Report on the development of the competence framework for chemical engineering

(Certified Master (industrial) in the field of chemistry)

SBG Dresden

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Summary of the occupational field

The chemical industry is the 3rd biggest industry in Germany (after: car manufacturing and mechanical engineering industry) and the 6th biggest employer with 446.000 employees.[1] For running of chemical plants foreman or chemical foremen are needed.

This technical middle level management ensures the functioning of processes, especially concerning technical and human resource issues. It is a formal profession with the following entry requirements:

- Occupation in the chemical industry, that requires a formal training or
- At least 4 years work experience in the chemical industry.

The further training (EQF-6) to become a chemical engineer ("Industriemeister Fachrichtung Chemie") takes place in private organisations in the frame of distance trainings (2 years) or full time trainings (approx. 6 months). Most of the participants prefer to their job an accompanying distance training.

The German competence framework was developed by industry specialists from chemical companies, under the guidance of the DIHK (Association of the German Chamber of Industry and Commerce). The framework is reviewed at least during a five years timespan or on demand. This ensures the inclusion of new working tasks.

The framework consists on so called base competences and action-specific competences. The base competences cover business, legal, communication and cooperation topics. The action-specific competences include chemical synthesis (chemical engineering), leadership (human resources, accounting, quality management, responsible care, information and communication) and further specializations, such as chemical synthesis planning, automatization and controlling.

In the future, the ongoing automatization in chemical industry (start in the 1970ies) and the impact of digitalisation will affect the course of the industry as well as the shift from the production of base chemicals toward speciality chemicals. This trends will influence the contents of the competence framework and will be pointed out during the meetings of the industry specialists to review the existing competence framework.

The rationale for your framework

There is a need for qualified technical, middle management in the chemical industry, which requires formal, further training. The training is equal to EQF-6 and therefore as the academic qualification of a bachelor. However, the practical skills obtained are much more extensive then solely academic studies.

[1] Chemical industry on a glance, association of the chemical industry (VCI), 2016, p.2.

The aim of developing the framework is primarily to review the current state of the already existing competence framework for the chemical foremen (“Industriemeister Fachrichtung Chemie”), in order to improve and enrich it. This ensures that the competence framework is up-to-date and responds at the same time to the requirements of SME’s and bigger firms in the chemical industry.

The development process

For the development of the framework of the recognized qualification *Industriemeister: certified Master (industrial) – in the field of chemistry* the specified **cyclic competency framework** was applied.

This kind of framework is a core capability model and it is centre-outward directional. The model describes occupation relevant skills and is not related to functional competences for an occupational role.

For the qualification of the *Industriemeister: certified Master (industrial) – in the field of chemistry* the applied model is useful, because professionalism is at the forefront. The *Industriemeister: certified Master* is competent and versatile applicable, after obtaining the relevant qualification.

In the framework of the recognized qualification *Industriemeister: certified Master (industrial) – in the field of chemistry* core capabilities have been described, which are the basis of the cyclic framework. These are business and production assessment, planning and decision-making, managing production and people as well as evaluation tasks. All these activities are connected to corporate and professional responsibility as well as self-development. The training of the *Industriemeister: certified Master* is a recognized qualification in Germany. So the cyclic framework model reflects all the necessary capabilities / skills and competences as well as transversal abilities.

The framework development for COMPROCOM included the following steps:

- Feedback by an internal SBG-industry expert, who is also member of the national council to review the competence framework
- Translation of the key elements of the existing competence framework for chemical foreman
- Advices with the scientific lead of COMPROCOM on which parts to include / structure and final contents of the framework
- Carrying out consultation and trailing phases

Consultation and trialling

At first the consultation was carried out, than the trailing phase followed. For both phases tidy drafts and accompanying questionnaires were used.

The sample groups were participants on the further training course to become a chemical engineer. Most of them work in the chemical industry for 4 and more years

The framework approach was presented to all of them in the classroom, with some of them expert interviews were carried out. During the consultation phase 23 person were asked by, and during trailing 17 questionnaires were received. The questionnaire during the consultation phase contained mainly question about the completeness and consistency of the framework, during trailing the completeness, consistency as well as the needs for the future were evaluated.

An overview of the results provide attachment 2 (consultation) and 3 (trailling).

Matters arising

The main matters arising from the consultation and trialling were:

- The framework was perceived as logic, good to understand and nothing obviously missing.
- There is (sometimes) a discrepancy between the skills need in small vs. bigger chemical firms
- This relates to a different perception of the impact of automatization and digitalisation on the competence profile in the future. In smaller firms this topics are mainly no issues, in bigger firms the awareness for their potential impacts is much higher.

Following the 2 phases SBG Dresden drew up an improved version of the competence framework.

Conclusions

The development process has been successful in reviewing and enriching the existing competence framework for industrial foreman in the chemical industry (“Industriemeister Fachrichtung Chemie”).

The framework will be used as a starting point the include trends, such as increasing digitization/automatization and (new) improved quality standards, in the regular reviewing process. This could lead to new contents in the frame of the current further training, to become an “Industriemeister Fachrichtung Chemie” and/or additional further training offers for industry specialists.

ATTACHMENTS

ATTACHMENT 1

Level 3 further details and explanations

1. Business assessment

1.1 Assess the economic situation of the company

This includes:

- identifying and evaluating production and accounting data to determine how the company or business unit is performing in relation to its targets and objectives
- identifying the economic significance of any deviations or shortfalls, and the reasons for them
- using a range of accounting tools, including choice and use of relevant costing methods; assessment of deviation; calculation of directly and indirectly costs, operating income and contribution margins; and assessment of trends over time
- identifying any changes that may be necessary or possible to improve performance

1.2 Identify customer demands and how they impact on products and production resources

This includes:

- identifying customers' quantitative and qualitative requirements, including any changes that can be identified or anticipated
- identifying any current or upcoming changes to legal and operating requirements, quality and compliance standards in own area of responsibility
- making an assessment of the implications of these requirements for production output and processes

2. Production assessment

2.1 Assess production quality and resourcing

This includes assessing compliance with quality objectives and quality management standards, as well as the use of production resources; and identifying any improvements that are needed.

2.2 Monitor chemical processes

This includes:

- classifying chemical reactions and taking into account reaction types
- monitoring and analyzing relevant technical data including as relevant pressure, temperature, pH- value, solvent, fuel distribution and residence time, and identifying the influence of rate of reaction, chemical equilibrium, solubility, catalysis, ions and concentration
- using process controls such as sampling, classical methods of analysis, instrumental analysis and online procedures

2.3 Assess the production processes

This includes:

- assessing the production conditions for chemical processes in accordance with the types of reaction
- distinguishing between mass and energy interconnection and transport group, and detecting and calculating of material and energy balances
- evaluating the hazard potential and the effect of human factors, facilities, operating equipment and environment

3. Planning and decision-making

3.1 Plan the application of operating and production resources

This includes:

- taking account of quality and quantity specifications
- selecting machines and system components, including any interactions between raw materials, consumables, operating materials and materials
- organizing of raw materials, consumables and operating materials

- participating in the selection and procurement of equipment, systems and facilities

3.2 Plan technological and production processes

This includes:

- incorporating the relevant quality and quantity standards
- planning the rational use of energy and resources and of energy and material flows
- selecting control, regulation and process control systems according to the relevant criteria
- selecting production technology equipment and procedures in accordance with the reactions and processes involved

3.3 Optimize the cost and performance ratio

This includes creating cost plans and cost controls, and applying measures to keep costs under control.

4. Managing production

4.1 Manage product-technical and related business processes

This includes:

- creating flow rates and energy balances
- controlling the rational use of energy and resources
- employing the relevant apparatus, equipment, and technical support facilities and ensuring their proper use
- coordinating and optimizing the start-up, running and shut-down of processes

4.2 Lead and supervise the production cycle

This includes:

- starting up and shutting down systems and processes
- arranging the optimum operation of plant to ensure that the required reactions take place

- carrying out process and quality control

4.3 Ensure compliance with qualitative and quantitative specifications

This includes:

- using relevant tools and methods, including statistical methods, for quality management
- description of operational processes and preparing audits and certifications
- ensuring appropriate training and qualification of personnel

4.4 Take measures to eliminate undesired deviations and confounding factors

This includes:

- detecting deviations and causes of faults, and assessing their impact
- securing the necessary energy supply
- using information systems to assess deviations
- performing risk assessments

It also involves being able to respond to contingencies and emergencies, including as necessary:

- shutting down the plant
- applying internal emergency plans and reporting systems
- carrying out troubleshooting and fault analysis, distinguishing between recurrent and random perturbations
- taking measures to limit damage and disruption
- disclosing relevant information to the public
- effectively communicating company information and instructions to staff (internal communication)

5. Managing people

5.1 Secure staff resources to meet production needs

This includes:

- planning staff requirements (quantity and qualification/training level) to meet production needs, and communicating them to those responsible for allocation, resourcing and recruitment

- adapting job descriptions to meet identified personnel needs

5.2 Allocate responsibilities to employees

This involves assigning tasks by taking into account operating criteria in accordance with commercial considerations, as well as consideration of individuals' suitability, competences and interests.

5.3 Assess, guide and support the development of individuals and groups

This involves inducting new staff into their work, arranging appropriate personal development measures (including for the qualification of employees), as well as taking responsibility for training trainees.

5.4 Supervise and communicate with staff

This includes:

- supervising and supporting working groups in order to ensure objectives are met and any problems resolved
- promoting productive cooperation and communication between staff members, with managers and with the workers' council
- effectively communicating company information and instructions to staff

5.5 Promote a culture of responsible conduct and innovation within the company

This includes:

- leading employees to contribute to corporate goals, including through quality improvement and innovative measures
- promoting quality management aims, quality awareness and customer orientation
- carrying out relevant training

6. Evaluation

6.1 Evaluate the application of operational and production resources

This includes:

- evaluating the use of raw materials, consumables and materials
- assessing any losses of materials and products during transport and storage

- assessing the impacts of processes on the environment, including compliance with environmental protection measures

6.2 Evaluate the optimum operation of facilities and possible undesired deviations and confounding factors

This involves evaluating how well facilities have been operated to meet production requirements, including meeting of quality criteria, production and efficiency targets as well as evaluating of planning and execution scheduled and unscheduled repairs.

It also involves assessing how well contingencies and emergencies were managed in order to minimise impact on production, cost, safety and the environment.

6.3 Evaluate cost developments and economic processes

This includes:

- assessing business processes, based on operating processes and value chains
- developing proposals to further optimize processes
- using key business data to provide information and set controls
- identifying measures to monitor costs and the impact on the business

6.4 Evaluate the work environment and the deployment of staff

This includes:

- evaluating performance against quality and production targets
- assessing the performance and development of individuals, taking into account their previous professional career and personal and social circumstances
- assessing the influence of the organisational culture and workplace on the work environment and the behavior of individuals
- evaluating the influence of group structure on behavior and cooperation

7. Corporate and professional responsibility

7.1 Ensure compliance with health and safety regulations and environmental policies

This includes:

- ensuring that the workplace is ergonomically laid out as far as possible, and compliant with the relevant regulations
- checking, and identifying any weaknesses in, workplace and plant safety, environmental and health protection
- ensuring instructions and information relating to plant safety, environmental and health protection are provided and understood

7.2 Develop and promote responsible care within the company

This includes:

- developing proposals and that support continuous improvement
- supporting and motivating staff towards independent, responsible action, and encouraging them to participate in decision-making processes
- supporting employees' openness to innovation
- promoting responsible care in the company through actions that might include taking relevant action directly, bringing potential improvements to the attention of colleagues, and supporting improvements in discussion with senior managers

8. (Self) development

8.1 Ensure up-to-date best practice, knowledge and competency in your occupational field as well as in interrelated areas

This includes maintaining up-to-date knowledge of technical documentation and methods, relevant regulations, production processes, methods and equipment, and management techniques.

8.2 Reflect on your own practice and continue learning

8.3 Adjust to altering methods and procedures of the company

This involves gaining a thorough operational understanding of changes, passing them on to others as necessary.

8.4 Contribute to the ongoing development of others

This involves, as appropriate, transferring knowledge and skills to colleagues and contributing to training sessions.

ATTACHMENT 2

Evaluation of consultation

The basis of consultation was the framework of the recognized qualification *Industriemeister* : *certified Master* (industrial) -in the field of chemistry* from September 2016.

In November 2016 the *Industriemeister: certified Master* (chemistry)* were questioned at the SBG. For that they got the current framework and the questionnaire „Consultation to the framework for the *Industriemeister: certified Master* (chemistry)*". 21 persons from 27 asked persons have answered (partly not completely).

Results

The respondents are still in training for the *Industriemeister: certified Master* (chemistry)*, so some questions could not be answered or not in its entirety (questions 1.1, 2.2, 2.3, 2.4, 2.6, 2.7). The most respondents have training as a chemical technician and they work currently as a chemical technician (operator), system operator or as a technical employee. The respondents working in companies of

- the chemical industry (production of paints and varnishes, plastic production, production of surfactants)
- pharmaceutical industry
- tannery
- food industry
- fertilizer production and
- crude oil refinery

The size of the companies are varied from approximately 30 to more than 10.000 employees.

The discription of the framework was good to understand for all. There were no ambiguities (question 2.1). The discription is a good summary for the work area of *Industriemeister: certified Master* (chemistry)* as far as this question has been answered (question 2.2). Already on this question has been identified that in larger companies a larger division of tasks is taking place, more than in smaller companies. It means that in larger companies not all descripted key activities the *Industriemeister: certified Master* (chemistry)* carries out. It was evaluated that nothing obviously missing in the framework (question 2.3). The question if there anything that is wrong or out-of-date was answered differently (question 2.4):

- yes, it is possible depend on the company size (2 answers)
- yes, the creation of flow rates and energy balances does not belong to the tasks for *Industriemeister: certified Master* (chemistry)* (1 answer)

For asking is there anything else that will become out-of-date over the next 5-10 years there were following answers (question 2.5):

- it becomes less specific and more management
- it becomes more specialists
- management of the employees
- automation technology and further strong development
- less staff needed and stronger use of computer technique
- the view of *Industriemeister: certified Master* (chemistry)* falls in favor of bachelor and engineering worker

The discription is workable in the work area of *Industriemeister: certified Master* (chemistry*) and depend often on the companies sizes (4 answers) (question 2.6). The work area of tannery is missing.

In the framework the descriptions are appropriate and not difficult (7 answers). However, it was pointed out that for instance the management of the employees is carried out from the staff department or there are different specialists in the company (question 2.7).

Summary

The framework was evaluated according to the previous experiences and from operational contexts of the respondents.
The framework is easy to understand and he mostly describe a good summary of activities of the *Industriemeister: certified Master* (chemistry*). The size of the companies are decisived. The more employees the more restricted are the work tasks and there are more specialists.

ATTACHMENT 3

Evaluation of trailing

The basis of trailing was the framework of the recognized qualification *Industriemeister* : *certified Master* (industrial) -in the field of chemistry*, which included the changes of the consultation phase.

In January 2017 the *Industriemeister: certified Master* (chemistry)* were questioned at the SBG. For carrying that out, the current framework and the questionnaire on "trailing to the framework for the Industriemeister, certified Master (chemistry)" was provided to 22 person, from which 17 answered the questionnaire.

This in-depth testing reflected the fact, that each of the person was additionally asked to select one task from the framework and to generate one working task for it. This helped to test the framework in extent and depth and provided the chance to refine the framework.

Results

The respondents are still undertaking the further training for becoming the *Industriemeister: certified Master* (chemistry)*. 16/17 are chemical operators and one is a trained chemical lab technician.

The respondents working in companies of

- the chemical industry (production of paints and varnishes, plastic production, production of surfactants) and
- pharmaceutical industry.

The size of the companies varied from approximately 150 to more than 15.000 employees.

The description of the framework was good to understand for all. The participants were asked concerning the importance to carry out relevant working tasks (2.1.). The answers varied from important to useful.

The importance of the current working tasks carried out, in the future (2.2), was perceived by 50% as the same and 50% rather increasing. Especially the person from bigger chemical firms answered with rather increasing. This is somehow interesting as the workplace requirements in smaller firms is rather more complex. This could also relate to the fact that bigger firms sensitize their employees more on future developments, as in smaller firms operational issues are more in the center, in comparison to strategic issues.

All persons asked saw themselves as competent and/or experts in the field (2.3), in order to cope with current demands on the workplace. In case of the required skills for the future to carry out the relevant working tasks, to picture is diverse (2.4). Some answered, that the demand for the relevant skills will increase, others answered they will stay the same and one answer was, rather less, because of the so called industry 4.0, which will lead to a higher automatization of chemical plants.
The key activities in the competence framework were perceived from all as clear, precise and nothing obviously missing as well as, from the current point of view, nothing will be so much outdated the next 5-10 years, except quality and quantity standards. (2.7.-2.9.).

Summary

The framework was evaluated according to the previous experiences and from operational contexts of the respondents.
The framework in the trailing phase was easy to understand and perceived as a good summary of the activities of the *Industriemeister: certified Master* (chemistry*).