Is there a Common Trend in Innovation Project Portfolios for Innovative Firms in the Netherlands that Is the Same for all Business sectors?

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ABSTRACT,
The field of innovation management research focusses on the marketing advantages of Innovation, and the firm performance due to innovation, this paper takes a closer look at the firm level. The firm level of innovation research looks at what traits make an innovative organization, what policies they have to foster innovation, how they innovative, and what for effect it has on their performance. This research paper is about the innovation project portfolios that innovative companies in the Netherlands develop over the years. Having a diverse portfolio is always considered as a good way of doing business, but is that actually the case? And is it the same, no matter what line of business you are in? This paper goes deeper into the standards and patterns in innovation portfolio management. The process of recognizing patterns is one of many steps. First the projects have to be classified in different types of innovation, and then investigated for a trend that connects them in a coherent portfolio. After that this paper compares different business sectors to see if they have the same innovation trends or if there are significant differences between them. Together with two other Bachelor students we worked hard to classify these projects and get to know more about the inner workings of innovation project portfolios. Then we each used this work for our own research, and this paper is the result of choosing the direction of innovation project portfolio trends and business sectors.

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1. INTRODUCTION

"The Study of innovation hardly needs justification as scholars, policy makers, business executives, and public administrators maintain that innovation is a primary source of economic growth, industrial change, competitive advantage, and public service." (Damanpour, Walker, & Avella, 2009)

"Firms innovate in a number of ways, including business models, products, services, processes and channels to maintain or capture markets, to outdistance competitors, and to assure long-term growth and survival, especially in highly complex and turbulent environments." (Siguaw, Simpson, & Enz, 2006, p. 556)

These two quotes show the significance to study and understand innovation and all that comes with it. As well as that they underline the need businesses experience for innovation, and how much time, money, and effort they invest in it. For the research part into innovation there are two main directions in research of innovation according to Subramanian & Nilakanta (1996):

1. Understanding the causes of innovative behavior of consumers, the individual level. Consumers who show a consistent tendency to buy new and innovative products are the target of this direction, because they are believed to be opinion leaders, influencing buying behavior. This direction is therefore more aimed at marketing practices. (Subramanian & Nilakanta, 1996)
2. The other direction is at firm level, and more present in the area of organizational theory and strategic management. This direction is aimed ad organizational characteristics of innovative organizations, what they do to innovate, which types of innovation they adapt, and the effect it has on their performance. (Subramanian & Nilakanta, 1996)

This paper will continue in the second research direction mentioned above. The scope is the types of innovation that firms adapt, and how they combine in a portfolio. Finding the balance within a portfolio of innovation projects is one of the challenges that strategy-makers face, due to the implications of these innovation types. An example of these implications can be found in the paper by Benner & Tushman (2003), here the balance is sought between short-term innovation projects and long-term innovation projects to keep their firm in business. More examples and implications will be discussed later.

To better understand innovation projects, innovation types, how they relate to one another, and if it is useful to balance that portfolio in some way has been a trending topic in research in the last decade(s) (Baker & Sinkula, 2007; Garcia & Calantone, 2002; Meifort, 2016). It is beneficial to have a balanced portfolio, according to Kleinschmidt et al. (2008). The habit of companies to study what balance in portfolios is common, and useful, is called portfolio mapping. Portfolio mapping leads to improvement in the following:

- New product success rate is higher with innovation portfolio mapping;
- Alignment with strategic objectives is improved with innovation portfolio mapping;
- Having high value projects in the portfolio strengthens the competitive position;
- Existing technologies and technological competencies are better known to the organization with innovation portfolio mapping.

The use of practices such as portfolio mapping methods result in a better balance in the innovation project portfolio (Killen, Hunt, & Kleinschmidt, 2008). This means that it is not just interesting to get an overview of the innovation project portfolio, but also beneficial to improve the current strategy of firms.

Many researchers have already attempted to deliver the best practices for balancing an Innovation Project Portfolio such as Garcia & Calantone (2002), Baker & Sinkula (2007), Killen, Hunt, & Kleinschmidt (2008), Peters, Schneider, Griesshaber, & Hoffman (2012), Dahlin (2014), and Meifort (2016). This list will keep expanding into the future, as more research continues to be done into the topic of innovation.

It is often the case that a certain product is the dominant design in a market. For innovation portfolios this works similar (Damanpour, Walker, & Avella, 2009; Suarez & Utterback, 1995; Allred & Swan, 2014). According to Damanpour et al. (2009) Portfolio mapping is the first step towards setting the dominant design or adapting to it, just as is the case with a dominant design for a specific product or process. Whether a company wants to adapt to the dominant design depends on the companies' strategy but realizing in what the firm differs from other firms is knowledge that can be used to assess one's position compared to competition (Damanpour, Walker, & Avella, 2009).

This leaves a research opportunity to explore whether different sectors have a different (dominant) balance in their innovation portfolio that arises from the specific market, industry, or sector they are in. This can have several causes. To name a few:

- Shorter product life cycles may require more incremental innovations (Restuccia, Brentani, Legoux, & Ouellet, 2016).
- Low protectability of technology and research may cause a reduction in larger or radical innovations (Andrade, Urbina, Follador, & Follador, 2016).
- General innovativeness levels of firms

Several papers have attempted to look at different sectors, but they often focus on a limited number of economic sectors and/or very specific businesses (Suarez & Utterback, 1995; Oke, Burke, & Myers, 2007; Madrigal-Sanchez & Quesada-Pineda, 2012). When they do look at a larger number of sectors and/or business types, they base their research on a limited number of innovation types and/or typologies and do not take the time-dimension into consideration (Jong & Vermeulen, 2006; Laforet, 2013).

This paper has the goal to create a clear overview of the most common trends/patterns in innovation project portfolios in a business setting, based on different typologies of innovations that will be explained in the next section. Trends and patterns will be terms used interchangably throughout this paper.

Then this paper will explore whether business sectors deviate from the dominant pattern in innovation portfolios, and if there is a most common or go-to trend within each sector. This should give an onverview of the differences between business sectors and their innovation efforts. The results should be helpful for firms in the sense that they know whether their innovation efforts are in line with the standard of their business sector, or if they deviate from it, and run the risk of failing.

This means that this paper will not deliver a plan of several steps to become succesful innovators, but it tries to identify the standard for different sectors, and to what is to the expected trend to be found in the different business sectors. Companies can use this information to anticipate the flow that their industry is in. What is meant with business sectors, is a more specific categorization than generalized sectors such as categories like "private-public", or "Goods-producing, Service-producing", but less precise than for example: "primary woodworking and crafting of products made of wood, cork, cane, and basketry not including furniture" (Centraal Bureau voor de Statistiek, 2018). For this, multiple typologies of innovation project portfolios will be used, because some typologies may not show the whole picture of what is going on and using multiple typologies may uncover different angles (Garcia & Calantone, 2002; Henderson & Clark, 1990). With the most common trend, the dominant design that was previously described by Suarez & Utterback, (1995) and Damanpour, Walker, & Avella, (2009) is intended, and will be used substitutedly in this paper.

The business sectors and the innovation typologies will be further explained in the next section.

2. THEORY

2.1 Innovation Typologies

2.1.1 Typologies in the field of innovation research

In the field of innovation research there is a wide variety in what are in a substitutable use called distinctions, categories, or typologies of innovation (Garcia & Calantone, 2002). This paper will mainly use the term typologies. In the critical review paper of innovation research, Garcia & Calantone (2002) summarized the different typologies up to that point in time with the following summation:

8-category:

- Reformulated/new parts/ remerchandising/ new improvements/ new products/ new user/ new market/ new customers

5-category:

- Systematic / major / minor / incremental / unrecorded

4-category:

- Incremental/modular/ architectural/ radical
- Niche creation / architectural / regular / revolutionary
- Incremental / evolutionary market / evolutionary technical / radical
- Incremental / market breakthrough / technical breakthrough/ radical
- Incremental / architectural / fusion / breakthrough

3-category:

- Low innovativeness/ moderate innovativeness/ high innovativeness
- Incremental/ new generation/ radically new

2-category:

- Discontinuous/ continuous
- Instrumental/ ultimate
- Variations/ re-orientations
- True/ adoption
- Original/ reformulated
- Innovations/ reinnovations
- Sustaining/ disruptive
- Really new/ incremental
- Breakthrough/ incremental
- Radical / Incremental

As Garcia & Calantone (2002) state, but also others such as Damanpour, Walker, & Avella (2009), Allred & Swan (2014), Dahling (2014), and Schilling (2017) express that classifying innovations is an ambiguous and relative process. The typologies are not independent, mutually exclusive, or separate from one another. "*The same innovation can be labeled on either ends of the scale of innovativeness depending on the researcher. This ambiguity in classification schemas makes it impractical, if not impossible, to accurately compare research studies.*" (Garcia & Calantone, 2002, p. 118)

Even though Garcia & Calantone summarized a decent number of typologies, they did not include all typologies that can be found in innovation literature. Sometimes because they deemed them to be the same as others, sometimes because they did not fall within their scope of analysis (Garcia & Calantone, 2002).

Some typologies that were either missed or developed after the critical reflection paper of Garcia & Calantone, but are predominant in modern research are the following dichotomies:

- Explorative versus exploitative innovation (Benner & Tushman, 2003; Jansen, Bosch, & Volberta, 2006; Andriopoulos & Lewis, 2009; Dahlin, 2014). Explorative innovations are innovations that aim to reach emerging markets and customer segments, and are often radical or architectural innovations. Exploitative innovations are aiming to improve existing products for current customer sets, through more incremental or modular innovations.
- Competence enhancing versus competence destroying (Schilling, 2017). Similar to

incremental versus radical, but with a focus on the knowledge required for an innovation. An innovation is competence enhancing, when an existing product, process, etc. is improved and new knowledge and skills are created additional to the existing knowledge and skills, where competence destroying innovations are created based on new/different competences, making the previous competences obsolete.
- Market-pull versus technology-push (Boddy, 2014; Peters, Schneider, Griesshaber, & Hoffman, 2012; Nemet, 2009). This typology focusses on the origin of the innovation. Whether it whas a technology developed in scientific fields that can be used in a new or enhanced product, process, etc. or if it was a need from the market for a novelty.

Although these typologies above might have the given terminologies, they can still be the same typology as one that is phrased differently. In the last typology stated above, market-pull is also sometimes called demand-pull, where technology-push is sometimes called science-push. But when examining the terminology used to describe a typology, and then assuming that typologies are the same even though they have different terms is a risk. The different terms are often in place on purpose to better characterize a certain scope or setting of research (Allred & Swan, 2014).

2.1.2 Typologies used in this Research Paper

For this paper that will look at the innovation portfolios of firms in different business sectors, several of the typologies described in the review paper by Garcia and Cantalone, but also others that were either developed after publishing of this paper, or that did not fall within the scope of that paper will be used. Below is the set of typologies that will be used:

- Explorative/exploitative
- Incremental/Modular/Architectural/ Radical
- Technology-push/Market-pull
- Product/Process

The next sections will explain why specifically these, and why there is a difference to be expected between the business sectors within these typologies.

2.1.2.1 Explorative/Exploitative

The first typology is the Explorative versus Exploitative innovation typology. A difference in portfolio is expected between business sectors within this typology When a firm includes both these types of innovations in their innovation portfolio, they will be termed an Ambidextrous firm (Benner & Tushman, 2003). According to Benner and Tushman it is important for firms to strike a balance between explorative and exploitative innovations, explorative to keep the firm afloat long-term, and exploitative to keep it running short-term. But it is not easy to have two so contradiction innovation types in a portfolio. According to Benner and Tushman (2003) companies either must strictly departmentalize the explorative activities into Research and Development (R&D) departments, apart from departments focusing on more incremental innovations, or the company must be able to switch between different organizational designs to support both innovation types.

Ambidextrous organizations must manage explorations-exploitation tensions to experience the benefits of their ambidexterity (Andriopoulos & Lewis, 2009). There are specifically three types of tensions:

- Strategic intent: they must balance profit emphasis and breakthrough emphasis. Meaning that they must balance stable revue and resource allocation for efficiency, with reputation building and risk-taking for long-term adaptability.
- Customer orientation: they must balance tight coupling with loose coupling. Meaning that they must balance fostering client satisfaction and loyalty through project goal achievements and clients' requirements helping projects to fulfil market needs, with probing new products/technologies for future opportunities and ongoing experimentation to extend the firms knowledge base.
- Personal drivers: they must balance discipline with passion. Meaning balancing well-defined development process to empower contribution, targets to encourage execution, and explicit roles to enable functions, with the personal expression, challenges, and pride to motivate knowledge workers' creativity.

Expected is that different business sectors strike different balances in their portfolio, creating different patterns over time. This is depending on the dynamism and competitiveness of the business sector. More competitive sectors require more exploitative innovations to stay afloat in the short-term, while more dynamic and changeable sectors require more explorative innovations to be prepared for the uncertain future (Jansen, Bosch, & Volberta, 2006).

Achieving the balances between exploitative and explorative innovations and the practices to enable them might be different in different industries. With the following hypothesis:

H1: *A difference is expected in the pattern that the Explorative / Exploitative innovation portfolios form between the different business sectors.*

2.1.2.2 Incremental/Modular/ Architectural/Radical

This typology of innovation has evolved from the dichotomous typology of radical incremental, so I shall explain those first. In the paper by Henderson & Clark they are described as follows:

- Incremental Innovation: introduces relatively minor changes to the existing product, exploits the potential of the established design, and often reinforces the dominance of established firms.

- Radical Innovation: is based on a different set of engineering and scientific principles and often opens up a whole new markets and potential applications.

In so far, these two are very similar to exploitative and explorative. But Henderson & Clark wanted to expand on the radical/incremental typology because this typology "*Provides little insight into the reasons why such apparently minor or straightforward innovations should have such consequences. In this paper we develop and apply a model that grew out of research in the automotive, machine tool, and ceramics industries that help to explain how minor innovations can have great competitive consequences"* (Henderson & Clark, 1990, p. 10)

The two added types as formulated by Henderson & Clark (1990) of innovation are then:

- Architectural: innovations that change the way in which the components of product are linked together, while leaving the core design concepts untouched.
- Component: a component is defined as a physically distinct portion of the product that embodies a core design concept and performs a well-defined function

The underlying thought here, is that successful product development requires two core types of knowledge, continuing in the formulation of Henderson & Clark (1990):

- Component knowledge, knowledge about each of the core design concepts and the way in which they are implemented in a particular component
- Architectural knowledge, knowledge about the ways in which components are integrated and linked together in a coherent whole.

From this a framework can be constructed to define innovation using this typology:

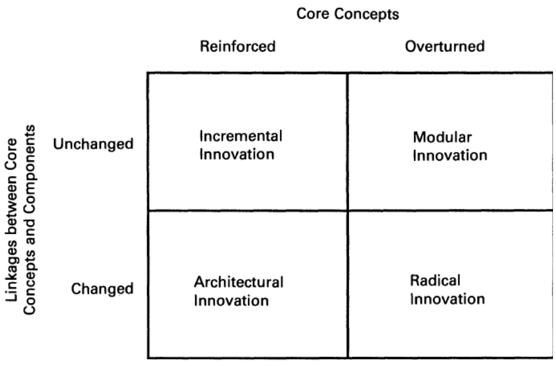

Figure 1 - innovation types matrix (Henderson & Clark, 1990)

The different with the previous typology is now clear, but that still means that they overlap. The main difference here is that the previous typology of explorative/exploitative focusses on the difference between short-term and long-term innovations of a firm, and this one is more concentrated on the actual build-up and impact on the existing structure and/or products of the innovation itself. The component innovation type is used interchangeably with modular innovation, Henderson & Clark (1990) also used these interchangeably already.

A difference between the business sectors is expected based on the nature of the goods and/or services that are produced in the sector. With more stable business sectors the innovations tend to be more incremental (Brem & Voigt, 2009). More complex sectors tend to have more architectural and modular innovations (Mlecnik, 2013). Business sectors that are dynamic tend to have more radical innovations (Jansen, Bosch, & Volberta, 2006).

The resulting hypothesis based on this typology is:

> H2: *A difference is expected in the pattern that the Incremental / Modular / Architectural / Radical innovation portfolios form between the different business sectors.*

2.1.2.3 Technology-push/Market-Pull

The previous two were both about the impact of the innovation on the existing structure and on the future of the organizations, for example whether an innovation would help the firm short-term by further exploiting a market by incrementally improving a product. But this typology is about the source of the innovation.

In (Nemet, 2009) there is a definition stated for technology-push (p. 701): *"The core of the science and technology-push argument is that advances in scientific understanding determine the rate and direction of innovation."* That continues later with: *"The availability of exploitable "technological opportunities" plays a role in determining the rate and direction of innovation, and that these may depend on the "strength of science" in each industry ... Firms must Invest in scientific knowledge to develop their "capacity to absorb" knowledge and exploit opportunities emerging from the state-of-the-art elsewhere."*

The definition of the market-pull, or as it is called in this paper, the demand-pull type of innovation is somewhat shorter: *"Demand drives the rate and direction of innovation. Changes in the market conditions create opportunities for firms to invest in innovation to satisfy unmet needs."* (Nemet, 2009, p. 701)

Originally these were not a typology together, they were both a theory to explain the origin of innovation. Critics said that the technology-push side did not take market conditions into account, while the market-pull side did not take technological capabilities into account. This is the reason that they are now a typology, describing the sources for innovation, besides the drive of organizations to survive.

The paper by Brem & Voigt (2009) and Török et al. (2018) illustrates the expectations that this typology will strike a differently balanced portfolio in different sectors. The paper by Brem & Voigt (2009) focusses on the software industry in Germany, where the technology-oriented attitude of a firm is critical to success, because software is a product-type that often has entirely new paradigms and/or methods behind them, that follow one another in rapid succession. This business sector is thus mainly Technology-Push (Brem & Voigt, 2009).

Opposed to the Software industry in Germany, the food and beverage industry in Hungary (and the European Union) is mostly reliant on market-pull innovations (Török, Tóth, & Balogh, 2018). According to Török et al. (2018) this is due to low R&D spending, and external impetuses.

For organizations to use this typology to the benefits of their own innovation process, organizations should have monitoring policies in place. They should monitor the market to find innovation opportunities in the changing needs and demands of the market place -domestic and foreign- (Jansen, Bosch, & Volberta, 2006). The same goes for monitoring of the technological environments, -domestic and foreign-. Additionally, here it is advisable for organizations to monitor in countries that have more (public) funding for science and technology (Jansen, Bosch, & Volberta, 2006). What should be kept in mind with Jansen et al. call "domestic technology-push policy funding in a technological field", is that when funding starts there is no immediate result, because innovations often follow the s-curve (Schilling, 2017) and does not immediately appear after funding has started.

The hypothesis resulting from this:

> H3: *A difference is expected in the pattern that the Technology-push / Market-pull innovation portfolios form between the different business sectors.*

2.1.2.4 Product/Process

After having looked at the origins of innovations, the specific intensity to the structure of innovations, and the orientation of the innovation towards short-term and long-term survival, one essential dimension to innovation portfolios remains.

The OECD Oslo manual (2005) comprised a typology with four categories: product, process, marketing, and organizational innovations:

- Product: The introduction of a good or service that is new or significantly improved regarding its characteristics or intended uses, including significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristic (European Commission, 2005).
- Process: an innovation of the delivery and/or production method. This includes significant changes in techniques, equipment and/or software (European Commission, 2005).
- Marketing: the implementation of a new marketing-method involving significant changes in product design or packaging, product placement, product promotion or pricing (European Commission, 2005).
- Organizational: the implementation of a new organizational method in the firm's business practices, workplace organization, or external relations organizational innovations have a tendency to increase firm performance by reducing administrative and transaction costs, improving work-place satisfaction (and thus labor productivity), gaining access to non-tradable assets (such as non-codified external knowledge) or reducing costs of supplies (European Commission, 2005).

For this paper the last two categories of this typology are not usable since it is about innovation projects, which have beforehand been labelled product or process by the firms in the dataset, but normally all four can be included in a diverse innovation portfolio. (Gunday, Ulusoy, Kilic, & Alpkan, 2011)

A difference in balance between the two above can be expected due to the fact that some industries are more mature compared to some of the newer industries around that are not as established yet. More matured industries tend to have more process innovations while newer industries tend to focus on product innovations (Allred & Swan, 2014).

But with the limited number of categories mentioned above in mind the following hypothesis can be formulated:

> H4: *A difference is expected in the pattern that the Product / Process innovation portfolios form between the different business sectors.*

2.2 Innovation Project Portfolios

Just like companies can have an investment portfolio, they can also have innovation project portfolios in a metaphorical way. These portfolios are aimed at specific goals to improve the competitive position of the firm (Damanpour, Walker, & Avella, 2009). In general, there is consensus in the literature that it is beneficial for the performance of firms to have a diversified portfolio (Garcia & Calantone, 2002). Not to spread the risk of losing money like is the case in an investment portfolio, but to spread the risk of missing opportunities in the long-term/short-term, in their product specifications, in their (potential) market(s), or internally (thinking of process or organizational innovations) (Killen, Hunt, & Kleinschmidt, 2008).

An innovation Project Portfolio can only show one typology at the same time, so for every Hypothesis there will be a sperate sub-portfolio. But this offers the opportunity to take a step back and compare Innovation Project Portfolios from different angles.

Because the data contains projects over time, the portfolios will be described in trends/patterns, to take into account the time dimension, but still display the direction of the portfolios.

As already said in the introduction, dominant designs occur in products as well as in innovation project portfolios (Damanpour, Walker, & Avella, 2009; Suarez & Utterback, 1995; Allred & Swan, 2014).

The next section will explain for what kind of categories of economic activities this paper will try to map these kinds of dominant design trends, as well as their differences and/or similarities across categories.

2.3 Business Sectors

For the categories of economic activities, preferably the Dutch version of the Standardized Industry Code (SIC) would be used, namely the "Standaard BedrijfsIndeling", from now on the (SBI).

This categorical system would fit well because the scope of this study remains on companies based in the Netherlands. Although categorical systems that are used internationally could be used too, below will be explained why the SBI is more suitable.

The SBI is a hierarchical layout of economic activity that the Dutch Central Bureau of Statistics uses to divvy up business-units into their main activity, so that they can use them for statistical purposes. (Centraal Bureau voor de Statistiek, 2018)

Every Dutch company is registered with an SBI-code, that consists of 5 digits. These 5 digits are built up in a certain way:

- The first 2 digits are taken from the International Standard Industrial Classification (ISIC), which is the World Standard set and required by the United Nations. This means that even though the SBI is only used in the Netherlands, it still incorporates a worldwide standard.
- The third and fourth digit are taken from the "*Nomenclature des Activités économiques des Communautés Européennes*" (NACE), which is the European's requirement of further detailing for all European Union member states' businesses. Although required, this still means that these Dutch firms, and this study can be compared with international settings and studies. The current NACE version in use is the NACE rev 2 (Eurostat - European Commission, 2008).
- The fifth digit is an extra split between categories of economic activities for national and statistical use, that is specific for the economic environment of the Netherlands.

(Centraal Bureau van de Statistiek, 2018)

Every year the SBI-list is edited on the 1st of January to adapt to new categories of economic activities that were previously not included, either because it did not exist yet, or it was not big enough to be a category on its own. (Centraal Bureau van de Statistiek, 2018)

Using the SBI allows this paper to analyse the innovation project portfolios and the dominant design through categories or category-groups on different levels based on the data that is used, whichever seems to be more appropriate.

Unfortunately, the SBI information is not accessible for the duration of this study. That is why for the firms used in the dataset, this study will use the second-best option, namely the NACE rev 2. This European Union standard is already quite specific, and usable for the types of economic activities conducted in (the Netherlands and other) knowledge-based economies (Eurostat - European Commission, 2008). There are some drawbacks to this industry coding system. For example: it was constructed in 2008, so it has not been regularly updated, but since it is still somewhat broad that should not be a problem for this paper. It works with 21 Sections, split further into 99 divisions. The full list can be found in Appendix 1. Depending on the usability of the data, a decision will be made whether to use the 99 divisions or the 21 broader sectors. Preferably the 99 divisions would be used, but this paper has a limited time-frame, and the data might not suffice for this number of divisions. Otherwise the 21 sections will have to do to still deliver useful conclusions.

3. METHODOLOGY

3.1 Hypotheses

To sum up the hypothesis once more:

> H_1: *A difference is expected in the pattern that the Explorative / Exploitative innovation portfolios form between the different business sectors.*
>
> H_2: *A difference is expected in the pattern that the Incremental / Modular / Architectural / Radical innovation portfolios form between the different business sectors*
>
> H_3: *A difference is expected in the pattern that the Technology-push / Market-pull innovation portfolios form between the different business sectors*
>
> H_4: *A difference is expected in the pattern that the Product / Process innovation portfolios form between the different business sectors.*

These hypotheses will be tested in a quantitative matter based on empiric data retrieved from the Bachelor Thesis Supervisor Matthias de Visser. The patterns that the innovation portfolios show, combined with the NACE rev 2 code will show what the dominant pattern in in each business sector, and whether there are significant differences between these sectors.

3.2 Measures

3.2.1 Dependent Variables

The "portfolios" as they have been called previously are collections of projects. The problem with the data is that these projects are often (several) years apart and are not measurable at specific points in time as one whole portfolio. For this paper to still contribute to the literature on innovation project portfolios, the portfolios will be categorized based on patterns that occur through these projects over time. The patterns are specific for every typology, since a dual typology will not have the same amount and sorts of patterns as a typology with 4 types. But before the patterns will be described, it will first be explained how the data was classified.

3.2.1.1 Manual Data Classification: Selection

The project descriptions that are used, are classified independently by at least 2 researchers, and later checked and commented on. Then they are discussed until consensus is reached, all to increase the validity of the data. There were 3 researchers working on this that preferably all went over every case, but most of the time it was 2 people. There were 3 groups of data, which are classified based on the first three portfolio-typologies described before, since the Product/Process typology was already given. First a selection of 179 projects was made of the portfolios of several companies, to get an idea of the portfolios, what they looked like, and how they were spread over time. Out of uncertainty and inexperience the cases that were software-projects were removed, decreasing this dataset to 151 cases. This was done because the software replaced product or process in the column that already provided that typology but was later determined to be a product.

Then another 150 projects were selected at random to train a text-mining machine to classify the remaining number of projects. These 150 cases were not enough so another set of 109 random projects was selected and classified to give the machine more materials to base its classifications on.

3.2.1.2 Manual Data Classification: Results I

The first time the first group consisting of 151 projects was classified there was a very low agreement rate (exploitative/explorative: 50.33%, Incremental/modular/architectural/radical: 30,46 %, Market-pull/Technology-push: 70.2%). Then clearer definitions to determine the classifications were agreed upon and the cases were re-classified. Specific cases were discussed with as a result a much higher agreement was achieved although not developed independently, so the percentages are somewhat ambiguous (exploitative/explorative: 98.68%, Incremental/ modular/architectural/radical: 62,25% and Market-pull/Technology-push: 100%). The last cases were then discussed and determined together to still function as usable data points, and deal with the ambiguity and differences between the researchers' views and understanding of the projects.

For the second group of 150 projects the agreement rates were also not ideal (exploitative/explorative: 50.67%, Incremental/ modular/architectural/radical: 28.67% and Market-pull/Technology-push: 42%). These cases were then commented on and then agreed upon through a discussion to also form usable data points.

The third group of 109 cases was classified and had the following agreement rates: exploitative/explorative: 50.51%, Incremental/ modular/architectural/radical: 37.37% and Market-pull/Technology-push: 69.7%. This group was also controlled and commented on, resulting in the following agreement rates: exploitative/explorative: 90.91%, Incremental/ modular/architectural/radical: 94.95%, Market-pull/Technology-push: 97.98%, Product/ Process: 100%. Remarkable enough this is the only section where the agreement on the Incremental-typology was not the lowest.

3.2.1.3 Manual Data Classification: Results II

After this manual classification was finalized, Tim Roelofs, a researcher who works on a bachelor thesis using this same data and who also helped with the classifying, worked on a machine-learning project that classified the remaining data using text-mining. He trained his machine based on the manually classified data. The accuracy of his machine-learning project resulted in about 90% accuracy on the dual-typologies, and 70% on the Incremental/Modular/ Architectural/Radical typology. Although these percentages might not be as high as preferred, it does again shed light on the ambiguity and relativity of classifying innovations (Allred & Swan, 2014; Dahlin, 2014).

The first group of 179 (later 151) cases was less usable for the training of the machine, since these were not randomly selected individual cases, but they were randomly selected portfolios (so groups of projects that belong together, and as a group were selected at random, instead of random individual projects). The removal of the software-projects was also not beneficial for the training of the machine. The second group was not sufficient for the training, hence the addition of a third group of cases.

3.2.1.4 Manual Data Classification: Results III

With the data from the classification work, the portfolios were clearly displayed, and using the time spent on research & development as a weight factor and using the time-frame of the projects to create a timeline, trends could be identified from the portfolios. These trends will be explained in the next sections separately per portfolio type.

3.2.1.5 Portfolio Type 1 Patterns

The trends that were recognized, and used to create a nominal variable for this typology are the following:

- **Explorative over Exploitative**: The time spent on explorative projects was more than the time spent on exploitative projects. This remained the same over the course of the time-frame for this paper.
- **Exploitative over Explorative**: The time spent on exploitative projects was more than the time spent on explorative projects. This remained the same over the course of the time-frame for this paper.
- **Explorative to Exploitative**: The time spent on explorative projects decreased and the time spent on exploitative projects increased. The scales were thus tipped from the explorative to the exploitative side.
- **Exploitative to Explorative**: The time spent on exploitative projects decreased and the time spent on explorative projects increased. The scales were thus tipped from the exploitative to the explorative side.
- **Exploitative and Explorative**: The time spent on either type of innovation project remained similar over time and somewhat in a balanced -in other words 'equal'- way.

3.2.1.6 Portfolio Type 2 Patterns

Incremental/Modular/Architectural/Radical Innovations are somewhat harder to define trends in than the other portfolio types, and they will consist of more possible patterns than the others. The dataset is not large enough to support the full range of patterns, so here are the most likely patterns, that can also be used in situations of doubt:

- **Incremental over the rest**: The time spent on incremental projects was more than the time spent on other types of projects. This remained the same over the course of the time-frame for this paper.
- **Modular over the rest:** The time spent on modular projects was more than the time spent on other types of projects. This remained the same over the course of the time-frame for this paper.
- **Architectural over the rest**: The time spent on architectural projects was more than the time spent on other types of projects. This remained the same over the course of the time-frame for this paper.
- **Radical over the rest**: The time spent on radical projects was more than the time spent on other types of projects. This remained the same over the course of the time-frame for this paper.
- **Other to Incremental**: The time spent on innovation projects became increasingly focused on incremental projects over the course of the time-frame for this paper.
- **Other to Modular**: The time spent on innovation projects became increasingly focused on modular projects over the course of the time-frame for this paper.
- **Other to Architectural**: The time spent on innovation projects became increasingly focused on architectural projects over the course of the time-frame for this paper.
- **Other to Radical**: The time spent on innovation projects became increasingly focused on radical projects over the course of the time-frame for this paper.
- **Concept overturning**: The time spent on innovation projects was majorly focused on concept overturning projects, meaning modular and radical projects.
- **Concept enhancing**: The time spent on innovation projects was majorly spent on concept enhancing projects, meaning incremental and architectural projects.
- **Component linkage maintaining**: The time spent on innovation projects was mainly spent on projects that maintain the component linkage, meaning incremental and modular projects.
- **Component linkage changing**: The time spent on innovation projects was mainly spent on projects that changed the linkage between components, meaning architectural and radical projects.
- **Unclear/Balance**: There was no clear pattern in the time spent on innovation projects. This was the case when the time spent on the different project types were similar, or there were too few to recognize a pattern.

3.2.1.7 Portfolio Type 3 Patterns

The trends that were recognized, and used to create a nominal variable for this third typology are the following:

- **Explorative over Market-pull**: The time spent on technology-push innovation projects was more than the time spent on market-pull innovation projects. This remained the same over the course of the time-frame for this paper.
- **Market-pull over Technology-push**: The time spent on market-pull innovation projects was more than the time spent on technology-push innovation projects. This remained the same over the course of the time-frame for this paper.
- **Technology-push to Market-pull**: The time spent on technology-push innovation projects decreased and the time spent on market-pull innovation projects increased. The scales were thus tipped from the technology-push to the market-pull side.
- **Market-pull to Technology-push**: The time spent on market-pull innovation projects decreased and the time spent on technology-push innovation projects increased. The scales were thus tipped from the market-pull to the technology-push side.
- **Market-pull and Technology-push**: The time spent on either type of innovation project remained similar over time and somewhat in a balanced -in other words ‘equal’- way.

3.2.1.8 Portfolio Type 4 Patterns

The trends that were recognized, and used to create a nominal variable for this last typology are the following:

- **Product over Process**: The time spent on product innovation projects was more than the time spent on process innovation projects. This remained the same over the course of the time-frame for this paper.
- **Process over Product**: The time spent on process innovation projects was more than the time spent on product innovation projects. This remained the same over the course of the time-frame for this paper.
- **Product to Process**: The time spent on product innovation projects decreased and the time spent on process innovation projects increased. The scales were thus tipped from the product to the process side.
- **Process to Product**: The time spent on process innovation projects decreased and the time spent on product innovation projects increased. The scales were thus tipped from the process to the product side.
- **Process and Product**: The time spent on either type of innovation project remained similar over time and somewhat in a balanced -in other words ‘equal’- way.

3.2.2 *Independent Variable:*

The NACE Rev. 2 works with sections and divisions as said before. The 99 sections are too specific for this data set and would result in around 2 or 3 companies in many divisions, but the sections, or the 'level 1 codes' as they are called by Eurostat are the following:

Level 1 codes – NACE Rev. 2

A	Agriculture, Forestry and Fishing
B	Mining and Quarrying
C	Manufacturing
D	Electricity, Gas, Steam and Air Conditioning Supply
E	Water Supply; Sewage, Waste Management and Remediation Activities
F	Construction
G	Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles
H	Transport and Storage
I	Accommodation; Food Service Activities
J	Information and Communication
K	Financial and Insurance Activities
L	Real Estate Activities
M	Professional, Scientific and Technical Activities
N	Administrative and Support Service Activities
O	Public Administration and Defense; Compulsory Social Security
P	Education
Q	Human Health and Social Works Activities
R	Arts, Entertainment and Recreation
S	Other Service Activities
T	Activities of Households as Employers; Undifferentiated goods- and services-producing activities of Households for own use
U	Activities of Extraterritorial Organizations and Bodies

Table 1 – Level 1 NACE Rev. 2 (Eurostat, 2018)

Most of the companies from the sample will be expected to lie in sections that are more towards the production side, but the specifics will follow in the Results section.

3.2.3 *statistical model*

What eventually will be shown is whether the different sectors have different trends in their innovation project portfolios. Since both variables are nominal variables, constructing a cross-tabulation and doing a Chi-square test for independence on the four different portfolios will be done, and a control of the 4 hypotheses that were stated before.

The results section will start with an overview of the project's types of innovation. Then the distribution of the resulting trends over the business sectors will be presented. Eventually the hypotheses will be discussed one by one.

I expect the 4 hypotheses all to be rejected, although the small sample size that was anticipated to be bigger might cause problems to reject the hypotheses with certainty, due to the expectation that the results of the innovation trends might be spread thin over the cells of the cross-tabulation, they might not represent the business sector.

Company age and size are control variables preferably included in the study but given the time-frame and resources of this study they are not included.

4. RESULTS

4.1.1 *Innovation Types*

The final dataset after the manual classifying and text-mining consisted of 900 project descriptions with the following distributions in innovation types (in numbers and percentages):

Exploitative vs. Explorative

	Frequency	Percent
Exploitative	295	32.8
Explorative	605	67.2
Total	900	100.0

Table 2 - Innovation type 1 distribution

Most innovation projects were explorative projects, but there is still roughly one third of the projects that was exploitative as can be seen in table 2. Opposite to what some researchers suggest according to (Garcia & Calantone (2002), exploitative innovations are not the same as Incremental innovations, and neither are explorative innovations always radical innovations. This difference can be seen when comparing table 2 and table 3.

Incremental vs. Modular vs. Architectural vs. Radical

	Frequency	Percent
Incremental	81	9.0
Modular	626	69.6
Architectural	38	4.2
Radical	155	17.2
Total	900	100.0

Table 3 - Innovation type 2 distribution

Remarkable is that most innovations in this sample were modular innovations, as is shown in table 3.

Market-pull vs. Technology-push

	Frequency	Percent
Market-Pull	469	52.1
Technology-Push	431	47.9
Total	900	100.0

Table 4 - Innovation type 3 distribution

The typology on the origin of the innovations was the most balanced one as can be seen in table 4 above.

As can be seen in table 5 on the previous page, most of the projects were product innovations rather than process innovations. The product category in this table includes the software innovations that were marked earlier as unclear. They were skipped in the first group of the manual classification, but they have since been re-added.

Product vs. Process

	Frequency	Percent
Product	650	72.2
Process	250	27.8
Total	900	100.0

Table 5 - Innovation type 4 distribution

4.1.2 Sample Distribution

Unfortunately, not from all companies in the dataset the NACE Rev. 2 was available. Table 6 shows that from 89 companies the NACE Rev. 2 was available, and from 60 it was not. It also shows that not all 21 sectors are represented in this study. And from the 7 sectors that are represented, some only have 1, 4 or 5 companies in them, which is not a strong representation either.

Business Sector

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Manufacturing	37	24.8	41.6	41.6
	Construction	5	3.4	5.6	47.2
	Wholesale	17	11.4	19.1	66.3
	Information and Communication	1	.7	1.1	67.4
	Financial and Insurance Activities	20	13.4	22.5	89.9
	Professional, Scientific and Technical Activities	4	2.7	4.5	94.4
	Administrative and Support Service Activities	4	2.7	4.5	98.9
	Other Service Activities	1	.7	1.1	100.0
	Total	89	59.7	100.0	
Missing	System	60	40.3		
Total		149	100.0		

Table 5 - Sample distribution of the companies in the Business Sectors

This sample size is disappointing compared to the expectations at the start of the study, and the smaller sample size will impact the results stated later.

4.1.3 Test Results

Before the specific portfolio results will be explained, some general information will be given on the tests used to deliver these results. Because of the sample size, some problems arose that were not foreseen or discussed in the planned methodology.

4.1.3.1 General

Having this smaller sample size makes it harder to make sensible statements about any of the hypotheses. Doing a Chi-square test for independence by rule of thumb requires more than 5 expected cases per cell of the cross-tabulation to give results that can be used to draw conclusions from (Veaux, Velleman, & Bock, 2016). Because of this I tried to use an exact method. The Fisher exact test is a test that is usable in a 2x2 contingency table (IBM, 2018). But there is an adaptation of this model by Freeman and Halton that is usable for bigger tables (Freeman & Halton, 1951). This exact test that is often called the 'Fisher-Freeman-Halton test' is incorporated in SPSS 25. It is a timely process, but it supposedly gives strong results if it can be run on the data.

Unfortunately, the contingency tables were too big for SPSS to be able to run it to completion, and the results were never delivered. Because it occurs more often that this process is too heavy (IBM, 2018), it is suggested to use the Monte Carlo simulation to approach meaningful results. The Monte Carlo method is useful in situations with several uncertainties (Mooney, 1997). The Monte Carlo simulation method works with a large number of repeated random sampled tables to approach problems through comparison with randomness. This method is somewhat crude compared to the exact tests. A bigger number of random samples in a Monte Carlo simulation does not damage the strength, except for the calculating speed. On the contrary, it can even bring biases to the light that would otherwise have gone unnoticed (Driels, 2004). SPSS starts with 10,000 samples, and this is considered large enough for most tests (Mooney, 1997).

The way that the Monte Carlo method works is that it compares the distribution of these typologies and checks whether they could have come about at random, or whether it is very unlikely if they came about randomly by creating 10,000 random distributions. A significant result (a P-value smaller than 0.05) would mean that it is very unlikely that it came about randomly. The Monte Carlo Simulation is actually more an extension to the Pearson Chi-Square, giving a confidence interval accurate to 95% around the P-value, that covers for the inaccuracy created by the broken rule of thumb discussed earlier.

The results that are to follow will display p-values, that if they are insignificant, mean that the hypotheses are not supported and thus assumed rejected.

4.1.3.2 *Portfolio 1*

The first portfolio of exploitative and explorative innovation projects was in line with table 2. The detailed results can be found in Appendix 2, but both the Pearson Chi-Square and Monte Carlo Confidence interval boundaries as can be found in table 7 show considerably clear insignificant results when using an alpha of 0.05 in a 2-sided trail.

Therefore, the hypothesis:

H1: “*The business sectors have the same pattern in Explorative / Exploitative innovations in their innovation project portfolios”* Cannot be rejected.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Monte Carlo Sig. (2-sided)		
					95% Confidence Interval	
				Significance	Lower Bound	Upper Bound
Pearson Chi-Square	29.406 [a]	28	.392	.384 [b]	.375	.394
Likelihood Ratio	28.112	28	.459	.427 [b]	.418	.437
Fisher's Exact Test	29.056			.376 [b]	.366	.385
N of Valid Cases	89					

a. 35 cells (87.5%) have expected count less than 5. The minimum expected count is .04.

b. Based on 10000 sampled tables with starting seed 2110151063.

Table 6 - Chi-Square Tests for Portfolio 1

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Monte Carlo Sig. (2-sided)		
					95% Confidence Interval	
				Significance	Lower Bound	Upper Bound
Pearson Chi-Square	68.082 [a]	63	.308	.337 [b]	.328	.347
Likelihood Ratio	45.810	63	.949	.604 [b]	.595	.614
Fisher's Exact Test	75.032			.573 [b]	.563	.583
N of Valid Cases	89					

a. 77 cells (96.3%) have expected count less than 5. The minimum expected count is .01.

b. Based on 10000 sampled tables with starting seed 2110151063.

Table 7 - Chi-square tests for Portfolio 2

4.1.3.3 *Portfolio 2*

The second portfolio of Incremental, Modular, Architectural and Radical innovation projects was spread very thin due to the larger number of possible patterns, but still the different business sectors had comparable patterns, as can be seen in more detail in Appendix 3. Table 8 shows the Pearson Chi-square with Monte Carlo simulations and again the hypothesis: H2: “*The business sectors have the same pattern in Incremental/ Modular/ Architectural/ Radical innovations in their innovation project portfolios”* could not be rejected.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Monte Carlo Sig. (2-sided)		
					95% Confidence Interval	
				Significance	Lower Bound	Upper Bound
Pearson Chi-Square	14.558[a]	28	.983	.936[b]	.931	.941
Likelihood Ratio	17.454	28	.939	.887[b]	.880	.893
Fisher's Exact Test	28.418			.881[b]	.874	.887
N of Valid Cases	89					

a. 35 cells (87.5%) have expected count less than 5. The minimum expected count is .01.

b. Based on 10000 sampled tables with starting seed 2110151063.

Table 8 - Chi-square tests for Portfolio 3

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Monte Carlo Sig. (2-sided)		
					95% Confidence Interval	
				Significance	Lower Bound	Upper Bound
Pearson Chi-Square	25.053[a]	28	.625	.603[b]	.593	.612
Likelihood Ratio	28.133	28	.457	.467[b]	.457	.477
Fisher's Exact Test	28.635			.379[b]	.370	.389
N of Valid Cases	89					

a. 34 cells (85.0%) have expected count less than 5. The minimum expected count is .06.

b. Based on 10000 sampled tables with starting seed 2110151063.

Table 9 - Chi-square tests for Portfolio 4

4.1.3.4 *Portfolio 3*

The third portfolio comprised of Market-pull and Technology-push innovation project patterns follows the same course as its predecessors. This portfolio too does not differ significantly from the hypothesis.

H3: “*The business sectors have the same pattern in Technology-push / Market-pull innovations in their innovation project portfolios”* cannot be rejected based on these tests. The p-values can be found in table 9, and the more specific distribution can be found in appendix 4.

4.1.3.5 *Portfolio 4*

The last portfolio consisting of Product and Process innovation projects was the closest to being fully explained by the hypothesis. This expectedly has something to do with the classifiable nature of the innovation typology. It is easier for manual classifiers to make the distinction between a product and a process, than to grasp the difference between incremental, modular, architectural or radical innovation projects. Whether that has to do with it or not, in table 10 the Chi-square test results can be found, and in Appendix 5 the more detailed distributions are visible. This study can again not say that the difference with the hypothesis is significant.

H4: “*The business sectors have the same pattern in Product / Process innovations in their innovation project portfolios”* Can also not be rejected based on the findings of this study.

5. CONCLUSION

A dataset consisting of 900 innovation projects, conducted by 149 companies has been analyzed to see whether the innovation pattern followed by these companies is in any way dependent on the Business sector they are operating in.

None of the innovation typologies that build up the innovation portfolios, and the trends which are based upon these, can be attributed the business sector they are in. The same pattern was recurring, no matter the business sectors.

Implicated is that for differences in patterns within innovation portfolios, another source needs to be sought.

An implication of the patterns that were discovered though, is for example that when looking at appendix 2, it is most common to have more explorative that exploitative innovation projects in the portfolio, so "balance" means something different in this case than an equal amount of both. It seems according to these results that searching for new knowledge is more important than expanding on the existing knowledge.

In the second typology it became apparent that most innovations were modular innovations, that does not mean that incremental, architectural, or radical innovations do not matter, or do not appear, but what could be an implication is that modular innovations are small enough to be completed in a relatively shorter time but perform well to stay in business. It could also be caused by the classification process. Perhaps an error occurred and because of that most innovation projects were classified as modular, but more on that in the limitations section.

When looking at Appendix 4 there is a less clear common pattern, except that technology-push over market-pull is at least represented in all sectors. This implies that all sectors proactively scan for possible technologies that can be implemented into their business, besides responding to market demands and requests. So, to stay competitive in any business a firm must stay aware of technological developments.

In this study, most sectors had a clear pattern of product over process as can be seen in Appendix 5, that might be because the results of a product innovation are better measurable, and deliver more revenue, whereas process innovations often try to make processes more efficient and reduce costs in that way. Product innovations might thus be more rewarding, but it might also be that for this dataset the process innovations were not always deemed to be full scale projects, or maybe it was because most of these projects came from manufacturing firms that make products, which make this the more common innovation type.

5.1 Discussion

5.1.1 Patterns

In this paper the patterns that were used have largely been based on the logic of possible outcomes similar to probability calculations. For the dual typologies these were not so elaborate, but once more categories of innovation came into play, the number of possible patterns also increased. For the second portfolio several more patterns can be thought of, but for the sake of this study with its' small sample size I have chosen to stick with the given selection, which might have been too much already. When looking at appendix 3, it is visible that the cases are spread thin across the cells. A solution for this could be to have a bigger sample size, but since this study is based on data that was already collected, and could not be expanded for this study, that is not an option. Having fewer patterns is also not a viable option because then the accuracy and specificity of the study would be limited further than it already is.

5.1.2 Business Sectors

The companies that were in the dataset have by law been attributed a NACE Rev. 2 code. But that does not exclude these companies from engaging in activities outside of the sector they have corresponding code for. For this study that would not be a problem, since the level 1 codes are used (sections and not divisions), but more specific studies would have to look very carefully at what other activities the companies in their dataset have. What could occur is that a company starts an innovation project for one of its upcoming economic activities in sector A (for example), while their NACE Rev. 2 code states they are operating in sector B.

5.1.3 Portfolios

The innovation typologies are not mutually exclusive, that has been stated before. That also means that the results of the 4 different portfolios are not fully independent. If one of the hypotheses would have been rejected due to a p-value that was smaller than 0.001, while other hypotheses were not rejected, that should be investigated. This study however does not reject any of the hypotheses so that is not a concern in this situation.

Some of the innovation project portfolios only consisted of very few projects, so these might not actually be representative of the patterns that they were identified as. For example, one of the companies had a project requiring 600 R&D hours in 2009 that was explorative, and a project requiring 620 R&D hours in 2011 that was exploitative, was identified as an Explorative to Exploitative pattern. But basing a pattern on 2 individual cases, instead of a larger group is debatable. For the sake of this study it has been done in this fashion.

5.2 Limitations and Future Research

5.2.1 Limitations

This research has been restricted by several limitations. Most of these limitations relate to the dataset, others to the amount of time and other resources available to conduct this study.

5.2.1.1 Manual Classification

The fact that the innovation projects had to be classified by hand opened the dataset to the liability of human error. A chunk of the data of about 409 cases has been open to debate and has been classified based on consensus. This is not the type of hard measurements and empiric data that a researcher prefers to work with.

5.2.1.2 Machine-Based Classification

In some cases, machine-learned classifiers can be more accurate than human classifying, Tim Roelofs discovered that in his thesis. But that is only the case if the machine has been trained properly. This section is not to blame or spread mistrust on the machine-learning project of my fellow researcher Tim Roelofs. But he himself said that the machine he trained can achieve about 90% accuracy on the dual typology classifications, and 70% on the incremental / modular / architectural / radical typology. These percentages do not mean that he did a bad job, but they do mean that the results of this study are less accurate, at least on some typologies, but the time-span of this paper did not allow for manual classification in all the cases where that would give better results.

5.2.1.3 Business Sectors

As stated in the results this study looks at 8 business sectors. But there are 21 sectors for a reason. This study was limited to come to conclusions for those 8 sectors. Besides that, for some of the sectors that were included, like "Information and Communication" they were very under-represented.

5.2.1.4 Control Variables

This study does not include any control variables. Earlier there has been mention of company age, and company size, which are both already supported influencers of innovation behavior (Jong & Vermeulen, 2006; Oke, Burke, & Myers, 2007). But besides those two, there can be other control variables, such as technology protectability of the industries, or product life-cycle time.

5.2.1.5 Open Innovation

Open innovation is nowadays a common concept, but it is not included in this study. In some cases, the innovation was done as an assignment for another company, and in others they were done in collaboration with a company in the supply-chain or environment of the companies in the dataset, but open innovation was otherwise not included.

5.2.1.6 Patterns

For every typology there was a minimum of 5 patterns. Maybe for the small dataset it would have been more appropriate to have fewer patterns. I felt it was necessary to also show direction in the patterns, but the result is that it was harder to draw conclusions based on the results of the current number of patterns.

5.2.2 Future Research

Almost all the topics mentioned in the limitations could be included in future research. Collecting more data from different sectors could be the answer to that point. But what would be better than collecting data from a wider range of sectors, might be to select more data from the sectors already included, so that the conclusions drawn can have a more substantial base.

Including control variables can benefit this direction of study as well, and it is already known which ones can be included.

A topic that remains a challenge is a way of classifying the dataset in a valid way, because humans are not reliable enough, and text-mining is still a relatively new topic that is still developing.

6. ACKNOWLEDGEMENTS

This research paper would not have been possible without the help and the input of Matthias de Visser who is also the supervisor of this paper. The data and starting ideas came from him, and he has been open to questions along the way.

The efforts of Sarah Wiegard and Tim Roelofs are also greatly appreciated. Together the three of us classified over 400 cases manually and discussed about the results to increase the validity. Tim also classified the other cases with his machine-learning project, great thanks to him for doing that.

Lastly, I want to thank Henry van Beusichem for providing us with all the other data outside the innovation projects

7. APPENDICES

7.1 Appendix 1: NACE Rev. 2

Broad Structure of NACE Rev. 2

Section	Title	Divisions
A	Agriculture, forestry and fishing	01 – 03
B	Mining and quarrying	05 – 09
C	Manufacturing	10 – 33
D	Electricity, gas, steam and air conditioning supply	35
E	Water supply; sewerage, waste management and remediation activities	36 – 39
F	Construction	41 – 43
G	Wholesale and retail trade; repair of motor vehicles and motorcycles	45 – 47
H	Transportation and storage	49 – 53
I	Accommodation and food service activities	55 – 56
J	Information and communication	58 – 63
K	Financial and insurance activities	64 – 66
L	Real estate activities	68
M	Professional, scientific and technical activities	69 – 75
N	Administrative and support service activities	77 – 82
O	Public administration and defence; compulsory social security	84
P	Education	85
Q	Human health and social work activities	86 – 88
R	Arts, entertainment and recreation	90 – 93
S	Other service activities	94 – 96
T	Activities of households as employers; u0ndifferentiated goods- and services-producing activities of households for own use	97 – 98
U	Activities of extraterritorial organisations and bodies	99

Appendix 1 - Broad Structure of NACE Rev. 2

7.2 Appendix 2: Portfolio 1 Distribution

Exploitative-Explorative Patterns over Business Sectors

Count

		Portfolio Patterns 1					
		Exploitative and Explorative	Exploitative over Explorative	Exploitative to Explorative	Explorative over Exploitative	Explorative to Exploitative	Total
Business Sector	Manufacturing	5	4	5	20	3	37
	Construction	2	1	0	2	0	5
	Wholesale	3	5	2	7	0	17
	Information and Communication	1	0	0	0	0	1
	Financial and Insurance Activities	2	5	1	12	0	20
	Professional, Scientific and Technical Activities	2	0	0	2	0	4
	Administrative and Support Service Activities	0	1	1	1	1	4
	Other Service Activities	0	1	0	0	0	1
Total		15	17	9	44	4	89

Appendix 2 - Exploitative vs Explorative Distribution

7.3 Appendix 3: Portfolio 2 Distribution

Incremental/Modular/Architectural/Radical Patterns over Business Sectors

Count

		Portfolio Patterns 2										
		Architectural over the rest	Component linkage maintaining	Concept overturning	Incremental over the rest	Modular over the rest	Other to Incremental	Other to Modular	other to Radical	Radical over the rest	Unclear/Balance	Total
Business Sector	Manufacturing	1	2	6	0	20	0	3	3	1	1	37
	Construction	0	0	2	0	3	0	0	0	0	0	5
	Wholesale	1	2	1	0	8	1	1	0	2	1	17
	Information and Communication	0	1	0	0	0	0	0	0	0	0	1
	Financial and Insurance Activities	0	1	2	1	11	0	3	0	1	1	20
	Professional, Scientific and Technical Activities	0	1	0	0	2	0	0	0	0	1	4
	Administrative and Support Service Activities	0	0	0	1	3	0	0	0	0	0	4
	Other Service Activities	0	0	0	0	0	0	0	0	1	0	1
Total		2	7	11	2	47	1	7	3	5	4	89

Appendix 3 - Incremental/Modular/Architectural/Radical Distribution

7.4 Appendix 4: Portfolio 3 Distribution

Market-pull vs Technology-push Patterns over Business Sectors

Count

		Patterns 3					
		Market-pull and Technology-push	Market-pull over Technology-push	Market-pull to Technology-push	Technology-push over Market-pull	Technology-push to Market-pull	Total
Business Sector	Manufacturing	9	16	2	7	3	37
	Construction	1	1	0	2	1	5
	Wholesale	5	2	0	8	2	17
	Information and Communication	0	0	0	1	0	1
	Financial and Insurance Activities	5	4	2	8	1	20
	Professional, Scientific and Technical Activities	1	0	0	3	0	4
	Administrative and Support Service Activities	1	2	1	0	0	4
	Other Service Activities	0	0	0	1	0	1
Total		22	25	5	30	7	89

Appendix 4 - Market-pull vs. Technology-push Distribution

7.5 Appendix 5: Portfolio 4 Distribution

Process vs. Product Patterns over Business Sectors

Count

		Patterns 4					
		Process over Product	Process to Product	Product and Process	Product over Process	Product to Process	Total
Business Sector	Manufacturing	10	1	7	18	1	37
	Construction	0	0	1	3	1	5
	Wholesale	3	0	2	11	1	17
	Information and Communication	0	0	0	1	0	1
	Financial and Insurance Activities	1	0	5	13	1	20
	Professional, Scientific and Technical Activities	1	0	0	3	0	4
	Administrative and Support Service Activities	1	0	0	3	0	4
	Other Service Activities	0	0	0	1	0	1
Total		16	1	15	53	4	89

Appendix 5 - Product vs. Process Distribution

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