On the Basis of the Sales Engineering Competences and Education

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Abstract. Sales engineers (SE) sell technical products and services to companies. They consult the professional customer and suggest technically and economically feasible solutions with maximum utility for both the customer and their own company. They combine technical knowledge with commercial skills. They are best trained to understand the requirements of the industry. Nowadays there is no clear definition of the profession of à sales engineer.

Sales engineering is a profession which includes at least as much skills than knowledge. This unique profession is a mixture of technical, sales, business, management and soft skills, internationalization included. Therefore traditional division between engineering, economics, management and other education does not seem to fit for sales engineering education and its needs.

Since there is no definition for SE curricula, the state-of-the-art of the education has never been studied before. This article reveals the need for the sales engineers, introduces methods for the definition of the sales engineering education, and presents a state-of-the-art education from European perspective. Study proposes boundary limits for sales engineering education and gives a basic definition for sales engineers´ education. Future research actions and needs are addressed at the end of the article.

Keywords: Sales engineer · Curricula · Education · Engineering · Sales · AASE

1 Introduction

Sales engineers (SE) sell technical products and services to companies. They consult the professional customer and suggest technically and economically feasible solutions with maximum utility for both the customer and their own company. They combine technical knowledge with commercial skills. They are best trained to understand the requirements of the industry [1].

SE understand the technology and the functions of the product. Thus, they need a base knowledge of engineering. At the same time, they are capable to link the technological viewpoints to the economically limiting conditions in terms of costs as well as in more general macro-economic relations. As consultant to their customers they also need communication skills as well as a certain psychological competence. They must

be able to ask their customers about their product, its applications and needs, thus finding out the customer's requirements which are not given in the technical specification. As for this, they may use techniques from Kano's model of customer satisfaction (CS) [2]. Many companies use the method of the House of Quality which is part of Akao's Quality Function Deployment (QFD) to optimize the product with respect to its technical performance [3]. However, SE are able to combine both methods which can be described as the method of Customer Satisfaction and Quality Function Deployment (CSQFD) which is described by Schneider-Störmann [1].

SE are working in a wide field of the industry: From technology-driven enterprises selling customer tailored investment goods to technical mass products such as electronic and mechanical components as well as standardized machine elements. If the product variety is wide, the depth of knowledge in the different engineering disciplines need to be flat, but the number of engineering disciplines to be covered needs to be varied as shown in Figure 1. Sales Engineers dealing with special tools such as customer designed investment goods need to be experts in the corresponding field of engineering. Thus, they need to have a large depth of knowledge in this field.

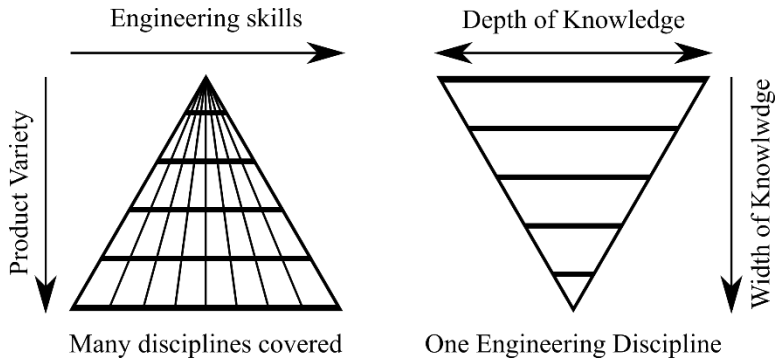

Fig. 1. Depth of knowledge vs. width of product range sold by a Sales Engineer [1]

SE are working in a wide range of B2B industries including but not limited to plant and machine engineering, electronics, medical industry, information and telecommunication, optics, software development or services.

Thus, a clear demand for Sales Engineer's competences can be pointed out:

1. They need to have a solid knowledge base in engineering
2. They must have profound sales, negotiation and marketing capabilities
3. Economic and business administrative issues have to be part of their thinking and actions
4. Communication skills are essential, including negotiation skills
5. Soft skills, such as giving presentations, are obvious.

Figure 2 shows the different scientific fields which should be present and part of sales engineers competences.

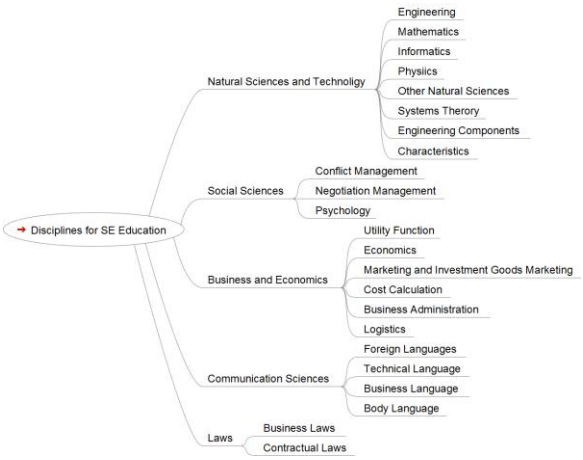

Fig. 2. Fields of sciences and education of Sales Engineers

Depending on their desired field of activity according to Figure 1, their detailed educational plan needs to be changed: If SE intend to sell investment goods, the engineering part of their education should be more in depth. In general, competences in methods lead to a more flexible SE compared with persons having huge and detailed knowledge in single disciplines. By covering all scientific fields, highlighted in Figure 2, more competent Sales Engineer can add value to his/her respected industry.

2 Need for Sales Engineers: A European Perspective

The internal trade between EU-28 (internal market) member states has been relatively stable from 2011 to 2015, with an annual value for 2015 of over EUR 3,063 billion €. Compared to the 1,908 billion € in 2002, value of trade has grown more than 50 % since. The global financial crisis, which started between the fourth quarter of 2008 and the second quarter of 2009, decreased trade value and volume tremendously. It came back to same level as it was before the crisis only in the beginning of 2011.

This EU´s internal market, which is the sum of all the nationally international markets, mainly consists of manufactured products. Their share was 80 % of the total intra-EU export in goods. Machinery and vehicles together with other manufactured goods were over 63 % of this share. Chemical products, which are included in the manufactured goods, sum up for 16 % and primary products for roughly 19 % of it, including food and drink (10 %), energy products (10 %) and raw materials (3 %). Export to regions outside EU also consisted mainly in manufactured products. These products represented about 80 % of the total annually EU exports. In 2013 the value of exported machinery, vehicles, and other manufactured goods reached 1,365 billion € [4,5].

All of this trade is international. Either it is international inside the EU or international between EU countries and non-EU countries. The main destinations in extra-EU goods export (including all goods exported) in 2014 were USA, China, Russia, Turkey,

Japan, South-Korea, Brazil, India, Saudi-Arabia, Canada, Australia, Mexico, South Africa, Indonesia and Argentina. USA were significantly the largest market with over 310 Billion € followed by China (165 Billion €) and Russia (100 Billion €). Turkey and Japan exceeded 50 Billion € and the other partners ordered goods for the sum of between 20 and 50 Billion €. Extra EU services export's main destinations were very similar to the goods exports in 2014. USA were extremely distinguishable with the value of 197 Billion €, which was over 25 % of total extra EU service exports. When scrutinizing USA´s share in goods exports, over 18 % from total value, it is clearly seen that USA is most important single market area for EU [6,7].

In 2013, manufacturing represented 2.1 million enterprises, 29.7 million employees, and an added value of 1,630 billion €, and the sole high-tech manufacturing branch consisted of 46 000 enterprises (2014) and an extra- and intra-EU trade volume of 683 billion € (2015) [8]. Manufacturing is therefore the largest contributor to non-financial business economy added value in Europe, accounting for more than one quarter of the total one in the EU [5]. Manufacturing is just one of the sectors of NASE, which is a statistical classification of economic activities in the European Community, where technical sales persons are needed. E.g. sectors of mining and quarrying, electricity, gas, steam and air-conditioning supply, construction, transportation and storage and Information and communication probably also needs SEs - just to mention a few - . Since manufacturing sector alone is about 80 % of total intra-EU trade (3063 Billion €), the total value of technical intra-EU trade sums up to more than 2,000 billion €, and more than 1 300 billion extra EU-trade summing up 3 300 Billion € trade. And these numbers are not counting other sectors than manufacturing!

When underlining that the above figures do not include domestic trade (done inside different EU countries) the huge need for well qualified and performant Sales Engineers as well as an appropriate SE education becomes very clear.

If we suppose that one SE is generating 5 Million € turnover per year it means that there is 660 000 persons working as SE in EU. And if we suppose that career for SE is 40 years we end up to conclusion that every year 16 500 new people is needed in the field of technical sales. These figures are not studied but given as demonstration purposes. Even if we double the sales volume for each SE to 10 Million per year it still means that more than 8 000 new persons is needed. When comparing that number of annual SE graduates from AASE members is less than 1 000 graduates it is easy to see the gap between need and supply.

3 Academic Association of Sales Engineering (AASE)

Unfortunately, sales engineering is not yet a well-established academic career at European Higher Education Institutions (EuHEI) nor is it an officially recognized profession. Founded in June 2014, the AASE, the Academic Association of Sales Engineering, currently counts 47 academic members from 19 EuHEI from Austria, Finland, France and Germany. All participating EuHEI, representing universities, universities of applied sciences (UAS) and schools, offer SE training with combined technical and commercial issues, including the more practical aspects of sales issues.

The AASE aims primarily at: 1) Promoting the profession of sales engineering to politicians, industrials and the public, 2) Defining standards for the SE education, 3)

Facilitating the acceptance of courses and curricula between the partner EuHEI and thereby increase the (international) student exchange and 4) Facilitating and organizing the cooperation between teachers, and lectures at partner EuHEIs.

The AASE pursues these objectives initially across Europe by associating academic employees from other EuHEIs offering or planning SE trainings. This is achieved within AASE by three working groups set up focusing on teaching, on research, and on public relations. The AASE members decided to cooperate on exchange programs of teachers, to facilitate (international) student mobility between the participating EuHEIs, and to work on common teaching methods, tools and materials. The AASE members also want to initiate common research projects and to do a concerted communication.

A first analysis of available information within the AASE member EuHEIs and on Internet sites has given very different results regarding Sales Engineering training offered by Austrian, Finnish, French, German, Italian and Spanish EuHEIs. In Germany, about 30 Bachelor and Master Degrees exist at about 20 EuHEI, all of them founded within the last 15 years. In the other countries, the identified offer is quite small or not existing: Two degrees in Austria, three in Finland, one in France and none at Italian and Spanish EuHEIs. The other European countries haven't been investigated thoroughly yet. Even when this analysis isn't exhaustive, there is a clear tendency showing the poor offer of initial sales engineering studies in Europe.

All existing SE studies follow their specific curricula, guidelines, focuses, planning and internship rules. The Bachelor Degrees durations vary from six to eight semesters (3-4 full years), and the Master Degrees between two and four semesters (1-2 full years). Generally, the minimum is that at least one international study or internship semester is requested as well as an internship of three month or more in a company.

All SE curricula respect the four pillars of issues shown in Figure 3 with different repartitions between them. These differences within the four pillars are due to local singularities such as existing infrastructures, local industrial competences or cooperation with companies.

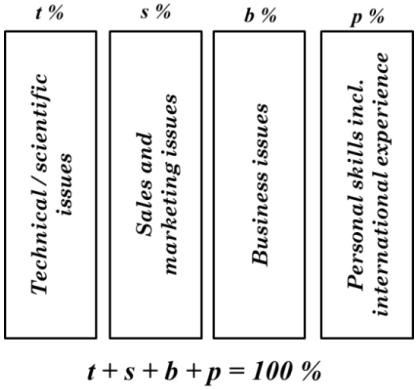

Fig. 3. The four pillars of a typical sales engineering training [9]

The two first pillars are strongly characterizing SE trainings. The technical/scientific pillar (t) includes the basics such as mathematics, physics, statistics, and so on, but also the technical lectures, e.g. mechanics, electronics, or others similar technical topics.

This technical part is varying from one EuHEI to another, but following one of the two alternatives, also represented in Figure 1.

Most of the sales engineering degrees have been set up at technical oriented EuHEIs as the technical education requires highly qualified staff and heavy investments in infrastructures. As EuHEIs are generally proposing a technical specialization, the SE training is connected to this specialization to benefit from existing resources and lectures. A graduate from such an EuHEI will have a strong specialization too, and s/he will probably work in this domain. Some EuHEIs propose more generally orientated SE trainings with a large spectrum of technical basis lectures. In this case, the sales engineer is mainly a generalist who can work in multiples industrials domains, but on a lower specialized level.

The second pillar (s) is the very important sales and marketing axis. Effectively, sales is done between people, and the appropriate tools and methods need to be known and mastered to understand the customer, to analyze their problems, and to suggest them value adding and an economically viable offer. Marketing issues must focus on B2B and industrial, technical or investment goods marketing, as the SE won't mostly sell to the end consumer with different marketing approaches. This axis includes also skills like negotiation or psychology.

The third pillar (b), business and management, covers topics related such as general economics, leadership management, accounting, logistics, legal aspects, export or human resources.

And the fourth and last pillar (p) regroups personal skills like languages, interpersonal communication and presentation; and also the international and professional experiences.

The broad range of the different contents indicates, that SE need to be able to think and act as an engineer, a business man and a sales professional at the same time. Compared with the pure engineering or economic domain, SE studies are quit a young discipline, and that is why there is an urgent need to structure and define the necessary content of the curricula.

4 Industries´ and students´ expectations

The industries´ and of students´ expectations of SE studies are not identical. Where the industry is looking for SE to respond to their needs in all aspects, students are also searching for personal fulfilment and experiences. In this paper, current division of education available at AASE member EuHEI´s is presented, based on Figure 3 pillars.

As said before, SE training is a young discipline, and there are no clear definitions of content or competences validated by studies. Therefore, minimum standards of competences and knowledge should be created. Existing SE trainings are different, and there is no guarantee that present curricula correspond to industrial needs, even if all member EuHEIs report employment rates of more than 95% at the end of the studies. That is the reason why there is a common conviction that minimum standards should be set up in line with the requirements of the industry on skills and competences to strengthen the profile of sales engineers.

These minimum standards must respond to two conditions: 1) They must define the competences and contents the industry is looking for. To achieve this a large study

needs to be undertaken to identify these expectations for two time horizons: today and in five to ten years. The SE environment is changing, due to upcoming and already existing digital sales and training tools and programs, and the further technical developments. This research work could confirm the number of SE required in the next ten years, a figure which will be very important for promoting and creating new SE trainings in Europe. 2) The proposed education schemes must be sufficiently flexible and open that all EuHEIs can adopt them, as well as national or local accreditation rules. One option could be to define minimum contents t', s', b', and p' for the four pillars from figure 3 responding to the following equation:

$$t' + s' + b' + p' < 100\ \%.$$

Another option could be to define a list of mandatory competences, knowledge and skills. This paper presents former one of the options.

In todays global business, adequate language skills are a must. International business language is English and therefore good English language capabilities are mandatory for each SE. A second foreign language generally would add value to every SE. Due to this,. That is why language skills, preferentially proven by international language certifications, should be integrated part of all SE curricula.

In addition, each student should benefit from a long lasting international experience in a non-native-language country to learn how to survive in an "unfamiliar" environment. During this experience the student will discover a foreign culture, experience new management or teaching styles, and meet new people to add to his/her future network. This first international experience should be proposed to all students, or even be compulsory during the studies. This experience could be an academic or an internship experience.

At least one internship, lasting minimum three month, should also be obligatory to force students to discover sales and/or marketing activities in a true professional environment, and to get first industrial contacts. This will be the opportunity to validate a chosen industrial sector or a type of company such as, e.g., start-up, SME or large company.

Establishing (international) student exchange is another ambitious objective. Today, such an exchange must be organized so that the student won't lose a semester or a year, which would be disadvantageous in his curriculum vita. Two strategies from EuHEI side are conceivable: 1) The first one consists in trying to build the exchange students´ study program based on existing lectures during their stay. Only by matching a certain number of subjects with the program of the host institution, this exchange will be successful from student's point of view. This strategy needs a lot of organizational effort from the host institution, and this will generally be a bilateral or trilateral agreement. 2) The second strategy is to harmonize one or several training semesters and to oblige students to do their exchange period during these semesters. Naturally organizational effort are required, but this needs to be done once. This way all student exchanges are part of the curricula and it is guaranteed that the exchange semesters are recognized at the home institution. The disadvantage of this option for the institutions is that modifications of their curricula would be necessary, which can only be done when new accreditation is requested for the degree. Sequence of accreditation varies from country to country and can be instantly or even five years.

In the beginning of cooperation, the only option is the first one with an individual program planning. But in the medium-term, the second strategy should be favored as it allows a smooth exchange between the multiple EuHEIs.

The AASE aims clearly at defining one or two semesters with a common training program once the above mentioned minimum standards have been defined. It then will be the mission of each EuHEIs to adopt their study program to this joint frame when they renew the accreditation.

One way to reinforce the visibility of sales engineers and SE education is to certificate the curricula according to defined conditions and to let industrials and politicians know about it. Such a certification has multiple advantages: 1) It permits to ensure a requested quality level of the curricula and to guarantee that the acquired knowledge and competences correspond well to what the SE will need in his/her professional live, 2) Certificated curricula are a guarantee for companies when they are looking for new SE employees. With this way, certification improves the chance for SE students to find employment, 3) Certification is an effective marketing argument to anchor this important but nearly unknown profession in the attention of society, and to draw the attention of politicians, funding organizations, industrial representatives and the public to it.

Regarding these goals and objectives this paper describes the present situation regarding the division into the pillars illustrated in Figure 3 of 20 SE studies in AASE member EuHEIs.

5 Research setting

All 19 member institutions in the AASE member EUHEIs have been asked to provide data on their specific sales engineering curriculum. Eighteen of them, corresponding to 95% of the contacted institutions, answered to the survey. By that detailed information about 14 Bachelor Degree, 5 Master degree, and one five-year diploma curriculum is available and used for the following data analysis. The participating EuHEIs are illustrated in Table 1.

The data include the type of the curriculum, the standard number of semesters to get graduated as well as the number of necessary ECTS, the type of the diploma, the distribution of the different lectures within the four above-mentioned thematic pillars, requested international internships or professional experiences, and finally general remarks concerning the study program.

The mapping of the different lectures to one of the four pillars Science & Technology, Sales & Marketing, Business & Management, and Personal Skills is done by each degree responsible. In most cases, this mapping is clear, but sometimes it is not. To harmonize the results of this analysis, some ambiguous lectures have been assigned to the same category for this evaluation. E.g. project management is assigned as well to the Scientific and Technology category as to the Business & Management category in local study programs, but always to the Business & Management category for this study.

As most degree programs offer different options for students, the degree responsible have been asked to enter a typical sales engineering curriculum. Slight differences in the individual programs of students at the same faculty are therefore possible.

Table 1. List of institutions and corresponding analyzed study programs

Institution	Country	Bachelor	Master	Diploma
UAS of the bfi Vienne	Austria	x		
UAS Wiener Neustadt	Austria		x	
Turku UAS	Finland	x	x	
ESTA Belfort	France			x
HTW Aalen	Germany	x	x	
UAS Aschaffenburg	Germany	x		
Ruhr-University Bochum	Germany	x		
EuFH Brühl	Germany	x		
UAS Düsseldorf	Germany	x		
UAS Hannover	Germany	x		
UAS Kaiserslautern	Germany		x	
UAS Karlsruhe	Germany	x		
UAS Kiel	Germany	x		
HAW Landshut	Germany	x		
UAS Ostfalia (Salzgitter)	Germany		x	
UAS Rosenheim	Germany	x		
DHBW Stuttgart	Germany	x		
UAS Südwestfalen	Germany	x		
Total		**14**	**5**	**1**

6 Data analysis

All study programs, follow the Bologna premises and request 30 ECTS per semester, except at the UAS Kaiserslautern, where the Bachelor is acquired with 180 ECTS in 7 semesters and the Master/MBA in 4 semesters with 90 ECTS. This data is therefore not separately described as linked to the analysis of study length.

The following data analysis is done within the groups Bachelor and Master, as basic conditions, specificities and objectives are different, completed by some remarks on the five-year Diploma degree. All below mentioned shares are calculated on the basis of the ECTS allocated to the corresponding lectures.

6.1 Bachelor Degrees curricula

The majority of ten Bachelor degrees last seven semesters, whereas two last only six semesters and two others eight semesters. In all cases, the degree is completed with a Bachelor thesis, realized in the last semester in cooperation with a company or internally at the home institution of the student. Three Bachelor Degree curricula represent Dual Studies, where students are hired by a company and are working and studying in parallel. Generally, the company incurs the expenses related to the education. Three Bachelor degrees request an international stay in form of an academic exchange or an overseas internship, in one case an overseas internship and in another two ones an academic exchange period is needed. Overseas experiences must last six weeks, three or four months (one time each) until one semester (four cases).

Regarding the analyzed Bachelor Degrees, the shares of the four thematic pillars vary heavily, table 2. The maximum share is the double of the minimum share for Science & Technology lectures, the triple for Sales & Marketing and Business & Management ones, and nearly seven times the minimum for the Personal Skills pillar. Sales engineers are selling technical products and services and thus this is well characterized by the important shares of Science & Technology (average of 40.3%) and Sales & Marketing (average 24.8%).

Table 2. Minimum, average and maximum shares per thematic axis of Sales Engineering Bachelor Degrees

Thematic axis	Minimum	Average	Maximum
Science & Technology	29.0%	40,3%	59.0%
Sales & Marketing	15.0%	24,8%	42.9%
Business & Management	10.5%	20,8%	33.8%
Personal skills	4.3%	14,1%	29.5%

Looking at the analyzed study programs, the two main pillars Science & Technology and Sales & Marketing should at least represent the minimum values of 30% respectively 15% in sales engineering Bachelor Degree curricula.

6.2 Master Degrees and the five-year diploma curricula

Information is available for five Sales Engineering Master Degrees. One of them lasts two semesters, one covers three semesters, and the three other ones last four semesters. The duration of the Master Degrees is linked to the local (national) Bachelor Degrees, insuring that a Bachelor plus a Master are lasting 10 semesters. In all programs a Master thesis must be written in the last semester. In all five cases, a successfully completed technical Bachelor Degree is requested to be admitted to the Sales Engineering Master Degree programs.

The Master Degree of UAS Ostfalia can only be obtained via correspondence courses. The Master Degree at UAS Kaiserslautern (MBA) is limited to graduated engineering or scientific students with a professional experience of at least one year, and the one of Turku UAS to those with three years of professional experience.

There are no internships included in these curricula. The minimum, average and maximum shares of the different pillars show that in Master Degree Programs Sales & Marketing and Business & Management lectures are predominant, with, looking at the average values, a total of 88.1%, Table 3.

Table 3. Minimum, average and maximum shares per thematic axis of Sales Engineering Master Degrees

Thematic axis	Minimum	Average	Maximum
Science & Technology	0.0%	5.8%	22.2%
Sales & Marketing	25.6%	47.2%	66.7%
Business & Management	20.8%	40.9%	69.2%
Personal skills	1.1%	6.2%	16.7%

Science & Technology and Personal skills are much less represented. The under-representation of at least scientific and especially technical lectures can be explained by the fact, that these Master Degrees address Bachelor graduates with a strong technical background, such as engineering, industrial engineering, or sales engineering bachelors. Imparting technical knowledge is considered as done, and less important within the Master Degrees. But Sales & Marketing are predominant in these study programs, with an average of nearly 50%, showing the significance degree responsible assign to this pillar for sales engineers. Beside technical knowledge, Sales & Marketing competences are the main important ones in a Sales Engineering education.

The five-year diploma is a specialty of the French private school ESTA offering this direct program to high-school graduates. Beside the specificity of a direct five-year education, this program includes also 20 month of professional internships, including one overseas semester, which is much longer than the internships requested in the Bachelor Degrees, with a maximum of six month.

The ESTA program comprises 27.1% Science & Technology and 31.5% Sales & Marketing lectures. These values need to be compared with a complete education with a seven semester lasting Bachelor Degree followed by a three semester lasting Master Degree: Effectively, the Science & Technology share accounts in such a calculation for 20.3% (basis: minimum values) or 30.1% (basis: average values) of the total of 300 ECTS, whereas Sales & Marketing accounts for 18.2% or 31.4% respectively. Thus, both pillars of the ESTA program are, with the above mentioned shares of 27.1% and 31.5% close to the calculated values based on the average shares of 30.1% and 31.4%.

7 Conclusions

Products and services, which includes technical knowledge are major part of EU´s exports, both intra-EU and extra-EU. These technical products and services are often sold by engineers. Depth of technical knowledge of sales engineers is depending on the complexity sold products and services. Two different technical approaches, focused but narrow and wide but not so deep, are needed. There are not remarkably many EuHEIs which provide sales engineering education nor is there consensus within the EU which issues sales engineering curricula should include. This paper describes the basic framework for analyzing sales engineering curricula by scrutinizing existing degree programs´ contents and analyzing those by four main categories: technical and scientific, sales and marketing, business and management and personal skills. Analysis contains information from 18 different EuHEI and their 20 different degree programs.

The following conclusions can be drawn from this analysis: 1) The Bachelor Degrees focus on scientific & technical issues with a minimum share of 30 % and an average one of 40 %. This scientific and technical education is accompanied by a basic Sales & Marketing part representing about 25% (average) of the Bachelor Degree program, with a minimum of at least 15 %. The Bachelor Degree programs led to sales engineers with strong technical, selling and marketing competences, being able to do their job: selling technical products and services. 2) The Master Degree considers the scientific and technical education finished and focus on in-depth Sales & Marketing topics (average of about 50%) as well as on Business & Management issues (average of about 40%). With these additional competences, Master Degree Sales Engineers are prepared to rapidly

take over responsibility and lead functions in companies. They possess on the one hand essential technical knowledges and selling competence; and on the other hand in-depth knowledge and competences in general economic and management issues. The total conclusion is that sales engineering degree program needs all of these four pillars in order to be called sales engineering education. Graduating students should possess the knowledge, skills and experience before they graduate as sales engineers.

This research was limited to EU region and AASE members. In order to widen the perspective a similar kind of study should be executed globally. Also more in depth research should be done regarding the contents of curricula and which kind of knowledge, competences and skills these curricula are providing to graduates. A longitudinal study of graduates´ careers in industry would be very feasible in order to find out which contents are found to be more useful than other in longer periods. The true sales volumes per SE for each industry should be studied in order to have need forecasting more accurate.

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