The deviation of Dutch SMEs from the selling stories of Smart Industry consultancy literature.

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ABSTRACT

This thesis is part of a more substantial research to see what the impact of Smart Industry is on Organisations. The purpose of this particular paper is to disclose the consultancy literature, or the so-called 'selling stories', and to see whether Dutch SMEs deviate from the papers concerning Smart Industry impact on manufacturing processes. The research was carried out as a survey, backed up with qualitative opinions gained in a Smart Industry conference. Due to the quantitative approach for this thesis, a questionnaire was sent to managers in SMEs, which measured the impact on three levels (accordingly with the three subjects of the researchers) and the results were analysed and discussed towards the end of the thesis. From these results, it can be concluded that Smaller and Medium sized organisations in The Netherlands deviate from the selling stories. Each manufacturing dimension measured is lower than stated in the consultancy literature. The SMEs present themselves in a different stage in the Gartner's Hype Cycle. There is still a lot to be investigated what accounts for the difference that has been found. New research could focus on how to successfully gap the bridge between hype and reality of Smart Industry.

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1. INTRODUCTION

This introductory chapter explains the background of the research topic and elaborates on the problem that arises within it. Based on this, the research question is identified, and the purpose of this research is addressed.

1.1 Background

Throughout the last years, many advancements in internet technology have had its effects on the economy and society. Currently, we are on the brink of another industrial revolution. With an industry that is now becoming 'Smart', organisations can take up their business to the next level. This Smart Industry consists of combining information and communication technologies with networks, robotics, and sensor technology to strive for better quality of products, flexibility, and automation in the production process, the increased involvement within the value chain and not to forget; to deliver the customer what *they* want. Smart Industry is aided by a network-centric approach and focusses on the usage of data throughout the organisation. According to Engel, innovation is a major driver for the world and it 'improves economic vitality and competitiveness of communities, regions, and nations' (Engel, 2015, p. 36). Smart Industry is considered to be the next step within organisations to achieve this, and that is why it is such an exciting and relevant to research this topic (see figure 1.1 in appendix).

1.1.1 Cyber-Physical System

Throughout the literature, it appeared that the application of Smart Industry within a production company is seen as a Cyber-Physical System (CPS) (Chen et al., 2018; Lee, Kao, & Yang, 2014; Wang, Wan, Zhang, Li, & Zhang, 2016). Such CPSs are increasingly blurring the boundaries between the real world and the virtual world (Deloitte AG, 2015). It enables real-time and close interaction between the physical and cyber components. Based on the network-centric approach as mentioned before, data, sensors, and machinery can communicate with each other without too much human involvement. The system consists of three layers, namely (1) Cloud systems, (2) Industrial Networks (3) and Physical Resources. Where Cloud Systems assist downstream self-organisation and upstream supervisory control and should be capable of analysing the semantics of various data (Wang et al., 2016), the Industrial Network is the backbone of the systems architecture, providing efficient data exchange and controllability. Technologies in this layer ensure reliable communication and cooperation among equipment (Chen et al., 2018). The physical resources layer includes the assets and other machinery used in the process of manufacturing and uses the two dimensions mentioned above to gain in significance concerning quality, throughput time and many other aspects. Figure 1 gives an excellent representation of this concept (>>).

1.1.2 Smart Manufacturing

Typically, the characteristics of the challenges that Smart Industry enhances is having flexible production capacity regarding products (specifications, quality, and design), volume, timing, and resources and cost efficiencies (Saldivar, Goh, Chen, & Li, 2016; Smetsers, 2016). Therefore, it seems that the physical resources layer is connected to Smart Manufacturing (SM). SM is the vividly exaggerated and prevalent application of networked information-based tools throughout the manufacturing life cycle of a product (Randhawa & Sethi, 2017). Consultancy firms like PWC, Deloitte, and McKinsey tend to strengthen this exaggeration. They present Smart Manufacturing in such a way that in order to stay competitive, 'all companies will need to accelerate their efforts along the Industry 4.0 journey (Lorenz, Küpper, Rüßmann, Heidermann, & Bause, 2016, p. 10)".

1.2 Problem discussion

There is a vast amount of selling stories about manufacturing in a Smart Industry context (i.e. Smart Manufacturing). Most of these papers 'sell' expectations or an ideal image of the production process in larger organisations, but it may be that reality confronts this. An example of this would be for example the outcome of a survey that McKinsey has done: *"Companies expect Industry 4.0 to increase revenues by 23 percent and productivity by 26 percent (Wee, Kelly, Cattel, & Breunig, 2015, p. 16)"*. This increase, of course, is a pleasant prospect. However, there is little research done about how the Analytics, Coordination technologies and Smart Industry as a whole affect smaller organisations and how they influence manufacturing dimensions in the status quo. Even though the Dutch Business community – large and small – has mostly everything it needs in order to respond to these developments; collaboration, high ICT quality infrastructure and the fostering of innovation (Smart Industry, n.d.), it is essential to dig deeper and to see if the above-mentioned statements are indeed representative of the smaller organisations in The Netherlands. Therefore, this thesis will focus on Smart Manufacturing, which is related to the third layer of the CPS as pictured in figure 1.

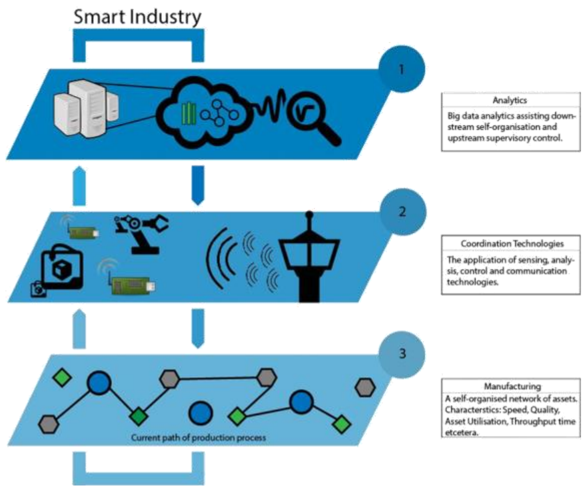

Figure 1. Smart Industry's Cyber-Physical System

1.3 The scope of this thesis

Research question: To what extent do SMEs in the Netherlands deviate from Smart Manufacturing selling stories?

These are the goals that will be tried to achieve throughout the thesis and will be assessed in the discussion and conclusion.

- Will try to challenge consultancy expectancies of Smart Manufacturing in SMEs.
- Will try to seek for the answer if Smart Industry is currently hype or reality.
- Will try to show what the impact of Smart Industry is on manufacturing processes within organisations.
- Will try to emphasise that there is a difference of impact between smaller and bigger SMEs

1.4 Outline

Now that the scope of the thesis has been defined, it may be useful to note what the structure of the thesis looks like. The first step was to review the literature that is currently available on manufacturing within Smart Industry. The theoretical framework identified the selling stories described in the problem discussion and any other relevant literature. After this, the methodology of this research is described.

To test the literature review, a research design was made which will prove the method. Then, data was collected to be able to answer the research question which was tested in the discussion. After this, a conclusion was made on the topic and the answer to the research question was given.

2. LITERATURE REVIEW

The literature review serves as the basis for the data collection and analysis. The theoretical framework that is used mainly consists of consultancy papers. The number of Consultancy firms that offer new industrial solutions has grown tremendously (Kruppa, 2016).

2.1 Consultancy literature

Most of the selling stories that are available can be found in the consulting literature. Top-consultancy firms like PWC, Deloitte and McKinsey have done extensive research in why manufacturing companies should implement the dimensions and how these influence the manufacturing practices in terms of money, speed and quality of the products. The companies that are used in their research are often quite large and big players in the manufacturing industry. Common ground in these papers will try to be found by doing a text (mining) analysis to find out the normative statements, and these statements can be challenged in the SMEs in the Netherlands.

There are **two types** of Smart Industry consultancy papers; the ones that try to sell the concept of Smart Manufacturing (on which lies the focus) and on the other hand the ones that work to shed light on the current adoption & implications of Smart Manufacturing.

What is the nature of the first type of literature? Well, they usually come in the form of white papers. In the origin, a white paper can be seen as a guide, informing readers about a complex issue. The goal of these papers is to help the readers solve a problem, make them understand the issue or to make a decision about the subject that is being addressed. These were usually shared by a government or any other authority. In the business context, the term white papers have often been applied to marketing or sales tools and are specifically designed to promote the services or products from an organisation. Acccording to G. Graham (Graham, 2010, p. 12), most white papers in business mostly have one of the following structures; 1) The product backgrounder; a deep dish about the benefits of a certain product or service, 2) the numbered list; a numbered set of tips, questions or answers about an issue or 3) the problem/solution; a persuasive essay that presents a new solution to a problem. In the particular papers that are analysed, a recurring theme is that the consultancy firms tend to persuade readers and organisations that Smart Industry, overall, has a positive effect on manufacturing processes. Thus, they mostly resemble the product backgrounder type. Usually, a common phrase is used in the form of:

- PWC: “Big Investments with Big impacts, it’s time to commit." or “The key findings we explore in the first half of this report confirm that no industrial company can afford to ignore the fundamental changes that Industry 4.0 will bring .”(Geissbauer, Vedso, & Schrauf, 2016, p. 7)
- Deloitte: “The value chain disruption will prompt players to radically rethink their way of doing business”(Wee, Kelly, Cattel, & Breunig, 2015, p. 34)
- Boston Consultancy Group: “To maintain their competitiveness, all companies will need to accelerate their efforts along the Industry 4.0 journey.”(Lorenz et al., 2016, p. 10)

These statements are (often, not always) then supported by factual numbers, which are presented in the next chapter.

2.1.1 Impact on manufacturing processes

It becomes clear that Smart Industry will change the manufacturing processes in such a way, that it is even called ‘radical’ or ‘disruptive’. Nonetheless there are also consultancy firms who think otherwise. According to McKinsey (Wee et al., 2015), the adoption of Smart Industry, or the transition towards this industry will be gradual as organisations want to carefully assess the trade-off between the benefits of introducing new technologies against the risks of the reliability of the process. Now that the expectancies of the consultancy firms are known, we move on towards what the firms think what kinds of positive effects it will have on the manufacturing processes. The findings throughout this literature add to the positive statements mentioned before.

So what are the operational impacts in the manufacturing firms in general? According to PWC (Geissbauer et al., 2016, p. 23), “companies in Japan and Germany are the furthest along in digitising internal operations and partnering across the horizontal value chain. With high investments in technology and employee training, they view their digital transformation primarily in terms of gains in operational efficiency, cost reduction and, quality assurance.”

As stated in Porter & Heppelmann (2015), if a company is not operationally effective and does not keep on adopting new practices, it will be left behind by competitors in terms of quality and costs. As reported in the research of McKinsey, organisations think they will be able to reduce quality costs by 10-20% and total costs with 30-50% (Wee, Kelly, Cattel, & Breunig, 2015, p. 25). The implementation of new technologies will enable maximum product quality which decreases the overall costs for quality checks and material usage. According to PWC, total costs will be reduced with 3.6% per annum**.**

Besides the decrease in overall costs and the increase of quality of products, operational efficiency is possibly increased. According to McKinsey, Smart Industry applications reduces inventory holding costs down with 20-50%. This can be achieved through the adoption of coordination technologies like 3D printing. “3D printing allows new production solutions” (Deloitte AG, 2015, p. 8).[1] The use of real-time data and performance measures enables reductions in dispatch costs and major efficiencies in spare-parts inventory control (Porter & Heppelmann, 2015). Besides inventory levels, operational efficiency can also be increased by decreasing the machine downtime. Sitech Services, a supplier of manufacturing services in the process industry, stated that in order to achieve less downtime for inspections and to achieve longer operating times, comprehensive databases (Big Data) are needed to analyse performance and adjust deviations (Smart Industry, n.d.).

As stated in the report of Capgemini[2] (Bechtold J, C Lauenstein, A Kern, L Bernhofer, 2014), Smart Industry also has an impact on the revenue increase of the organisation. With the use of Smart products, revenue will grow because of an enhanced user experience and because of an improved cost of ownership. These factors enhance the customer relationship and interaction. Organisations are able to offer completely new value propositions towards the consumer/customer.

[1] (e.g. functionality, higher complexity without additional cost) or new supply chain solutions (e.g. inventory reduction, faster delivery times).

[2] Capgemini is a French consultancy company with its roots in IT.

Besides the increase in value through enhanced customer relationships, SMEs established higher revenue in existing, new and foreign markets (Smetsers, 2016). McKinsey even states[3] a specific percentage, namely an increase of revenue by 23%. PWC says that organisations have increased their revenue by 2.9% annually on average – and a significant minority that expects total increases of more than 50% over five years.

This intensified customer relationship also means that Smart Industry accounts for a better match between the supply and demand of an organisation and that it can fulfil specific customer needs. According to McKinsey, Smart Industry increases this match with 85% (due to better forecasting). PWC agrees that Smart Industry accounts for a better match, but only states in what percentage of areas this happens within the organisation.

In the Smart Industry report (Smart Industry, n.d.), the importance of collaboration is clarified: "What applies to our company goes for the entire process industry in the Netherlands. We must all learn to deal with these innovations. Without collaboration in this area within the corporate world of the Netherlands, there cannot be a healthy future for our company or for the Dutch process industry. (Smart Industry, n.d., p. 45)."

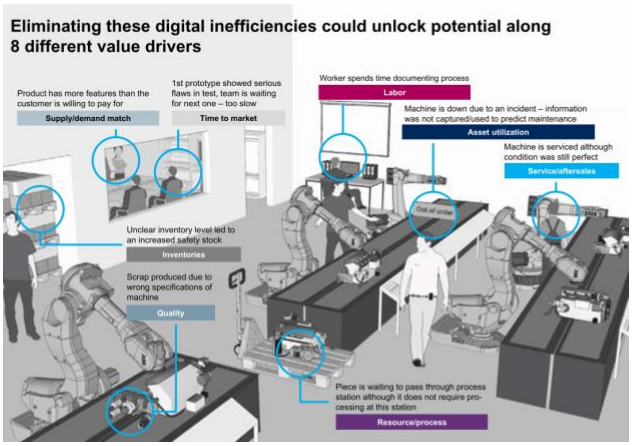

Figure 2. Smart Manufacturing dimensions & improvements (Wee et al., 2015)

2.1.2 Smart Manufacturing Strategies

Despite the massive advantages of the adoption of innovations in the production process, it still is subject to frustration within organisations. Despite significant investments and management's time, initiatives often fail or do not turn out as predicted. Successful innovators like Nokia, Yahoo, Hewlett-Packard have shown this in the past. So why is it so hard to maintain the innovation? Successful implantation goes further than just the failure to execute, namely the fact that organisations do not have or lack in the innovation strategy (Pisano, 2015).

Not only does the consultancy literature present the positive sides of Smart Industry adoption, but they also present strategy frameworks that organisations could use (see appendix for example; figure 2.1). Other organisations also propose such strategy frameworks. "Successful management of innovation takes in the entire company and covers **strategy**, organisation, project portfolio management and product development (Deloitte AG, 2015, p. 24)." In the 'Overview on External Consulting Providers Industrie 4.0 – Consulting' many propose a roadmap, strategy or framework that could be implemented when hiring them (Kruppa, 2016).

One should not just copy the system or strategy that is presented. Because plans and policies adapt towards the companies' needs and goals, it is highly unlikely that they fit all companies equally well or that it works under all circumstances. This does not mean that it is not possible to learn from others; following, for example, PWC's strategy would not imply that there would be a correct adoption of Smart manufacturing that would work within each organisation. But what should be not forgotten is that an innovation strategy (in this case Smart Industry adoption) helps organisations design a system that will match the specific competitive needs. Without one, chances of success may be lower than with having one.

2.2 Smart Manufacturing, hype or reality…

Chapter 2.1.1 presents the positive sides of Smart Manufacturing. However, it should be made clear what the hype around this subjects means; has this new revolution just started or is the implementation already becoming a reality? According to the Kvk (Smetsers, 2016), only 15 per cent of the SMEs has heard of the term "Smart Industry" in 2016. Therefore, it is possible that not many feel the urge to commit to this new industry and that the impacts of Smart Industry on manufacturing that have been described are not that big (yet). Certainly, this was in 2016, which is three years from now. There is a significant possibility that it has changed in this time.

2.2.1 Gartner's hype cycle

"Three years after the advent of Industry 4.0 as a concept it has now developed into a true hype in the manufacturing industry. Hardly any conference, think-tank or exhibition escapes the gravitational pull caused by the promise of a new industrial revolution (Bechtold J, C Lauenstein, A Kern, L Bernhofer, 2014, p. 4)"[4] The Hype Cycle of Gartner[5], is a tool to assess the hype of innovations. This is done by offering an overview of the maturity of new technologies in a particular domain. "They provide not only a scorecard to separate hype from reality, but also models that help enterprises decide when they should adopt a new technology (Linden & Fenn, 2003, p. 1)". This hype cycle is critical because it can give a picture to what extent Smart Industry is adopted throughout the world. Especially in the case of this study, the hype of consultancy can be compared to the hype of reality of SMEs.

Figure 3. Gartner's Hype cycle 2014

Above, in figure 3 we can see Smart Industry innovations placed on a chart (Big Data, 3D printing, Analytics etcetera) in 2014.

[3] In their research of 2015. See figure 3.

[4] Industry 4.0 is the same as Smart Industry.

[5] Gartner is the world's leading research and advisory company.

However, for this theoretical framework, figure 2.2 in the appendix s used as a guideline because it explains how this cycle works. This particular hype cycle only covers the early stages of technology adoption. In these early stages, the fluctuations are mostly caused by market events. Firstly, **‘The Technology Trigger’ stage** is seen as a technological breakthrough of the emerging technology. Press releases or any other events have generated interest and publicity. Secondly, **‘On the rise’** is seen as the informative stage where media explains the impacts and usage of the technology. First-generation products arise but they are expensive to make and difficult to use. Thirdly, at **‘At the peak’**, a minor part of organisations start to examine how the innovations can be adopted and how they fit within their business models. However, most still take an inactive attitude towards adoption. Fourthly, in the **‘Slide into the Trough’** stage, the emerged technology does not fulfil the media’s and organisations inflated expectations. Only certain companies and vendors (early adopters) are currently benefiting from the technology and are trying to improve the technique based on issues and feedback. Lastly, from this stage on, the slope is characterised by three different type of organisations. Type A organisations (technologically aggressive) are relatively comfortable with adopting the technology whereas Type B (moderately aggressive) organisations start to test the technology and its effects.

The more conservative organisations, Type C, remain in discomfort and are not likely yet to adopt it. At the initiation of the slope, only around five per cent of the market segment has been penetrated. This will eventually grow towards thirty per cent when it enters the later stages (Linden & Fenn, 2003).

On the one hand, we could say that Smart Industry is overhyped at the moment. Nonetheless, management within organisations should take care that they do not only invest because of the hype. On the other hand, organisations should not just ignore the technologies because they are not living up to the hyped expectations. (Linden & Fenn, 2003).

2.3 Smart Industry and size of SMEs

In chapter 2.1, it became clear how consultancy firms sell their expectations and strategies about Smart Manufacturing and what numbers are involved with it. In chapter 2.2, the background of the hype behind this subject is explained and can be further analysed in the remaining’s of this report. This section addresses the goal of identifying the difference of impact between different sizes of organisations.

According to Deloitte AG (Deloitte AG, 2015), Smart Industry requires adaption of existing installations, and sometimes even completely new structures of Information Technology. Communication networks possibly have to be developed from scratch and interconnected systems have to learn to communicate with each other. Larger manufacturing firms and multinationals take this topic very seriously and consider it of great importance. SMEs (small and medium-sized companies) however, seem to lack the consideration that they are the ones that could gain the most potential out of these new manufacturing technologies. Moreover, they can transform promptly towards this digitalisation because they can implement and develop new IT structures quite easily, because they are less complex in their organisational structure. Large manufacturing organisations on the other hand, have to deal with a greater amount of **complexity.** However, it may be that SMEs have less financial resources and run into the lack of skilled employees in comparison to larger firms. This is even called the ‘Top Challenge’ by the Boston consulting group (Lorenz et al., 2016).

2.4 The formulation of hypotheses

To fulfil the research goals, the following null hypotheses are tested (quantitatively), based on the literature review:

$H1_0$. The decreases in total costs is the same as the stated gains in the literature.
$H2_0$. The decreases in machine downtime the same as the stated gains in the literature.
$H3_0$. The gains in revenue is the same from the stated benefits in the literature.
$H4_0$. The reduction of quality costs is the same as the stated gains in the literature
$H5_0$. The decline in inventory holding costs is the same as stated in the literature.

These hypotheses are treated as so called 'null hypotheses’. These are presumed to be true, until there is statistical evidence that makes it obsolete in change for an alternative hypothesis. An example of an alternative hypothesis would be (for $H1_0$): $H1_A$. The decreases in total costs are different from the stated gains in the literature. These alternative hypotheses are developed for each an individual null hypothesis.[6]

3. METHODOLOGY

To fulfil the aims of this thesis, quantitative research was performed to collect opinions and to measure the impact of Smart Industry on the manufacturing dimensions of organisations following the consultancy literature and Gartner’s Hype Cycle. To understand this consultancy literature, desk research (through text mining analysis) was performed. This desk research was focused on publicly available data sources drawn from trustworthy organisations, institutions, and individuals. To ensure that the information gathered was not considered obsolete, as Smart Industry is a recent term, most of the sources used in the theoretical framework are not older than 2014. The sources that are older than this consist of theoretical frameworks that have been tested throughout the years, but are still relevant. Because of the practicality of this research, it is about manufacturing in organisations; the sources were not only limited to academic publications. The thesis uses scholarly papers published in renown journals like *IEEE Access*, *Harvard Business Review* and *Journal of Business Venturing*.

3.1 Conceptualisation & Operationalization

To recall, the research question is; To what extent do SMEs in the Netherlands deviate from Smart Manufacturing selling stories? To be able to answer this question, the concepts deviation and smart manufacturing stories had to be defined to be able to operationalise and measure them. The concept of smart manufacturing stories was defined as ‘the dimensions of the manufacturing process that are positively influenced’. Now we have to define the concept of deviation. This is the difference between the observed values of the dimensions and the values of the consultancy literature. For example, if the research study tells us that organisations only have 1% or even negative numbers (so a cost increase) in cost reductions, then the deviation is considerable and should be tested. To be able to measure the concepts of Manufacturing Stories it had to be operationalised. Through the text mining analysis, it became clear that manufacturing consists of the following dimensions. These dimensions were adjusted towards the ability of organisations to answer or measure these on the spot. Therefore, they did not contain difficult formulae or ratios (figure 4).

[6] A more in depth explanation can be found in section 4.1.1.

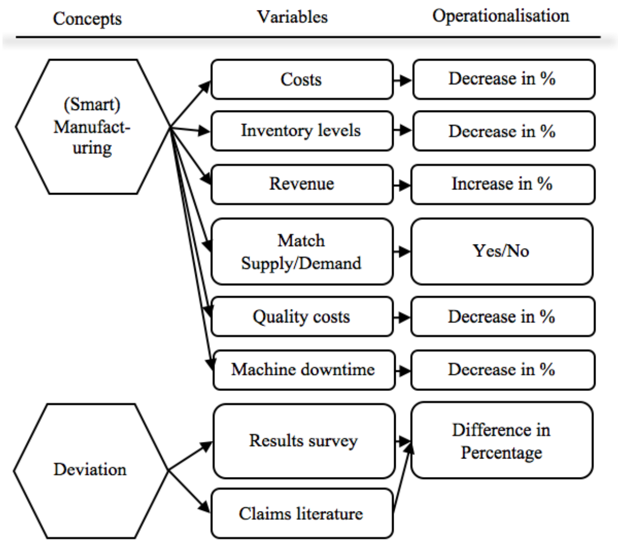

Figure 4. Conceptualisation & Operationalisation

These dimensions were measured in the status quo (so do organisations think they have already gained in manufacturing dimensions), but also in the near future (what are future possibilities?). The concept of deviation is based on these dimensions, and the amount of deviation was measured by the average difference between the percentages stated in the literature and the results from the samples of the survey.

3.2 Sampling

This particular study focuses on manufacturing organisations. The people that were asked to participate in the study were the ones with knowledge about the manufacturing process and technological solutions. Preferably these were managers that had an overview of the company and that had a sufficient knowledge background of the organisation's goals and plans. This was done with the intention to reduce the probability that individuals lack interpretations of terminology and concepts used in the study (Dew, Read, Sarasvathy, & Wiltbank, 2009). We can call this sample technique purposive sampling. This is "a type of non-probability sampling that is most effective when one needs to study a certain cultural domain with knowledgeable experts within (Tongco, 2007, p. 1)." The other inclusion criteria were that the organisation should not have more than 250 employees. The organisation should be in the area of Twente, but *for research purposes on gathering as much data as possible, the provinces outside of this region were also be taken into account.* The expert contacts were collected by calling the organisations that fitted the research and by searching for their e-mail address on the website. Moreover, we made use of a professional business network[7]. This will increase the number of respondents. In total +/- 800 companies were invited to participate in the survey. To stimulate the participants in participating in the research, they will be sent the results after the thesis has been completed.

3.3 Research Design

This research design was part of a more prominent group of researchers, which consisted of three in total. Because we wanted to see what the impact of Smart Industry is throughout The Netherlands, we agreed together to send a survey (with Qualtrics[8]) to a variety of companies. The advantages of a survey were that it was easier to target a more extensive group online than it is in real life. Online, hundreds and thousands of people regularly participate in discussions about what interests them (Wright, 2006). Moreover, online surveys allowed us to reach hundreds of people that fulfil the characteristics in a small amount of time. The disadvantages of such a survey could be that there may arise credibility issues. When selecting the experts online, we made use of superficial information. Therefore, there were undoubtedly some individuals who were more likely than others to complete the online survey due to knowledge, time or skills. Moreover, when using email to distribute the questionnaires, one could face rejections. "An unwanted email advertisement is often considered an invasion of privacy (Wright, 2006)." We noticed that the invitation gets deleted or that we got complaints from the participants that they were not interested. Besides quantitative research, attending a Smart Industry conference gave this research more depth together with collected data. Therefore, we could call this a mixed study because on the one hand, data was measured and it was compared to the numbers of the theoretical framework with SPSS[9] and on the other hand, qualitative data was used to enhance the interpretation of the quantitative data (see figure 5).

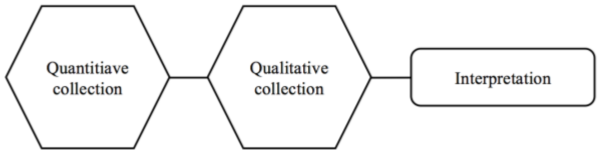

Figure 5. This research started with the quantitative research and then used insights gained in qualitative research to frame the analysis and interpretation of the research question.

To ensure that the data was kept confidential, we only shared the results connected with the company names between the three individual researchers. In the results, no private information was used, only the outcomes of the measurements were analysed. The survey specified this and respondents always had the opportunity throughout the study to withdraw from the research. Moreover, if the respondents had any questions and remarks, they had the choice to e-mail the researchers or the supervisor F. Wijnhoven at any time. To ensure that the survey was representative, we targeted for a certain amount of respondents. According to de Veaux (2015), "for a survey that tries to find the proportion of the population falling into a category, you'll usually need several hundred respondents to say anything precise enough to be useful (p. 313)". Thus, a larger sample will make our results more precise.

Therefore, we targeted for 100 organisations. As for our questions that we asked in the survey, "results depend crucially on the questionnaire that scripts this conversation (irrespective of how the conversation is mediated, e.g., by an interviewer or a computer). To minimise response errors, questionnaires should be crafted following best practices (Krosnick & Presser, 2010)." Especially within the field of Smart Industry with specific terms, it was quite difficult to make the questionnaire one hundred per cent understandable.

[7] Especially LinkedIn and personal business networks.

[8] The Qualtrics survey tool is an online-based tool for conducting studies and is often supported by educational organisations.

[9] This is software package used for interactive, or batched, statistical analysis.

However, to make it as good as possible, when making our questionnaire, we included the following best practices.[10]

1) Avoided double-barreled questions. (%). 2) Used Simple jargon for words that were difficult. 3) Avoided questions with single or double negations. 4) Short questions. 5) Avoided leading or loaded questions that led respondents toward an answer. 6) Ensured that every respondent interpreted the words/sentence in the same way.

Besides the quantitative survey, attending the Smart Industry Conference at Trade Center in Hengelo at 07/06 gave a better insight in what organisation think of Smart Industry. Speaking to multiple Executives of different organisations helped to back up or debunk the data analysis. (Baars, 2017).

A small recap: From the collected data from the conference and survey, the factors that should be captured were to what extent smart industry has an impact on manufacturing characteristics. This data could be compared to the papers of the consultancy firms, which said that Smart Industry had great influence on the capabilities of the manufacturing process, as described above. The question was if this is true for SMEs in The Netherlands. The essence was to capture the amount of hype and to compare this to the hype of the literature.

4. DATA ANALYSIS

In this part, the findings of the survey, interview and conference are displayed systematically. This is where the theoretical framework section is put to practice.

Because the values from the publication did not provide a measure of precision or uncertainty of their estimates, we cannot provide any significance of the comparisons. However, one can always compare to values. For example, 2 (A) < 7 (B), so you should expect that for group B, Smart Industry has had more impact on manufacturing than for group A. The key here is that we cannot assign too much confidence on this expectation. Because we are comparing one expectation (the selling stories) to raw data, we state the significance of the difference. Typically, in practice, the confidences are obtained from the combination of statistical model and variability of the data. Therefore, the variance of data is needed to perform a statistical analysis of the difference. Since we do not have this data, that is not possible. The survey was distributed from the 31st of May Until the 13th of June. We got 71 responses in progress, of which 21 were finished. 17 out of 21 responses were useful for the manufacturing dimensions. The other three were not filled in correctly. This is from a total sample of 800+ organisations. This means the conversion rate is 2.13%. For an overview of the participants, please look at table 1 on page 8.

4.1 Comparison of the means (status quo)

In this chapter, the means of the results are compared to the means of the consultancy literature (or 'selling stories'). First, some descriptive statistics are given, and after that, a statistical analysis will be performed. As can be seen in figure 6, five dimensions of the manufacturing process were measured by asking the organisations what impact Smart Industry had on their manufacturing process. In figure 7, the question was asked if companies saw an increase in the match between supply & demand, which was also a dimension part of the manufacturing process as defined after the literature review. Further statistics such as minimum, maximum and standard deviation per dimension can be found in the appendix table 4.1. To ensure that the same construct was measured between these questions about the manufacturing dimensions, an internal reliability test was done by using Cronbach's alfa in SPSS. The five questions asked were designed to measure Smart Industry impacts on manufacturing as a whole (figure 4). If very different answers are given to each question, respondents may have misinterpreted the questions. This reliability test is used when "(a) a researcher believes all measure the same construct, (b) are therefore correlated with each other, and (c) thus could be formed into some type of scale (Lavrakas, 2008, p. 1)." With a reliability measure of 91,6%, the internal reliability of the questionnaire is very high (table 3, page 7).

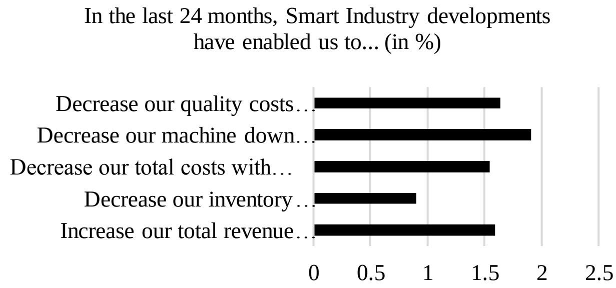

Figure 6. The impact of Smart Industry on manufacturing dimensions in percentages.

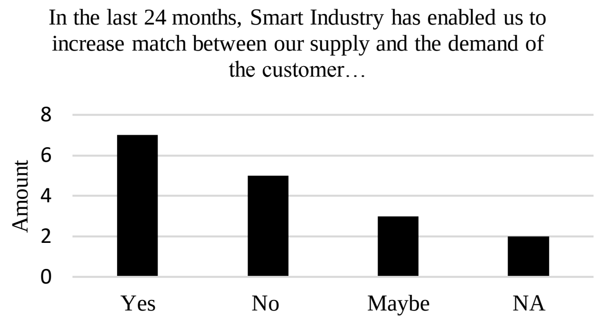

Figure 7. The impact of Smart Industry on the match between supply and demand.

Table 3. Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.916	.935	5

Now that the descriptives have been given of the manufacturing dimensions, we perform a test to compare each one with the consultancy literature to test the hypotheses. The only statistical analysis that can be performed to do this is the One-Sample *t*-Test. The One-Sample *t*-Test determines whether the sample mean is statistically different from a known or hypothesised population mean. It is a parametric test. It has several assumptions that have to be fulfilled to carry out the test (Lani, n.d.).

- ✓ The dependent variable must be continuous (interval/ratio).
- ✓ The observations are independent of one another.
- ✓ The dependent variable should be approximately normally distributed.
- ✓ The dependent variable should not contain any outliers.

[10] Questions for the questionnaire can be found in appendix 3.1.

Table 1.

Organizational and personal characteristics of respondents (N=17). No.

Size organisation	Sector	Location Twente	Other Province	Role within company
2-50	Industry	No	Friesland	Account Manager
2-50	Automotive	Yes		Owner
2-50	Industry	No	Friesland	Assistant Director
2-50	Construction Industry	Yes		Project Employee
2-50	Industry	No	Zeeland	Office Manager
2-50	Automotive	Yes		Director
2-50	Industry	No	Gelderland	Director Operations
2-50	Industry	Yes		Factory Manager
51-100	Industry	Yes		Managing Director
51-100	Industry	Yes		Manager R&D
51-100	Industry	Yes		Sales Manager
51-100	Industry	Yes		Director
51-100	Industry	No	Drenthe	Plant Manager
101-150	Industry	Yes		Commercial Director
101-150	Industry	No	Gelderland	Jr. Business Controller
101-150	Industry	No	Gelderland	CTO
151-200	Industry	Yes		Director Programs

These assumptions have to be tested. In theoretical models, money (also measured in %), can be defined as either a descriptive or continuous variable. The creator of the model and the function of the money within the model can determine this. You cannot have 0.0001 in your bank account. Therefore, in that sense, money is discrete. However, in economic studies such as estimating the wage return per demographical group, money can be seen as a continuous variable, and this works well for analysis. We assume that the observations are independent of each other, even though we selected organisations that fulfilled our inclusion criteria. The dependent variable data should be approximately normally distributed. This can be tested by making a histogram and was done for each of the five variables. Moreover, it is assured that the data does not contain any outliers to make the data as reliable as possible. "Real-world data are almost never perfectly normal, so this assumption can be considered reasonably met if the shape looks approximately symmetric and bell-shaped. (Lani, n.d.)"

4.1.1 Statistical significance

In table 2 (p. 9), we can see the performed *t*-Test for each dimension. The tested values are derived from the literature in chapter 2.1. The values taken were the lowest that were found. We determine the statistical significance, which is highlighted in grey. This is the p-value.

It gives the probability that you observe the test results (so in the study) under the null hypothesis. The lower this significance is, the lower the probability is that you will observe the tested value if the null hypothesis was right. "The cut-off value for determining statistical significance is ultimately decided on by the researcher, but usually a value of .05 or less is chosen. This corresponds to a 5% (or less) chance of obtaining a result like the one that was observed if the null hypothesis was true (Lani, n.d.)." This means when each significance is below 0.05, we can reject each null hypothesis that we stated at the end of the theoretical framework. May it be higher than 0.05, we do not reject, but accept the null hypothesis.

What does this exactly mean? Well, we have established the fact that there is a difference between the means of the manufacturing dimensions measured and the means that have been stated in the consultancy literature. For each dimension, we have two hypotheses, namely H0 and HA. Now, we choose to reject one of the two and to accept the other. Well, for hypothesis one until five, we are significantly convinced that (with 95%) the H0 can be rejected. Therefore, we accept each alternative hypothesis. To conclude, we accept the HA and reject the H0 because there is a difference between the savings in the literature and the measured results from the SMEs.

4.2 Strategy

In the survey, the question was asked to what extent organisations had an innovation/smart industry strategy or roadmap currently implemented (figure 8). Only 18% of the organisations, at the time of the survey, had this to some extent. There are quite some organisations in the sample, 35%, that have a strategy in the development phase. They are internally discussing how to put this into practice.

There are also organisations in the sample that do not have a roadmap/strategy for Smart Industry, but that do have positive influences on the manufacturing process by implementing Smart Manufacturing measures. Based on this fact, it could be that some organisations are trying to implement Smart Manufacturing, but are not focused yet on achieving certain goals with it in the overall strategy of the organisation.

Figure 8. Does the organisation currently have a strategy/roadmap implemented for the implementation of Smart Industry techniques?

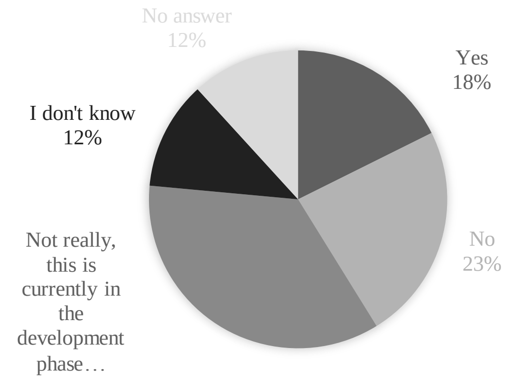

Table 2. The performed *t*-Test for each manufacturing dimension. Question: In the last 24 months, Smart Industry has enabled us to…

One-Sample Test

	Test Value = **5.8 (%)**					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Decrease total costs with	-4.241	10	.002	-4.255	-6.49	-2.02

One-Sample Test

	Test Value = **7.2 (%)**					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Increase the revenue with	-5.031	10	.001	-5.564	-8.03	-3.10

One-Sample Test

	Test Value = **10 (%)**					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Decrease quality costs with	-9.540	10	.000	-8.364	-10.32	-6.41

One-Sample Test

	Test Value = **20 (%)**					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Decrease inventory holding costs with	-11.873	9	.000	-19.100	-22.74	-15.46

One-Sample Test

	Test Value = **30 (%)**					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
The decrease machine downtime with	-26.794	10	.000	-28.091	-30.43	-25.75

4.3 Association: Smart Industry and Size

To attain the goal of comparing Smart Industry within different sizes of organisations, an association analysis was done in SPSS. The types of organisations that are tested lie within the sample. Therefore, organisations of 2-50, 51-100, 101-150 employees are examined. An association measures the strength of the relationship between two variables.

Since the variable of size is ordinal, because it is categorised and has an explicit ordering between them, and because we treat the percentages as continuous variables (see chapter 4.1), the only type of measurement of association that can be used is Eta (Kaap, 2016). "Association should not be mistaken with correlation or causality. In everyday language, dependence, association, and correlation are used interchangeably. Technically, however, an association is synonymous with dependence and is different from correlation, Association is a very general relationship: one variable provides information about another. Correlation is more specific: two variables are correlated when they display an increasing or decreasing trend (Altman & Krzywinski, 2015, p. 899)." Eta Squared (η^2) is how much variation is explained in the dependent variable by the independent variable. According to Cohen (1988), the significance is small when $\eta^2 = .02$, moderate when $\eta^2 = .13$ and large when η^2 is around .026. The results are given in table 4.

Variables	Association η^2	Significance
Quality Costs / Size	0.125	Moderate
Overall Costs / Size	0.153	Moderate
Inventory Holding Costs / Size	0.073	Low
Revenue / Size	0.327	High
Machine downtime / Size	0.075	Low

Table 4. The association between size and dimensions[11]

4.4 Future expectations of Smart Industry

Future expectations of Smart Industry seem to be substantial (figure 4.3 appendix, p. 15). Almost no organisations disagree with the statements that have been asked. This shows the relevance of the hype that is attached to Smart Industry.

Within the sample, there were some respondents (5) that did not fill in what impact Smart Industry currently had on their production process (analysed in chapter 4.1.1). However, they did answer which developments would impact their production process within five years. Compared to what they currently gain from Smart Manufacturing (which is not high, as all hypotheses have been rejected), the sampled organisations still have high expectations of implementing innovations in their production process for the upcoming 5 years.

5. DISCUSSION

This discussion will consist of argumentation. Phenomena that have become apparent in the analysis are investigated from different perspectives. Moreover, here the theoretical framework is applied in an independent matter.

The goals stated at the beginning of the research will be questioned and discussed. To recall, the goals of this research were:

1) Will try to challenge consultancy expectancies of Smart Manufacturing in SMEs. 2) Will try to seek for the answer if Smart Industry is currently hype or reality. 3) Will try to show what the impact of Smart Industry is on manufacturing processes within organisations. 4) Will try to emphasise that there is a difference of impact between smaller and bigger SMEs.

The selling stories of the consultancy literature are tested. It becomes clear that all of the hypotheses have been rejected. *Therefore, it seems that SMEs deviate quite a bit from the selling stories of the literature.* On the one hand, the numbers stated in the literature are quite unrealistic. If they would have been more conservative, like table 4.2 in the appendix, then, the H0 would not be rejected (with 95% confidence) which means that the sample, would've looked the same as the population means in the theoretical framework.

On the other hand, it could be, because the tested sample is so small, that it does not represent the SMEs in The Netherlands well. The internal reliability, as measured with the Cronbach's Alpha, is high. Therefore, the questionnaire is reliable and measures the same concepts. However, it could be that the overall reliability of the results is low. There is also a difference in practical and statistical relevance. This research has focused on statistical relevance, i.e., trying to say something about the usefulness and selling stories of the consultancy literature. However, even though it is statically significant, the practical relevance of what the real reasons are for this differences are missing. Of course, it is possible to say that employees are not skilled enough, or, that SMEs do not have the right financial resources and time. However, for now, these are just assumptions. In the survey, the question was asked if they hired consultants to implement Smart Manufacturing in the past. The majority did not do this. However, when the question was asked how likely this would be in the future, the majority said that it would be likely that this would happen in the future.

As for strategy, in the results, the majority of the organisations do not have a Smart Industry roadmap or strategy currently implemented. This could be the reason why the stated results of Smart Manufacturing are so low compared to the literature. However, because there are so many unmeasured variables that could be taken into account, we cannot say this with 100% certainty.

Moreover, is it really true that larger organisations are more successful at implementing Smart Industry techniques? Within this sample, we can say that this is not the case. The only, significantly high, association was the overall revenue. This means that the size of the organisation is positively associated to increase in revenue through Smart Manufacturing. Nonetheless, this does not ensure causality between the two variables.

Hype cycle. There is a lot of hype around Smart Industry. Because the tested organisations deviate from the means of selling stories, we also see that they are in a different hype stage. Referring back to figure 3, combined with the results, it seems as if SMEs are currently in the negative 'sliding into trough' stage.

At the attended conference (Baars, 2017), people were to be fed up with the term Smart Industry. Expectations are still very high, but the term has gotten a negative load attached to it. A lot of people at the conference said that organisations are currently in an economic upturn. SMEs are more focused on delivering their products at high speed instead of experimenting with innovations (which costs time and money). Moreover, what became most apparent in the meeting, was that almost every innovation within a company would be put under the term Smart Industry, where it would function as a 'coat rack'.

[11] The meaning of this 'significance' between the two variables is explained in the discussion.

In figure 10, this idea is represented in a graph. The deviation can be best described as pilots and deployments. It seems that the organisations tested are in the pilot stage (companies A) and the expectancies from the literature are that companies are already in the deployment stage (companies A). To bridge this gap, organisations will have to collaborate to excel in the best practices that Smart Industry brings.

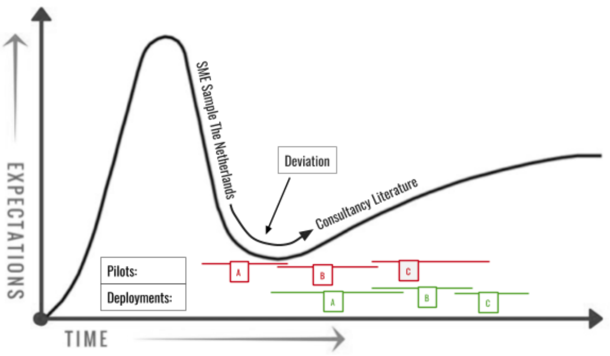

Figure 10. Deviation on the Hype Cycle

6. CONCLUSION

Now that the research goals have been discussed, it is time to answer the central research question, namely: To what extent do SMEs in the Netherlands deviate from Smart Manufacturing selling stories?

To conclude, yes, small to medium sized firms in The Netherlands deviate from the selling stories.

To what extent do they deviate? Well, they deviate to the extent that each null hypothesis in the One-Sample *t*-Test has been rejected. This means that the sample of organisations researched does not look like the selling stories of the tested population in the literature.
Dutch SMEs tend to currently be in the pilot stage, moderately testing the capabilities of Smart Manufacturing, but not adopting it too much yet, whilst the selling stories expect that Smart manufacturing techniques are already deployed readily, by group A companies, throughout the manufacturing process.

The impact on manufacturing is currently quite low because they are focused towards the increased revenue and keeping costs low. They currently do not do this through innovating, but do this by making use of the demand that there currently is because of an economic upturn. Within the next few years, organisations will start to adopt Smart Industry practices more and more because they will have to show their competitive advantage to the consumers when times are not as good as they currently are.

7. LIMITATIONS AND FURTHER RESEARCH

The goals of this research have been attained. However, there were limitations in this research that have to be addressed. The primary limitation of this research is sample size. If the sample size is too small, it will be difficult to draw significant relationships from the data. On the one hand, the data did not propose any serious implications as it was possible to carry out a statistical test. On the other hand, it was not sure how valid this data was. In other words, if it was representative for the group that was tested. It is possible that the sample that was used is unique in its characteristics. Nonetheless, because the data is backed up by qualitative opinions, I think that the right aspects were measured and that there indeed is an exaggeration in the literature.

The reason why this sample was smaller than anticipated, consists of three factors. Firstly, time constraints. Because we (as a group of three researchers), started too late with collecting data and focused too much on the research proposal, the timeframe for the collection was quite short. This, paired with the fact that we had not accounted for the fact that organisations do not answer that quickly, or are difficult to reach. This also had to do with the fact that there has been introduced a new law regarding privacy data customers. Lastly, because the research was initially focused on organisations in Twente, the scope was quite limited, making it difficult to collect data efficiently. Therefore, we changed the subject area from Twente to The Netherlands during the research.

There are multiple ways to solve this in the future research of this subject, namely to give an incentive to answer the questionnaire, to start earlier and to target a broader audience. If the answer rate of the questionnaire would be the same, targeting a larger audience would increase the absolute number of completed surveys.

Besides practical limitations, there were also some theoretical limitations. The amount of theory on Smart Industry is quite large. However, the amount of consultancy theory is quite low, and the theoretical framework mainly consists of papers by the consultancy firms themselves. A critical investigation of this is quite new, and therefore this thesis could have the ability to open up a new field of research.

Smart Industry is a vital and alluring subject. Now it is known how far the organisations are in adopting this practice (or at least, at what stage they are in the hype cycle). Further research could focus more on this subject and can try to replicate this study with a bigger sample size. Besides, a more important question is how organisations can implement these new techniques successfully if they are struggling with it. The consultancy literature, selling stories, does not only provide exaggeration, but it also presents beneficial concepts that organisations could use. Research could therefore also focus on making this gap smaller.

An example of such a research question could be:

How to successfully gap the bridge between hype and reality of Smart Industry in The Netherlands?

8. ACKNOWLEDGEMENTS

This thesis is written by one student and is part of a more substantial research. What was written is the outcome of 3 months of research with a freely chosen topic in the field of Smart Industry in the domain of Business Administration. The intention is to broaden the knowledge about this exciting innovation topic which is, for now, still quite ambiguous.

I want to acknowledge the help, knowledge, and support from my tutor and examiner Fons Wijnhoven. Besides, I want to thank my other examiner Raymond Loohuis. My gratitude also goes to all the survey participants that helped me to collect the empirical material of this thesis as well as to Petra Deterink from VMO[12] who has supported the distribution.

Moreover, I want to thank all the people that attended the Smart Industry conference in Hengelo on the 7th of June. Talking with you has helped tremendously on gaining insights on this subject and has assisted to better interpret the data analysis and results.

Lastly, I want to thank my proofreaders and colleagues for bringing this research to a success.

[12] Verenigde Maakindustrie Oost

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10. APPENDIX

Figure 1.1. Smart Industry's effect on society and industry

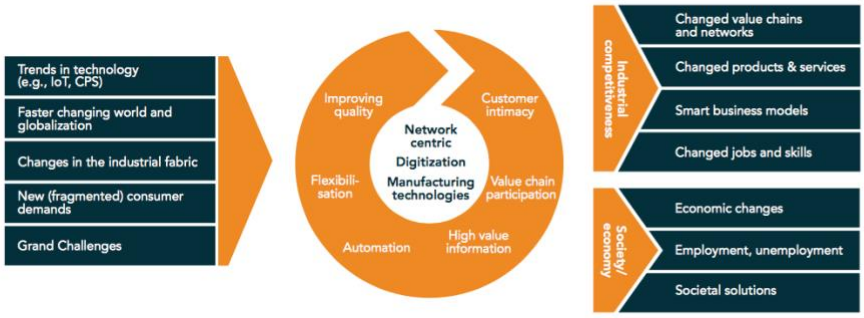
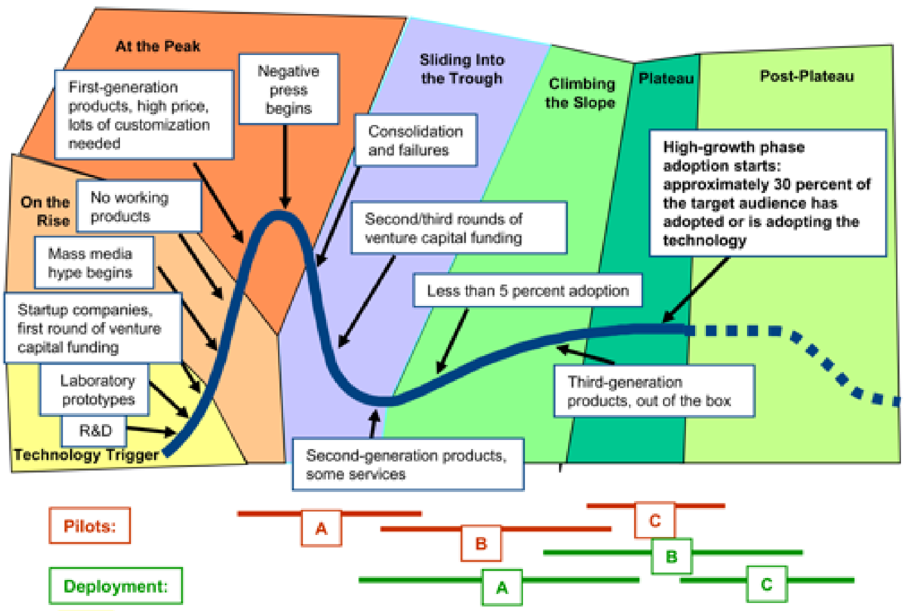


Figure 2.1. PWC's Smart Industry roadmap

Figure 2.2. Gartner's hype cycle explanation



3.1. Survey questions

1. Does the organisation have a roadmap/strategy for the implementation of Smart Industry techniques?
   - Yes
   - No

Comment for the following questions: Minus is also possible if it was counterproductive
2. In the last 24 months, Smart Industry developments have enabled us to increase our total revenue with (in %)...
3. In the last 24 months, Smart Industry developments have enabled us to decrease our inventory holding costs with (in %)...
4. In the last 24 months, Smart Industry developments have enabled us to decrease our total costs with (in %)...
5. In the last 24 months, Smart Industry developments have enabled us to decrease our machine downtime with (in %)...
6. In the last 24 months, Smart Industry developments have enabled us to decrease our quality costs with (in %)…

7. In the last 24 months, Smart Industry developments have enabled us to increase the match between our supply and the demand of the customer...
   - Yes
   - No

8. In the next 5 years, Smart Industry will help us to achieve the following developments even more... (totally disagree – totally agree)

• An increase in total revenue
• An increase in quality of our products
• The match between (your) supply and demand of the customer
• A decrease in machine downtime
• A decrease in inventory levels
• A decrease in total costs of the production process

9. Have you had consultants help you with implementing/designing Smart Industry techniques within your organisation in the past?

10. How likely is it that consultants will help you with implementing Smart Industry techniques in the future? (Highly unlikely – Highly likely)

Table 4.1. The measured dimensions of impact on manufacturing

	Increase Revenue	Decrease Holding Costs	Decrease Total Costs	Decrease Machine Downtime	Increase Quality Costs
Mean	1.64	.90	1.55	1.91	1.64
N	11	10	11	11	11
Std. Deviation	3.668	5.087	3.328	3.477	2.908
Minimum	-5	-10	-2	0	0
Maximum	8	10	10	10	8

Table 4.2. Realistic values

Variable tested	Realistic percentages
Machine downtime	4.25%
Revenue	4.1%
Total costs	3.78%
Quality cost	3.59%
Inventory holding costs	4.54%

Figure 4.3. Expectations of Smart Industry the upcoming five years.