Regionalization of Engineering: A Structured Process including Risk Considerations

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***Abstract*--The companies active in international project business are faced with the optimization task how the different phases in the technical value chain can most efficiently be shared between headquarter and local country organizations.**

Many regionalization cases the authors have examined have critical issues in domains such as internal setup, strategy, risk assessment, or know-how transfer. Therefore, in this paper, a process detailing how regionalization efforts in engineering can be effectively organized is explained, especially taking into account how typical risks inherent to regionalization can be identified.

The process starts by defining regionalization goals in relation to the business strategy and identifying possible risks. After analyzing the preconditions, a regionalization concept is established by careful evaluation of different scenarios. Upon decision for a certain scenario, detailed planning of regionalization is started, including e.g., preparation of change management and ramp-up of engineering manpower. Setting up the local organization includes training of employees, preparation of suitable environments and adaption of engineering processes. In this phase, the first regionalized projects can be performed. A carefully chosen lessons learned process helps to augment the performance of the organization in its environment; a phase-out step may conclude the work in a regionalized environment.

Practical information gained from expert interviews and taken from real regionalization cases in a multi-national company is presented in appropriate detail to illustrate the principles. They verify the approach and show the direction of further research.

I. INTRODUCTION

In international companies, economic success is based on the capability to perform customer projects efficiently, especially concerning the quality of the chosen components and the processes and methods applied [1][2].

The technical management of such projects requires cooperation of employees in several countries: electrical engineering of several components may for instance take place in the country where the headquarter is located; erection and commissioning are often performed in the country where the plant or facility has to be built.

The chain of economic value added of a given project is a composition of value-creating steps in different countries, and the question arises how those steps can be most efficiently allocated and transferred to the various departments involved [3][4]. In the case where these departments are located in different countries, this allocation and transformation process is known as regionalization.

The rationale of the study presented here is given by the fact that many international companies in industrialized countries are actively managing their headcount distribution with a tendency to increase headcount in the countries they are doing business in instead of doing this in their home country [5]. This situation is one of the background drivers of engineering regionalization.

The regionalization process is often characterized by unforeseen problems, resulting in increased delays, insufficient quality or higher costs. In this paper, such regionalization issues are identified. In order to avoid them, a structured process, taking inherent risks into account, is proposed.

After a definition of basic terms, typical regionalization problems are described. A regionalization example is given to illustrate them and a regionalization process is depicted based on literature study and expert interviews. Typical risks inherent to regionalization are explained and aspects of validation and experience obtained are given.

II. BASIC TERMS

Engineering is one of the central disciplines in international project business and, hence, in companies working in a technical domain. It is defined as "(the) creative application of scientific principles to design or develop structures, machines, apparatus, or manufacturing processes, or works utilizing them singly or in combination; or to construct or operate the same with full cognizance of their design; or to forecast their behavior under specific operating conditions; all as respects an intended function, economics of operation and safety to life and property" [6].

When considering engineering processes in a given company, different business models can be concerned. One of them is customer project business, which is defined here as the design, realization, erection, installation, commissioning and/or operation of an industrial plant for a special purpose and within a given time frame [7]. An example of a project delivery process fitting the application domains used here is depicted in Figure 1. Phases with intensive engineering participation are shown in light grey background.

Figure 1: Project delivery process [8]

Outsourcing is understood as "the act of transferring some of an organization's recurring internal activities and decision rights to outside providers, as set forth in a contract" [9]. Regionalization of engineering means transferring some or all of a given organization's recurring activities and decisions in engineering to a company internal partner or affiliated company in another country. In the case outside providers are located in a foreign country, this act is called offshore outsourcing. See Figure 2 for a comprehensive illustration.

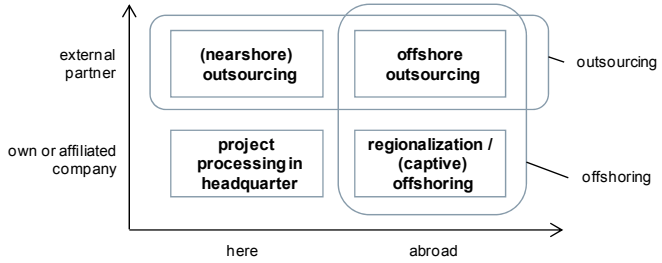

Figure 2: Regionalization and related concepts

Regionalization and customer project delivery can both proceed according to given processes. It is required to distinguish them clearly: Regionalization is an effort which a company does or has to do in order to modify the allocation of activities or responsibilities in its value chain. It describes a transition from an initial state of allocation, say A_1, to a new state, A_2. A given customer project makes use of the allocation as defined by A_1 or A_2, in order to deliver an industrial plant as per its underlying contract and applicable internal process descriptions.

III. SCIENTIFIC METHODOLOGY

The insights presented in this paper have been obtained in three phases.

In a first phase, more than 10 extensive interviews with different stakeholders of regionalization projects in recent years have been conducted [5] in order to get an overview on typical challenges in the context of regionalization of engineering (RoE). The interviewees and workshop participants bore various responsibilities in project business, such as personal contributor, team leader, regionalization project head, customer project head, department manager, Senior Vice President. According to their responsibility and role in the company, they were working in different projects and in different technical domains, such as (but not limited to) Industry Automation, Transportation, Power Transmission, Power Generation. Most, but not all of the interviewees were German citizens; their location was the headquarter of the business unit they were working in. The interviews were conducted in a semi structured way: The questions were pre-formulated as a guideline, but the interviewees were given room to answer freely. The typical issues in regionalization projects revealed during the interviews are given in chapter 0. Further details of the interviews will be presented in another publication.

In the next phase, an intensive literature review about regionalization, offshoring and outsourcing has been performed in order to lay the theoretical basis for further research. The results of this review are presented in chapter 0.

In a third phase, based on literature review, interview results and the authors' own experiences with regionalization, a regionalization process model and a risk analysis have been defined and settled in workshops with stakeholders. The results are described in detail in chapters 0 and 0.

IV. TYPICAL ISSUES IN REGIONALIZATION AND OFFSHORING

The hypothesis that outsourcing efforts often have issues is also supported in literature. Figure 3 shows the results of a relevant inquiry. It shows that more than half of the investigated projects have faced one or more difficulty at setup. The problems encountered are related to staff (such as, e.g., available competence or intensity of training needed), to the selection of an appropriate partner, to the management of the change induced by outsourcing, to IT or to legal questions. Although the categories mentioned may not be applicable directly to regionalization of engineering, it can nevertheless be devised from this inquiry that it is worthwhile to prepare and plan outsourcing and regionalization efforts intensively.

Interviews in a multi-national company active in customer project business revealed that similar problems occur in RoE. In Figure 4, the most important issues found are depicted. A situation that typically originates in the headquarter is that management has high expectations regarding with RoE, sets ambitious deadlines and requests high local shares of project work. Additionally, in some investigated cases, the engineering process is not ready for regionalization (e.g., because descriptions of work packages and interfaces are not available). A systematic approach is needed at least in cases where several RoE efforts are performed in parallel. During regionalization, critical scenarios include situations where work packages have formally been shifted to a certain region, but for any reason the regional unit is not able to perform accordingly, e.g. because the manpower needed is not available. Another critical situation can occur if an organization intending to regionalize has not analyzed or is not sufficiently aware of its key competencies.

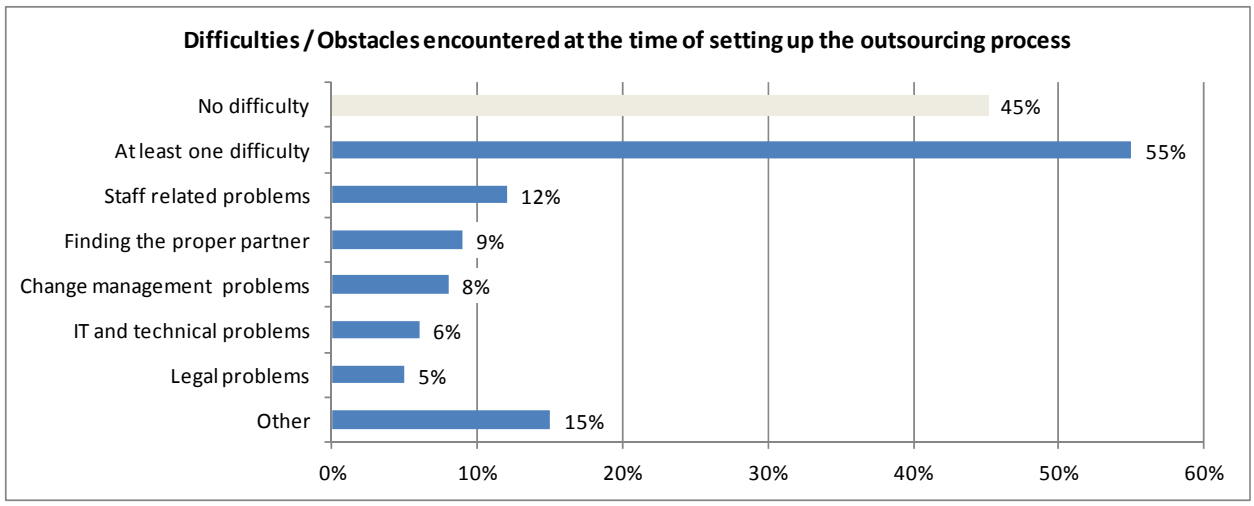

Figure 3: Difficulties and obstacles in outsourcing [10]

Regionalization of key competencies has to be done carefully (if at all) because in many cases, such competencies are required in headquarter to control and develop the business from a technical perspective. Typical regional problems encountered during RoE include higher employee turnover (and induced knowledge loss), insufficient infrastructure (such as availability of fast internet or network connections – these are needed for international collaboration) or restrictions due to local law. Co-operation between regional unit and headquarter was named as a further problem source. This includes misalignment between functional strategies, lacks in mutual understanding based on cultural differences, undefined ways of collaboration and difficult transfer of responsibility.

The RoE approach itself is one of the major problem sources. In several cases, a RoE concept or strategy was not defined and consequently, actions were unaligned or decided upon only based on operational considerations. Operating procedures, describing how to perform RoE, were not available or unclear. In some cases, RoE undertakings did not have proper schedules, reviews or risk management actions; sometimes, underlying concepts, methods and tools were not available, e.g. in the sense of best practices.

As a summary, interviewees described RoE as an undertaking with high inherent risks which nevertheless is not systematically performed in many cases. Based on these takeaways, in this paper, a methodic approach to RoE is depicted (chapter 7) and typical risks in RoE are explained (chapter 8).

V. LITERATURE REVIEW

An extensive literature study was performed, intending to find out suitable processes for RoE.

Wiener [11] describes a three step approach to offshoring mainly in the software business, composed of “Planning and Analysis”, “Decision and Negotiation”, “Implementation”. It turns out that this process establishes a clear decision phase, names several related activities and provides important aspects of regionalization. Nevertheless, with three steps only, it does not provide an in-depth description, but remains relatively generic. As it is a process intended for offshoring in the software business, there is only limited applicability to engineering which has to consider software as well as hardware design.

Brown and Wilson [12] provide a six step regionalization process, comprising the phases Strategy, Scope, Negotiation, Implementation, Management, Completion / Termination.

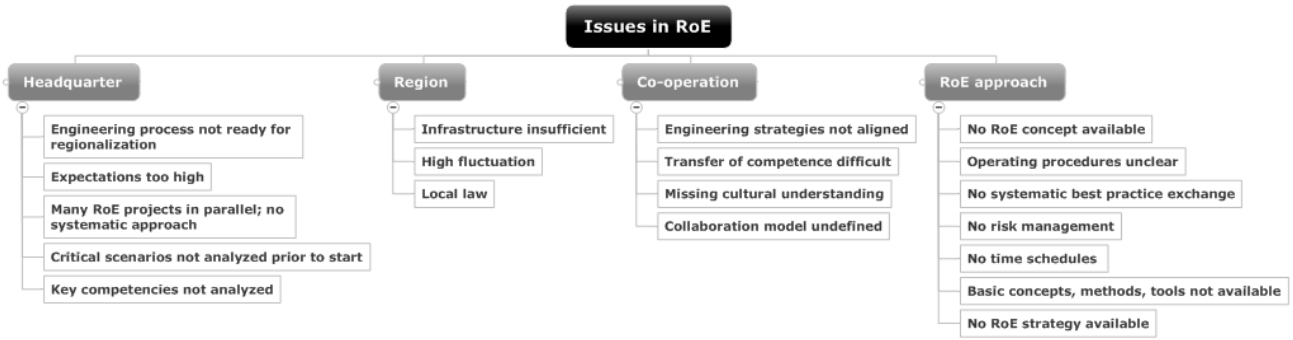

Figure 4: Issues encountered in RoE efforts

This more differentiated process especially comprises a much more detailed and extended management phase, but it does not clearly distinguish between regionalization and performing a project in a regionalized environment. In its completion phase, accent is put on delivering of results and termination of contracts only. The situation of a permanently existing organization in a foreign country is not considered. In this sense, the description is incomplete.

The process as given in [13] includes the generically defined phases "Why", "What", "Which", "How", "Outcome". This abstract naming provides for broad applicability on the one hand, a certain lack of clarity may have to be considered as a disadvantage. This process is said to be based upon decision theory. Continuous improvement and closed learning loops are strong points of the approach which is applicable to the outsourcing of information systems but not engineering in particular.

The process as described in [14] is applicable to the lifecycle of IT outsourcing. Its phases are "Architect", "Engage", "Operate", and "Regenerate". With a certain amount of interpretation, in principle this could be applied to engineering as well. The focus is on a relatively extensive decision and selection procedure, but the whole process remains relatively abstract.

The approach of Hodel et al. [15] is built of four phases, named (translated from German) "Preparation", "Initiation", "Transformation", "Operation". Fallback plans and risk management are explicitly included, but the realization is performed – even on a conceptual level – relatively late in the depicted process.

There are several key learnings which can be taken from this literature study:

First, the processes described are incomplete as none covers all steps required from a technical perspective. The processes described focus on IT outsourcing or offshoring; they remain on a relatively abstract level. No process is sufficiently detailed to be directly applicable to a real regionalization project. To the knowledge of the authors, a regionalization process for engineering is not available in literature.

Second, as the processes described take a management perspective, productive tasks (such as engineering) do appear, but are not detailed. This detail is required, especially for the planning and preparation phases [3] and for the calculation of cost effectiveness of regionalization efforts in engineering.

Third, the described phases respect the need for differentiation on the one hand and comprehensibility and acceptance for users on the other hand. Special attention has to be brought to the naming of the phases in order to provide a clear, transparent and consistent distinction between them.

Fourth, the regionalization approaches in literature do not distinguish clearly between the regionalization effort in its own, including the required preparatory phases, and the execution of a customer project in a regionalized environment. This distinction is highly important as the execution of customer projects is the fundamental objective of the considered company.

To sum up this review, a RoE process is currently not available in literature, but as outlined in chapter 0, it is nonetheless required in order to perform RoE systematically.

VI. AN EXAMPLE FOR REGIONALIZATION OF ENGINEERING

Figure 5: Example of a HVDC (inside of converter hall)

In this chapter, the example of a HVDC (High Voltage Direct Current) project is used in order to illustrate regionalization efforts in principle. HVDC links are used to transmit "electrical power in bulk over large distances by overhead lines or cables, for coupling non-synchronous networks and for supplying densely populated areas if there is a shortage of transmission routes" [16]. A look into a typical HVDC substation is given in Figure 5. HVDC is mainly useful in areas with booming energy demand, such as emerging countries [17], and, by its nature, in situations where long distances occur between generation and consumption of electrical power because of the lower losses compared to alternating current transmission systems [16]. HVDC projects require large civil and mechanical installations (see again Figure 5 for an example of the steel structures and buildings, with heights of more than 20 m). This, in combination with local regulations prescribing a degree of "local content" (a requirement that a certain amount of value adding actions must originate or be purchased in the country where the plant will be built [18]), makes such projects particularly interesting for reflections which parts of the value chain can be performed in the destination country. With respect to engineering, a regionalization effort is required to do this.

HVDC projects can be performed on the basis of the project process mentioned in chapter 0. During regionalization, for every step in every project phase, one has to decide in which location this step has to be performed under given criteria and boundary conditions. For this, a headquarter (HQ) perspective of a strategic business unit (SBU) of a multi-national company [5], desiring to set up or

extend its business in one or more local entities (LEs) is adopted in this paper.

A relevant step for regionalization in a HVDC project could be basic and detailed engineering of civil installations. As erection must naturally take place in the destination country, all relevant civil engineering tasks may also be performed under the responsibility of the LE in the destination country. On the other hand, as interdependencies of engineering tasks in a HVDC project generally have to be considered, and engineering of crucial components such as the converter units might remain under the umbrella of HQ, there might also be the desire to keep converter design and civil design in one place. Furthermore, the aspect of know-how protection may add further important boundary conditions. Similar questions arise when considering testing and commissioning. All electrical equipment undergoes intensive functional and performance testing during the commissioning stage before it can be put into operation. Hence, all testing could take place during commissioning. Another approach could be to deliver pre-tested equipment on site, whose individual testing has already taken place in the location where its engineering is executed, and to perform integration tests (and possibly performance tests) on site only.

A real RoE effort is underlying this description; more detail cannot be given here for confidentiality reasons. The considerations made here nevertheless show the reflections, decisions and dependencies that need to be taken into account for regionalization of engineering. A structured process for this is given in detail in the next chapter.

VII. REGIONALIZATION OF ENGINEERING PROCESS

As interviews revealed that RoE requires a systematic approach, in this chapter, a process for regionalization of engineering (RoE) is depicted (Figure 6), with the purpose to prepare, plan and perform RoE effectively.

It is composed of 7 process steps. These are explained in brief in the following; underlying examples illustrate the procedure. Full RoE process details are not given here; this is subject to a further publication.

A. Define Goals

Clarification of goals and intentions is the first step of a structured RoE effort. Let us consider the example of an SBU with world-wide responsibility for power stations. An element of the SBU strategy might be to use cost advantages in countries in which the SBU is active. Different stakeholders exist, such as management of SBU and project units, engineering managers and staff in HQ and in considered countries. A balance between the different interests of these stakeholder groups is needed and critical points have to be identified out and clarified. Special attention has to be brought to cultural differences here; these have an impact on possible lines of action [20]. Possible RoE regions should be in line with business responsibility as per the underlying strategy, taking possible local hub concepts into consideration, see [21]. It is recommended to organize RoE as a project in itself [5]. Risks and chances have to be identified at an early stage (for details, see chapter 0); the identified risks have to be taken special care of during the whole RoE undertaking. Experience with regionalization already available in the organization should be inserted here, e.g. by means of allocating experienced staff to the RoE project.

This initial phase should end up in a documentation of the scope (and non-scope) of RoE. Figure 7 gives details of the initial phase "Define Goals".

Figure 6: Regionalization of engineering process [19]

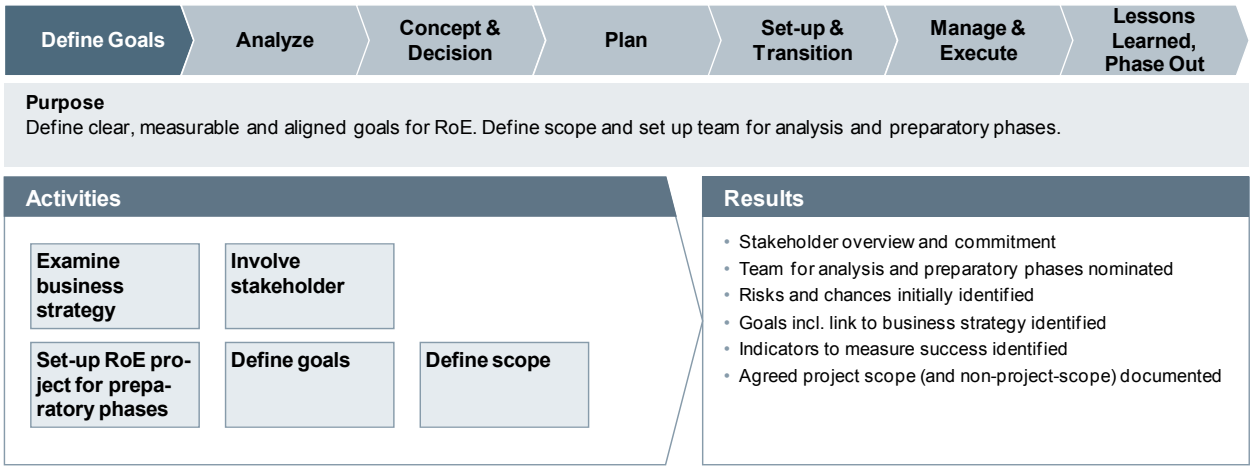

Figure 7: Regionalization phase "Define Goals"

B. Analyze

An overview of the second phase of RoE, "Analyze", is given in Figure 8. The purpose of this phase is to get a detailed view of the own situation with respect to RoE, and to define the options to be investigated more closely during RoE.

By analyzing the SBU's product / solution portfolio, suitable elements for regionalization can be identified. Next, own core-competences and typical work volume for engineering tasks required for these elements have to be identified, taking know-how protection issues (such as, e.g., special automation algorithms or control functions) into account. The SBU might then deduce that for a certain region, engineering of certain types of HVDC [16] has to be considered for regionalization, on the basis of lower costs in certain countries or available know-how.

Regionalization models have to be evaluated, such as, e.g., to set up a newly incorporated subsidiary, to buy a local company or to co-operate with an existing company based on a contractual agreement. Some of these models may be ruled out easily for certain reasons (e.g., strategic directions); this should be made transparent. As the considered country's local law influences decisions in many ways, region specific advice from legal services is recommended. Regionalization goals as defined in the previous phase can be affected by boundary conditions related to the choice of regionalization models; hence, there is an interdependency not shown in Figure 8.

Now, the initial situation of possible partners has to be characterized by, e.g., available expertise, processes, infrastructure, tools, etc. The evaluation of these aspect leads to a list of suitable partners for closer investigation. The HVDC SBU as described above might come up with the decision that in order to regionalize engineering in Brazil, it is suitable to extend an already existing sales and project department in the subsidiary by handing over engineering responsibility.

In order to select the concrete tasks for RoE, a fit gap analysis can be used [22]. These tasks should be agreed upon by management from HQ as well as LE, considering the scope of possible pilot projects. Finally, the risk evaluation has to be updated and measures have to be taken.

A Go/no Go decision for the next regionalization phase, taken on SBU management level, concludes this phase.

C. Concept & Decision

During concept / decision as shown in Figure 9, the previously performed analyses are combined in so-called regionalization scenarios. This is a set of instantiations of the parameters

- selected portfolio elements,
- tasks,
- region or partner,
- regionalization model.

For the relevant scenario or scenarios, a business case calculation has to be done, showing costs and benefits of regionalization over time based on an assumption of market evolution. The parameters are dependent on domain and market; see [23] for an introduction to the calculation of business cases. It is important to include the previously identified and evaluated risks into this consideration, estimating the stability of the business case by calculating best and worst case scenarios. This important step cannot be done by business administration solely, but requires involvement of engineering as well as regionalization experts [3]. RoE benefits may also be immaterial, such as market access by fulfilling customer requirements concerning local content.

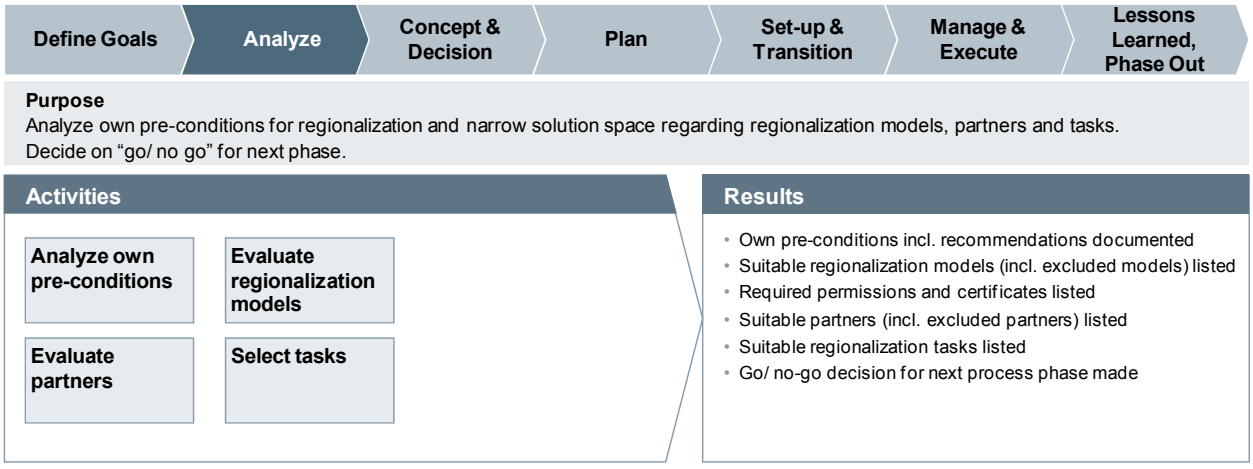

Figure 8: Regionalization phase "Analyze"

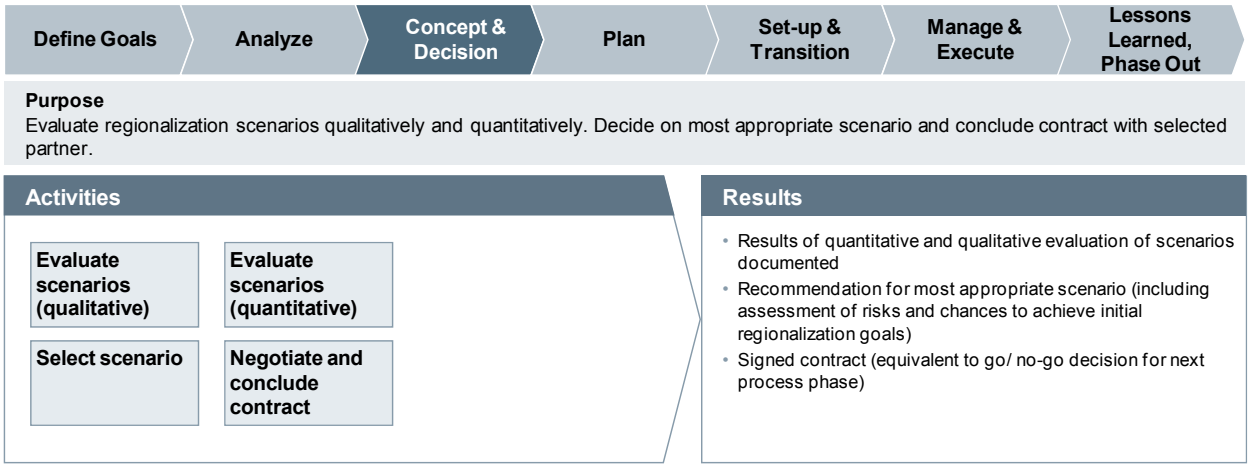

Figure 9: Regionalization phase "Concept & Decision"

Contract negotiations and conclusions can subsequently start with the best partners as per the business case calculation. Legal service should be involved to make sure that company internal regulations are followed. In company internal affairs, business agreements which are internally binding may replace the formal prerequisite of contract conclusion.

D. Further Phases

Detailed **planning** of the following regionalization phases includes classical project planning elements, such as the definition of timelines, milestones and deliveries, or set-up of a project team. Processes and workflows between HQ and LE need to be aligned. This can be done by using a model for the analysis of engineering processes [3]. Such an analysis can reveal situations in project processing with fractions between e.g. tools or artifacts. These fractions have to be investigated closely, as they can be considered as candidates for a shift of responsibility from HQ to LE.

"**Set-up & Transition**" has the objective to enable the LE to perform the engineering steps agreed upon, by basically carrying out the plans established in the previous phases. For this, the processing of a pilot project is a recommended way. This may require the help of HQ delegates, at least for a transitional period. In a situation where the LE should be set up as a hub [21], these delegated experts could make sure that know-how on technical specifics in countries served from the hub is available as well. The main accent in this phase is on allocation, insertion and training of employees in order to provide valuable resources. Further, processes, workflows and infrastructure elements, such as tools, devices, licenses, etc, have to be put into operation as well.

"**Manage & Execute**" is the very phase where regionalized customer projects are processed. The first of these projects may probably be accompanied closely by management on both HQ and LE, in order to unblock difficult or unforeseen situations rapidly. Such situations may result from, e.g., too optimistic planning, lack of experience, contract variations, or other. Gradually, work load and responsibility borne in the LE may increase in line with experience gained. Regionalization is not terminated here, as further investment is needed in order to keep the know-how of the employees up to date, to improve or extend the available infrastructure, etc. Beyond a good relationship, suitable checks should be implemented to track the objectives of regionalization on the one hand and the situation of customer projects in the new regionalized environment. In order to manage quality of the engineering artifacts produced in LE and HQ, suitable KPIs and reviews should be defined and monitored / conducted.

The RoE phase "**Lessons learned**" intends to collect and make available all experiences gained within projects in a regionalized environment. This is not only applicable to engineering, but also to regionalization as a whole, from its initiation to its termination. For a comprehensive overview of lessons learned from regionalization of engineering, see [5]. A "**Phase out**" may conclude RoE if required.

VIII. RISKS IN REGIONALIZATION OF ENGINEERING

As one of the results of the interviews was that special care has to be taken of the risks inherent to RoE, these have been investigated closely. Risks are mainly dealt with in the phases "Define Goals", "Analyze", "Concept & Decision" and "Manage & Execute" of the RoE process described before.

Generally speaking, a risk is an uncertain event with the potential to negatively impact the RoE initiative. For quantification, a maximum amount of loss (measured in money) and a probability of occurrence have to be assigned to the risk under consideration. Typical risks that may appear in RoE are shown in Table 1. A selection of them is explained in the following.

TABLE 1: RISKS IN ROE

Risk origin	Risk
Headquarter	
	Loss of key employees
	Loss of core competencies
	Loss of intellectual property
	Deterioration of customer relationship
	Changes in laws / regulations in HQ country (e.g., embargoes)
Region/ country	
	Social / political instabilities or radical political changes
	Catastrophes / fundamental events
	Strikes
	Changes in laws / regulations in region
	Currency exchange fluctuations
	Time zone difficulties
Regional partner	
	Insolvency of partner
	External takeover of partner
	Change of partner's business strategy
	High employee fluctuation
	Increasing labor costs
	Insufficient/ incompatible infrastructure
	Insufficient or missing data backup concept
Setup of Co-operation (HQ / regional partner)	
	Insufficient contract quality
	Unclear responsibilities
	Missing regionalization experience
	Insufficient processes / workflows
	Divergent work styles
	Language difficulties
	Cultural problems
	Underestimation of change management
Operational risks	
	Inappropriate selection of tasks
	Unclear task specifications
	Changing requirements
	Insufficient employee ramp-up
	Slow learning curve
	Insufficient technical / technological capability (e.g., tooling)
	Insufficient scientific capability (e.g., education and training)
	Insufficient quality
	Information hiding
	Unmanaged conflicts
	Hesitant hand-over of control

Table 1 is organized in 5 categories called risk origins. Risks may come from headquarter, from the region or country, from the RoE partner, from the setup of the cooperation or from operations.

A typical headquarter borne risk is the loss of key employees. They may leave the company or department because of many reasons, such as a felt or real loss of importance of their work or contribution, causing a decline of expertise in HQ and replacements which are expensive and time consuming. Furthermore, RoE may increase complexity in the organization at first hand or regionalized projects may not be processed with sufficient performance in the beginning. Therefore, the relationship between customers and HQ may deteriorate, leading even to reduced order volume from such customers in the future. Another risk may originate from export regulations. With changing political situations, restrictions may be enforced concerning the export goods and services to certain countries. This may severely hurt or impede RoE to such a country.

Risks caused by the region or country may first be due to the social or political situation. Instabilities or political changes, such as riots, revolts, overthrowing of government etc., may lead to interruptions or even terminations of work, uncertainty of delivery, loss of property or tangible assets. Even the termination of the entire RoE initiative and transfer of work and responsibility back to HQ may be a consequence. Next, in the region or country considered, laws and regulations may change independent from the situation in HQ. For example, import and export regulations may be changed or taxes or commercial law may be subject to modifications. This may have a significant impact on costs and time of the RoE initiative and the projects performed under it. Moreover, dependant on the geographical situation, different time zones and times of work may affect communication and collaboration more than expected. This

can lead to a decrease of efficiency and higher coordination efforts.

Regarding the regional partner, a typical risk is coming from its relative or absolute independence with respect to the business strategy. Fundamental changes in the behavior of the regional partner may conflict with the goals of RoE. This may have a significant impact on costs and time. Furthermore, even if an increase of labor costs has been anticipated in the business case calculation, the increase may actually be higher or take place earlier than estimated. This may reduce the financial benefit from RoE or even make the whole RoE initiative unprofitable.

During the setup of the RoE cooperation, the risk of insufficient contract quality occurs. The contract may be incomplete or imprecise, e.g. regarding the definition of responsibilities, the split of work, the acceptance criteria for engineering results, the responsibility for required re-works etc. As a consequence, claims may be issued internally between HQ and partner. This can result in additional cost and time for their management, or additional engineering work in HQ or local partner. Further, different work styles of HQ and regional partner may cause the need for additional communication or coordination effort. Cultural problems may be linked to this: The cultural barriers may be higher than expected and may impede an efficient communication. A situation has been observed where people in a local organization were performing very similar engineering tasks (bus bar protection in a high voltage substation on 110 kV and 400 kV levels [16]). The people had the same country of origin and were sitting at adjacent desks. Hence, management of engineering in HQ and LE assumed that they would automatically get into close contact and align their designs. As was found out during design reviews and based on customer comments, this was not the case as people from this country often tend to hide their know-how. In addition, there is a risk to under-estimate the amount of change management needed for RoE. This may lead to acceptance problems among employees which may significantly decrease work performance.

Operational risks of RoE include insufficient employee ramp-up. This may be caused by problems or delays in allocation, recruiting or delegation. This may result in the incapability to perform agreed tasks or the missing of deadlines. As a consequence, it may be necessary that HQ personnel have to work on packages previously intended to be regionalized, with higher costs incurred. In addition, the learning curve of the local partner may be slower than anticipated, e.g. due to insufficient qualification of employees. Additional trainings may be required. This may influence work efficiency and schedules. Moreover, HQ might be hesitant to hand over control or responsibility to the local partner. Such unclear responsibilities may create cycles of extra work, costing extra money. Furthermore, HQ may have guaranteed a certain amount of work load or capacity utilization in the regional organization. Contract clauses may stipulate that payments be made even in case of unused capacity.

Risk analysis provides important data, e.g. to the business case calculation. It has to be regularly updated during RoE as explained before in order to manage and monitor risks closely. Risk mitigation measures basically intend to attenuate the negative consequences in case of occurrence or to reduce the probability of risk occurence. This includes avoiding (by not starting or stopping RoE), accepting (but continuing RoE nevertheless) or mitigating the risk by performing appropriate actions.

IX. VALIDATION, EXPERIENCE AND FUTURE WORK

The RoE process and risk assessment described in this paper have been defined based on interviews with engineering experts and intensive literature research. Validation done so far, based on reviews by domain experts and application in several phases of regionalization projects in various markets, such as power generation or energy transmission, has provided positive results concerning usability and structure of the approach. Even if the presented process has been mainly applied in the energy domain, its results can be applied to other technical domains as well.

Based on this study, it can be concluded that regionalization of engineering requires intensive preparation and risk management. With the described RoE process, it can be performed in a structured way; it is recommended to set it up as a project.

Further research will include a more detailed analysis of certain aspects of regionalization, such as a company's or SBU's readiness for regionalization, and of different models and concepts for regionalization of engineering.

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