A Work Project, presented as part of the requirements for the Award of a Masters Degree in Management from the NOVA - School of Business and Economics

Optimization of Export Support Systems:

How to Promote Exports from Portugal to Germany in the Area of Information Technology and Electronics

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#1706

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January 2015

Acknowledgements

This work project marks the end of a long but exciting academic period at Nova School of Business and Economics. It is the conclusion of an intense academic learning and also personal and professional development.

I would like to begin by thanking my academic advisor Mr. Alexandre Dias da Cunha and Mr. Hans-Joachim Böhmer for the excellent initiative of this project and Mr. João Brazão for the collaboration. I would also like to thank for all the support and dedication in this project as well as the valuable feedback that helped us make this project successfully.

I would like to thank my family and colleagues for their support on this journey.

Abstract

This work project focuses on developing new approaches which enhance Portuguese exports towards a defined German industry sector within the information technology and electronics fields.

Firstly and foremost, information was collected and a set of expert and top managers' interviews were performed in order to acknowledge the demand of the German market while identifying compatible Portuguese supply capabilities.

Among the main findings, Industry 4.0 presents itself as a valuable opportunity in the German market for Portuguese medium sized companies in the embedded systems area of expertise for machinery and equipment companies.

In order to achieve the purpose of the work project, an embedded systems platform targeting machinery and equipment companies was suggested as well as it was developed several recommendations on how to implement it.

An alternative approach for this platform was also considered within the German market namely the eHealth sector having the purpose of enhancing the current healthcare service provision.

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1. Overview of the project

1.1. Client - ANETIE (Associação Nacional das Empresas das Tecnologias de Informação e Electrónica)

This work project focused on conducting a research to strengthen business cooperation between Portugal and Germany while closely working with Associação Nacional das Empresas das Tecnologias de Informação e Electrónica (ANETIE) – represented by Mr. João Brazão[1]. ANETIE is a Portuguese Association which aims at promoting sustained growth among more than 100 companies within the Portuguese information technology and electronics sector. ANETIE's main guidelines are endorsed not only at a political level – through the collaboration within the development of nationwide policies but also by supporting and promoting partnership at a business level amongst technology-driven companies and their internationalization processes[2].

Additionally, the German-Portuguese Chamber of Industry and Commerce (CCILA), namely Mr. Hans-Joachim Böhmer[3], performed a crucial role since this project's early stages of development to its current state. The possibility of improving business relations between Portugal and Germany within the IT industry was also perceived as critical success factor during this project.

1.2. Market overview

In 2013, Portuguese exports have reached a total of €67 216 million which were segmented amongst the following main trading partners: Spain (23,6%), Germany (11,6%) and France (11,6%)[4]. The most exported products from Germany are car and car components, chemical products and machines/engines.

Amongst the findings within Roland Berger's paper[5], it's possible to determine that Portuguese exports towards the German market have increased at an annual rate of 3,4%. However, Portugal exports less to Germany comparing to its main competitors such as Spain, Poland, China, Czech Republic, Hungary, Romania, being in an unfavourable position. Beyond that, in the German market, the exports of the

[1] Board Member of ANETIE
[2] ANETIE (2012)
[3] Executive Director of CCILA
[4] Banco de Portugal (2014)
[5] Further information can be accessed in 1.4.1

competitors' countries have been growing successfully due to the technological products.

Looking to Germany, in 2013, in terms of imports, Portugal ranked the position 30 as trading partner, representing only 0,6% of a total of €895 billion comparing to Netherlands (9,94%) and China (8,21%)[6]. The most imported products from Portugal are car and car components, machines/engines and gum and plastic products[7].

1.3. Current client situation

When analysing the last years, Portuguese companies' exports sharply rose mainly due to a wide-ranging investment in Brazil and PALOP[8] markets such as Angola and Mozambique. Although these markets present unique attributes along with exceptional growth opportunities, Portuguese companies must diversify their exports destination towards more stable and sustained markets, able of providing long-lasting partnerships which enhances value co-creation.

Currently, the internationalization of Portuguese companies is faced as one of the top priorities for ANETIE. Therefore the search for emerging technological opportunities and solutions for high entry barriers markets is considered critical for such goals to be achieved. Additionally, R&D investment is also being approached - by ANETIE - as critical success factor for companies struggling to differentiate themselves from the competition, since unique and innovative products/services have proven to be decisive in fulfilling foreign markets' demand[9].

1.4. The project challenge

1.4.1. Introduction and Goal of the Study

This work project which was developed in collaboration with Jürgen Thomas Weber was built on the paper *Portugal Plus* conducted by Roland Berger Strategy Consultants and promoted by CCILA. This paper aims at conducting a research to develop and propose new approaches to strengthen strategic and business partnership between

[6] DIHK (2014) *(Deutsche-Industrie und Handelskammer)*
[7] Das Statistik-Portal (2013)
[8] Portuguese-speaking African countries
[9] ANETIE (2012)

Germany and Portugal while analysing both German investment within Portugal and Portuguese service exports towards Germany.

This work project focus on the area of information technology and electronics and, for that reason, the Portuguese sector association ANETIE was invited to be a collaborative partner in whom our recommendations are directed to it. Consequently, the goal of the master-thesis is to provide concrete recommendations to the Portuguese IT companies with the purpose of expanding the exports in a long-term.

1.4.2. Methodology and Approach of the Study

Throughout the development stage of this work project there were several meetings with Mr. Hans-Joachim Böhmer, Mr. João Brazão and the academic advisor Mr. Alexandre Dias da Cunha from Nova School of Business and Economics which proven to be essential to the outcome of this project due to both their knowledge and expertise. Their guidelines ensured a correct alignment of goals while providing invaluable guidance in enhancing the development stage of this project.

The development stage of this project started with a market analysis which was conducted in order to identify German specific demands within the industry sector. Such analysis was firstly aimed at determining emergent market opportunities which could be explored to establish market segment. Secondly, this work project focused on identifying niches with less rivalry enabling for a reachable yet sustainable business section. Then, the identified subsectors were analysed according to specific criteria adapted to Portuguese companies.

Lastly, the German market segment and the Portuguese companies were paired and an analysis was performed to acknowledge how both entities could benefit from a well-structured partnership. The goal was to identify win-win scenarios for both partakers.

The matching process was divided into four development phases, each using different data sources. Within the first phase, the project topic was defined based on macro-trends collected from publications such as companies' reports, research papers, trend analysis and statistics[10]. The second phase of development included two different approaches performed simultaneously. One of these approaches consisted on expert interviews with German decision-makers within the industry sector which aimed at accessing

[10] Selection criteria are based on Roland Berger (May 2013, p. 40)

experienced insight into the topic while identifying present and future requirements regarding Industry 4.0[11], market segment and the business idea itself. Within the other approach, executive members of multinational enterprises operating in Portugal were interviewed with the intent of identifying the Portuguese critical success factors and possible competitive advantages developed within Portugal. The third phase focused on listing, classifying and interviewing medium-sized IT companies and institutes with the purpose of evaluating Portuguese competencies and resources in the German identified market segment. The final phase aimed at bringing together the identified market segment's demand and the Portuguese supply capabilities in order to access and propose a business solution able of ensuring a win-win scenario for both entities.

1.5. Summary of recommendations

1.5.1. Identification of Trends - The Sources of Future Change

The major sources of future paradigms can be classified in three categories: society and culture, technology and environment[12]. This work project focused on the outcome of technological changes that somehow impacted the industry, hence reinventing business models.

Nowadays, companies face a competitive pressure to implement faster production processes, tighten resource expenditure and innovate within product design in order to satisfy the consumer demand worldwide. Therefore technology is considered to be the driver in process innovation not only application wise but also imbued within the business strategy itself[13].

Technology has redefined old paradigms while creating new opportunities such as cloud computing, integrated production processes, enhanced mobile accessibility and global network applications. Technological innovation now plays a crucial role in a company's value chain, thus creating the foundation for a competitive advantage to emerge.

[11] Further information can be accessed in 1.5.2

[12] ARTEMIS Industry Association and ITEA (2013*) High-level vision 2030: opportunities for Europe*

[13] Davenport, Thomas H. *Process innovation: reengineering work through information technology.* Harvard Business Press, 2013.

1.5.2. Definition of Identified sector – *Industry 4.0*

Industrie 4.0 was originally developed by the German Government in order to improve the performance of Germany's industry sector, thus increasing its competitiveness. Through Industry 4.0, Germany intends to revolutionize the manufacturing field by turning it into a more flexible, efficient and sustainable sector while increasing its competitiveness through strategic networking[14].

Cyber-Physical Systems (CPS) is considered to be the technological basis of Industry 4.0 and consists on a sophisticated network where interactions between intelligent machines, production systems and processes are established[13]. Such communication is ensured by sensors within production process machinery which establish networks not only between themselves (horizontal integration) but also between the planning and resource systems with the production (vertical integration)[15]. These automatic and independently operating systems optimize the production as a whole in a holistic manner since every component plays a crucial and integrated role.

To sum up, machines self-organize their flows through production in a more dynamic, flexible and cost-efficient way in which small and medium-sized companies will play an important role by providing individualized products and services[16]. Companies and customers will also benefit from the CPS paradigm since production can easily be adapted to market changes hence better fulfilling customer demand. The implementation plan of such program is expected to last twenty years and has the expected governmental support of €200 million until 2020[17]. The outcome of Industry 4.0 is estimated at €78,77 billion until 2025 in value creation. Germany's industry sector also expects to reach €40 billion per year in investment until 2020[18]. Over the next five years, 80% of the companies will have the value chain integrated with digital solutions which will net up to 18% in increased efficiency due to production improvements and enhanced resource management[19]. As a result, Industry 4.0 is

[14] Germany Trade & Invest (2014) *Industrie 4.0 Smart Manufacturing for future*
[15] Ralf-Michael Franke, CEO Drive Technologies (2012)
[16] Matthias Dietel, Manager Technical Sales, IBM
[17] Germany Trade & Invest (July 2014) *Industrie 4.0 Smart Manufacturing for future*
[18] PwC (2014) *INDUSTRIE 4.0 - Chancen und Herausforderungen der vierten industriellen Revolution*
[19] Davenport, T. H. (2013). *Process innovation: reengineering work through information technology. Harvard Business Press.*

expected to increase not only the sector's productivity but also its efficiency gains, hence creating new business opportunities while redesigning existing business models.

Germany, Sweden and Ireland are structurally ready for the implementation of Industry 4.0 within their industry sector which contrasts with Portugal, Poland and Spain[20]. While Portugal is not considered as a leading country in Industry 4.0 - due to a low manufacturing share of the Portuguese GDP accompanied with an inferior RB Industry 4.0 readiness index - it's still possible for Portugal to play an active role within this program[21].

The analysis of the current situation of Industry 4.0 in Portugal[22] shows that even though the government does not have a long-term national strategy, there is a strategy for the use of the European Community funds that led to the establishment of Competitiveness Clusters such as the TICE[23]. On the companies' side, there is no specific approach for this topic since the R&D department is focused on developing new technologies in order to follow the market trends and there is no expected immediate implementation. However, the conducted interviews highlights that Portuguese companies show interest in the Industry 4.0 and in innovation by visiting trade fairs[24] and participating on conferences as well as motivation to cooperate with German companies and institutions in the research, development and implementation of new products[25]. Furthermore, Portuguese employees have the valuable competences[26]. In contrast, universities as Faculty of Engineering University of Porto and research centers like CISTER[27] have projects in the area of "Internet of Things".

Industry 4.0's technological sectors were determined according to the ability of machines, objects and ICT systems to network intelligently with people as well as the development of the first applications of Industry 4.0[28].

The technological fields are the following: (i) IT-Security (data protection, information security), (ii) embedded systems (intelligent products, machine to machine interaction,

[20] Roland Berger Strategy Consultants (2014) *INDUSTRY 4.0: The new industrial revolution - How Europe will succeed*

[21] Further information can be accessed in Appendix 2

[22] Findings from Interviews with Professor Pedro Cunha

[23] Pólo de Competitividade das Tecnologias de Informação, Comunicação e Electrónica

[24] Findings from Interview with Controlar

[25] Further information can be accessed in Appendix 3

[26] Further information can be accessed in Appendix 4

[27] Research Center in Real-Time & Embedded Computing Systems

[28] BITKOM (2014) *Industrie 4.0 – Volkswirtschaftliches Potenzial für Deutschland*

sensors), (iii) cloud computing (real-time data, virtual storage, big data), (iv) smart-factory (social machines, automation, virtualization) and (v) reliable communication networks (broadband, mobile devices)[29].

1.5.3. Narrowing down Industry 4.0 to promising subsectors

The following fields were defined through interviews performed with German-decision makers which concluded that reliable communication networks are not an attractive niche opportunity due to high competition and already established technologies and also smart-factory is not a feasible objective because it represents the ultimate objective of Industry 4.0. The IT security, embedded systems/system integration, big data and cloud computing were the most promising subsectors in the Industry 4.0.

1.5.3.a. IT Security

Both information security and data protection represent two key issues within Industry 4.0 mainly due to the high amount of data exchange that occurs throughout the value chain process. This network of information may be targeted by outside threats with the intent of sabotaging the production process itself or committing product piracy with adverse effects for end-users[30]. Therefore, IT security presents itself as a major requirement for enhancing enterprises' value chain through the usage of technology.
As a result of such paradigm, for the German IT security market - accounted for €4,7 billion in 2008 - the forecasted revenue for 2015 will peak at €10,6 billion[31]. Aligned with the mentioned projections, the Portuguese IT security market has also increased its value from €128,6 million in 2010 to €135,6 million in 2011, representing a 5.6% growth[32]. Currently there are forty[33] companies operating within the mentioned Portuguese sector and the national data security budget is projected to represent 8% of the total IT budget in 2015[34].

[29] BITKOM (2014) *Industrie 4.0 – Volkswirtschaftliches Potenzial für Deutschland*
[30] Deutsch Bank (2014) *Industry 4.0 Upgrading of Germany's industrial capabilities on the horizon*
[31] Germany Trade & Invest (2009)
[32] Semana Informática (2014) *Segurança informática vai render 136 milhões este ano*
[33] Kompass.com
[34] Survey conducted by Ponemon Institute

Companies operating within the IT security sector are also expected to have an in-depth knowledge of the latest trends in technology, thus ensuring updated solutions to face the upcoming technological hazards. The development of information security and data protection solutions is also affected by the market segment's legal and regulatory framework while being defined through a market-driven approach certification wise. Nevertheless, the IT security subsector is represented as a high competitive field with major worldwide players who continuously develop flexible solutions. Currently Portuguese companies are still perceived abroad as small players who often operate internationally through the usage of partnership approach with other major companies[35].

1.5.3.b. Embedded System/System Integration

Through the usage of an embedded system/system integration approach allows rapid and customized production responses based on updated information while taking into account the patterns in historical data. Although embedded systems require hardware and software components, the software element offers the highest value creation potential.

The German embedded systems market is considered to be the third biggest worldwide increasing from €20 billion in 2012 to € 40 billion in 2020[36].

Within Portugal, when comparing the several product types and associated services within the IT industry, the software sector represents the largest contributor to the aggregate turnover. Over 120 companies[37] currently operate in the Portuguese embedded software sector, these companies key activities focus on R&D, sales & marketing, production and support. Examples of these companies application fields vary from electronic defence and aerospace (Critical Software), interactivity and augmented reality software (Intelligent Sensing Anywhere) and equipment management and automation systems (Brisa)[38].

[35] Findings from Interview with Multicert
[36] BITKOM (2014)
[37] Kompass.com
[38] Leadership Business Consulting (2013)

1.5.3.c. Big Data

The Industry 4.0: big data paradigm has unlocked new potential service offerings in the B2B market segment. By taking advantage of big data potential, companies expect to impact the customer relationship management, product development and business operations within the next five years[39]. Such impact may be fuelled not only by the development of new services but also through design of innovative products able of satisfying the B2B market demand.

In Germany, it is expected that the big data market grow from 650.5 million EUR in 2013 to almost 1.7 billion EUR in 2016[40]. Within Portugal it's estimated that up to 25% of major enterprises were/are developing big data projects with the intent to use analytics tools in business applications[41]. Additionally - according to Portugal Telecom - big data is expected to differentiate companies' solutions as well as their approach to the market, since data management within networks may yield considerable gain in efficiency. Nonetheless the lack of experience, security hazards and budget restrictions are still considered to be the major challenges faced by big data technology[33]. Moreover, just 5 to 6 Portuguese companies[42] currently offer big data software solutions and even though statistics for this subsector are scarce, it's forecasted a significant market growth in this area.

1.5.3.d. Cloud Computing

Through the usage of Cloud technology it is possible to achieve real-time optimized operations while ensuring an improved cost and risk management, thus enhancing both process efficiency and service responsiveness[43].

Within Germany, the B2B cloud computing market is expected to grow by 46% up to €6,4 billion by 2020. Additionally, the fact that 79% of German companies invested within storage capabilities in 2013 accompanied with 90%, expresses a growing

[39] Accenture (2014)
[40] BITKOM/The Experton Group
[41] IDC (2012)
[42] Findings from Interview with Primavera Business Software Solutions
[43] Group of the Industry-Science Research Alliance and acatech – National Academy of Science and Engineering (2013) *Recommendations for implementing the strategic initiative INDUSTRIE 4.0*

demand for data storage solutions[44]. Such demand is transversally boosted by the increased amount of data produced which requires a secure and safe storage while still supporting a fast and efficient data access.

In Portugal it's estimated that Cloud computing market value increases from €90 million in 2014[45] to €184 million in 2017[46] even though currently only two major players stand out - Telecom and VMuse[47].

However safeguarding confidential information still presents itself as a major requirement for enterprises worldwide and Cloud computing faces such security concern throughout its adoption[48].

1.5.4. Subsector Ranking – Evaluating the most promising markets

In order to successfully assess the most promising German subsectors, two frameworks were applied: market attractiveness analysis in Germany and key competencies evaluation in Portugal.

The market analysis within the German industry sector was the first framework to be analysed focusing on key factors such as market size, market growth and pricing trends. This framework was developed through the usage of Porter's four forces analysis which consists on accessing market entry costs, supplier's position, threat of substitutes and degree of competitiveness, differentiating opportunities and expected customer loyalty. This analysis classified the several subsectors from "not favourable" to "very favourable", hence allowing a more precise approach on the market subsector overview. Upon concluding Porter's four forces analysis the subsectors were considered to be promising and very promising in which the IT security outstands in terms of market perspectives[49]. Furthermore, the market attractiveness assessment has accompanied the results of the performed expert interviews thus highlighting the importance of following a narrow niche strategy in each sub-sector[50].

[44] BITKOM 2014
[45] Computerworld (2014) *Cloud Computing em Portugal vai valer 90 milhões*
[46] Semana Informática (2013) *Quanto vale o mercado cloud em Portugal?*
[47] kompass.com
[48] Findings from Interviews
[49] Further information can be accessed in Appendix 5
[50] Findings from Interview with Dr. Olaf Sauer

The second framework focused on identifying potential competencies able of being exported through the usage of four key criteria: number of companies, technological knowledge/experience, competitive field and player importance according to "very favourable", "favourable" and "less favourable"[51].

Amongst the several findings, embedded software was considered as a very favourable exporting solution by the four mentioned criteria.

Upon comparing the German market attractiveness and Portuguese delivery potential, the embedded system implementation was considered as the most suitable option for Portuguese exporters[52].

1.5.5. Selection of the Target Market

After selecting the best subsector to export, a specific target market in Germany was determined. It was taken into account three potential target markets: machinery and equipment companies, automobile suppliers and aeronautics suppliers. These target markets were selected according to their importance on the German industry. In Germany, the machinery and equipment sector is the largest and strongest in Europe[53], the automotive industry is the Europe's leading industry in production and in sales market[54] and the German aeronautics industry has been a global leader in the development of aeroplanes since the first decades of the 20th century[55].

Afterwards, these markets were submitted to four selection criteria composed by market size, expected growth opportunities, proportion of firms with less than five hundred employees in the industry[56] and degree of individualization and complexity of the produced products[57].

In terms of potential market for embedded systems, machinery and equipment companies have the highest economic potential (22,6%), followed by automobile

[51] Further information can be accessed in Appendix 6
[52] Further information can be accessed in Appendix 7
[53] Germany Trade and Invest (2013) *Industry Overview – The Machinery & Equipment Industry in Germany*
[54] Germany Trade and Invest (2013) *Industry Overview – The Machinery & Equipment Industry in Germany*
[55] ECORYS Research and Consulting (2009) *FWC Sector Competitiveness Studies - Competitiveness of the EU Aerospace Industry with focus on: Aeronautics Industry*
[56] The criteria "less than 500 employees" serves as an orientation, since smaller companies do usually not have the needed IT know-how
[57] The higher the degree of individualization and complexity of the products, the more demand individual firms have for embedded system solutions

suppliers (4,2%) and aeronautics suppliers (2,8%)[58]. The investment in Industry 4.0 until 2020 will be 3,5% of annual turnover for machinery and equipment companies and 2,9% for automobile suppliers. In 2013, the machinery and equipment's sector turnover was €206 billion[59] in contrast to €70 billion in the automobile sector and €30,6 billion in the aeronautic sector. Machinery and equipment companies produce single pieces or in small series in which 87% of these companies have less than five hundred employees[60]. Regarding automobile suppliers, the production is in high volume and standardized and 75% of the commercial vehicles' companies have less than five hundred employees. Finally, aeronautics suppliers have a standardized production and 19,5% of their companies have less than five hundred employees.

Therefore, small and medium sized companies with less than five hundred employees are considered the most promising target group due to they lack the know-how needed to the preparation of their production lines and products for Industry 4.0. Additionally, machinery and equipment companies are pressured to implement the embedded systems since their customers are the drivers of the industrial revolution. Machinery and equipment companies produce production and industrial machinery for manufactures. To summarize, the final characteristics for the target niche market are machinery and equipment companies with less than five hundred employees.

1.5.6. Business Idea – Embedded system implementation

In order to propose the business idea about embedded system implementation, it was necessary to take into account the specific circumstances in Portugal. The purpose of the business idea is to unlock the national potential in the area of embedded system implementation.

There are some important aspects that should be considered before the implementation of the proposal. The first aspect relates to the customer's expectations towards a company. The differentiation strategy relies on the companies' expected competences, particularly reliability, confidentiality, expertise in business processes, advisory skills,

[58] Germany Trade and Invest (2013) *Industry Overview – The Machinery & Equipment Industry in Germany*
[59] Germany Trade and Invest (2012*) Machinery & Equipment Industry Market Leadership Powered by German Engineering*
[60] Germany Trade & Invest (2014) *Industry 4.0 –Market Developments in Germany and Opportunities for Finnish Companies*

services/support quality, meet German "standards", transparency and ensure interconnectivity and on specific and technical solutions that meets the sector's requirements. To compete successfully in the market, it is required the identification of key success factors. Looking back to the competences mentioned they are a major requirement to overcome the trust problem in the market by focusing on long-term relationships. On the product side, companies have to supply what customers want. In this particular case, they look for reference projects done by suppliers, software with greater adaptability, products that are easily adapted to new standards in the industry and customized embedded systems for their products that ensure interconnectivity to other systems on the markets and meet German standards. Therefore, companies should offer added-value solutions for specific problems that meet costumer's individual needs and, in this way, they are following a differentiation-focused strategy on customized products and services. Overall, the key success factors identified and the early market entry will create a sustainable competitive advantage[61].

1.5.6.a. Embedded System Implementation Platform

According to ANETIE, cooperation between technological companies, government entities, universities and research institutions is perceived to yield a high valued network able of converting critical shared knowledge into demanded solutions able of increasing competiveness in challenging markets. Therefore, this paper business idea consists on an embedded systems implementation platform within Portugal composed by embedded system firms, associations, industrial companies, universities[62] and research institutes[63] that follow a common strategy.

According to Industry 4.0 guidelines, international cooperation among entities is considered to be critical success factor for such implementation program. This business idea aims at taking full advantage of the shared knowledge within Portuguese universities, research institutes, enterprise associations, embedded systems/ implementation firms and domestic manufacturing companies in order to better reach the German industry sector.

[61] Further information can be accessed in Appendix 8
[62] FCT - Faculty of Sciences and Technologies, Polytechnic Institute of Porto, FEUP - Faculty of Engineering University of Porto, Uni-Nova according with the interview with CISTER
[63] CISTER

However, in order to successfully access the German subsector Portuguese companies must overcome market entry barriers such as the inability to find suitable partners, obstacles related to trade and distribution, social and cultural barriers, technical barriers and ensuring product/service quality upon delivery. Such scenario along with information asymmetries like the lack of updated business data and unawareness towards possible business opportunities within the defined German market are major concerns in Portuguese service exports[64]. Nevertheless the implementation of the mentioned platform ensures that Portuguese companies are able of overcoming identified entry barriers upon accessing the German industry sector.

This business idea is segmented into two development steps[65] which aim at simplifying the implementation within this project while accurately describing each of the intervening entities.

The first step of development comprises three different phases which focused on accessing the Portuguese coordination[66] from a holistic approach. Within the first phase, the platform frameworks were defined along with the common strategic guidelines followed by the several entities which is expected to last three months. The second phase consisted on the development activities determined in the initial concept and is planned to require ten months. Upon concluding the two mentioned phases, the intervening partners within the platform can develop simultaneously the third phase of the first step and the second step itself. While the third phase of the first step focused on the establishment of a local platform representative, the second step of development aims at reaching the German industry sector.

1.5.6.a.1. Step 1 – Coordination within Portugal

To begin with, several members should integrate the platform. The business association ANETIE should support the implementation of the embedded systems' platform, organize the phases and provide the facilities. The embedded software companies are the central players of the platform because they offer products, services and further

[64] ANETIE, INOVA-RIA (2011) *Análise do Comportamento das Empresas Portuguesas de Tecnologias de Informação e Electrónica face à Internacionalização*

[65] Scheme can be accessed in Appendix 9

[66] Findings from Interview with Mr. Jörn Lehmann

developments based on their know-how. The universities and research institutes[67] have qualified personnel which play an important role in the development of the products and services. Domestic machinery and equipment companies should serve as a market test for the solutions. Other associations, including AICEP, should be invited afterwards with the purpose of expanding the number of member companies because there are relevant Portuguese Information Technology and Electronics companies that are not members of ANETIE.

The process of bringing together the different interest groups in Portugal should start with a kick-off meeting follow by regular meetings of the organizational bodies. Furthermore, there should be regular workshops for members and potential members as well as participation in technology fairs and conferences in Portugal which will join the community and convince foreign companies of the platform's concept. The common strategy should involve vision, mission, values and goal. The platform aims to be the coordination between the national know-how and capabilities of embedded system implementation services in order to enable member companies to export. The mission of the platform is to set a common strategy for Portuguese companies in the area of embedded systems and help the Portuguese economy to successfully export its products and services to foreign countries. Regarding the statement of values, the combination of an effective coordination of the national activities and the cooperation among the embedded system companies will make the mission successful. The platform's objective is to become a top 5 embedded system implementation provider in the German market within the next five years. In terms of the organizational structure, the platform leadership should be ahead by an entity or an organization such as a company leader or an expert that know the German's demand and organize the Portuguese companies in order to find and present a solution to German companies. Internally, companies will join and find a solution.

The second phase should rely on the organizational activities. As far as branding is concerned, the name has to be chosen and registered and also it has to be created the logo and the website in German. All the activities abroad have to be communicated by using the chosen platform name and logo. After the branding, members have to exchange information, plan cooperative and collaborative activities, make use of greater

[67] CISTER - Research Centre in Real-Time and Embedded Computing Systems, Escola Superior de Tecnologia de Setúbal; Instituto Politécnico de Lisboa

purchasing power, approach security solutions and identify optimization measures and potential for cost reductions. Then, the platform should have a legal form since this improves the credibility of the platform and is a precondition to obtain public funding of the government and the European Commission[68] (e.g. Horizon 2020). In order to keep the employees continuously qualified, the members should exchange knowledge and experience between science and practice, participate in the apprenticeship/dualistic education initiative in Portugal and attend training programs. The last organizational activity should aim to the contractual arrangements. These includes the plan and determination of a budget, the setting of safety and security standards, trust agreements, contractual frameworks that join the platform members and documentation and manuals written in English.

The last stage of the second phase should focus on the development of the initial concept for a concrete solution which is a condition to show the necessary competences and know-how and to enter in the German market. Although the introduction of a product in Germany just needs technical and legal formalities, German companies and institutions require the fulfilment of the requirements, particularly certificates for imports to Germany, safety marking, quality seals and preparation of use cases for concrete solutions in which it is provided a detail description of the implementation and functionality of the solution in a way that proves the expertise and compliance with German standards. To make sure the solution meets the market requirements, Portuguese companies should contact the German Engineering Federation. Moreover, the development of the initial concept serves as the basis for use cases which will be shown to potential partner institutions and companies in Germany.

Finally, it is essential to have a permanent office in Germany represented by a German-speaking person[69]. This is especially crucial for complex technical solutions as the case of embedded system implementation because they require personalized advice and personal support locally[70]. The local branch office should have a marketing and sales department that is responsible for getting offers, taking orders and providing service after sales. Therefore, a local branch office in Germany is considered the best option in terms of local representative in this country because it allows having a maximum

[68] Findings from Interview with CISTER
[69] Findings from Interview with Quidgest
[70] Findings from Interview with Critical Software

control and flexibility of the solutions, facilitates the communication and market entry and it is advantageous for setting up long-term business relations to customers. However, the recruitment process for the German-speaking employee is complex and, at the beginning, the revenues from the business activities will not cover the costs of the establishment of a local branch office making it an expensive investment.

1.5.6.a.2. Step 2 – German Market Entry

The second step will be divided in three phases in order to enter in the German market. In phase 1, the members of the platform should build personal relationships[71] and reputation and participate on R&D projects[72] that will take one year. Then, the companies should work on the first reference project that requires one and half years. After concluding these two phases, the phase 3 involves the introduction and distribution of the product that will last one year.

The purpose of phase 1 is to enable the platform to participate in a R&D project. In order to stand out for the mass of the companies in the German market, the establishment of personal relationships is one way of approaching the market by Portuguese companies. After completing successfully the development of the initial concept and performing all activities, the members should get in touch with associations, like VDMA[73], research institutes and technological clusters[74] and show their competences in the embedded system integration sector. Furthermore, the visit of trade fairs and conferences in Germany are the key to start the process of approaching cooperation partners[75]. Through the cooperation with institutions[76], the first completed R&D project and articles published in technical journals and business publications, the platform gains reputation and easier entrance in the German market. For the purpose of getting involved in the relevant project, firstly delegations from the local branch office should visit trade-fairs and conferences[77].

[71] Findings from Interview with Mr. Jörn Lehmann
[72] Findings from Interview with Dr. Olaf Sauer
[73] Verband Deutscher Maschinen- und Anlagenbau e.V. is a German engineering association
[74] Further information can be accessed in Appendix 10
[75] Findings from Interview with Mr. Jörn Lehmann
[76] Germany Trade & Invest helps with contacts and market expertise
[77] Further information can be accessed in Appendix 11

The product introduction in the market will be easier after completing the first project in cooperation with a German machinery and equipment company which will improve the trust building. The platform should advertise intensively the product in technical journals, trade fairs and conferences' visits and R&D project's participation as a strategic argument to show the member's competences in order to engage in a first practical project that serve as a reference project.

There are three aspects to take into consideration when implementing embedded system services in the market. We recommend following a price skimming strategy in which the platform charges the highest initial price that German companies are able to pay and then lowers the price to attract more companies. This price strategy is typical used for new technological products and services entering in the market. Although the machinery and equipment companies change from cooperation partners to buyer of the ESI services, the promotional activities remain unchanged. At this stage, the sales department should focus on the acceptance of the new product in the market and develop the platform as a brand. Regarding the distribution, the product should be demonstrated in the trade fairs[78] and sold directly from the local branch office in Germany to the potential customers[79].

2. Embedded Systems in the German healthcare sector

This section proposes the implementation of the platform developed and described in section 1.5.6. "Business idea - Embedded system implementation" to other business fields is approached. This project offers an alternative approach to the previously developed platform with the intent of adapting such platform to a new target market within the German economy. The proposal of this section focuses on the implementation of embedded systems in the German healthcare sector's paradigm, namely the eHealth field of expertise, hence enhancing the current healthcare service provision.

The spreading of new healthcare service offerings within emerging countries along with the improved access to pharmaceutical products is revamping the healthcare paradigm worldwide. Additionally, technological innovations are expanding the convergence of

[78] The trade pre-select the audience to specialists from companies
[79] Further information can be accessed in Appendix 12

medical fields, pharmaceutic research and biotech developments, thus increasing the demand for a wider healthcare IT system integration, semi-autonomous workflow and decision support applications[80].

The increasing health expenditure and the growing healthcare awareness are some of the challenges faced by societies worldwide. Furthermore, statistics indicate that population with over 60 years will rise from 600 million in 2010 to 2 billion until 2045 which further increases the social pressure for healthcare efficiency solutions. Such social pressure will keep growing with the ascending chronic and degenerative illnesses along the staff shortage in health related institutions[81].

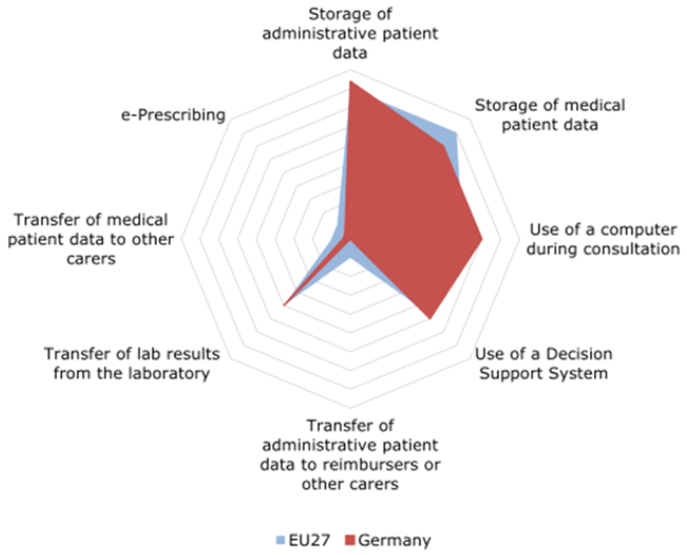
Currently, the usage of IT and telecommunication solutions within health related institutions plays a crucial role within healthcare management, providing decision makers with updated and detailed information throughout the service delivery. An example of such applications is the telemedicine market which is expected to worth over € 5 billion by 2015 within Germany has over 240 telemedicine projects spread through 100 cities and communities[82]. However, telemedicine still faces numerous implementation challenges in the short-term within Germany. An example of such challenges is the current doctor's code of conduct which states that remote treatment is only available through at least one physical consult with the patient. Other drawbacks to telemedicine implementation with Germany feature the disparity of internet quality among regions, connectivity-related issues and the national lack of awareness towards the inherent advantages of e-health services[83].

The eHealth market segment in Germany is still emerging with isolated solutions being transferred across healthcare centres and integrated solutions struggling to become viable nationwide. Nevertheless, the eHealth segment is perceived as a high potential opportunity able of transversely increase healthcare efficiency and effectiveness while demanding more complex embedded system solutions. Currently these solutions are being applied in medical functions such as storage of administrative patient data, storage of medical patient data, usage of IT during consults, usage of a decision making support system, transfer of administrative patient data to reimburses or other carers, integration of lab results, patient medical data transfer to other carers and e-prescribing.

[80] ARTEMIS Industry Association and ITEA (2013) *High-level vision 2030: opportunities for Europe*
[81] ARTEMIS (2013) *Embedded / Cyber-Physical Systems Major Challenges: 2014-2020*
[82] CBI Ministry of Foreign Affairs (2014) *Embedded systems for telemedicine in Germany*
[83] CBI Ministry of Foreign Affairs (2014) *Embedded systems for telemedicine in Germany*

The usage of the mentioned medical functions can be analysed within Figure 1 "eHealth use in Germany and in Europe."

Figure 1: eHealth use in Germany and in Europe



By analysing the average usage of eHealth in Europe (EU27) and more specifically within Germany, it's possible to conclude that there is an overall resemblance between both sources. Even though Germany leads within storage of administrative patient data, usage of IT during consults, usage of a decision making support system and integration of lab results, the remaining areas remain relatively uncharted. Therefore, the usage of embedded systems within eHealth still retains business opportunities for both manufacturers and healthcare providers.

Among the several eHealth business areas, the exchange of patient medical information between healthcare providers is considered a high potential area of expertise for increasing quality and efficiency in health-related services. An example of such approach is the development of new pharmaceutical services through the increase in information exchange between carers. Pharmacies can benefit from such technological shift through a diversification in service offerings while developing and improving CRM programs. Additionally pharmacies hold to potential to establish new service channels due to the strengthened relationship between patients and pharmacists[84]. The development of new services along with the implementation of embedded systems

[84] MELLO, D. 2013. *Designing Pharmaceutical Services Using the Multilevel Service Design Methodology*

within the healthcare sector, namely within community pharmacies, is able of empowering the pharmacy role with healthcare systems while ensuring that healthcare decision making is supported on updated patient data from an holistic standpoint (Barros, Martins et al. 2012). Additionally, through the data mining of patient profiles and healthcare service provisions it's possible to ensure an improved therapeutic management while simultaneously ensuring a more effective control of pharmaceutical drugs. This paradigm shift is aligned with emerging healthcare trends suggesting the end of pharmaceutical services restrained to a physical environment of the community pharmacy (Castelino, Bajorek et al. 2011). Furthermore, the development of new service offerings such as the ePharmacare project, remote physician consultations and the improvement of pharmaceutical services leans towards a patient-oriented practice[85]. Lastly, the enhanced access to patient data from a healthcare standpoint will lead to a more personalized healthcare which is able of establishing a positive impact in patient satisfaction throughout his or her service journey[86].

Simultaneously, the new developments within eHealth care are raising new requirements from embedded systems such as real-time data transfer and communication, customized service offering, interactive resource management, multitasking & multithreading and wide network coverage[87]. All of the mentioned requirements aim at improving the healthcare services provision while ensuring the service delivery quality. By taking full advantage of a service offering combining the medical care and IT it's possible to further boost service delivery while improving service accessibility[88]. Additionally embedded systems specifications must fulfil specified German requirements while complying with European standards regarding quality, safety and reliability while being able to offer customized solutions required in eHealth[89].

However, embedded systems implementation within the healthcare sector presents several challenges from both a social and technologic perspective. Firstly, information security and data protection fields become critical issues when approaching patient

[85] MELLO, D. 2013. *Designing Pharmaceutical Services Using the Multilevel Service Design Methodology*
[86] LAPÃO, L., GREGÓRIO, J., MELLO, D., CAVACO, A., DA SILVA,M.M., LOVIS,C., 2014. *Using Design Science Research to develop Online Enhanced Pharmaceutical Care Services. Studies in Health Technology and Informatics.*
[87] CBI Ministry of Foreign Affairs (2014*) Embedded systems for telemedicine in Germany*
[88] IDC (2012) *Final study report: design of future embedded systems*
[89] CBI Ministry of Foreign Affairs (2014) *Embedded systems for telemedicine in Germany*

sensitive data. Another major concern lies within the importance of the physician to be physically present throughout the service delivery stage, in order to grant the healthcare provision with an altruistic aspect. Additionally, it's vital to acknowledge the complexity and security hazards involved in customer using their own devices to access eHealth services. Although suppliers tend to narrow the set of choices for end-users in an attempt to minimize service failure along with possible user errors while ensuring reliable usage standards[58].

Upon analysing the eHealth scenario described within this paper, some considerations should be accounted for when attempting to export embedded systems and know-how to the German healthcare sector. Firstly the manufacturing and exporting costs should be lower than those operating within Germany domestic manufacturers. Secondly, it's critical to invest within the R&D stage of the production process in order to differentiate service offering while attempting to create and maintain a competitive advantage within the German healthcare market. Lastly exporting companies should acknowledge the existing German business culture while approaching the desired market segment through alliances and partnerships with German manufacturers of embedded systems[90].

3. Reflection on learning

3.1. Previous knowledge applied

During the Master Degree Program, I acquired knowledge and important concepts that I applied in the work project. The strategy course was essential to evaluate the most promising subsectors by using strategic frameworks such as market attractiveness and Porter's five forces. Furthermore, after a deep understanding of the importance of the key success factors for companies and the need of sustainable competitive advantage in order to compete in the market, it was necessary to take that learning into consideration in this study.

On the other hand, one of the key contents learned in the international business course was the impact of cultural and commercial factors when exporting. In this case, the cultural differences between Portugal and Germany led to the establishment of a local

[90] CBI Ministry of Foreign Affairs (2014) *Embedded systems for telemedicine in Germany*

branch office in Germany managed by a German-speaking person. The commercial factors, such as the difficulty of Portuguese companies to establish partnerships in Germany, is one of the reasons that lead to the creation of the platform composed by a strong group of Portuguese companies, universities and research institutes and associations in order to overcome trade barriers like the one mentioned. Lastly, this course helped in the screening process to identify target markets as well as in the entry mode strategy of the product such as price, promotion and distribution.

3.2 New knowledge: new methodologies and frameworks

This work project allowed me to acquire new business contents related to project management such as planning, executing and monitoring were used along the development of the thesis. In the beginning, it was identified the deliverables and the activities needed to complete those deliverables, and then it was followed processes in order to complete the work defined. Finally, it was monitored and controlled the project execution with the purpose to adjust the plan.

By developing this project, consulting knowhow was acquired by firstly understanding the problem, then defining key possible solutions for further examination and finally making appropriate recommendations for the problem and translating recommendations into an effective implementation plan. Moreover, the consulting information about how to build slides provided by the academic advisor contributed to the formulation of meaningful presentations as well as the clear understanding from the audience.

3.3 Personal experience

Concerning the strengths of my experience in this work, the fact that the team was composed by a German and a Portuguese student with innovative perspectives and different methods of work helped to create a dynamic during the development of work as well as to overcome the complexity of the topic. Furthermore, the work experience of my colleague was important to define the goals of the work project as well as to work efficiently. The execution of the work project allowed me to put into practice the theories learned during the Master Degree as well as strengthening analytical skills that

were a determinant factor when analysing and selecting the vast amount of available data. On the other hand, being exposed to the vast experience of the partners and also the top management of the companies enhanced my communication skills, leadership and ability to deal with constructive criticism.

One of the aspects that weakened the project was the time available to develop the complex topic that we were involved in which led us to make fast decisions, in the Portuguese side, without a detailed and deep analysis. Additionally, since this is a future's topic, it was hard to find online information about the subsectors in Portugal and to obtain answers and interviews from Portuguese companies.

3.4 Benefit of hindsight

In my point of view, interviews that were performed throughout this project in Portugal and in Germany added most value for this project because the information provided by the experts and the executive managers complemented the information available online. The area that needs to be improved is the analysis of the Portuguese side regarding the four fields selected since a deep analysis should be conducted in order to have more precise information.

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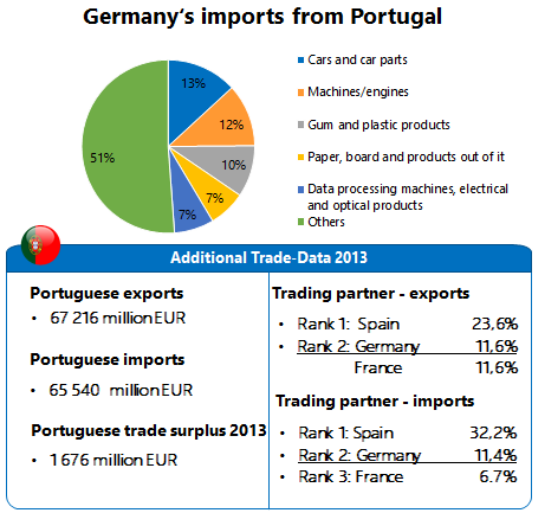
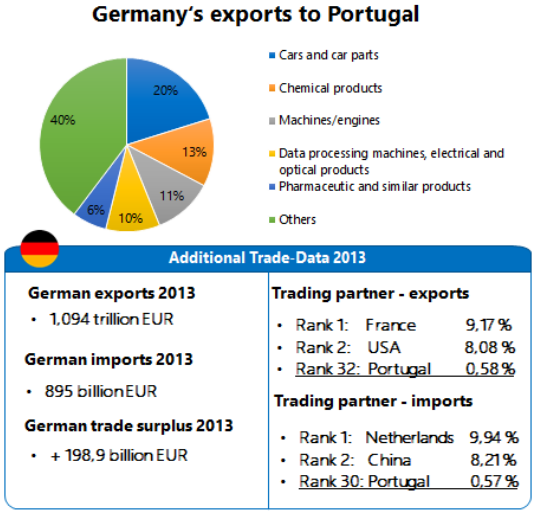
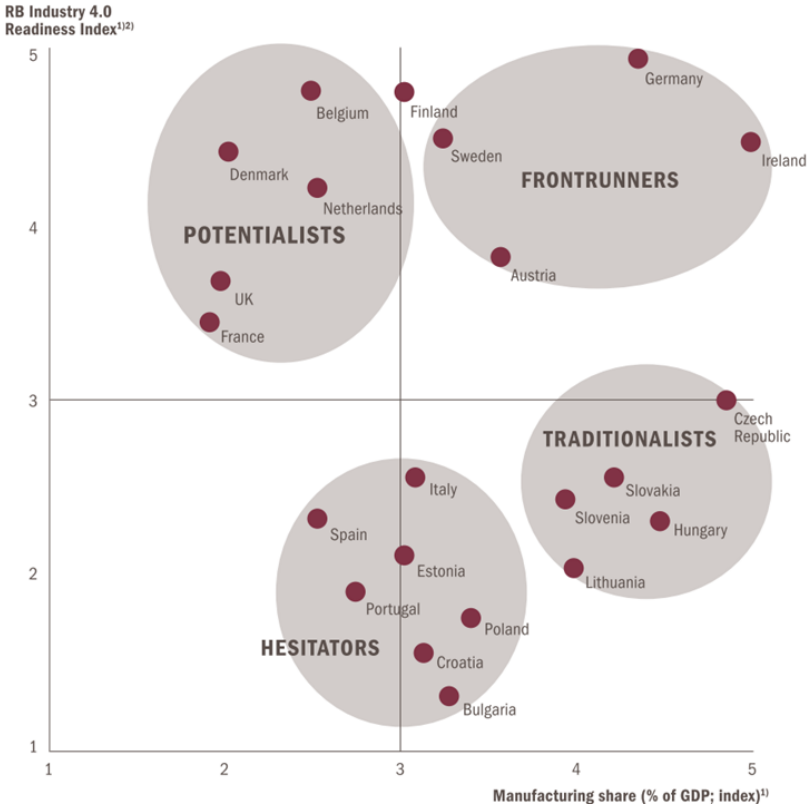
Appendix

Appendix 1 – Overview of Trade-Data





Appendix 2 – Portugal's Industrie 4.0 Readiness within Europe



Appendix 3 – Current Situation of Industry 4.0 in Portugal

- Portugal should have a national program in this area of Industry 4.0 to enhance greater cooperation between the companies in the development of the industrial area.
- Portuguese companies have innovative products that respond to Industry 4.0 requirements

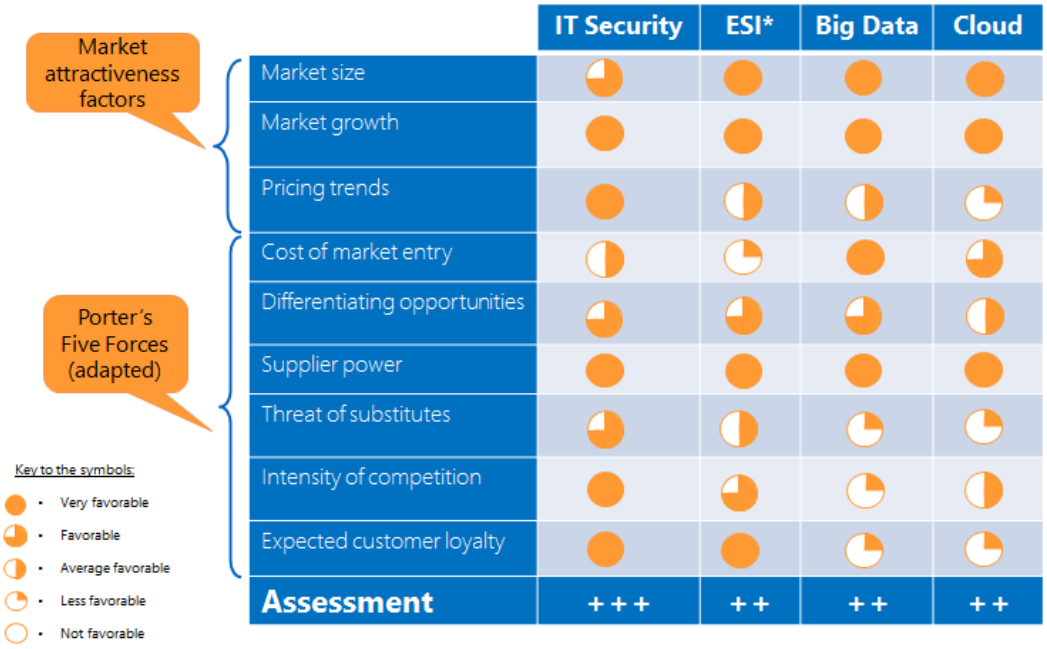
"Our product comes out with intelligence to be integrated in systems where the product is equipped to engage automatically, with protocols that are standardized, on an Internet format that make self-diagnosis, communicate this diagnosis automatically, which allow you to interact with other devices automatically to exchange information" Microprocessor

- Portuguese companies are interested in the Industry 4.0 as well as motivated to cooperate with German companies and institutions in the research, development and implementation of new products.

Appendix 4 – Initial Situation of Portugal regarding its Export Potential

- Portuguese employees are considered to have an "**innovative and problem-solving**" mind*
- Portuguese employees are **better in solving Industrie 4.0** related **problems** than Germans*
- Several groups are working on **innovative technologies**
- **High-qualified** labor is **relatively cheap** compared to Germany
- The **productivity is approaching to the German level***
- Several multinational companies are about to create **competence centers in Portugal**
- **Flexible workforce**
- Employees have **very good English skills**
- **Availability and willingness for international cooperation's**

Appendix 5 – Market Attractiveness Ranking



	IT Security	ESI*	Big Data	Cloud
Market size				
Market growth				
Pricing trends				
Cost of market entry				
Differentiating opportunities				
Supplier power				
Threat of substitutes				
Intensity of competition				
Expected customer loyalty				
Assessment	+++	++	++	++

Appendix 6 – Ranking of the subsectors according to the selected criteria

	IT Security	ESI*	Big Data	Cloud
Number of Companies	++	+++	+	+
Technology knowledge/experience	+	+++	+	+
Competitive field	+++	+++	++	++
Player importance	+	+++	+	+
Assessment	++	+++	+	+

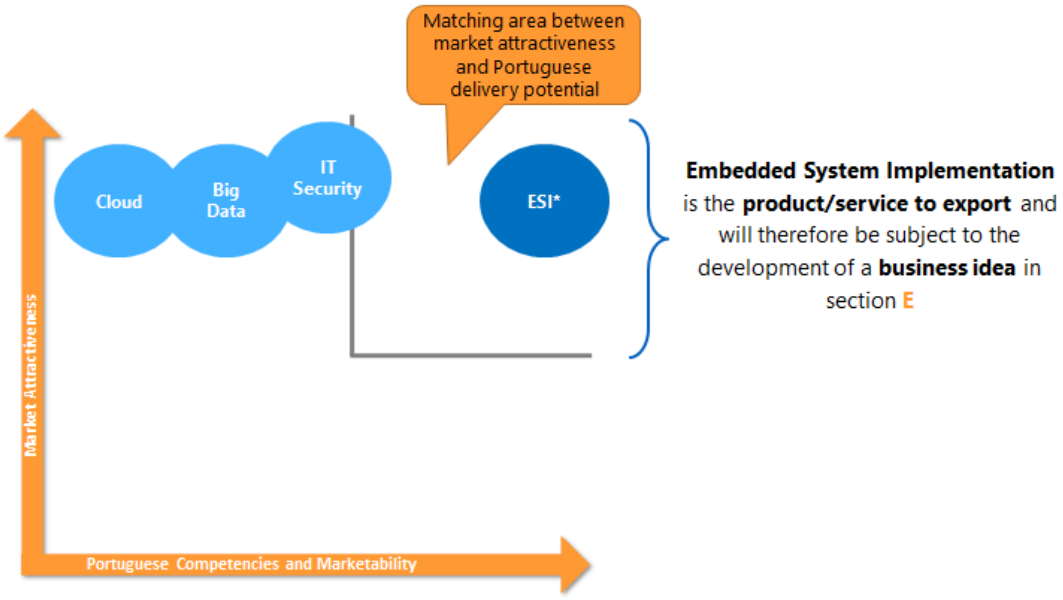
Key to the symbols:

+ + + **Very favorable**

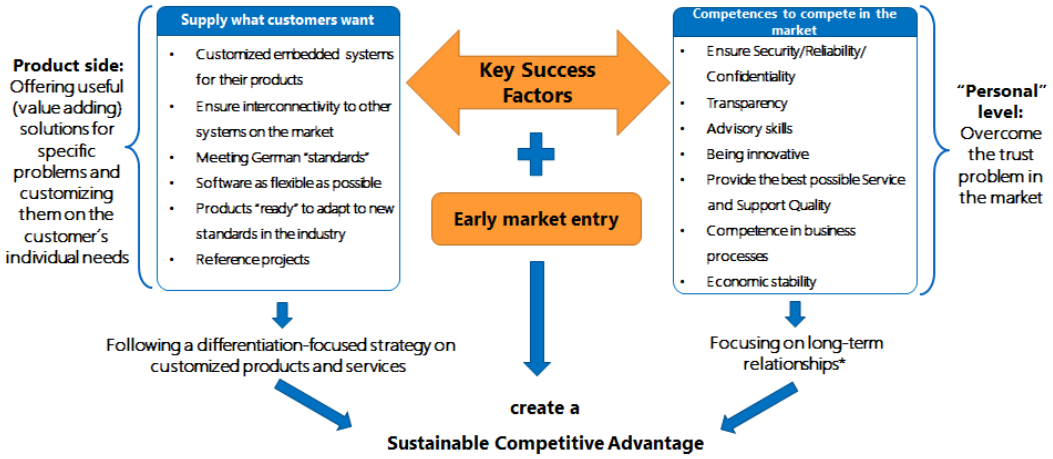
+ + **Favorable**

+ **Less favorable**

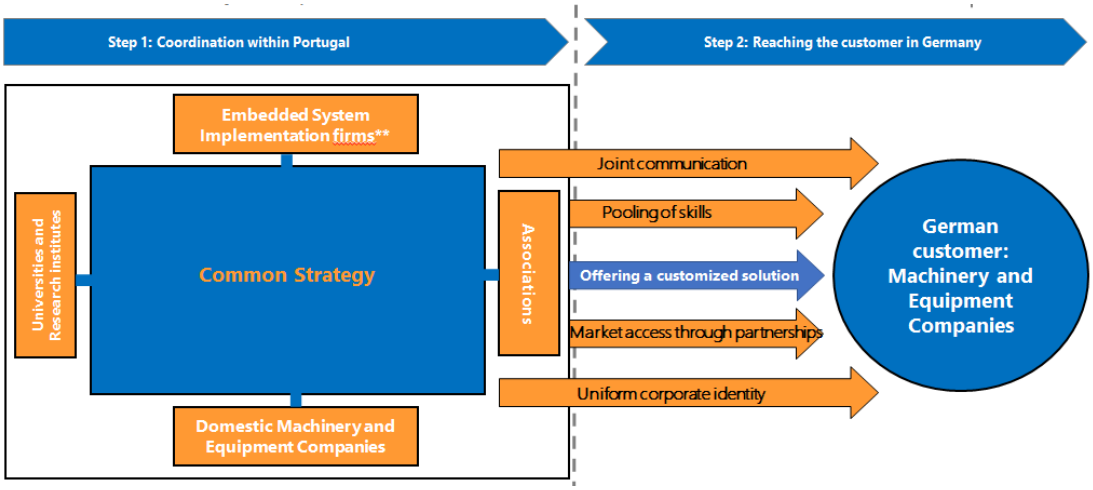
Appendix 7 - Comparative analysis: Market attractiveness and Portuguese Supply Capabilities



Appendix 8 – Creating a Sustainable Competitive Advantage



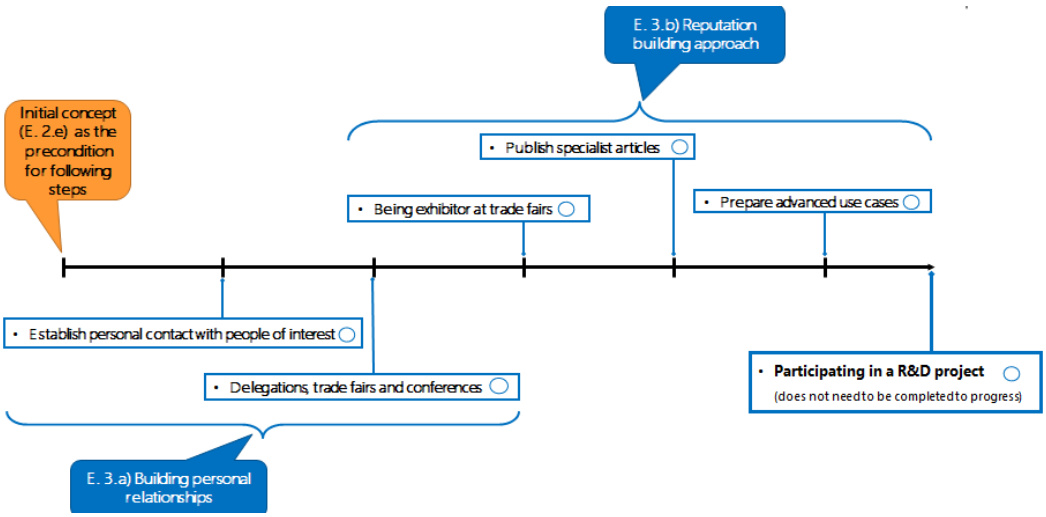
Appendix 9 – The Embedded System Implementation Platform



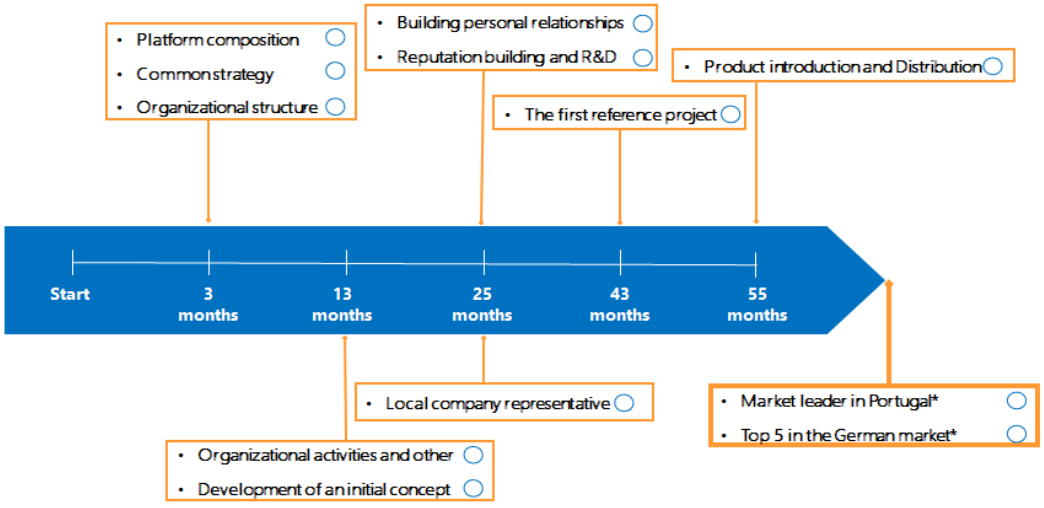
Appendix 10 – Contact Information in Germany

Associations	Technical journals	Universities/Research Institutions	Clusters	Other organizations and fairs
• www.vdma.org • www.vdw.de • www.vda.de/de • www.fdm.de • www.bdli.de	• www.antriebspraxis.de • www.industrie-service.de • www.dima-magazin.com • www.industrielle-automation.net • www.ate-magazine.com • www.mda-technologies.com • www.vdi-z.de • www.technia-online.ch • www.publish-industry.net	• www.iosb.fraunhofer.de • www.ipa.fraunhofer.de • www.hni.uni-paderborn.de • http://www.aif.de • http://www.dfg.de • http://www.max-planck-innovation.de • http://www.helmholtz.de	• www.its-owl.de • www.automatisierungsregion.de • www.tti-md.de • www.fermeth.de • www.icm-chemnitz.de • www.auto-rlp.de • www.automotive-bw.de • www.automotivecluster.com/ • www.wfgheilbronn.de • www.automotive.saarland.de • www.ae-network.de • http://www.region-stuttgart.de	• www.bmwi.de • www.gtai.de • www.ccila-portugal.com • www.portugalglobal.pt **Trade Fairs** • www.maschinenbau-gipfel.de • www.hannovermesse.de • www.messe-intec.com • www.fmb-messe.de/ • www.euroblech.com • www.messe-stuttgart.de

Appendix 11 – Phase 1: Processes to be followed



Appendix 12 – Evaluation of Success



Appendix 13 - Interviews German Companies and Institutes

Name	Position and Institution/Company	Type of Interview
Christian Dülme	Research assistant in the research group Product Engineering at Heinz Nixdorf Institut - Acatec	Conducted by phone
Daniel Eckelt	Research assistant in the research group Product Engineering at Heinz Nixdorf Institut - Acatec	Conducted by phone
Dr. Carsten Malischewski	Business Development Executive Hewlett-Packard GmbH	Conducted by phone
Dr. Olaf Sauer	Deputy head of Fraunhofer IOSB and in charge of business development.	Conducted by phone
Dr. Thomas Wolf	Operations Manager Industrial Products at PwC	Conducted by email
Jörn Lehmann	Projectmanager VDMA (German Engineering Federation for Research and Innovation) and Speaker of the Industrie 4.0 Platform (VDMA, ZVEI and Bitkom)	Conducted by phone
Marco Kayser	Projektassistent Zukunftsfeld Cyber-Physical-Systems at WITTENSTEIN AG	Conducted by email
Martin Theben	Partner and Head of Industrial Production at PwC	Conducted by email
Matthias Dietel	Manager Executive Briefing Center IBM Deutschland Research & Development GmbH	Conducted by phone

Appendix 14 - Interviews Multinationals and Institutes in Portugal

Name	Position and Institution/Company	Type of Interview
Andreas Maertz	Director of Siemens IT Competence Center	Conducted personally
Glória Peixe	Project Manager at IBM	Conducted by video conference
Luís Lino Ferreira	Research Associate at CISTER (Research Center in Real-Time & Embedded Computing Systems)	Conducted by video conference
Nathalia Pessôa	Corporate Communications Officer at Bosch	Conducted by email
Pedro Cunha	Professor at the Polytechnic Institute of Setúbal in the Technology and Industrial Organizationand Director of the Center for Integration and Innovation Processes (CENI)	Conducted by video conference
Professor Dirk Elias	President of the Executive Board - Fraunhofer Portugal	Conducted by phone
Tiago Esteves	Responsible for business management solutions Microsoft Dynamics CRM	Conducted by video conference

Appendix 15 - Interviews Portuguese Companies

Name	Position and Institution/Company	Type of Interview
Anonymous at request	PT	Conducted by email
António Carneiro	Director of the business unit informação ao público at Microprocessador	Conducted by video conference
Fernando Leite	Co-Fundador of Controlar	Conducted by video conference
Luís Gargaté	Business Development Manager in the area of railway and automotive at Critical Software	Conducted personally
Nicolas Kinting	Responsible for the German-speaking markets at Quidgest	Conducted by video conference
Nuno Ponte	Head of Advanced Solutions at Multicert	Conducted by email
Nuno Ribeiro	COO and co-founder of Ubiwhere	Conducted by video conference
Ruben Cunha	Business Developer Manufacturing Business Unit at Primavera SS	Conducted by email