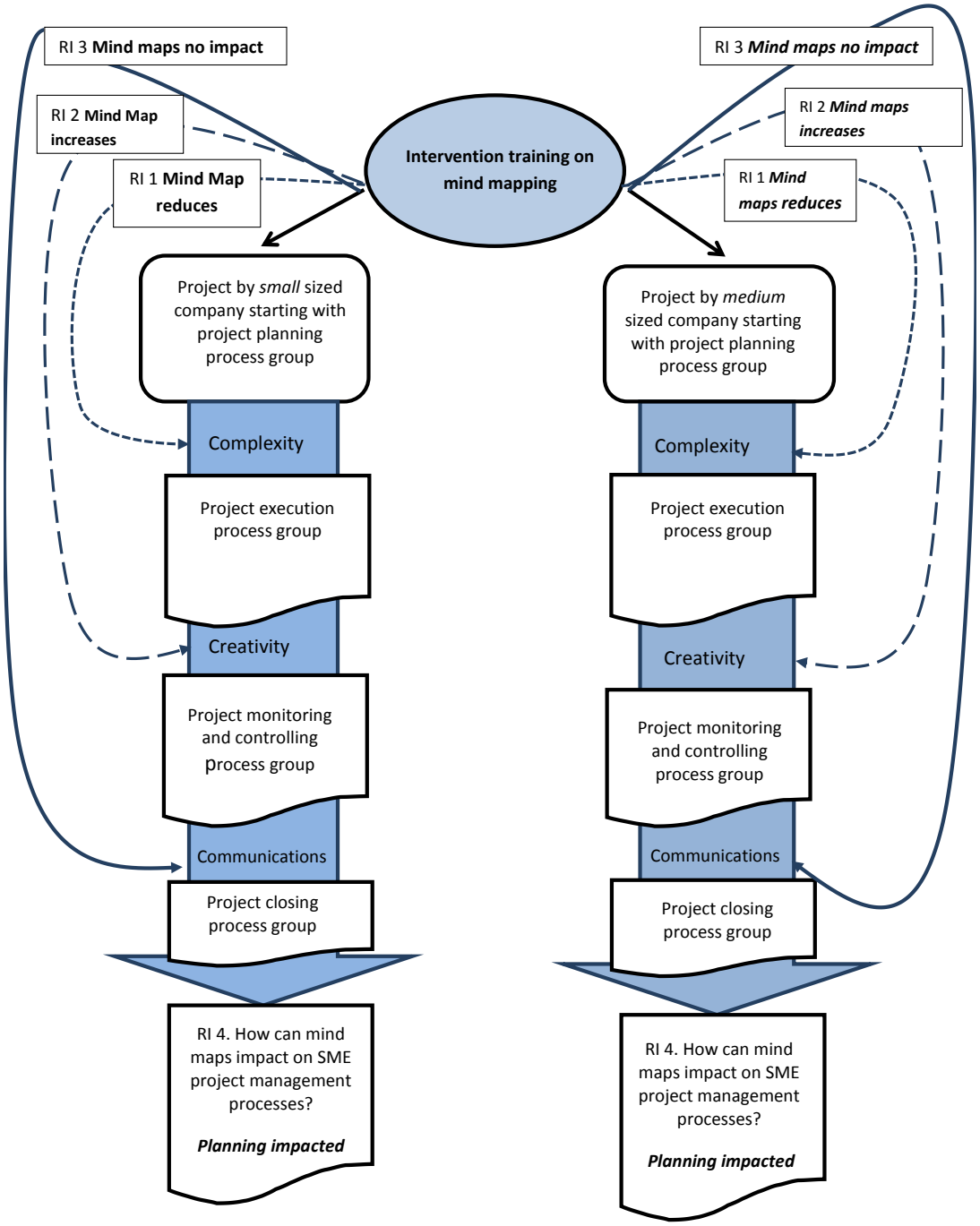
virtually unanimous acceptance of mind maps as a project management tool amongst the interviewees, especially for large and complex projects.

On the background above, this section addresses the overall research problem of how mind maps impact the process of project management—it is the final result of this theory-building research. That is, the final theoretical framework incorporates and *ties together* the findings above. Project teams wishing to use mind maps for their projects start with training on mind mapping so that all project members have the prerequisite skills to use mind maps in their project. Because planning is the project management process most impacted by mind maps, and because it overcomes the weakness in project management practices in small and medium sized companies, it is essential that the project team come together to plan for the project using a mind map. Sufficient time should be set aside for thorough and detailed planning.

The next process stages of project monitoring and controlling will also benefit from the use of mind maps. In this stage, information technology based companies benefit more from the use of mind maps than non-technical companies. Indeed the nature of mind maps, with both the overview and details available on the same page, helps in monitoring and controlling project work. Finally, project execution is not particularly impacted by mind maps, therefore other tools could be used for this phase of the project management process. Some of the tools used for executing small projects can be common software such as MS Excel, MS Projects and MS Outlook. These tools are also useful for task scheduling for small projects which helps in monitoring and controlling. This whole theoretical framework is summarised in Figure 2.

Overall, after all these processes and regardless of the type of industry and the type of project, a mind map reduces project complexity. In turn, a mind map enhances creativity by allowing users to see the project pathways and allowing them to mix ideas on the mind maps.

Figure 2 **Summary of the final theoretical framework**



## Discussion

**Implications for theory about project management.** This research has three implications for the background theory of project management. Firstly, all four cases did not use project management processes prescribed by the Project Management Institute, nor any other prescribed method of project management. Literature indicated that there was no one way that project management was understood or adopted (Thomas & Mullaly 2008). Therefore, the form of project management that some small and medium sized companies practice can at best be described as a loose form of project management and this should be acknowledged more often in the literature.

By the way, some of the selected small and medium sized companies suffered from a lack of tools for small projects (Turner et al. 2008) because few tools were available for them. Moreover, many interviewees indicated that they did not use tools because the set up time and effort of those tools were not commensurate with the size of the project they were working on. Therefore, while there are easily available tools for project management such as Microsoft Project and some PC and smartphone apps, they are not designed for the types of small projects that small and medium sized companies like those in Singapore work on.

The final implication for theory complements the literature about how larger projects are becoming more complex (Anthes 2008; Burgess 2008; Cicmil et al. 2009; Robertson & Williams 2006; Vidal & Marle 2008). This research found that project complexity is felt even for small projects—almost all interviewees reported that their projects were complex.

**Implications for policy.** In turn, consider implications for policy in Singapore and possibly other countries. Small and medium sized companies in Singapore make up 99 percent of all companies and employ about 60 percent of the total workforce (Ministry of Trade and Industry 2012). Singapore's small and medium sized companies are increasingly project based. Indeed, case B estimated that about 85% of their activities were project based, while case D said the percentage was about 20%. Singapore's call for higher productivity,

especially in small and medium sized companies, could be partly answered by the use of mind maps to increase project productivity.

For example, while tertiary institutions teach basic management theory to prepare workers for industry, this teaching should now include project management. Project management training should also be designed for application in small and medium companies. Large companies would typically have professionally trained project managers, indeed the Project Management Institute's *Project Management Professional* certification is designed for large companies. Interviewees who had undergone such a course noted that it was not suitable for small and medium sized companies. In brief, improving project management training in small and medium sized companies could have a significant impact on the Singapore economy.

As well, more project management tools need to be developed for small and medium sized companies (Turner et al. 2008). The current tools available for the selected small and medium companies are too complex and unwieldy for use on small projects—reasons given in this research for not using tools were because it took too much time and effort to set up the tools. More appropriate tools would help these companies to better manage projects.

**Implications for practice.** Findings in this research have implications for the practice of mind mapping in project management. Firstly, a mind map *is* a suitable tool for project management for some small and medium sized companies. In turn, a mind map is a tool that can be used across all four project management processes namely, planning, executing, monitoring and controlling, and closing. This research finding confirms literature on the suitability of mind maps for project management (Aucoin 2007; Brown & Hyer 2002; Buzan & Griffiths 2010; Swan & Pitta 2006; Wycoff 1991). Mind maps could be included in the list of tools for many of the processes involved in project management within small and medium sized companies.

In particular, the biggest impact of mind maps was found to be in the project planning process. The planning process is a critical process as about half of the 42 sub-processes prescribed by the Project Management Institute's *Project Management Body of Knowledge* are dedicated to it. Therefore, mind maps impact the most critical aspect of project management. Indeed, planning is the weakest aspect of project management for small and medium sized companies (Turner et al. 2008) and this practice of using mind maps for planning would improve project management practices. Focussed application of mind maps on the project planning process will likely produce better project results. Therefore, mind maps should be used for small and medium sized companies in their project planning process.

The third implication for practice arises from the effect of mind maps on project complexity. Mind maps have the effect of reducing project complexity. Reducing complexity results in better managed risks (Vidal & Marle 2008). Mind maps are a tool to reduce complexity in projects for small and medium sized companies and therefore reduce business risks for these companies.

The fourth implication for practice is that mind maps help increase creativity in projects. Mind maps have the additional effect of stimulating creativity in projects across different types of projects and across industry. More than half of interviewees experienced greater creativity though the use of mind maps. This increase confirms similar experiences reported in literature (Brown & Hyer 2001; 2002; Swan & Pitta 2006).

Finally, this research indicated that some training is necessary in order to use mind maps in project management. The intervention training took about 1.5 hours; while this amount of training time was sufficient for the effects reported in this research, some interviewees requested additional training. In brief, training is needed for users to experience the impacts of mind maps on project management and more than 1.5 hours would often be needed. Such training could be included in a company's formal courses (as well as those of educational institutions noted above).

**Limitations and further research.** The case research methodology has limitations like other methodologies, but we addressed them. One possible limitation of this research was that the case research methodology can sometimes lead to overly complex theories and can result in narrow and idiosyncratic theories, as Eisenhardt (1989) notes. But this research's use and development of prior theory and specific research issues to address issues within the theoretical framework overcame this problem (Yin 2009). Case research has also been criticised for its logistical and operational problems (Eisenhardt 1989), but our use of replication logic and the development of the interviewer and observation guides addressed these concerns. As well, case research is sometimes criticised for a lack of rigour. In this research, rigour was built into the research by ensuring the usual attention in case research to construct validity, internal validity and external validity in evidence gathering (Healy & Perry 2000; Yin 2009, pp. 40-45). Reliability was further strengthened with the elements of a case protocol, a case research database and replication logic (Yin 2009). In brief, the case research methodology is not an important limitation of this research.

Note that the research was exploratory and descriptive in nature and is limited to the *analytic* generalisation of this article, as is usual for case research (Yin 2009); that is, the case research findings have been fitted in the extant theory. But quantitative research such as surveys and large scale interviews could be done to further extend the research for *statistical g*eneralisation.

As well, this research looked at some small and medium companies in Singapore. Companies outside of Singapore or large companies in Singapore were not included in this research. Further research could cover small and medium companies in other countries or large companies in Singapore. Research into the suitability of mind maps in project management by industry type could also be an extension of this research. Nevertheless, this research setting of some small and medium sized companies in Singapore is not a severe limitation. Singapore is a developed economy that is linked with global companies and markets in the

West and Asia. The research's findings should apply to many other companies around the world.

Finally, for the reasons given above, this research could not study the impact of mind maps on the process of project initiation. Further but difficult research could include this process.

## Conclusion

In summary, this research uncovered the practices of selected small and medium companies in their project management. It found that mind maps were a suitable tool for project management in small and medium sized companies. In conclusion, mind map training does yield positive project management effects on increased creativity, reduced complexity, improved communications, and improved planning, monitoring and control.

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