

The Paradox of Operational Excellence Leading to Radical Innovation

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Executive Summary

As firms grow larger they can apply Operational Excellence models to structure their organization and to continuously improve their current processes, most often incrementally. However, this focus on exploitation of their current processes, technologies and services through Operational Excellence can cause them to lose their propensity to innovate radically. As a solution, a functional structure in an organization ensures that the R&D department can focus on developing radical innovations while the manufacturing department can focus on improving processes. However, this solution does not take into account that opportunities to innovate radically can arise anywhere in the organization. With both radical and incremental innovation being essential for the future life of an organization, this asks for a situation where an organization needs an environment that is both Operational Excellent and capable of generating radical innovations. Therefore, the goal of this research is to find how Operational Excellence can be managed so that it can lead to both radical and incremental innovations. Within this thesis, first an overview is given of what operational excellence is and what radical innovation is. This was done by gathering information through conduction literature studies and a case study. This resulted in a framework that described the trade-offs that have to be done in order to create radical innovations next to incremental innovations while Operational Excellent. This framework was then used to systematically conduct a case study to explore how this is done in practice. The case study was done within Boston Scientific, an innovative international medical device manufacturer that applies Operational Excellence within its organization. The results of this study are that in order to radically innovate within an organization, there needs to be a combination of diverse organizational knowledge. This can be done through knowledge management on the individual level by training employees in new knowledge fields or letting them work in different departments, on the team level through cross-functional teams, or by acquiring new technologies, patents or people from different

industries. Maintaining a systematic view ensures that interdepartmental barriers are removed, thus allowing the sharing of diverse knowledge. This diverse organizational knowledge can then be leveraged by the Organizational Excellence principles into radical innovations. In this process, Organizational culture and standardization facilitate radical idea implementation, setting strategic Goals leads to radical idea generation and Continuous Improvement, Systematic Thinking and a Customer Centric Strategy lead to both. However, in combining Operational Excellence with radical innovations, trade-offs have to be done so that risk of the innovation process is reduced as much as possible while still be able to generate radical innovations. Important implications for the area of Management of Technology and Boston Scientific are that simply adapting to a culture of Operational Excellence principles won't lead to radical innovations. Operational Excellence provides a structure and requires a certain culture to be implemented and supported by the leaders of an organization. If the organization invests in obtaining diverse knowledge, then through certain Operational Excellence principles, radical innovations can be developed. An implication for Boston Scientific is that when they want to innovate in a more radical way, necessary is to make clear that a radical innovation results from combination of diverse knowledge and is entailed with a higher risk for implementation success. An understanding of this definition allows employees to coordinate their actions better towards this result. This paper provides the answer on how to generate and implement radical innovations while operating in an Operational Excellent environment.

Introduction

With different markets being highly competitive these days, there's a high pressure on companies to maintain sustained competitive advantage (Barney, 1991). According to Barney this type of advantage means that a company is pursuing a value creating activity that cannot be competed with due to duplication efforts of other firms. It is important for companies to keep developing and improving products and services but at the same time they have to be operational efficient. Another challenge lies in finding the right balance between these two activities because you can't spend your money twice. If a company focuses too much on making its production processes as efficient possible, they might miss out on certain opportunities that arise in the market. On the other hand, spending most time and money on exploring new opportunities might cause that the production processes remain costly. In 1976, Duncan described the pursuing of both these activities as 'organizational ambidexterity'. This term was then further explored by March (1991) who described it as a balance between exploitation and exploration. Exploitation refers to "refinement, efficiency, selection and implementation" and exploration refers to "search, variation, experimentation and innovation" (p. 71). Exploitation is thus a process where an already existing process or idea is worked out further or refined. Exploration is more a process of search where new ideas are sought in areas that are relatively unknown. Therefore, experimentation is performed and variation is created to find ideas beyond the knowledge and technologies that currently exist.

Within large organizations, these activities are most often functionally separated through a research and development department and a manufacturing department. The one focusses on exploring new possibilities to innovate while the other focusses on manufacturing the products in a cost saving and efficient way. This structural separation can however result in a situation where an innovative idea generated within the manufacturing department needs to undergo a long road of procedures before it reaches the R&D department. This notion is acknowledged by Gibson and Birkinshaw (2009) who state that sometimes there is a need for contextual ambidexterity by "building a set of processes or systems that enable and encourage individuals to make their own judgments about how to divide their time between conflicting demands for alignment and adaptability (p. 201)". This would mean that both explorative and exploitative activities have to be managed at the same time by these individuals. This indicates that organizations that have a functional structure might consider stepping away from this functional structure. However, as described by Papachroni (2015), the earlier described explorative and exploitative activities seem like the exact opposite of each other and

“Experimenting and exploring is more time consuming, entails uncertain results, and has a longer time horizon than refining current knowledge and extending current competencies” (p.3). However, March (1991) states that the right balance between the two can lead to superior organizational performance. Organizational performance is described as a reflection of how firms take the best advantage of their existing knowledge assets, routines, and capabilities (Wang & Li, 2008). Sarkees and Hulland (2009) argue that ambidextrous organizations might even outpace purely innovation companies in terms of innovative outcomes even though this sounds counter-intuitive. They state that efficiency and innovation can be complementary rather than contradicting in some cases. For instance, in organizations two types of innovations occur namely incremental and radical innovations. Incremental innovations are most often related to exploitative activities and radical innovation to explorative activities. Both innovations are important to the organization and solely focusing might hamper the long time survival of the organization. This suggests a similar balance suggested by March (1991) between these two types of innovation.

To manage the exploitative activities within the manufacturing department of a large organization a culture of Operational Excellence can be applied (Basu, 2002). This culture focused on continuous improvement of processes and removing variation tends to drive out explorative activities because these activities are associated with high risk and variation to the organization (O’Sullivan, 2009). However, in practice, not all radical innovations solely occur within or originate from the department that focusses on explorative activities. Also within a manufacturing or supply chain environment opportunities to radically innovate might exist. The problem is that once firms grow larger and they attend to an Operational Excellence model to structure their organization and to manage the exploitative activities they lose the propensity to innovate radically (McLaughlin et al. 2009). An explanation for this is that simultaneously conducting exploitative and explorative activities is not a straightforward task as these activities require radically different mind sets and organizational routines (Gupta et al., 2006). Within the academic literature on ambidexterity an overview is given of what resources are needed to manage this form of ambidexterity (Turner, Swart and Maylor, 2012). Yet, unclear is which organizational structure, organizational culture and methods are needed to both grasp the opportunities to innovate radically and turn them into an innovation as well as being Operational Excellent.

1.1 Research Objective

In order to find an answer to the previously stated problem, this research's objective is to find out to what extent Operational Excellence can enable both incremental and radical innovation.

1.2 Research Questions

The previously stated research objective leads to the next main research question that will be addressed in the thesis:

Research question: How can large organizations be Operational Excellent while being able to innovate radically?

In order to answer this question, an idea of what Operational Excellence is must be obtained. A definition of Operational Excellence will be obtained from literature and an overview of Operational Excellence models will be given. This leads to the first sub question:

Sub question 1: What is Operational Excellence?

After that, a better idea of what radical innovation is must be obtained. There are different definitions of radical innovation and there are different settings in which radical innovations can occur. For instance, the innovations within a service company can differ from the innovations within a company that produces tangible products. Damanpour (1991) stated that distinguishing different types of innovation is important for understanding organizations' adoption behaviour and the determinants of innovation in them. For this reason, the second sub question is stated:

Sub question 2: Which types of radical innovation exist within a large organization?

Operational Excellence has an origin in quality management models and these models are based on quality management principles that have a certain overlap. These overlapping or core principles on which these models are based will be examined further in how they can facilitate radical innovation within an organization. This leads to the third sub question:

Sub question 3: What is the relation between the core elements of Operational Excellence and radical innovation?

1.3 Research Methodology

The following structure will be followed in the rest of this thesis: The first three chapters describe a literature study conducted to find the relations described between Operational Excellence and radical innovation. Within chapter two will be explained how large organizations conceive Operational Excellence. In chapter three, the same will be done for radical innovation. After that, chapter four will describe how Operational Excellence relates to radical innovation. At the end of chapter four a framework will be shown that contains how the individual elements of which Operational Excellence consists relate to radical innovation. The purpose of this framework is to form a structure by which a case study can be conducted. The reason for this case study is to extend the framework with practical examples because undescribed is how radical innovations can occur within an Operational Excellent environment. The following paragraphs provide a more detailed description of how these chapters will take shape.

1.3.1 Literature study

Within chapter two, an overview of how Operational Excellence is given. The following paragraph will explain how this study is structured. Organizations need to implement one or more quality management systems within their organization in order to become operational excellent. There are different quality management models, different institutions that grant awards for quality management and authors that write about quality management. What these three groups have in common is that the models and ideas are based upon certain quality management principles. These principles differ somewhat from each other but there is a certain overlap among the different principle sets. In the first literature study an overview will be given of different models, awards and authors on quality management. After that, the core principles found in this literature study will then be put in a framework which will be used later to identify the relationship between the different elements of Operational Excellence and radical innovation. Describing each individual element gives then a view on how Operational Excellence relates to radical Innovation. In total, ten different lists of quality management principles will be studied. The selection of quality management sources was based on the recurrence of being mentioned in academic journals when looking with key terms such as “Operational Excellence” and “quality management models”. Noted should be that principles that were only mentioned by one quality management model were excluded from framework. Next to that, principles that were found within multiple models were placed under a certain

header. However, once looking into academic literature based on search terms related to these headers, the case could be that this theme was described with a different name but meant the same. If this was the case, then the name of this group was changed into the name mentioned in literature. To clarify this with an example, within the quality management sources was described that practices and methods should be documented and reported to other employees so in the beginning of this research this group was called 'documentation and reporting'. However, within academic literature this was called 'standardization'. To be able to find relevant literature that related this phenomenon to radical innovation, the term 'standardization' was put in the framework.

Another notion regarding the creation of this framework is that the commitment of the top management team will not be discussed. In literature is described that the quality management philosophy has to be promoted by the top management team and that they have to motivate people in constantly learning through training. (Savoilanen & Haikonen, 2007). This shows that the top management team has a role in ensuring that other people learn and become skilled in continuous improvement. However, the scope of this does not include finding the ways how this team should manage people and for this reason the commitment of them is left outside of the scope of this thesis.

The second part of the literature study aims to find an answer to how radical innovation is perceived by a large firm. In literature there are different definitions used but in order study the relation between Operational Excellence and radical innovation, a clear overview must be obtained. This will be done by analyzing different academic literature and providing an overview within a framework of the definitions of radical innovation and the characteristics of this type of innovation. From this framework a conclusion will be drawn of which type of radical innovation is relevant for this study. The reason why this study narrows down its scope to large organizations is because in literature is described that large organizations lack discovery competencies and have an unsupportive organizational structure to generate radical innovations (Sandberg, 2009). Also, an Organizational Excellence culture is mostly seen in larger organizations because change an organizational culture is time and money consuming (Oakland, 2009). This compared with SME's that face different problems such as insufficient resources and lack of incubation competences. (Sandberg, 2009).

1.3.2 Creation of the framework that relates Operational Excellence to Radical innovation

Chapter two and chapter three provide two frameworks that show how Operational Excellence and Radical Innovation are seen from the perspective of a large organization.

Within chapter four of this thesis, the goal will be to look to how the core principles described in the first framework relate to the used definition of radical innovation. Examples of these principles are continuous improvement, having a customer centric strategy and maintaining a systematic view. Further looking into academic literature will then be done in order to look how these elements relate to radical innovation. These findings are then put into a framework to provide an overview of how the Operational Excellence principles relate to radical innovation. Also, this framework can then be used as a structure to analyze a case study.

1.3.3 Case study Boston Scientific Maple Grove

After the framework has been created, it will be used to structurally analyse a case study within a large organization. A descriptive case study will describe an intervention or phenomenon and the real-life context in which it occurred (Yin, 2003). In this specific case the phenomena that will be observed are how the elements of Operational Excellence relate to radical innovation within a large established firm. A single case study is done because in this research an in depth understanding is required of how organizations can innovate radically while operating in an Operational Excellent environment. Through semi structured interviews with different managers from the so called global enterprise excellence team, the theoretical framework will be extended. The academic literature does not provide a description how both incremental and radical innovations can be managed in an operational excellent environment. The reason to conduct a case study within a large firm to obtain practical information on how to do so.

The reason why conducting a case study within Boston Scientific is appropriate for this research is because this organization is known for being very innovative, while at the same time work with an Operational Excellent culture. Boston Scientific operates within the medical device industry with direct competitors such as Medtronic, Abbott and St. Jude Medical which are key players within this industry (Top 30 Global Medical Device Companies, 2016). Next to that, the plant in which the interviews were conducted was awarded with the prize for ‘best plant’ in 2014 which, according to the vice president operations of that location, is “*a respected standard for operational excellence, and our Maple Grove team is honoured to receive their award recognizing our progress in improving quality, driving efficiencies, and delivering technologies that meet the needs of our customers*”. Besides that, Boston Scientific won seven awards in the past few years among which two examples were the “EHRA most innovative product” award, and the “EDISON award” which is an annual competition honouring excellence in new product and service development, marketing, human-centred design, and

innovation. Also, Boston Scientific invests approximately \$850 million in research and development which lead to 7200 patent applications pending world wide. These large investments in R&D and the number of patents pending together with the awards show that Boston Scientific is both a highly innovative and Operational Excellent organization.

1.3.4 Semi structured interviews

Before interviewing the managers from Boston Scientific, the framework created in chapter four will provide themes that can be touched within the interviews. The managers then get the opportunity to give case examples of how operational might or might not be able to facilitate radical innovations in practice. Semi structured interviews provide the respondents with the opportunity to explain how they think Operational Excellence relates to radical innovation. By doing 14 interviews with different managers, a managerial perspective will be provided. The first interview will be conducted with a manager who works in a distribution centre of Boston Scientific in the Netherlands. This interview functions as an introduction to Boston Scientific as a company. The next 12 Interviews were conducted within a team that drives Operational Excellence throughout Boston Scientific. The last interview involved an R&D engineer to provide a contrast view on Operational Excellence from someone who is not working in the Operational Excellence team. The reason why these respondents were selected is because the twelve members of the Global Enterprise Excellence team their function is to not only apply the Operational Excellence principles but also to overthink how they can be improved. Other employees in for instance the manufacturing department mostly execute the Operational Excellence principles. The members of the Operational Excellence team are the managers who have a systematic view of the organization and this can help to obtain an understanding how an organization as a whole should manage Operational Excellence and radical innovation. The last interview was held with an R&D engineer to provide a view from a department that works with product development instead of product manufacturing.

2 Operational Excellence

This first chapter will describe what Operational Excellence is exactly in order to answer the first sub question of this thesis. This will be done by first describing the origin of Operational Excellence, followed by its definition and an overview of its core principles within section 3.1.

In large organizations, most often there is a functional organizational structure through which explorative and exploitative activities are separated. Exploitation refers to “refinement, efficiency, selection and implementation” and exploration refers to “search, variation, experimentation and innovation” (March, 1991 p. 71). This functional structure allows different ways to manage these exploitative and explorative activities. Concerning the exploitative activities, the goal can be to make the processes more efficient, and to reduce the costs per made product. An example of this is the scientific method designed by Frederick Taylor around 1910 that was focused on economic efficiency and labour productivity (Boje & Winsor, 1993). In 1946, there was a shift from productivity, efficiency and mass production to the focus on customer value. Toyota came with a system known as the ‘Toyota production system’ that focused on customer value, removing activities from processes that didn’t contribute to customer value and increasing flow of value to the customer (Melton, 2005). The Toyota production system became known as ‘Lean’ later as described by Womack *et al.* (1990) in *The Machine That Changed the World*.

The Scientific method of Taylor and Lean are just two examples of models that are being applied to manage exploitative activities within organizations. Other examples of models being applied to manage exploitative activities are Total Quality Management, Six Sigma, ISO9000. These programs strive for continuous improvement in all functions of an organization, and it can be achieved only if the total quality concept is utilized from the acquisition of resources to customer service after the sale (Kaynak, 2003). Quality management has been developing in the past years and new methods are growing (Zu & Fredendall, 2008). These waves of quality management (QM) led to a new philosophy called Operational Excellence (OE) (Basu, 2002). There is some overlap between QM and OE because OE is a broader programme of improving and sustaining business excellence in which QM is embedded (Basu, 2002). Basu (2002) described a way for organizations to become Operational Excellent which includes putting customer value central, shaping a culture of continuous improvement and using one or more of the quality management programs described earlier. However, what separates OE from an ordinary implementation of a total quality management system is building quality into people

(Dahlgaard, 2006). According to Dahlgaard's definition, organizational excellence is a result of building quality within the 4p's:

- (1) People
- (2) Partnership
- (3) Processes of work; and
- (4) Products/service products.

There is a focus on the implementation of quality within four different categories within an organization. The following part will be dedicated to explaining the relevance of quality for an organization. According to Oakland (2014) for an organization to be truly effective, each component of the 4p's must work properly together. This means that when building quality in one element, this should not occur at the cost of quality within another element. Building quality into all these elements first requires an understanding of what quality is. Quality of a product can be the through the usage of certain materials, quality of a service can be met when for instance the customer gets exactly what it wants. Which materials to use, deciding which service suits a certain customer all depends on what the customer requires. A product designer can use the lightest metal with the best anti-rust coating for a hammer but this might be unnecessary to the customer who will use it to hit nails. A definition of quality of a product does not need to include the usage of exclusive materials but the usage of materials that the customer wants to be used. With respect to how quality can be defined when used within management, a definition of quality is simply meeting the customer requirements (Oakland, 2014) (Flood, 1991) (Basu, 2002). Looking back at building quality within the 4p's, this means that each element can be seen as high quality once its organized in such a way that it brings maximum value to the customer.

In short, the previous paragraph describes that Operational Excellence means doing business the best way possible. This is established by implementing one or more quality management programs and creating an organizational culture in which quality is built within people, products, partnerships and processes. Examples of these quality models are Lean Manufacturing, Six-Sigma, Shingo principles, TQM, EFQM and ISO9000. The following section will be dedicated to giving an overview of these models and finding the fundamental values of these quality management models.

2.1 Principles of quality management models

This section describes how Operational Excellence is based on quality management models and it provides an overview and description of quality management principles it is based on. There are different quality management models and between them there are similarities and differences in the number of core principles around which they are designed. Dean and Bowen (1994) describe that most that is written about quality is built around three core principles: Customer focus, continuous improvement and team work. Dahlgaard et al. (1998) include five more principles: Management commitment, Focus on the customer and the employee, focus on facts, continuous improvement and everyone's participation. Quality and Excellence models are built around these same principles but the number of principles depend on context and differ per author (Nilson & Dahlgaard, 2005).

In the following table, an overview will be given of the principles on which quality management is based. There are different people, the so called 'quality gurus' (Tummala & Tang, 1996), who described different principles for quality management, different models that prescribe how to manage quality within an organization and awards that can be given to organizations who succeeded in managing quality. These awards, models and frameworks exist around different principles of what quality management is. The examples that will be used to find the overlapping principles of quality management are: The Shingo principles, Six-Sigma, Lean manufacturing, ISO9000, Malcolm Bridge National Quality Award and TQM, W. Edwards Deming, Joseph Juran and Philip B. Crosby. Basu (2002) describes a roadmap to Operational Excellence and names TQM, ISO9000, Lean manufacturing and Six-sigma as usable tools. Next to this, Oakland (2014) describes EFQM, TQM and the Malcolm Bridge National awards as roadmaps for a QM implementation. Also, Bendell (2006) provides a review and comparison of Lean manufacturing and Six-Sigma because these models are described as 'hot' process improvement approaches. Next to these models, there is the Shingo award for Operational Excellence that is being awarded in USA to organizations that comply with standards set by the Shingo institute.

Recurring elements of quality management models or frameworks
Employee training and Respect
Maintain Quality
Top management team
Customer centric and Value
Continuous Improvement
Shaping the right organizational culture
Vision and strategy
Systematic view and flow
Documentation and reporting
Systematic problem solving tools

Table 1: Recurring elements in quality management models and frameworks.

Table 1 shows a summary of recurring elements described by quality management philosophers, quality management models and quality management award programs. A table with references for used sources is included at the end of thesis in the bibliography. The following paragraphs will the individual elements of table one and describe from which elements they are constituted.

Employee training and respect

As Dahlgaard (2006) described, in order to reach Operational Excellence within an organization, quality has to be built into the 4p's. This shows an importance of people in creating an operational excellent environment. All of the different sources analyzed had an element integrated related to the management of people. For instance, within the Shingo Principles is mentioned that every individual must be respected as a cultural enabler of Operational Excellence. Next to that, all sources included that employees should be educated so that they can perform their job better.

Maintain quality

Each source described that is important to manage quality within the organization. For instance, this could be done by organizing a quality improvement team (Crosby) or assuring quality at the source (Shingo). Assuring quality at the source means that when a problem occurs, the problem is faced immediately and won't be pushed forward to another department.

Top management team

Six out of ten sources described that top management team had an important function in the management of quality in an organization. For instance, The Shingo principles describe that leaders should lead with humility so that employees feel respected and listened to. Next to that, multiple sources state that the top management team should be committed in order to make quality management work for their organization.

Customer centric and value oriented strategy

One of the themes that can be found in most of the sources used is related to creating customer value. This is either described as a ‘customer centric strategy’ (Womack, Lean Manufacturing) or ‘conformance to customer requirements’ (ISO 9000) or ‘creating value for the customer’ (Shingo). The idea behind this theme is that organizations need to know customer preferences in order to be able to deliver value to this group. A definition of quality is meeting customer requirements (Oakland, 2014) (Flood, 1991) (Basu, 2002) and thus there must be a focus on the customer in order to obtain their preferences.

Continuous Improvement

Continuous improvement (CI) is a philosophy that was described as “Improvement initiatives that increase successes and reduce failures” (Bhuiyan, 2000). By some, it is seen as constantly applying fast incremental improvements. (Manos, 2007). It is used in organizations of all types and sizes worldwide from mass manufacturers to public sector organizations (Brown & Eatock, 2008). There are two strands of continuous improvement namely continuous productivity improvement such as Lean thinking and continuous quality improvement such as TQM and Six Sigma (Brown, 2008). Continuous improvement of processes and quality means that constantly the current state is being questioned. In case of the Six Sigma methodology, the DMAIC cycle is used. This cycle consists of the elements Define, Measure, Analyze, Improve and Control through which processes and activities can constantly be improved.

Shaping the right organizational culture

Prajogo and Mcdermott describe that implementation of quality management models depends strongly on organizational culture (Prajogo & Mcdermott, 2005). There is a need for an appropriate culture to support the scope of Total Quality Management (TQM). Customer focus, systems approach, teamwork, involved management and continuous improvement are

the aspects of TQM that facilitate improved organizational success, growth, and competitiveness (Irani & Beskese, 2004). These elements make a certain organizational culture but the sources analyzed in this case describe more elements related to creating a culture. For instance, there must be awareness among the employees that there is a need for continuous improvement (Juran). Also, fear must be driven out so that people feel comfortable in sharing their ideas (Deming), people need to work independently and should have intrinsic motivation to work (Deming) and creativity from employees must be harnessed (EFQM).

Systematic view and process flow

One of the principles of lean manufacturing is that activities that don't contribute to customer value should be removed (Womack). However, sometimes an activity might be seen as extra work to one department but if done properly, can save a lot of time and energy later in the value chain. Therefore, several quality management models described that managers should apply a systematic view which means that all processes should be seen as a whole instead of as a single entity. This way, the different processes can be linked together better so that there is a faster flow through all activities. This view and flow was described in different ways in the quality management literature with for instance, flow through processes (Womack), conformance (ISO9000), and thinking systematically (Shingo), flow and pull value (Shingo) or obtaining an end-to-end view (Hansen & Birkinshaw, 2007).

Vision and strategy

In an organization decisions are made multiple times every day. In a large organization this counts up to large numbers of decisions because there are many managers present. All these decisions might turn into chaos if not managed properly. For instance, the case might be that one department isn't fully aware of what other departments are doing. This could then result in double work done or even work against other work done. In order to prevent this, there should be a proper vision and clear goals that state in which direction the organization is heading. Shingo describes a constancy of purpose as: "An unwavering clarity of why the organization exists, where it is going, and how it will get there enables people to align their actions, as well as to innovate, adapt and take risks with greater confidence" (Shingoprize.org). This clarity is achieved by setting proper goals (Crosby). and by organizing projects and initiatives to the strategic goals that are set (Juran).

Documentation and reporting

Within the Six Sigma model the DMAIC method is used which is used to continuously improve quality and processes within an organization. In this method, one step is defined as ‘Measure’ and the last one as ‘Control’. This shows that there is a need for measuring the effect of activities and processes and to control them so that they can be altered to a certain preferred state. The various quality management sources describe a form of documentation and reporting like communicating results, document results, report progress and keeping score of progress. These documented results can then be used to improve the processes that provided the documented results. Within the quality management models, this theme is described as information and analysis (MBNQA), measurement (Crosby), communicate results (Juran).

Use of systematic problem solving tools

The last recurring theme was the use of systematic problem solving tools which means that there are specific methods that everyone in the organization uses to solve problems. Examples could be the DMAIC cycle of Six Sigma, ishikawa diagrams, root cause analysis, and 7 why method. Shingo describes that scientific thinking should be embraced and six sigma states that Problem solving methodology using systematic and organized project management tools.

The previous paragraphs provide a view how Operational Excellence is perceived in literature and it shows a framework that contains the principles of Operational Excellence. In the following chapter an overview will be given of how radical innovation is perceived compared to incremental innovations in large organizations.

3 Radical and incremental innovation

In the previous chapter a definition of Operational Excellence is given together with its core principles. In the following section an overview will be given on what innovation is with a special focus on a form of innovation called radical innovation. First, a general definition of innovation will be obtained from literature and a description will be given of incremental and radical innovation and how they differ. Then through comparing radical innovation and incremental innovation, a framework will be made of the domains in which they differ from each other. From this framework a conclusion will be drawn of what type of radical innovation will be relevant for this research. Also, the relevance for established organizations to invest in both these types will be discussed and how these types relate to each other.

3.1 Definition of innovation

Innovation is widely regarded as a critical source of competitive advantage in an increasingly changing environment (Tushman & O'Reilly, 1996). A very straightforward definition of innovation is that it is the generation, acceptance and implementation of new ideas, processes, services and products (Thompson, 1965). Schumpeter sheds light upon this by describing that innovations may be classified according to type: Product innovations, process innovations, new sources of supply, exploitation of new markets and new ways to organize a business. This then provides a better view of the kind of innovation but still there can be discussion how new an innovation has to be compared to the status quo. A new machine within a process line for one organization might be rather old for another fast growing organization. Also there can be a line of small improvements that accumulated form a big change. Two forms of innovation that describe these examples are radical versus incremental innovations.

3.2 Radical innovation versus Incremental innovation

In literature there are several synonyms or closely related terms used for radical innovation. For instance, terms like discontinuous innovation (Lynn, Morone, Paulson, 1996), disruptive innovation (Christensen, Craig, & Hart, 2001) and really new product development (Füller, J., & Matzler, K., 2007). According to Miller and Dismukes (2005) radical innovation creates dramatic change in technology, processes, products and/or services that considerably transform existing markets and industries, or even give rise to new ones. Sandberg (2014), acknowledges that radical innovation is a broad term that entails newness in services, processes

and technology representing the firm as well as newness to a market. Sandberg therefore describes radical innovation with the following broad definition: an innovation that brings considerable changes to a firm and/or a market.

The previous described definitions describe a radical innovation as being ‘a considerable’ or a ‘dramatic’ change. However, these notions remain vague and don’t provide clarity when rating an innovation on its radicalness. Johannessen, Olsen and Lumpkin (2001) acknowledge this by stating that looking at how new an innovation is raises more questions such as ‘what is new?’, ‘how new?’ and ‘new to whom?’ (p.22).

3.3 Large organizations and radical innovations

As described earlier, in large organizations a functional structure exists in which the explorative activities and exploitative activities are separated. The R&D department develop new technologies or improve existing ones while the manufacturing department improves production efficiency and tries to reduce production costs. However, an organization can’t predict when the R&D department will come up with a new innovation that will provide them with new profits in the upcoming year. Also, organizations that only grow by gaining efficiencies of scale and scope in a specific area makes this area a core rigidity to them (Leonard-Barton, 1992) or a core incompetence (Dougherty, 1995) because the organizations invest in gaining knowledge related to this specific area. Established firms tend to spend too much resources in internal R&D and existing networks, rather than external sources and emerging networks (Stringer, 2000; Birkinshaw et al., 2007). This inward and myopic searching (March, 1991) prevents large organizations from recognizing opportunities for radically innovations.

Comparing radical innovations to incremental innovations might bring clarity upon what makes an innovation radical and it’s ‘newness’ compared to other innovations. Incremental changes are different from radical innovation because they are associated with less risk for the organization (O’Sullivan, 2009), (Sorescu & Spanjol, 2008). Besides a lower risk, incremental innovations require less input of capital (Manos, 2007). The relative lower risk and costs make incremental innovations fast and easy improvements.

The difference can furthermore be explained through relating the two to the definitions of exploitative and explorative activities. Incremental innovations are more related to exploitative activities and radical innovations more to explorative activities (Tushman and O’Reilly, 2013). As described earlier exploitation relates to refinement, efficiency, selection and implementation while exploration relates to search, variation, experimentation and

innovation (Rosenau, 2001). Radical innovations can thus be established through search, experimentation and variation but experimentations and variation do not guarantee results immediately. Incremental innovations on the other hand are refinements in existing processes or products or services (O'Sullivan, 2009). This difference shows that incremental innovations are more closely related to technologies or processes that already exist within the organization. Radical innovations on the other hand come forth out of processes like experimenting and creating variation in order to enter a field that is new compared to the old practices.

Li and Vanhaverbeke (2008) describe a similar difference in terms of types of knowledge used between exploitative activities and the related incremental innovations and exploration and radical innovation. Incremental innovations and exploitative activities rely on a different type and amount of learning than explorative activities and radical innovation. According to these authors these types of learning or knowledge sharing differs depending on level of analysis. For instance, on an individual level, exploration and exploitation are considered as different types of creative idea generation (Audia & Goncalo, 2007). On a project level these activities differ in composition of project development teams (Perretti & Negro, 2008). On a firm level exploitation relates to proximate knowledge search and exploration to distant knowledge search (Benner and Tushman, 2002). However, even though exploitation and exploration are often related to incremental and radical innovations, Li and Vanhaverbeke state that there is still a discussion going whether these always lead to one of these types of innovations. The literature that does describe this relation fails in measuring how explorative or radical an activity is (Li & Vanhaverbeke, 2008).

The previous paragraphs described how radical and incremental innovations are generated. However, another difference between radical and incremental innovation results occurs in how they become implemented. Innovation is not just coming up with ideas but it is also implementing these ideas. O'Sullivan (2009) describes innovation as the sum of creativity and exploitation which shows that in order to innovate the creative idea should also be implemented (Landau & Rosenberg, 1986). The way how they differ is exemplified by for instance innovation within products. Once new products are brought to market after they've passed the development phase, they have to cross the so called innovation gap which explains that some innovations don't make it to the large public. This gap, also called the valley of death by Markham et al. (1995) is the space between opportunity discovery and product development and there are various factors that influence why certain products are able to cross the gap and others aren't. Fuentes (2003) describes that within organizations and among customers there is an increased resistance to change when it comes to radical innovations

compared to incremental innovations. This resistance to change is one reason why incremental innovations are implemented more easily compared to radical innovations (Landau & Rosenberg, 1986).

What has been described is the difference between radical and incremental innovation. It is associated with different amounts of risk, implementation time, costs, amount of resistance, impact on the way of working and different idea generation processes. However, unclear remains to what degree the previously mentioned points contribute to making an innovation radical or incremental. For example, an innovation might have a short implementation time, and might be a cheap solution to a problem but it could still be seen as a radical improvement regarding the way how the organization works from that point on. The following part will describe another theory on how radical innovations can be distinguished from incremental innovations.

Despite the fact that organizations face trouble recognizing radical opportunities, 'breakthrough' or radical inventions are important for wealth creation (Schumpeter, 1975). Such inventions function at the start of new technological paths and are important for creative destruction. This means that currently used technologies are replaced by new ones. The replacement of technologies with new ones and opening up for new technology paths is described by the innovation streams and technology cycle theories. Innovation streams are portfolios of innovations that include incremental innovations in a firm's existing products as well as more substantial innovation that extend a firm's existing technical trajectory and/or move it into different markets (Abernathy and Clark, 1985). In order to understand better the relation between these incremental innovations and substantial or radical innovations within these streams, the technology cycle (Tushman, 1997) must be understood.

The technology cycle described by Tushman explains how incremental innovations relate to radical or discontinuous innovations over time. A technological cycle is composed of a technological discontinuity which is a rare, unpredictable event triggered by scientific advance or through the unique combination of existing technology. Technological discontinuities stop existing incremental improvement plans and give rise to an age of ferment. This means that several options for new designs are competing with each other. From this era of ferment, a dominant design arises and this dominant design will then be improved incrementally till the next technological discontinuity (Tushman, 1997).

To look back at the innovation streams theory, an organization needs incremental change as well as discontinuous change within their portfolio in order to stay competitive. The technological cycle then explains that periods of incremental change and technological

discontinuities or radical innovations alter each other. This model shows after incremental innovation; a radical innovation gives rise to new incremental innovations. An example of this is that a steam engine can be improved but despite these changes it will stay a steam engine. A radical change could be to place a combustion engine in the same boat which allows for new smaller improvements to this type of engine and stops the line of improvements related to the steam engine. This is acknowledged by Fleming (1999) who states that inventions that serve as the source of many subsequent inventions can be regarded as breakthrough or radical because they have demonstrated their utility on the path of technological progress. The results of the literature study on radical innovation have been put into the following table:

Radical Innovation compared to Incremental innovation	Source
Creates drastic changes in technology, services or processes that considerably transform markets and industries or even give rise to new ones.	Miller and Dismukes (2005)
An innovation that brings considerable changes to a firm and or market.	Sandberg (2014)
Associated with a higher risk than incremental innovations	O'Sullivan (2009)
Higher input of capital	Manos (2007)
Result from explorative activities	Tushman & O'Reilly (2013)
Related to technologies distant from the organization	O'Sullivan (2009)
Combination of distant knowledge	Li and van Haverbeke (2008)
Experience more resistance to change	Fuentes (2003), Landau & Rosenberg (1986)
Give rise to new serie of incremental innovations	Fleming (1999)
Longer implementation time	Landau & Rosenberg (1986)

Table2: Framework that shows characteristics of radical innovation and comparison to incremental innovations.

3.4 Definition of radical innovation

To conclude this chapter, this literature study provided a framework that allows to make a distinction between incremental and radical innovations within an organization. In the previous sections has been described that radical innovations differ from incremental innovations on different points and that organizations need radical innovations. Next to that, the definition of Tushman (1997) and Fleming (1999) define radical innovation as a moment where a line of incremental innovations stops and after which a new line of incremental innovations starts. A problem however is that studies fail to describe how the degree of innovativeness in terms of radicalness can be measured. Li and Vanhaverbeke acknowledge this by stating that one universal definition of radical innovation is hard to formulate since there are many different types varying on the level of analysis. However, on each level of analysis, what separates an incremental innovation from a radical innovation in terms of how they are generated depends

on the way how knowledge is combined and can occur on different levels within the organization. Important factors in the implementation of radical ideas are time and the amount of risk that is associated with the projects. These last points constitute the definition of radical innovation that will be used in this thesis. The reason for this is that the problem described in this thesis is that large organizations are entrenched in certain lines of technology development. They require new knowledge or the combination of different types of knowledge which then results in radical innovations. Thus it is not the size of the investment or the degree of change that matters because even incremental innovations can be costly and the degree to which this innovation is different is too ambiguous. Therefore, a radical innovation is seen in this thesis as a result from using distant knowledge and combining different knowledge that is entailed with increased risk for success.

4 Operational Excellence and Radical Innovation

In the previous chapters, a literature study resulted in a definition of radical innovation as seen by a large organization that will be used in this thesis and a framework of the core principles of Operational Excellence and quality management. Within this chapter a framework will be created in which the relation between the individual Operational Excellence principles and radical innovation is shown. The following paragraphs will each describe one of these principles in relation to radical innovation to gain a theoretical understanding of how these principles can be managed so that radical innovations can occur. At the end of this chapter these findings will be put into a framework to provide a clear overview. This framework will then be used in chapter five to structure the interviews necessary to conduct a case study within Boston Scientific.

4.1 Continuous Improvement

A definition of CI is “an organization-wide process of focused and sustained incremental innovation” (Bessant and Caffyn, 1997). Others see CI as part of quality management programs such as Six Sigma, Lean manufacturing or TQM (Oakland, 2009). Continuous improvement (CI) is a general term that acquired many of its attributes from other quality improvement programs such as Six Sigma, Lean Manufacturing and TQM (Bhuiyan and Baghel, 2005).

Bhuiyan and Baghel (2005) define CI as generally as a culture of sustained improvement targeting the elimination of waste in all systems and processes of an organization. It involves everyone working together to make improvements without necessarily making huge capital investments. They state that improvements can occur through incremental innovations or through radical change. Bhuiyan and Baghel (2005) don't exclude that radical innovations can result from continuous improvement. However, other authors such as Sony & Naik (2012) state that continuous improvement relies on a specific type of learning called first order learning (Fox-Wolfgramm et al., 1998). First order learning is detecting and removing errors within a given set of governing variables and double loop learning aims to change those variables (Savolainen and Haikonen, 2007). This first order learning leads to incremental change while second order learning can lead to radical innovation (Sony & Naik, 2012). Since continuous improvement is based on first order learning, it can only result in incremental innovations.

Argyris and Schon (1978) suggested that problem solving is a learning process in which

different types of knowledge are being integrated resulting in new types of knowledge. This shows that obtaining new knowledge is the primary innovation resource (Teece et al., 1997). Looking back at the comparison between incremental and radical innovations, the statement of Teece would suggest that combining proximate knowledge would result in incremental innovations but combining distant knowledge can result in more radical innovations.

To find an answer why some authors state that continuous improvement leads to incremental innovations, a closer look can be taken in the specific tools that are being used for CI such as the DMAIC cycle and the Kaizen events. A Kaizen event, in which Kaizen is Japanese for ‘continuous improvement’ is a focused and structured improvement project, using a dedicated cross-functional team to improve a targeted work area, with specific goals within a couple of days (Farris et al., 2008). Despite the fact that a kaizen event is performed by a cross-functional team, which allows the combination of distant knowledge sources, the team is restricted to the short time made available. Next to this time restriction, the team is bound to a certain budget that they can use to make improvements which puts pressure on the team in finding an affordable solution to a certain problem. According to Damanpour (1991), setting financial constraints on innovation projects reduces creativity and innovation meaning that due to the constraints they are limited in the options that they can choose and are bound to pick a certain cheap solution without having the possibility to consider more expensive solutions. However, Hoegl and Gibbert (2008) argue that sometimes setting financial constraints promotes managers in finding creative ways to solve a certain problem given a smaller budget. This means that when a project team is not given financial constraints they have the luxury to choose any solution to a problem and can choose the first one that comes up without having to look for alternatives. For a kaizen event, which is often restricted to a certain budget, this means that this budget constraint can drive the team in coming up with solutions that are radically different than when they are given a bigger budget. However, the problem remains that a Kaizen event occurs within an accelerated time frame. Gruber and Davis (1988) state that creativity takes time, a great deal of hard work, and strenuous mental energy. Therefore, when managing for creativity, time is a critical resource that managers need to ensure their employees have access to. Here, it is important to emphasize that, in general, it is far easier for most employees to stick to routine tried and tested methods that are typically more efficient rather than experimenting and trying to come up with creative approaches.

Another continuous improvement tool is Six Sigma’s DMAIC cycle. This cycle contains the steps Define, Measure, Analyze, Improve and Control in which it addresses a problem, measures the difference between a desired state, requires a solution and after that asks

for an implementation and control. Continuously performing these steps can stimulate organization members to creatively evaluate how tasks are organized and performed (Prajogo and Sohal, 2003). This suggests that simply applying the DMAIC cycle won't deliver creative solutions that might be radical innovations. However, organizations can demand from their manufacturing department that they meet annual productivity increases. With the pressure from top management to meet these annual improvements, a process improvement team needs to become more creative to reach these goals. The reason for this is that continuously improving a certain process at a certain moment reaches the point where nearly everything is optimized and thus hard to improve even further. The DMAIC cycle seems to function as a tool to remove errors from processes and this can result in both incremental and radical innovations but the 'Improve' step does not guarantee one of these outcomes. This depends on different methods that the manager uses to improve a certain process.

4.2 Standardization

Within Operational Excellence and quality management models, one goal is to standardize certain processes as much as possible so that variation in these processes can be reduced (Yusof & Aspinwall, 2000). However, standards and standardization are described to represent the 'iron cages' of organizational control and regulation that impede innovation (Wright & Sturdy, 2012) which suggests that standardization restricts innovation. A distinction within this study is made between innovation and improvement. On the other hand, some say that formalization might support innovation because they offer a structured approach of capturing knowledge and facilitating the implementation phase of innovation. Implementing a quality management model like Six Sigma or TQM causes a complete change of culture within an organization. These models bring tools and standards to which employees have to adapt which makes this change on itself already a radical innovation (Abrahamson, 1996). However, Benner and Tushman (2003) argue that these standard methods focus on exploiting current knowledge and thus only lead to incremental innovations. This is acknowledged by Adler and Boris (1996) who state that standardization may also offer innovation advantages by creating common languages and methods for experimentation, and allowing a process of incremental improvement based on previous experience through learning.

To conclude this section, standardization can on the one hand be seen as a strict set of rules that restrict people in being creative. On the other hand, it can provide a platform that allows people to communicate better with each other which can lead to radical innovations through sharing of different knowledge.

4.3 Customer Centric Strategy

This strategy entails putting the customer central in such a way that customer demands are leading. Quality management models and Operational Excellence first acquire customer demands, followed by organizing their processes and developing products so that most value is brought to the customer. According to Galbraith (2011) organizations mistakenly confuse a customer focus with a customer centric strategy. The difference between the two is that the customer focus puts the customer central and translates their demands into service improvements while a customer centric strategy builds around the customer. This means that the organization builds a strong relationship with the customer and a solutions culture. A solutions culture is not focused at creating solutions in which the company can sell as many products as possible. It revolves around creating a solution in which the organization and the customer find the best combination of products or service for the customer while looking for more ways to keep improving service for the customer (Galbraith, 2011). Building an organization around the customer allows the organization to provide completely new services and products instead of incrementally developing old products and services. A reason for this is that the customer is not always aware of its future needs. A commonly used quote relating to the car industry is: “If I had asked people what they wanted, they would have said faster horses”. What this line shows, that customers most often don’t know what their own needs are in terms of innovations. This quote points at the time when the transportation paradigm was transportation by horse and before the invention of the combustion engine, most people couldn’t even dream of this technology. A customer centric strategy allows the organization to detect needs of the customer that the customer is not aware of. This can then lead to radically new services and products which leads to another type of radical innovation namely radical process innovation. If an organization finds a new opportunity to make a product they have to align their processes to this new technology which can cause a radical change within the organization.

Through following a customer centric strategy, an organization can translate unmet needs of customers into innovations. This can lead to products and services that are new to both the customer and the organization. However, this strategy reduces the risk for organizations in finding radical innovations, but it restricts them from opening up new markets.

4.4 Training of employees & Knowledge management

The core principle of Operational Excellence models “training employees and respect” can be compared to terms in academic literature as training, or increasing professionalism (Caulfield, 1997). Morgan (1991) states that in order to manage quickly changing environments, one needs to develop the intelligence, knowledge and creative potential at every level of the organization. Leonard-Barton (1995) acknowledges this by stating that knowledge is central to innovative activity. Mechanisms to manage this are importing, absorbing, transferring and developing knowledge across the entire organization. Examples how this occurs is through working with cross-functional teams, providing training to employees in a specialized area, or letting people work in different departments in an organization (Shah & Ward, 2003).

Katzenbach and Smith (1993) related major changes within an organization to knowledge management by stating that these changes involve circumstances that require personal to become good at skills and behaviour with which they are not very adept. Incremental change requires coping with the normal scope of existing management practices. This shows a difference between incremental and radical innovation in how knowledge should be managed.

Katzenbach and Smith state just like Taylor and Greve (2006) that a broad knowledge set ensures coping with more radical change through the combination of knowledge from different fields of expertise. In contrast, Laursen and Salter (2006) pose that a diversity of knowledge may lead to a different variety of ideas, without too much effort and work, those ideas will just touch on shallow surfaces instead of getting a breakthrough idea, which promotes incremental but not radical innovation. In order to manage radical innovations within an organization, one needs in depth knowledge so that one has an understanding which is necessary to implement a radical innovation (Zahra & George, 2002).

Zhou and Bingxin (2012) provide an overview of the relation of broad and in depth knowledge to radical innovation and come to the conclusion that both are needed. However, they do find that organizations who have one of these types of knowledge rely on different mechanisms. According to them, firms with a broad knowledge base are more capable of developing radical innovations in the presence of internal knowledge sharing rather than external-focused market knowledge acquisition. However, firms with more in depth knowledge are described by them as being better in achieving radical innovation through enhanced market knowledge acquisition rather than internal knowledge sharing.

The way how training and knowledge management is described to lead to radical innovation is by providing training to employees, letting people work in different departments and using cross-functional teams. Important is to have both in depth and broad knowledge within the organization.

4.5 Systematic Thinking

Systematic thinking, as described by the different quality management models, is making sure that there is a flow through the organizational processes or the value chain. Flow through a value chain is linking the activities in such a way that the entire value chain works as efficient as possible. Flow is concerned with processes, people and culture (Goldratt and Cox, 1993) and the purpose is to work on the big picture, not just individual processes and improving the whole, not just optimizing the parts (Rother and Shook, 1999). In other words, efficiency and effectiveness of the whole supply chain needs to be improved and not just one part of it. This would mean in practice that sometimes a department does a little bit extra work so that it might save a lot of extra time further down the value chain. This requires a good cooperation between the different departments and breaking down the barriers between departments (Melton, 2005). Breaking down the barriers between departments and individuals is a principle that is integrated in different quality management models. Van der Panne, van Beers and Kleinknecht (2003) describe how interdepartmental barriers can hamper innovation. They describe that cultural resistance to innovation may arise from entrenched routines and interpretative barriers. This results in employees focusing solely on their own tasks and responsibilities. In a large organization where many different departments have to work together, barriers arise when they focus only on their own responsibilities and tasks. Fuentes (2003) describes that within organizations and among customers there is an increased resistance to change when it comes to radical innovations compared to incremental innovations. What might happen, is that a department has a breakthrough idea but this idea requires cooperation of many different departments that might have a resistance to this moment of change because it requires them to change their current practices and routines. A solution to this would be to involve all departments when a project starts (Van der Panne, van Beers, Kleinknecht, 2003). This enhances communication between the different departments which, if performed adequate, leads to a culture susceptible to innovation. (Cavusgil and Calantone, 2003). However, if there is a conflict between departments like in the case where two departments have conflicting priorities, then the greater the interdepartmental conflict, the lower the rate of intra-organizational diffusion of technological products (Kim & Srivastava,

1998).

This section described that maintaining a systematic view is necessary to remove interdepartmental barriers which enhances interdepartmental communication. This enables the sharing of different types of knowledge which can lead to the generation of radical ideas.

4.6 Setting Strategic Goals

Quality management models such as Lean manufacturing suggest that an organization should set a goal to bring value to the customer (Melton, 2005). Any actions that don't bring value to the customer are seen as waste and should be removed from the organizational processes. According to the goal setting theory by Lock and Latham (1990), there are five principles for goal setting that improve the chances of success.

- A goal needs to have clarity so that people know what to do exactly.
- A goal has to be challenging so that they have motivation to do it, but not too challenging so it can't be reached.
- The team or individual has to be committed because they are more likely to accept a goal if they are involved in setting the goal.
- Obtain feedback is required to obtain a clarity of the employees' expectations and if the goal is too difficult to reach, to re-evaluate the setting of the goal.
- Consider task complexity so that the task doesn't become too complicated because then employees might become overworked.

Within an organization, the top management team can for instance set fixed goals of 5% productivity increase of processes or 6% reduction in process costs. According to the goal setting theory, these goals can have an increased change of success if they comply to the goal settings five principles. However, Ettlie and Rosenthal (2008) argue that setting these types of goals work counter-productive when it comes to generating radical ideas. In order to make sure that these efficiency targets don't work counter-productive, radical innovations should be isolated from the main body of the organization. Markides (2006) states that when an organization has a strategy that has success in adopting incremental innovation, this is negatively correlated with adopting a strategy of radical innovation. Melnyk, Hansen and Roger (2010) suggest that it is important to pursue a process improvement strategy as well as a radical innovation pursuing strategy in a balanced trade-off. They found that at the executive level, where the strategic goals are set, this balance was determined by how much risk an organization is willing to take. Setting goals for a process improvement strategy was related to more incremental steps with little risk while pursuing a radical innovation strategy was more

uncertain and related to more risk but also with a higher potential payoff.

To summarize the previous section, an organization can set goals in order to pursue different strategic targets. Some strategic goals are negatively correlated with each other and some authors suggest they shouldn't be pursued within the same department; others suggest they should occur within a balanced trade-off. An organization can set goals that result in smaller incremental steps, which are associated with little risk or set more radical goals that are associated with more risk but also a higher potential pay-off. The goal prescribed by Operational Excellence that innovations must bring value to the customer lowers the risk of innovation success for organizations but also restricts the organization in finding innovations that target different markets.

4.7 Shaping the Right Organizational Culture

As has been described by Bhuiyan and Baghel (2005) implementing continuous improvement and a quality management model requires a cultural change within an organization in which everyone should be working together to eliminate waste in all systems and processes of an organization. However, McLaughlin *et al.* (2008, 300) argued that “established companies often lose the propensity to be innovative, as some of the cultural enablers of previous incremental changes become the current cultural inhibitors of radical innovation”. Incremental change become the current cultural inhibitors of radical change”. This means that once an organization starts to incrementally improve a certain product, they focus on more knowledge regarding this technology but this means they focus less on different technologies which narrows down their scope.

In order to foster radical innovations, an organization should adapt a culture that supports risk-taking, freedom and self-management of employees (McLaughlin *et al.*, 2008). Next to that, an autonomous culture, that fosters individuality, creativity and a tolerance of failure also supports the pursuit of organizations for radical innovation (O'Connor and McDermott, 2004). Similar to the risk associated with setting goals for radical innovation, a culture to nurture radical innovations shouldn't be risk averted.

Within chapter two of this thesis was described that a culture for Operational Excellence must also support people to work independently, that they should have intrinsic motivation and that their creativity must be harnesses. The difference is however that quality management models aim to reduce failure and variation as much as possible within their processes, while a method for reaching radical innovation is probing which is a trial-and-error approach that allows mistakes (Lynn, Morone, Paulson, 1996). This differences in the

acceptance of failure indicates that a culture of Operational Excellence might not appropriate in fostering radical innovations.

4.8 The Framework relating the Operational Excellence principles to radical innovation

This chapter provided an overview of how the principles of how the Operational Excellence principles can lead to radical innovations. An overview of these results are shown in table 3. In the following chapter, the created framework will be used to analyse the case study of Boston Scientific.

Framework composed through literature study relating Operational Excellence principles to Radical Innovation	
Element of Operational Excellence	Description of relation
Continuous Improvement	Is based on first order learning which causes incremental innovations. Uses methods such as Kaizen and DMAIC cycle can result in radical innovations. Most often occurs in an accelerated time frame which inclines results most often in incremental innovations. Projects are most often bound to a budget which might result in both incremental and radical innovations.
Standardization	Formalized rules and structures are seen as the 'iron cages' of innovation. Using standardized methods is using current knowledge which leads to incremental innovation. Creates a common language that enables employees to leverage their knowledge together to create radical innovations.
Customer Centric Strategy	Can lead to radical innovations when closely collaborating with the customers with reduced risk for success but does not allow the organization to target new markets. Can lead to radically new processes once the organization creates radically new products and services.
Training and Knowledge Management	Important to have broad and in depth knowledge for radical idea generation. Training of employees, cross-functional teams, letting people work in different departments leads to radical idea generation.
Systematic Thinking	Can break down interdepartmental barriers which enhances communication between departments. This enhances interdepartmental communication which can lead to radical innovations.
Setting Strategic Goals	Can lead to radical innovation depending on the amount of risk an organization is willing to take.
Shaping Right Organizational Culture	A culture that supports risk taking, creativity and tolerance of failure is needed to lead to radical innovations.

Table3: Descriptions of how the individual elements of Operational Excellence can lead to radical innovations based on a literature study.

5 Case Study Boston Scientific Maple Grove

In the previous chapter, a framework was created that shows how Operational Excellence relates to radical innovation within a large organization. The case study that has been done describes how Boston Scientific Maple in Maple Grove implements the principles of Operational Excellence from the perspective of the managers who apply Operational Excellence in the organization. The team that is responsible for this task is called the Global Enterprise Excellence Team and it is an internationally assembled team with its main location in Maple Grove, Minneapolis U.S.A. The purpose of this team is to drive Operational Excellence all through Boston Scientific.

5.1 Introduction to Boston Scientific

Boston Scientific Corporation (BSCI) is a large multinational that was founded in 1979 and is headquartered in Marlborough, Massachusetts with Mike Mahoney being the CEO since 2012. BSCI operates in the field of healthcare and medical appliances and equipment together with 24.000 employee's world wide within 100 different countries. The company is world leader in the production least invasive medical devices which means that these products do little damage to the human body when placed. BSCI offers products in three different segments: Cardiovascular, Rhythm Management and MedSurg. In these research areas, their R&D investments in 2015 were \$861 million. Currently, Boston Scientific's enterprise value is estimated to be \$33.97 billion, its stocks are rated at \$21,15 with 1.36 billion shares outstanding and the organization makes approximately \$7,5 billion in annual revenue (finance.yahoo.com/quote/BSX). Boston Scientific applies a corporate venture strategy where they invest in technologies that are related to their core business areas with the possibility of acquiring them later after the clinical approval process of these technologies. In total 21 acquisitions have been done within an approximate price range of \$65 million for Iogyn to \$1,5 billion for American Medical Systems (Crunchbase.com). In 2014, Boston Scientific's U.S. patent grant earning was 943 placing them at the place 37 in the IFI CLAIM list which is a database that provides information on patent data (www.ipwatchdog.com) which shows their activity in developing patents for the organization compared to other companies. In total, they issued 16.000+ patents and they have approximately 7,200 patent applications pending world wide (Boston Scientific Key Figures, 2015).

The case study was conducted within a site of Boston Scientific in Maple Grove Minnesota. Maple Grove is a plant that harbours the manufacturing and research and

development department for the interventional cardiology department of Boston Scientific as well as a distribution centre and overhead departments such as the marketing, sales and finance departments. Because all these departments are located at Maple Grove, this plant provides an opportunity to explore how Operational Excellence relates to radical innovations in all of these departments.

5.2 Functions of the respondents

In total, fourteen interviews have been conducted. Table 4 presents an overview of the different functions of the respondents. These functions are used in text to indicate which statement was mentioned by which respondent. Their functions give an idea of the background and expertise of the respondents.

Respondent	Function
1	Facility Manager and Procurement
2	Global Supply Chain Manager
3	Senior Manager Global Business Excellence
4	Senior Business Consultant
5	Enterprise Consultant
6	Senior Project manager
7	Principal Global Enterprise Consultant
8	Senior Consultant Manager
9	Solutions Development Manager
10	Solutions Delivery Manager
11	Principal Process Improvement Analyst
12	Lean and Six-Sigma Business Consultant
13	Principal R&D Engineer
14	Vice President Global Enterprise Excellence

Table4: Respondents and their function title within Boston Scientific.

Within each interview, the same questions were asked but the answers provided came from different business areas. Table 5 shows the number of interviews conducted and an overview of the departments in which the Operational Excellence principles were applied.

Business area	#Interviews
Global Enterprise Excellence	1
Product Development Process Improvement	3
Supply Chain Management	1
Medical Solutions Delivery	2
Manufacturing Process Improvement	3
Human Resource Management	1
Standardization through Boston Scientific Essentials	1
Facility management and procurement	1
Research and Development	1
Total	14

Table5: Field of responsibility that was discussed with respondents.

The way how the interviews will be processed is by shortly describing each principle from the theoretical framework and use the interview data to describe how this principle is applied within Boston Scientific. After each paragraph, a discussion will be given of how the theoretical framework relates to the case study. At the end of this chapter all the findings will be put in a framework to provide an overview of what the case study adds to the theoretical framework.

5.3 Definition of Radical Innovation according to respondents

During each interview the question was asked how the respondents define radical innovation. Important for this research is to get a view of how radical innovation is perceived within Boston Scientific. When the respondents give an example of a project that resulted in a radical innovation, obtaining their definition of radical innovation allows to see how this definition deviates from the definition that resulted from this studies literature study. The case could be that a respondent sees a radical innovation as a project that was expensive and took a while to implement, but according to this studies literature study a project like that doesn't have to be radical. Table 6 shows how radical innovation is perceived by the respondents. Some respondents describe what a radical innovation is, and others gave a description of the action one has to take to get a radical innovation instead of an incremental one. Some respondents also gave a description of what innovation is and these descriptions are also included in this analysis.

Descriptions of Radical Innovation
Create new capabilities
Setting wild goals
Demonstrated ways of doing things that lead to proven results and repeatable
Result from questioning "Why do we do, what we do?"
Taking a step back from current working methods
Constraint driven projects with a higher risk
Completely doing things different from normal
Challenge current ideas
Innovation is a result that is aligned with strategy of Boston Scientific
More smaller steps combined make a drastic change
Don't only look what you can change today, but also what can be changed in the days after.
Viable new things that adds value to the customer

Table6: Descriptions of radical innovation by respondents.

As table 6 shows, multiple descriptions of radical innovation have been given and they somewhat differ but there are also similarities. Four of the descriptions mentioned that a radical innovation can occur when current working methods are being questioned. The question “*why do we do what we do?*” (Enterprise Consultant) was mentioned in line with the statement this questioning should be altered with following a structured way of working. The respondent described that in daily operations one follows a structured way of working like improving a certain process. However, at a certain moment a manager should reflect critically on what he or she is doing and this might open up new perspectives or ideas.

The two descriptions “*setting wild goals*” (Principle Process Improvement Analyst) and “*constraint driven projects with a higher risk*” show that radical innovation is associated by these two managers with wild targets and higher risk. Wild targets mean in this context that it might be hard to reach this target and is thus associated with more risk than a more common project.

“*Create new capabilities*” (Global Supply Chain Manager) as mentioned by one of the respondents refers to organizational capabilities “preconditions that are necessary for the effort to flourish” (Gold, Malhotra, Segars., 2001, pg186). The respondent describes that these capabilities can be created by the organization and that they result in radical innovations for an organization. Next to these radical innovations, most of the time incremental innovations occur within an organization.

The description *that ‘innovations are demonstrated ways of working that lead to proven results and are repeatable’* (Enterprise Consultant) shows that in this case innovation is seen

as a process instead of an outcome. The respondent also mentioned that this way of innovating is alternated with moments where you question what you are doing for which reason. Questioning your working methods in this way can result in a result in doing things differently which can deliver radically different results than normal. This depends on how the current working method fits in the current organization. The situation could be that new processes and technologies are developed within the organization and that certain older processes become obsolete. Thus in such a situation, having such a view will result in a radical change in processes. Next to questioning your working methods, one respondent suggested that one should not only look what to improve today, but also look what can be improved in the future.

One respondent gave a more general notion concerning innovation which was that an innovation must be aligned with the strategy set by the organization. If this is not the case, then this is not an innovation for this organization because it will not find an implementation. The idea behind this is that an innovation is both the generation of an idea and the implementation of it. If an idea is not implemented because it doesn't fit with the corporate strategy, then it won't be implemented and thus it cannot be considered as an innovation for the company.

The next notion that was given was that radical innovation is not something that occurs suddenly. One respondent gave the example of an I-phone that consists of many different parts that by themselves aren't improved drastically, but altogether form a radically new device. This description shows that the result of a radical innovation is a drastic change for the users of the product.

The last description of radical innovation '*viable new things that add value*' (Vice President Global Enterprise Excellence) consists of two important elements namely that the radical innovation is viable and that it adds value. Viable means that something is capable of success or continuing effectiveness and adding value inclines that customer requirements are met.

5.3.1 Discussion of the radical innovation definitions

In order to get a view of how both the case study and the literature study describe the relation between the Operational Excellence principles and radical innovation, first the definitions of radical innovation must be compared. This in order to see whether the respondents have a similar perception of what radical innovation is compared to the results from the literature study of this thesis. This important because later in this study the results of the literature study and the case study on the relation of radical innovation and Operational

Excellence will be compared. To make this comparison, a requirement is that there must be an overview what the similarities and differences are between the two definitions.

According to the literature study on radical innovation in this thesis, a radical innovation can occur within services, technology or processes and is new to the firm and/or the market. Generating radical innovations is associated with more risk and uncertainty, takes more time to be implemented and require more capital. Radical innovation can occur in different levels within an organization. On an individual level it can occur through the combination of distant knowledge, on a project level through the cooperation of team members from different departments, and on a firm level through obtaining new knowledge. Implementing radical innovations within an organization face more resistance to change compared to incremental innovations and once implemented, these radical innovations give rise to a new series of incremental changes.

In the case study, different descriptions were given for radical innovation. Respondents used words such as ‘new’ in new capabilities and viable new things to indicate that it is an innovation that is different from other innovations. These descriptions don’t necessarily include that it is new to the firm and or market. The R&D engineer and a senior manager global business excellence described that an innovation in general to Boston Scientific has to align to their corporate strategy. Also radical innovations are associated with a higher risk for an organization. The way how they can be generated is by taking a step back from a strict structure and allowing to overthink why things are done in a certain way and allow this to change.

Comparing the two definitions of radical innovation gives the following results: Both studies show that radical innovations entail projects with an increased risk in becoming implemented. Also the literature study described that radical innovations are associated with more costs and a longer implementation time. Within the case study is only mentioned that the difference between the Kaizen incremental improvement method and the innovation challenge (which should lead to more radical innovations) is that it these radical innovation projects take longer to implement. Another similarity between the frameworks definition of radical innovation and the literature study is that radical innovations differ from incremental innovations based on how they are generated. Both studies describe that in order to generate radical ideas, there is a need to combine different types of knowledge, people with different kinds of expertise. These results show that whether an innovation can be named radical, it doesn’t necessarily matter what the size of the project is in terms of resources need. An explanation for this could be that large organizations with large budgets can do projects that are costly and they acquire expensive technologies more easily.

What makes an innovation radical depends on both how an idea is generated and how it is implemented. Related to the implementation process is the amount of risk associated with this project due to its chance on success. With regard to the idea generation process, is the combination and usage of distant knowledge that makes an innovation radical. Because the knowledge associated with this technology is more distant it requires people to learn new things and work with things that they are not familiar with. This uncertain situation puts employees in a situation where they can experience trouble in estimating the risk associated with a project because they never been in a situation like this before.

5.4 Case Study: Operational Excellence and Radical Innovation

In the following sections, the case study within Boston Scientific Maple Grove will be discussed. This will be done alongside the core principles described in the theoretical framework that related the Operational Excellence principles to radical innovation. The way how this description is structured is by first stating which question was presented to the respondents, followed by case examples given by them. After each section a discussion will be given of how the case study examples relate to the theoretical framework.

5.5 Continuous Improvement and Radical Innovation

The respondents were asked whether continuous improvement could lead to more radical innovations. The respondents provided answers that can be divided in three different themes related to continuous improvement. Within four interviews the Kaizen events were discussed, four interviews were related to the I3 method, two discussed continuous improvement in general. The next three paragraphs will discuss each of these three themes with case examples how they might relate to radical innovation.

5.5.1 Kaizen Events

As discussed in chapter four, the Kaizen events are meeting sessions that require a team to come up with a solution for a certain problem within a certain time limit given a certain budget. The definition that Boston Scientific uses for the Kaizen method is the following:

“Kaizen helps the organization to continually and incrementally improve efficiency, eliminate waste, reduce costs, improve quality and reduce time in existing processes” (Boston Scientific’s Innovation Challenge Proposal, May 2016). This definition shows that a Kaizen

method is used to continuously improve certain processes and that the outcomes are incremental. However, in the interviews there are extra notions concerning the outcomes of the Kaizen method. One respondent mentioned that a Kaizen event can result in a radical innovation.

“People are creative enough to come with more radical ideas but it is the applicability of the idea and the amount of risk that is associated with these solutions that determines whether they will be adopted. If one is willing to take more risk than one can adopt a more radical solution” (Lean and Six-Sigma Business Consultant).

If this is not the case, then the kaizen event will lead to more incremental innovations. People can come up with great ideas but if you provide them with risks and rules then the solution becomes less applicable.

Another respondent described how kaizen methods resulted in a radical change in the organizational process of recruitment of new employees. The problem here was that Boston Scientific previously hired a recruitment agency to approach and select potential employees for certain jobs. Boston Scientific provided the agency with a list of requirements and the agency would then start a recruitment procedure. This would result in a group of potential people that could take the job. The problem was that once this group would then go to phase two of the recruitment procedure, Boston Scientific had to redo part of the procedure so they would get a better view themselves. This two step procedure felt like doing the same procedure twice and thus a waste of resources. Through a kaizen event, Boston Scientific came with the solution to remove the agency from the recruitment procedure and to use a team from within Boston Scientific that would recruit specifically for a certain department. This means that people are approached with more specific demands related to a certain department and this results in a faster recruitment fewer people with a better fit to the open function.

The third interview in which the results of Kaizen events were discussed where an respondent acknowledged that the time constraints of the Kaizen events restricted employees in coming up with breakthrough ideas. The goal of a Kaizen event was to come up with a solution to a problem but there was no requirement for a breakthrough solution. This restriction of Kaizen events resulted in the event where Boston Scientific tried to elevate the current Kaizen approach to a new one *“that would inspire teams to deliver more innovative solutions and world class business results”* (Innovation challenge proposal, May 2016). The respondent mentioned that in theory a Kaizen event could lead to radical innovations but that this didn't

occur that often. For that reason, they designed the innovation challenge so more breakthrough innovations could be developed.

5.5.2 Innovation Challenge and I3

The innovation challenge mentioned in the previous paragraph had the purpose of providing an alternative to Kaizen Events that would lead to more breakthrough innovations. In this section will be explained what the innovation challenge and I3-method is and how it, according to Boston Scientific, can lead to more radical innovations. Appendix B contains the differences between the Kaizen method and the Innovation Challenge designed by Boston Scientific.

Appendix B gives a detailed difference between Kaizen and the Innovation challenge but what it comes down to is that the innovation challenge focusses on new value and unmet needs while the Kaizen method focusses on existing processes and the improvement of them. The way how these solutions are made up for the innovation challenge is *“by challenging business assumptions by taking a step back”* (Senior Project Manager). This process requires time and that’s why the innovation challenge, in contrary to Kaizen, is allowed to have a longer timespan with multiple workshops in cooperation with multiple actors from different disciplines.

Where the Kaizen method uses six-sigma’s DMAIC cycle, the innovation challenge uses the I3 process. This process is a derivative of Stanford’s Bio-Design in which multidisciplinary teams of Stanford students research and validate real-world medical needs, invent new health technology products to address them, and plan for their implementation into patient care (biodesign.stanford.edu). The three steps identification, invention and implementation in this process together form the I3 process which is adopted by Boston Scientific within their innovation challenge. Within this method, the identification step allows a team to identify the current needs and unmet needs of the customers. This allows for incremental improvement of current products and services but also for radical innovations since the I3 method allows to spend more time and resources for exploring possible ways to meet those needs.

5.5.3 Continuous Improvement

As described in chapter four of this thesis, continuous improvement is most often associated with incremental innovation and standard working methods. Some argued that continuous improvement might even impede radical innovations. When the respondents were asked

whether continuous improvement could lead to radical innovation, the answers were somewhat divided. One respondent described that continuous improvement does not get you in a new market because it focusses on current processes. Another respondent said that even though continuous improvement feels like incremental, there can be outcomes that are more of a radical nature depending on the amount of risk you are willing to take.

Six respondents described that continuous improvement does not form a restriction for being creative or to come up with breakthrough innovations. Rather, using structured working methods reduces mistakes in daily operations and it reduces resources necessary for these activities. These resources like time and money can then be spent on other activities that are more explorative. They indicated that it is not continuous improvement that necessarily leads to radical innovations but when a company adopts this improvement method, it opens up resources for activities that can result in radical innovations.

5.5.4 Discussion of continuous improvement

As described within chapter four of this thesis, there are different views on whether continuous improvement can lead to radical innovations besides incremental innovations. Within the literature study is described that radical innovations can result from continuous improvement through for instance Kaizen events or through the use of Six Sigma's DMAIC cycle. However, what is important in the application of these methods is that they most accompanied by resources constraints set by the top management team. Setting constraints in terms of financial aid can result in creative and radical solutions to a problem but time constraints puts pressure on employees so that they are more likely to choose for a fast and easy solution.

Within the case study is acknowledged that the Kaizen events and continuous improvement cycles can result in radical solutions to problems. These methods can both be used for radical idea generation and radical idea implementation. However, in practice they experience that Kaizen events are most often used for improvement rather than creating radical change. For this type of change they developed another method called 'The Innovation Challenge' that relies on an improvement cycle called I3-method that has a time span of months to years instead of days to weeks. This method allows employees to use more distant knowledge and allows to take more time to develop projects that are more distant from Boston Scientific's current practices. Thus, it is important when using a method like the Innovation Challenge that diverse and distant knowledge is used, else this method would also lead to incremental idea generation. However, regarding the implementation of these radical ideas,

both methods describe a structured path that can be used for the implementation of innovative ideas. Yet, the Innovation Challenge deals with the increased risk and uncertainty that are entailed with these radical ideas by allowing more time to be tested and implemented. The reason why this works over a Kaizen method is that employees have to meet annual targets and have to document their progress. This focus on these short time progress might keep them from spending time on exploring solutions that might result in big leaps of progress after a longer time period of for instance two years. The Innovation Challenge can force them to spend time on thinking about these possible long time solutions in between running their daily operations.

5.6 Standardization

As described in this thesis, some state that standardization of organizational processes represents ‘iron cages’ of organizational control and regulation that impedes innovation (Wright & Sturdy, 2012). In this same article, others described that the structured approach helps capturing and spreading knowledge within the organization and speeds up the implementation phase of innovation.

In this section, an overview will be given of how Boston Scientific standardizes and documents procedures within their organization and how this might relate to radical innovation. The question that was asked was whether the standard procedures resulting from applying Operational Excellence impeded the respondents in the way how they could innovate within their work. To explain the question even further, the question was refined into asking if there is room to be creative and try something radically different if you have to work in an environment that consists of many fixed working methods. To understand the answers given by the respondents better, first an overview will be given of how Boston Scientific standardizes their processes. Next, the case examples given by the respondents will be described.

In order to document Boston Scientific’s best practices, they developed the so called Essential Series which are documents that contain highly described methods how Boston Scientific works. For instance, how to use Six Sigma’s DMAIC method, or what the steps of product development life cycle are. According to one of the developers of the Essential Series, these documents allow employees to know where they are in terms of knowledge. These standards prevent people from having to invent the same working method over and over again and enables them to rely on these proven methods for success. The essentials can provide a context for innovative thinking.

The way how these standardized methods relate to incremental and radical innovation was explained by multiple respondents. The first relation described between standardization

and innovation was that it reduces time spent on standard procedures and it saves costs of processes. The resources that an organization saves this way can be spent in explorative activities. Also, respondent 5 described that *“standardization creates a platform for people to work with through creating a uniform language so people can communicate better with each other.”* (Enterprise Consultant). Explained was that no improvement can be done without a standard because there has to be a base from which you can elevate. Respondent 15 described that within Boston Scientific are approximately 62000 employees and each of them are seen as innovators. The innovations and methods documented within the Essential Series were created so that all employees can leverage these innovations. This respondent used the following metaphor to describe this leverage:

“The essential series are seen as the rising tide that lifts all boats which inclines that it brings all employees to a higher level of knowledge for them to work with.” (Vice President Global Enterprise Excellence).

Recognized was however, that there is a dichotomy around standardization and the inhibition of innovation. Within Boston Scientific, they are trying to build the best practices within each employee but allow the flexibility to innovate the standards. An example given was that standards aren't simply applied to each plant of Boston Scientific. Each context is different and because of this it is impossible to boldly copy each standard to another context. This requires employees to use the standards as guiding tools but remain creative and flexible themselves.

5.6.1 Discussion of Standardization

Within the literature study is described that some authors think standardization of organizational practices are the 'iron cages' that impede innovation. Others think standardization creates a common language and a platform that helps employees to communicate with each other. Within Boston Scientific, the 'Essential Series' are the standardized best practices that are being used within their organization. Acknowledged was that there exists a dichotomy around standardization impeding innovation. However, within the case study was described that standards are necessary to have a starting point from which you can built on and that the standardization does not represent the iron cages of innovation. Mentioned was that standards shouldn't be applied blindly but there must be flexibility to constantly improve these standards. This enables employees to use the knowledge and best

practices and leverage it into innovations for the organization. This means that standardization as a knowledge source can be used for the generation of radical innovations. However, even though standardization might help in the generation of radical ideas, it is not proven that when an organization standardizes their methods that this will then result in radical ideas. What could be an explanation is that the standardized methods can help in the generation of radical ideas. An explanation would be that the role of standardization is that everybody in the organization uses the same methods which allows them to work together more effectively. The standards provide methods to work with but what is decisive is that these methods combine different types of knowledge so radical ideas can result from then. Thus, argued is that standardization alone does not result in radical ideas. With regard to the implementation of ideas, standard methods can provide a structured path for people to follow which provides a project with high risk a higher chance in succeeding. What is important to mention however is that if an organization applies the operational excellence principles, these standard procedures might be designed for the implementation of incremental innovations. Using these methods for the implementation of radical innovation might become problematic since these projects are associated with a higher risk for the organization and might face resistance from certain stakeholders. This suggests that standard methods for the implementation process of radical innovation need to include a step or method to deal with this uncertainty of these stakeholders.

5.7 Customer Centric Strategy

Operational Excellence and quality management models aim to bring value to the customer and to arrange processes in such a way that contribute to this customer value. The topic that was discussed with seven respondents was how bringing value to the customers might drive innovation. Four respondents gave an answer that explained how translation of customer demands can drive innovation and three respondents described how Boston Scientific works with a supply chain optimization program. Boston Scientific's supply chain optimization programs offer a strategic approach and include a range of services to help healthcare providers improve operational efficiencies and implement cost-saving measures (Interview with Brian Gilpin, 2016). These programs were set up because customers were having too much inventory, spending too much time managing inventory, chasing orders, not having enough lab or shelf. Boston Scientific provided these customers with training in Lean Manufacturing methods, inventory optimization, order consolidation and vendor-managed inventory. This allowed clinicians to spend less time on things like inventory and more on patient care.

The respondents described that this cooperation with the customer allowed a radical transformation in how products were delivered to their customers. Boston Scientific received insights within the storage facility of a hospital so that they could manage the amount of products themselves. If there was a surplus of products, then they could take products and move them to another location where there was a shortage. This ensured that a customer would always have enough products but would never have too many. Managing inventories in this way takes away the focus from selling as many products as possible and replacing it with a stronger customer relationship with the customer. Another benefit is that it changes the way in how Boston Scientific can deliver products to the hospital. Instead of receiving an order and providing the service of delivering it as soon as possible, they can now manage the product inventories themselves and can take multiple days to deliver the product. This allows them to deliver the products as cheap as possible without risking that the product inventories reach a critical level. Respondent two described this as '*creating new capabilities*' (Global Supply Chain Manager), where the focus was drawn from delivering products as fast as possible and as many as possible to delivering the right amount needed at the lowest cost.

Next to training provided in managing the storage facility, Boston Scientific provided training Lean principles and Six Sigma to clinicians. This way, they learned to standardize certain practices. This then reduced variation within the results of these practices which is beneficial for the patient care. This cooperation with the clinicians strengthened their relationship, and the close communication allowed Boston Scientific to get a better view on the latent customer needs of clinicians and patients which could be translated to new healthcare solutions by Boston Scientific.

One respondent described a trend within healthcare that provided Boston Scientific with an opportunity to radically change their working practices. Boston Scientific already produces products that are least invasive, which means the negative effects of surgery are present as little as possible. However, they acknowledge that preventing a disease is better than curing it. Respondent nine describes the result of this change in paradigm with the following statement:

"The goal of keeping patients out of the hospital is contrary to goal of Boston Scientific to sell more products. That's why we have to change our business model together with it. Where do we want to be in the future?" (Solutions Development Manager).

The respondent described that through their cooperation with the hospitals and clinicians, they were able to work together to future solutions to this trend. The same respondent describes that you have to plan out multiple years to reach a solution like this and you have to work on it each day. Operational Excellence could achieve this through finding the unmet customer needs but it depends on “how you apply the terms of Operational Excellence how it can drive innovation”.

5.7.1 Discussion Customer Centric Strategy

Within the theoretical framework is described that having a customer focus satisfies current customer needs. However, not every customer knows what its future needs are and for this reason there are customer relationship management programs. These models aim to obtain a strong relationship with the customer through which they can identify unmet needs of the customer. These needs can then be translated into new products and services accompanied by possible new processes. Boston Scientific provides healthcare solutions which is their way of meeting the customers' unmet needs. Both the literature study as the case study describe that this way of managing the customer relationship leads to radically new services and radically new products. However, the case study shows that there is a trade-off for Boston Scientific between their strategic goals. On the one hand they can satisfy customer needs better by managing the inventory of hospitals themselves but this occurs at the cost of selling as much products as possible to these hospitals.

How having a customer centric strategy relates to radical idea generation is that it can ensure that an organization can obtain new knowledge from the customer which can be translated into an innovation. Because these needs are unmet, they require Boston Scientific to develop technologies, services and processes that are also new to Boston Scientific to meet those needs. Regarding the implementation of these radical ideas, a customer centric strategy can facilitate this because there is a strong relationship between the organization and the customer. This relationship allows to make the customer acquainted with these changes by showing that there is a mutual benefit for customer and Boston Scientific. An example of this is the trade-off that was described earlier where Boston Scientific could manage the inventory of hospitals which improved stock management for Boston Scientific while at the same time ensuring that the hospitals will never more products in stock than necessary. One notion has to be made regarding the radical innovations that can result from a customer centric strategy. Employing this strategy restricts the organization to innovating within the customer needs. The

translation of unmet needs results in technologies and services that are new to both the customer and the organization and sometimes require the combination of distant knowledge and out of the box thinking. However, it does not bring your organization into new markets. An alternative to a customer centric strategy could be a patient centric strategy which would have more risk for success, but it does allow you to develop new products for new markets.

5.8 Training and Knowledge Management

The way how Boston Scientific manages knowledge is described in the following section. First will be described how they acquire new knowledge through their corporate venture program, then how they develop new knowledge through their own R&D activities and last how they combine and share knowledge. The first question related to this subject that was presented to the respondents was how applying a structured working method would affect the exploratory outcomes of R&D. The second question was how Operational Excellence through for instance six sigma and lean manufacturing could lead to more radical innovation within an organization. Five respondents gave answers related to the PLCP method and three respondents described how Operational Excellence promotes learning of employees.

5.8.1.1 *Importing and absorbing knowledge*

Boston Scientific uses a corporate venture strategy to acquire other companies that have developed a certain technology. The reason for this is because the development of medical devices is costly, risky and time consuming because it has to undergo multiple clinical trials before getting an approval from the Food and Drug Agency. For a lot of companies, it is too expensive and risky to follow this approval path and that's why Boston Scientific does investments in starting companies who still have to get approval from the FDA. Once these companies have passed the clinical testing, BSC invests more and might even acquire the company.

Once Boston Scientific has acquired a company they have a structured process of integrating this company into their own. This process occurs in four steps that have a slight overlap with each other. This process is called Plant-Network Optimization and it consists of the following steps:

- System Integration: Make sure the acquired company uses the same system such as SAP.

- Logistical Integration: The acquired company now distributes their products to central locations of Boston Scientific.
- Manufacturing Integration: Employees of Boston Scientific start to work at the acquired firms so the manufacturing of the products is well understood. This knowledge is then transferred to one of the bigger production plants of Boston Scientific.
- Manufacturing spreading: Since the new technology might replace an old technology of Boston Scientific, the manufacturing of the old products is then replaced to one of the smaller production plants in a different country. These products are then produced with cheaper labor force and then distributed to countries that suffice with less than the newest state of the art technologies.

5.8.1.2 Develop knowledge

Next to acquiring technologies through the corporate venturing program, Boston Scientific improves the acquired technologies within their R&D department where they also develop new technologies. In two interviews with a principal R&D engineer and with a senior manager in global business excellence, a description was given of how the business processes of R&D are changed in the past few years. Boston Scientific created a product life-cycle plan for R&D to work with. This stepwise plan consists of the step following steps: Plan project, define product, develop product, confirm product and commercialize product. Each of these steps consist of multiple steps, and points where the development can be frozen. At these moments, the R&D team has to show their progress and this allows a certain control over the R&D process. The reason for this life-cycle plan was explained by respondent 3 by stating:

“Until we did the Product Life Cycle Project, our methodology for exploratory work and technology development were very ad hoc. This meant that they did what felt right and the results weren’t that good.” (Senior Manager Global Business Excellence).

Boston Scientific wanted to have more control over this process. The R&D team were promised to get incentives for meeting targets within the technology development process. If the R&D agreed to follow this structured approach, then Boston Scientific would be willing to spend more on the R&D portfolio.

The R&D engineer provided a view on the PLCP method from an R&D perspective by mentioning that the PLCP was a structure that helped with commercializing more effectively.

It helps finding new customer needs and translating them into product requirements. Previously, the R&D department interviewed sales and marketing departments in order to find unmet needs within a clinical setting. Right now, the R&D engineers go and meet the customers themselves. This enables them to detect latent user needs of which the clinicians were unaware of.

5.8.1.3 *Combining and sharing knowledge*

Corporate venturing and development through R&D are related to acquiring and developing new technologies for Boston Scientific. However, there are also innovations possible by the combination of knowledge of employees of Boston Scientific. Examples that were given in the interviews were: forming cross-functional teams, job rotation programs where employees could work in different departments, training of employees in Lean and Six Sigma principles, allowing employees to follow education financed by Boston Scientific, recruitment of people from other industries and project awesomeness.

Respondent eight described how employees from the R&D department had to work within manufacturing functions first. This provided them with insights in the values of these departments and this enabled them to incorporate these values more easily when developing products. The reason why this is important for Boston Scientific is because after a product is developed, it has to be manufactured elsewhere in the organization. If the values of manufacturing are not incorporated within the product developed by R&D, the manufacturing department will face troubles in producing these products. It is therefore beneficial for the flow through these processes if the R&D employees have a good understanding of the values of the manufacturing department. This can be obtained by letting R&D employees work in a manufacturing environment first.

Respondent one described that Operational Excellence meant within his responsibilities *“a part of Operational Excellence is to attain and attract key talent”* and *“provide the opportunity for employees to keep learning by letting Boston Scientific financially aiding their education”*. (Facility Manager and Procurement). He explained that besides creating a certain culture, which will be explained in a later paragraph, increasing knowledge in people is important to generate different innovations.

5.8.2 Discussion of Training and Knowledge Management

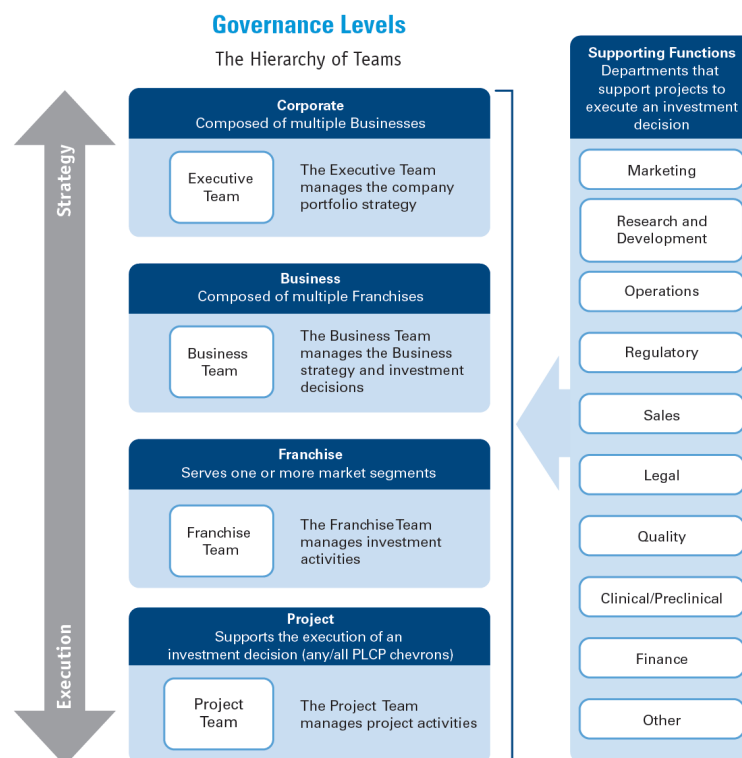
Within the theoretical framework is described that managing knowledge can result in radical innovations within an organization. Some authors state that in depth knowledge is required, others stress that more broad knowledge is required. The case study shows that Boston Scientific invests in both acquiring knowledge and technologies from outside of the company through corporate venturing and internal development through R&D. With regard to the acquisition of new technologies, Boston Scientific invests in organizations that work on new technologies with the possibility of acquiring this organization after they passed the FDA clinical trials. This is an investment in acquiring more broad knowledge but with a reduced amount of risk. Through the PLCP model, the R&D department is able to explore the unmet needs of their customers and translate this to radically new products or product improvements.

The way how knowledge management relates to radical innovation is that can increase the amount of knowledge that a company has. The types of knowledge that constitute this organizational knowledge are patents owned by Boston Scientific, employees, technologies and processes that are present in the organization. Through training of employees, hiring employees from different sectors, acquiring new technologies, buying and inventing patents, this pool of knowledge can be increased. In order to innovate, the knowledge present should be combined. Through acquiring knowledge more distant knowledge compared to the existing knowledge, new combinations can be made which will result in radical innovations. Thus, knowledge management and training increases the amount of knowledge within an organization. However, in order to facilitate radical innovations, distant and diverse knowledge is needed. This knowledge is new for the company and related with uncertainty for employees to work with because they have no experience with it. A factor that influences the degree to which an organization wants to accept the risk of this uncertainty is depending on whether there is a risk averse culture or not. Thus, knowledge management does not directly relate to radical idea generation and implementation but increases the organizational knowledge and this knowledge can then be used together with other organizational excellence principles to innovate. However, in order for radical innovations to occur, the organizational knowledge needs to be diverse.

5.9 Systematic thinking

Systematic thinking, as described in chapter two of this thesis, means that interdepartmental barriers should be removed and that all processes within an organization

should work together in an efficient way. The answers relating to this topic were obtained by asking how Operational Excellence with a continuous improvement culture can still innovate in a radical way when an organization faces trouble further incrementally improving processes. Six employees answered that it is important to collaborate with different departments and to remove barriers between them. In order to further understand the relationships and interconnectedness within Boston Scientific, first an overview of its organizational structure will be given. After that, case examples will be provided that describe how Boston Scientific manages this interconnectedness.



This organizational structure is set up in such a way that the executive team makes the strategic decisions and these are made in the upper organizational levels. They are communicated to the lower organizational levels. The next level is the business level which is responsible for a certain segment of the organization like the urology segment. The business level determines a strategy for their business and communicates this downwards to the franchise level who are responsible for a certain group of products within the business. From there the franchise works with project teams who follow the strategic decisions made in the upper levels. The way how the teams work when making a decision is that cross-functional engagement must be sought so that better decisions can be made. Through this cross-functional engagement, project issues will have a faster speed to market. (Product Life Cycle Process

Essentials, Boston Scientific). According to the respondents, the product life cycle process helps research and development to collaborate better with customers to uncover their latent demands. Next to that, it helps them to work together with process engineers so that the values of manufacturing department can be integrated in product development.

Before a project team works on a plan, they gather the right internal and external stakeholders. This allows a cross-functional look on each project and makes sure that this does not have to happen later in the process. Boston Scientific believes that it's better to scrutinize projects strongly at the front end because it's easier and cheaper to kill projects at the beginning than later on (Product Life Cycle plan, Boston Scientific).

The previous example describes the relevance of all stakeholders' participation to execute a plan, but Described was that applying Lean Manufacturing in an organization aims at improving process flow and that there needs to be a *"cooperation and alignment with stakeholders both internally and externally"* (Global Supply Chain Manager).

A case example of a project that was set up to promote innovations within the organization was 'project awesomeness'. Respondent six described that there were over 35000 value improvement projects within Boston Scientific. These VIP's are documented projects in which an improvement project as successfully implemented within the organization. These projects were mentioned to be mostly incremental innovations but there were also radical innovations but no ratio between them was given. This database was filled with solution to problems that occurred somewhere within the organization. However, these 35000 documents remained quite unused over time. Instead of finding a custom made solution problem, the plan was to create a platform in which employees could share their improvement project with each other. This would allow people to use an already existing solution to a problem that would arise somewhere else in the organization. Respondent 6 described that this sharing of knowledge can drive innovation by *"Just walking through different departments and take a look there and learn from other departments how these simple little things can drive improvement"* (Senior Project Manager). After this notion, the question was asked whether the use of this platform could be integrated within the continuous improvement cycle or within R&D cycle to drive different types of innovation. The answer was that there could be a possibility to do this but that the plan was too young to draw conclusions from that.

Another case example given by respondent 1 was regarding the implementation of a new storage system in one of Boston Scientific's distribution centres. Boston Scientific stated that the distribution could not expand to in reaction to an increase of products that would go through

this plant. Instead, they had to use their current square meters more efficiently. In order still manage this increase in flow through of products, they had to reorganize the plant. This would however cost approximately 20 million dollars to realize. Instead of following this plan, there was an alternative to do an investment of 6,5 million dollars where a new storage system would be acquired called 'auto store'. The corporate team approved of plan since it was an investment that was significantly lower. After this approval, the team located in the distribution center immediately started with trials with a prototype followed by the implementation of the real project. In doing this, the IT team was left outside of the beginning of the implementation process until later. The respondent mentioned that this greatly sped up the implementation process while keeping great results. Next to this, this respondent described that it is important to determine at the start of the project who is responsible for the project. This team or person should then manage the project from beginning to end.

5.9.1 Discussion Systematic View

In order to share knowledge and manage cooperation between different departments, barriers between these departments should be broken down. This cooperation can result in the combination of different knowledge which can result in both incremental as radical innovations. Both the literature study and the case study describe that it is important to involve all stakeholders in the innovation process so that different values can be integrated and different people with different looks can review a certain project proposal. On the other hand, this does have an effect on the implementation time of a certain project. Involving all these stakeholders is time consuming and if there are contradicting priorities between the stakeholders then a certain project might be delayed or put to a halt. One could ask the question whether there remains plenty of freedom for explorative activities that entail more risk than normal projects. Managing with a systematic view has a twofold relation to radical innovation as described by the case study. On the one hand, involving all stakeholders in projects and integrating all their values might enable the generation of radical ideas and it can reduce the risk for a project to succeed. However, if a project is mostly executed within a certain department, involving other departments who have less experience within this field might slow down or even stop the implementation of a project if it is too risky or there is too much resistance to change. Next to these two relations, maintaining a systemic view causes different departments to communicate better which leads to more information sharing. For this reason, is argued that a systemic view supports knowledge management within an organization next to radical idea generation and

implementation. An explanation is that acquiring diverse knowledge alone is not enough to create radical innovations but necessary is to share it all through the organization. Maintaining a systemic view is essential in this process because this reduces the interdepartmental barriers and allows this knowledge to flourish through the entire company.

5.10 Setting Strategic Goals

With respect to this theme, the question was asked how having the goal of bringing customer value can lead to radical innovations. This question was accompanied with the question whether it was possible to do projects that deviated from the strategic goals set by Boston Scientific.

As described in the previous section, within the organizational structure of Boston Scientific, the strategic goals are set higher in the hierarchical chain. The strategic goals are then communicated from corporate level at the top to project level at the bottom. Within the product life cycle process is described that projects teams must be focused on the right goals within the organization. This is done by focusing on the four voices:

- Voice of the customer: Customer needs, expectations and wants.
- Voice of business: Business needs, wants and expectations.
- Voice of regulatory: Regulatory needs
- Voice of technology: Internal and external technology capabilities and solution concepts.

An employee can also come up with an initiative by presenting them to a franchise team who can then decide if the idea is worth pursuing compared to other opportunities. The franchise team will make a recommendation to the business team if appropriate. What the business team does then is challenging the recommendations, refining them and possibly approve. A project needs a certain strategic fit in order to gain approval. According to the interview with the R&D engineer, innovations done that have a strategic fit are approved more easily than innovations that haven't. This does mean that innovations deviating from this strategic target are harder to get approval for and thus won't occur that often. However, because a goal is to bring value to the customer, R&D has to cooperate more closely with them. This close cooperation between R&D and the customer, which in this case were the clinicians, didn't happen in this way previously. Before the PLCP was implemented for R&D, the sales

representatives and marketing department provided R&D with customer requirements. However, by working together with the customer themselves they were able to detect completely different customer needs. By aligning R&D to the strategic objective of bringing more customer value they were able to do more product improvements and create entirely new products. This working method, so was described by respondent 2, 6 and 11, reduced the risk of implementation of projects. Respondent 11 stated that Boston Scientific was risk averse and explained why they couldn't afford to take this risk:

“People say that you have to be like a small entrepreneur, which would work for a software organization, but not for Boston Scientific because the barriers in new device manufacturing are so incredible high” (Principle Process Improvement Analyst).

These respondents described that Boston Scientific risk averseness can be seen from how they acquire technologies after the approval of the FDA and how they structure the research and development process with the PLCP model.

5.10.1 Discussion Setting Strategic Goals

The literature study described that when strategic goals are set in a way that more risk is accepted, this is positively correlated with radical innovations. Boston Scientific, so was explained, is risk averse which means according to the literature study that this would lead to less radical innovations for the organization. According to Boston Scientific, they can radically innovate by setting the strategic goal to increase customer value by looking for unmet needs among customers and satisfy them which creates radically new products or services for the customer. This means that there is room for radical innovations within Boston Scientific but only within a certain range of risk that is allowed and when increase in customer value is satisfied eventually. Noted should be that setting strategic goals in this way leads to the generation of ideas through translation of unmet customer needs. However, the company will then only focus in radical ideas related to this customer group but won't open up new markets. An explanation for this could be that this strategy uses the customers' unmet demands as a source of information to which they can attend. This is knowledge different from what Boston Scientific currently has and thus results in innovations that are radically different from their current innovations. However, there is no knowledge obtained related to the needs of new markets and thus solely focussing on current markets won't open up new markets. To reach this, new customer groups have to be approached and a relationship has to be built with them

so their unmet needs can be translated into innovations. However, just like described for the paragraph ‘customer centric strategy’ this focus on the customer moves the organization away from a patient orientation.

5.11 Organizational culture

Within chapter four of this thesis was described that in an organizational culture must support risk taking, creativity and autonomy of employees in order to foster radical innovations.

Six respondents described the relevance of building the Operational Excellence culture within people. Within Boston Scientific’s product life cycle process is described that a knowledge driven culture is important within their organization. Project ideas from teams have to approved by franchise teams and business teams who challenge the ideas. Proof has to be given by providing real facts to the franchise and business teams and should not be based on opinions or strong feelings. A culture of Operational Excellence within employees should result in that employees keep questioning why they are doing something the way they do it. From the interviews appeared that this way of thinking breaks the culture where people follow a certain structure just because they are used to it. Breaking this routinized thinking opens up for a culture for radical change. A way to do this is by “*taking a step back and ask the question why you do what you are doing*” (Senior Consultant Manager).

Respondent one described that “an important part of an organizational culture are the soft elements of an organization” (Facility Manager). Not only obtaining knowledge and combining knowledge is important for radical innovation, also promoting a winning mentality. Respondent one described:

“They wanted to create a working place that had an innovative vibe. From the moment you step into the organization you have to get the feeling that this is the place where high technology products are developed and made” (Facility Manager).

He described that a part from this is due to certain leadership that can motivate employees to act in a certain way, but also the so called workplace strategy can motivate people. Creating a working place with the best machines and innovation centres where the progress of projects can be followed could then result in new innovative ideas.

Another example how organizational culture is managed within Boston Scientific is that one of Boston Scientific's core values is embracing diversity. One of their values is described as: "We embrace diversity and value the unique talents, ideas and experiences of our employees" (bostonscientific.com – mission and values). This shows that they harness a culture that embraces diversity with the idea that it leads to diverse knowledge from different people. Thus they describe that organizational culture can drive diversity which leads to more diverse knowledge in the organization which, through combination with other operational excellence principles can lead to radical idea generation.

5.11.1 Discussion Organizational Culture

As described in this thesis literature study, an organization should not avert risk when they want to innovate radically. However, as described in the case study, innovating within the medical device manufacturing industry is costly and entailed with high risk. Boston Scientific tries to reduce risk as much as possible in areas where it is possible such as the implementation process of innovative ideas. Boston Scientific needs both incremental as radical innovations within their organization but according the literature study, incremental changes inhibit radical changes. To prevent that the employees become entrenched within a mind set of incremental innovations, an organizational culture is required where people are able to take a step back from a process, stay critical and ask the question "why are we doing this the way we do it". This allows employees to think beyond the line of incremental improvements that are currently being done and look for radically different ways of working. An example of how this would work in practice is when an organization is acquiring new technologies or new people. These technologies require people to learn new methods to work with, and acquiring new people might bring in new knowledge if they previously worked in a completely different industry. These changes result in new knowledge for an organization to work with. At this moment for instance a process engineer might consider re-evaluating the processes that are currently within the organization. The acquired new knowledge can be used to come up with radical new solutions to how these processes can be managed. This example shows that organizational culture can influence the different types of knowledge within the total organizational knowledge. This can then lead to radical idea generation through combination with the other Operational Excellence principles. Thus, creating a certain organizational culture can increase the diversity within the organization which creates a diverse portfolio of organizational knowledge which is an enabler of radical idea generation.

In short, an organizational culture can determine the amount of risk that an organization is willing to take and it can enhance diversity within the organization. Allowing more risk can lead to the acquisition of more distant technologies and knowledge which can be used to create more diverse organizational knowledge. Also creating a culture where people have to think autonomously and keep questioning why and if certain methods still work, allows the previously diverse knowledge to be used for the generation of radical innovative ideas. Also organizational culture can lead to more diverse knowledge if diversity of employees is promoted. An explanation for this is that employing people with different professional and ethnic backgrounds allow for different insights on current organizational processes which might open for more radical solutions.

5.12 Overall Discussion of the case study findings

To provide an overview of the previous sections and the discussions that followed, the findings have been put into a framework. This framework shows the results of the case study and the discussion of each sub part.

Conclusions of how Operational Excellence principles can lead to Radical Innovation	
Elements of Operational Excellence	Results from case and literature studies
Continuous Improvement	Instead of using a Kaizen method, an innovation challenge is suggested that is still focussing on identifying customer needs but allowing more time and resources to be spent on the development of these radical ideas. Can lead to radical innovations when the different types of knowledge are combined.
Standardization	The standards should not be seen as a checklist that has to be followed blindly, but as guidelines and a common platform for all employees to enhance communication. This methods described within the standards work can then lead to radical innovations when diverse knowledge is used.
Customer Centric Strategy	This strategy can be used to find unmet needs and translate them into radical innovation opportunities. Thus, this type of strategy can lead to radical idea generation and facilitate implementation. This risk of success of radical innovation implementation is reduced because there is a customer base for these innovations. However, this type of strategy can lead to a certain trade-off that has to be done as explained in paragraph 5.5.1.
Training and Knowledge Management	Management of knowledge and training can increase the organizational knowledge by training people in new skills, working in cross-functional teams, hiring from different industries and acquiring new technologies and patents. This diverse knowledge can then be used in combination with other operational excellence principles to lead to radical innovations.
Systematic Thinking	Removing the interdepartmental barriers leads to better communication so that knowledge can be shared more effective. In combination with for instance Continuous Improvement this can lead to radical ideas. Also better interdepartmental communication facilitates radical idea implementation. However, if there are conflicting departmental priorities then this can slow down, or terminate the radical innovation projects. Important is involve all relevant stakeholders at the beginning so that mistakes made up front can be identified by them early.
Setting Strategic Goals	Setting the strategic goal that innovation must lead to an increase in customer value and that unmet customer needs must be identified, can lead to radical innovations but innovations that don't meet these requirements are hard to find approval for.
Shaping Right Organizational Culture	Depeding on the amount of risk accepted by the organization, results in more distant knowledge for the organization. Creating a culture that embraces diversity can result in the acquisition of employees with different ethnic and professional backgrounds. This brings in different insights in the organization and more diverse knowledge.

Table8:Description by respondents on how Operational Excellence should be managed in relation to radical innovation.

patents, technologies and processes. This knowledge is present within the organization but an important notion that has to be made is that the degree of systematic thinking determines how well this communication is shared between different departments. This sharing of communication allows different types of knowledge to be combined which can lead to radical innovations. The principles 'knowledge management' and 'organizational culture' increase the amount of knowledge within an organization. Knowledge management should result in hiring new employees from different industries to bring in new insights and knowledge that is new to the company while training of current employees, or working in cross-functional teams can ensure that different types of knowledge are combined. These activities can result in radical innovations through using new knowledge or combining old and new knowledge.

The knowledge present within the organization can be used in combination with different operational excellence activities such as Continuous Improvement, Standardization, Systematic Thinking and Customer Centric Strategy. The types of knowledge that are present determines what kind of innovations will result from these processes. If for instance continuous improvement is done with a team from one department who share similar knowledge, then this will most likely result in an incremental improvement. However, if a cross-functional team is used, then different types of knowledge are being combined, which can result more likely in radical innovations.

The Operational Excellence principles can have an influence on radical idea generation and/or idea implementation. Standardization and organizational culture influence radical idea implementation while Setting Strategic goals only influences radical idea generation. However, Continuous Improvement, Systematic Thinking and having a Customer Centric Strategy are related to both radical idea generation and implementation. As shown in figure one, the last Operational Excellence principle 'knowledge management' is not linked to either radical idea generation or implementation. The reason for this is because knowledge management does not directly influence radical idea generation or implementation. However, through managing the organizational knowledge, there is an indirect influence on these two. As mentioned, diversifying the organizational knowledge is important so that this diverse knowledge can be used together with the Operational Excellence principles to create radical innovations instead of incremental innovations. A way how this can be done is by acquiring new patents or technologies but more important is stimulating diversification among employees by hiring people with different backgrounds and stimulating them to speak their minds. This way their ideas can be used and combined with other types of knowledge to create radical innovative ideas. Important however is that in order for this knowledge to actually be combined into

radical innovations, there should be a leadership team and a culture that supports this diversity. Operational Excellence prescribes a certain structure for organization to follow, and it describes that it should be built in all employees through the creation of a culture.

6 Conclusion

This thesis started with describing the situation that many organizations face once they grow larger which is that they lose the propensity to radically innovate. Once a company has a breakthrough technology they start to produce on a large scale, invest in increasing production efficiency and incrementally develop their product to make profit. However, in order to also ensure future profits, there is a need to invest in more radical innovations.

Based on quality management models, Operational Excellence models have been developed to bring structure within these organizations to increase efficiency and reduce costs through continuous innovation of business processes. These activities are often result in incremental innovations and were described to impede radical innovation. However, large organizations need both incremental and radical innovations. Described is that Operational Excellence leads to incremental innovations but undescribed is how it can lead to radical innovations. For this reason, the objective of this research was to find how Operational Excellence can lead to radical innovations within a large organization. The research question posed within this thesis is therefore:

How can large organizations be Operational Excellent while being able to innovate radically?

The overall conclusions and the answer to the main question is that simply applying Operational Excellence within an organization won't lead to more radical innovation. It is foundational for an organization to run its daily operations. However, the individual elements of Operational Excellence can under certain circumstances result in radical innovations but this occurs under certain trade-offs. For instance, a customer centric strategy can lead to more radical innovations within an existing customer domain but won't lead to the discovery of new markets. Also continuous improvement will only result in radical innovation when diverse knowledge is combined and more time is made available for the implementation of the idea. Next to these trade-offs, a prerequisite for radical innovation to be possible in an Operational Excellent environment is that there must be diverse organizational knowledge. Here, knowledge management can lead to an increase in the amount and diversity of organizational knowledge while systematic thinking can result in organization wide sharing of this knowledge. An organizational culture and leadership that promote diversity are crucial in this relation because an organization wide accepted culture that sets diversity as a core value helps in obtaining diverse organizational knowledge. This knowledge, can then be turned into radical

innovations. In this process, Organizational culture and standardization facilitate radical idea implementation, setting strategic Goals leads to radical idea generation and Continuous Improvement, Systematic Thinking and a Customer Centric Strategy lead to both. An implication for Boston Scientific is that if they want employees to contribute to the radical innovation process, each person needs to have the following understanding of what radical innovation is. A radical innovation is the result of a process of combining diverse organizational knowledge which has a higher risk of implementation success. Other definitions of radical innovation that describe it as being ‘a large change’ or ‘costly’ describe an outcome of radical innovation but lack clarity on how to reach this point. This paper shows large organizations how to reach radical innovations while operating in an Operational Excellent environment.

6.1 Research relevancy

The problem stated in the beginning of this thesis described that organizations lose the propensity to radically innovate once they grow larger. If a company decides to apply the Operational Excellence principles, this does not mean they keep this propensity. However, what this study describes which trade-offs can be done in order to be Operational Excellent, while creating opportunities to radically innovate. These opportunities have as prerequisite that there must be diverse knowledge within the organization. Through conducting the case study was found that not every employee perceives radical innovation as a result of the combination of diverse knowledge. However, when managing the Operational Excellence principles so that they can lead to radical innovations, it is important to integrate the value of diversity. Yet, the relevance of knowledge diversity might be clear in the strategy forming levels of Boston Scientific, but this study shows this vision should be well communicated in the levels where the strategy of Boston Scientific is executed.

For the research field of management of technology, this study provides a framework by which organizations can structurally analyse an organization on how the Operational Excellence principles are managed in relation to radical innovation. Also this study shows how the elements of Operational Excellence are related to each other and that diverse organizational knowledge forms the base on which the Operational Excellence structure can build to lead to radical innovations. This shows that accompanied by certain trade-offs, radical innovation can occur in an environment that is highly structured.

6.2 Research limitations

As described in the methodology of this thesis, the created framework was applied to the case study within Boston Scientific to validate and as an addition to the framework. Also the case study shows practical examples of how Operational Excellence is managed in relation to radical innovation. However, there are some limitations within this research that will be addressed in this section. The first is that out of fourteen interviews, twelve respondents worked within the Global Enterprise Excellence team which shows a one sided perspective on the relation between Operational Excellence and radical innovation. These respondents are biased with respect to the relation between Operational Excellence and radical innovation and thus their answers differ from other employees in the organization. By interviewing more employees who are not part of the Global Enterprise Excellence group, a more generalizable view could have been obtained.

Also, within this research was chosen to do one case study to get an in-depth understanding of how the Operational Excellence principles relate to radical innovation. Due to time limitations, there was only the opportunity to conduct one case study. However, when conducting the case study within Boston Scientific, observed was that Operational Excellence is strongly connected with the culture of that organization. The results could be very different for organizations in the same industry with a different culture.

Regarding the selection of the respondents there is room for improvement. In this study mostly managers who overthink the Operational Excellence principles and apply them within different departments were interviewed. However, most employees within Boston Scientific are not overthinking methods but apply them within their daily operations. This study therefore provides a view that is restricted to the upper levels of management but not the lower levels of the organization.

Another limit of this research is that the case study is conducted within the medical device manufacturing sector. Boston Scientific operates within the medical device manufacturing industry which is known for high entry barriers due to high research costs and the risk of not getting a technology approved by the FDA. Thus conducting this research within different industries might give different results.

6.3 Implications for future research

This study shows the importance for diversity within an organization. An important factor in driving diversity is the influence of leaders and top management. However, among leaders and the top management there can be a resistance to change or diversity because it puts them in an unknown situation for them to deal with. Operational Excellence provides methods and

structures for idea generation and implementation. An implication for future research would be to see which methods and structures can reduce the impact of human judgment in processes that require the input of diverse knowledge.

With regard to having a customer centered strategy, an alternative for Boston Scientific would be to have a patient centered strategy. The problem with this strategy is that product development for these patients has to go through a series of clinical trials, making this process costly and risk full. Future research could be pointed at finding methods and circumstances to speed this process. Suggestions are to scan for new patient groups that can be treated with existing products with a slight modification so that the FDA approval process doesn't have to be that extensive.

Another implication that can be done is regarding the organizational structure within the large most often functionally structured organizations. This functional structure is a result of trying to separate the exploitative and explorative activities within an organization. Boston Scientific also describes that there is a hierarchical and functional structure within their business departments. Yet, when observing the case of Boston Scientific, the cross-functional and departmental collaboration gives the impression that the structure is far from functional. However, each employee still has to account to their own boss of their own section. An implication for future research would be to see what the influence is of this functional accountability on the outcomes of these diverse collaboration.

Another observation within the case study was that there were 35.000 documented improvement projects but that these remained unused within Boston Scientific. Boston Scientific stated that they would like to see that these projects would function as examples for other managers when doing similar projects. A suggestion is to look how the use of these documented projects could be integrated in the processes for innovation that currently exist within the organization.

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Sources used for overview of Operational Excellence Principles

Source	Model
Shingoprize.org	Shingo
EFQM.org	EFQM
Dahlgaard, J. J, Kai Kristensen, and G. K Kanji. <i>Fundamentals Of Total Quality Management</i> . London: Chapman & Hall, 1998. Print.	TQM
V.M. Rao Tummala C.L. Tang, (1996),"Strategic quality management, Malcolm Baldrige and European quality awards and ISO 9000 certification", <i>International Journal of Quality & Reliability Management</i> , Vol. 13 Iss 4 pp. 8 - 38	ISO9000
Womack	Lean
Navin Shamji Dedhia (2005) Six sigma basics, <i>Total Quality Management & Business Excellence</i> , 16:5, 567-574,	Six Sigma
V.M. Rao Tummala C.L. Tang, (1996),"Strategic quality management, Malcolm Baldrige and European quality awards and ISO 9000 certification", <i>International Journal of Quality & Reliability Management</i> , Vol. 13 Iss 4 pp. 8 - 38	MBNQA
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Table 9: Sources used for obtaining principles of models, awards and quality management authors.

9 Appendix

Differences between the Kaizen method and the Innovation Challenge.

	KAIZEN	INNOVATION CHALLENGE
Objective	Continuous Improvement; Incrementally improve the known; Deliver incremental improvement to a present, focused goal.	Redesign, Rethink, Step Change Improvement; Invent the unknown; Deliver breakthrough results to a challenge statement.
Process/Method	Process Improvement Roadmap (DMAIC).	I3 process (Identify, Invent, Implement).
Scope	Generally focused on single process/area.	Generally broader focus, multiple areas impacted.
Sponsor role	Align on scope, goals, & resources / team kickoff/ review results/ recognition.	Align on strategic focus, challenge statement, & resources/ Team kickoff / Milestone reviews / Recognition.
Team selection	Core Team; SME's with some cross-functional support.	Core Team + more cross-functional support, suppliers, customers, outsiders, etc.
Facilitator Experience	Deliberate, consistent.	Advanced, adaptive.
Risk	Very low.	Higher than Kaizen - some failures.
Time commitment	Define: Limited pre-work. Measure/Analyze: 2-4 days (single workshop). Improve/Control: 30-90 days.	Identify: Upfront resarch, earlier team engagement. Invent: 46 weeks (multiple workshops). Implement: 2 quarters-2years.
Physical environment	Onsite for workshop duration.	A persistant room to invite broader participation.
Visibility	Low, generally promoted only within focus area.	High, branded & promoted broadly.