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Ramp-up Management of Automated Distribution Centers

Analysis, Evaluation and Improvement

Master Thesis

by

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Department of Industrial Logistics

University of Leoben

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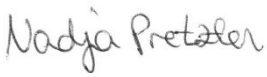
Leoben, January 2013

Affidavit

I declare in lieu of oath, that I wrote this thesis and performed the associated research myself, using only literature cited in this volume.



Leoben, 31.1.2013 Nadja Pretzler

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Abstract

This master thesis has the objective to investigate the ramp-up of automated Distribution Centers in detail, in order to determine measures and strategies for a successful ramp-up management to improve the performance of this process and to minimize problems. The focus is not only on the ramp-up management, but also on the investigation of the ramp-up curve, the description and development of the performance during the ramp-up.

In the first chapter the company Knapp Systemintegration GmbH is presented as well as the initial situation of the ramp-up for this thesis. Additionally, the objectives of this investigation are defined and the structure of this document is illustrated.

In the second chapter the theoretical investigation results from literature studies are shown. The objectives of the ramp-up, time, costs and quality as well as effectiveness and efficiency are explained in more detail. The analysis of the ramp-up describes a guideline for using methods to analyze the process. In this sense the customer demand analysis, analysis of open issue list, expert interviews, SWOT (Strengths, Weakness, Opportunities and Threats) analysis, Fishbone analysis, ramp-up graph and analysis of variance are proposed. The evaluation of the ramp-up describes the tools key figures systems, the Balanced Scorecard and Benchmarking in order to interpret the ramp-up.

In the third chapter the results of the practical application of the analysis and evaluation of a specific ramp-up in Brazil are presented. After the description of the project, the analysis of the ramp-up follows, including customer demand analysis, analysis of open issue list, expert interviews, SWOT analysis, Fishbone analysis, ramp-up graph and the analysis of variance. The evaluation of the ramp-up by applying the Balanced Scorecard and Benchmarking, are described and summarized in the conclusion.

In the fourth chapter the outcomes of the general analysis of the ramp-up and management are described that were collected in expert interviews in and outside of the company Knapp. The description of the ramp-up, the success factors for the ramp-up and the main problems that appear during this phase of the project are determined.

In the fifth chapter the final results of the analysis of the ramp-up in Brazil and the general analysis with expert interviews are demonstrated. The areas for improvement are categorized regarding to hard and soft factors. Improvements related to hard factors are sales, planning and specification phase, resource planning, software development, internal acceptance, ramp-up preparation, documentation, training, tests on-site, support, service, ramp-up analysis and knowledge management. Improvements related to soft factors are intercultural issues, cooperation with local agencies and communication.

The sixth chapter contains the description of the practical application of the ramp-up checklist on a project in France. After the description of the project follows the summary of the results.

The last chapter contains the discussion of the investigation methods and results of this thesis and future steps that should be taken based on investigation outcomes.

Kurzfassung

Diese Masterarbeit hat das Ziel den Anlaufprozess von automatisierten Distributionszentren genauer zu untersuchen und Maßnahmen, sowie Strategien, für ein erfolgreiches Anlaufmanagement festzulegen, welches diesen Prozess verbessert. Der Fokus ist nicht nur auf dem Anlaufmanagement, sondern auch an der Forschung bezüglich der Anlaufkurve, der Beschreibung, der Leistung, und deren Entwicklung, im Laufe des Anlaufes.

Im ersten Kapitel wird die Firma Knapp Systemintegration GmbH präsentiert und die Ausgangssituation dieser Forschungsarbeit, sowie deren Ziele und Struktur definiert.

Im zweiten Kapitel werden theoretische Forschungsergebnisse basierend auf Literaturstudien beschrieben. Die Ziele des Anlaufprozesses, Zeit, Kosten, Qualität, sowie Effektivität und Effizienz, werden im Detail beschrieben. Maßnahmen zur Analyse des Anlaufprozesses bestehen aus der Analyse von Kundenanforderungen, Analyse der offenen Punkteliste (Open issue list), Experteninterviews, SWOT (Strengths, Weaknesses, Opportunities and Threats) Analyse, Fishbone Diagramm, Anlaufkurve und Abweichungsanalyse. Weitere Bewertungswerkzeuge für den Anlaufprozess, wie Kennzahlensysteme, Balanced Scorecard und Benchmarking, werden beschrieben.

Im dritten Kapitel werden die Ergebnisse des praktischen Teils der Forschungsarbeit von einem Projekt in Brasilien gezeigt. Nach der Beschreibung dieses Projektes erfolgt die Präsentation der Ergebnisse der durchgeführten Analyse und Bewertung mit den aus dem theoretischen Kapitel beschriebenen Werkzeugen und eine Zusammenfassung.

Im vierten Kapitel werden die Ergebnisse einer generellen Untersuchung des Anlaufprozesses mittels Experteninterviews, welche innerhalb und außerhalb der Firma Knapp durchgeführt wurden, dokumentiert. Die Beschreibung des Anlaufprozesses, der wichtigsten Erfolgsfaktoren und der Hauptprobleme wurde ebenfalls durchgeführt.

Im fünften Kapitel werden die Ergebnisse der Analyse des Anlaufprozesses in Brasilien und der Experteninterviews beschrieben. Der Output beinhaltet Verbesserungsmaßnahmen der harten und weichen Faktoren bzgl. eines erfolgreichen Anlaufprozesses. Jene bezogen auf die harten Faktoren sind Verkauf, Planungs- und Spezifikationsphase, Ressourcenplanung, Softwareentwicklung, interne Abnahme, Anlaufvorbereitung, Dokumentation, Schulung, Tests vor Ort, Begleitung, Service, Analyse des Anlaufprozesses und Wissensmanagement. Jene Maßnahmen bezogen auf weiche Faktoren sind interkulturelle Weiterbildung, Zusammenarbeit mit Niederlassungen und Kommunikation.

Im sechsten Kapitel wird das Ergebnis der Anwendung des Anlaufmanagementleitfadens an einem Projekt in Frankreich beschrieben. Nach der Beschreibung des Projekts erfolgt die Zusammenfassung der Umsetzung.

Das letzte Kapitel beinhaltet eine Diskussion der Forschungsmethoden und –ergebnisse sowie zukünftige Schritte, die für weitere Untersuchungen bzgl. dieses Themas nötig sind.

Content

Tables, Equations and Figures

1 Introduction

The changing requirements of industries initialized by globalization and technological advances lead to new and faster internal and external processes. Globalization affects production processes, employment of labor, investment, technology and diffusion of technology.[1]

Globalization is a constant process which leads to connectivity of markets all around the world - North America, Europe, Japan and South East Asia, but the market is changing quickly in terms of is economic and political conditions. The speed of these changing processes is different on the economic, political and cultural levels. From the economic point of view globalization refers to the availability of resources in the whole world and from the production point of view it refers to the production in various international locations.[2]

As shown in Figure 1, the main drivers of globalization are converging demand, global offer, technological progress and neo-liberal policies. These factors have an impact on competition, decrease the control of capacities of national states and an explosion of financial markets and convergent life styles.[3]

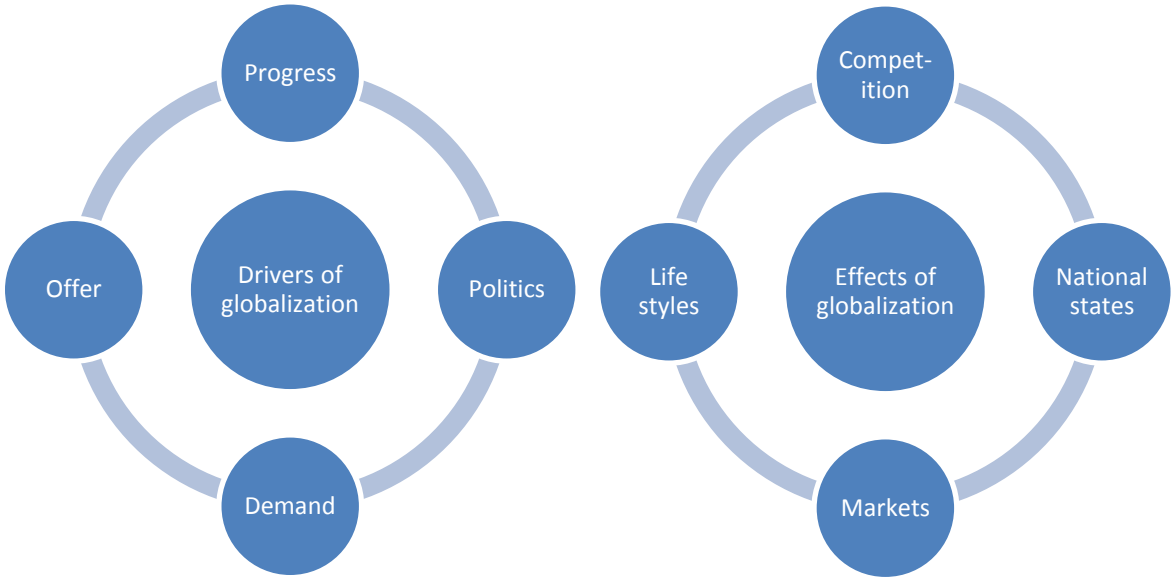

Figure 1: Drivers and effects of globalization[4]

Globalization is a process that results in new geopolitical maps and in a time of abrupt breaks. Other results are processes of integrated production and economic linkage all around the world as well as changes to the structure of national states.[5]

[1] Cf. Chatterji/ Gangopadhyay (2005), p.70.
[2] Cf. Hirt/ Schneider (2007), p.5-6.
[3] Cf. Ibid., p.34.
[4] Based on Hirt/ Schneider (2007), p.34.
[5] Cf. Hirt/ Schneider (2007), p.35.

Besides the main effects, the changing conditions cause strong alterations in many different organizations. As a consequence, structures in companies are rearranged, since "Globalization has often been named as a main driver for organizational change […]."[6]
New requirements for companies lead to higher competition on the market, caused by globalization which "[…] has major effects on efficiency, productivity and competitiveness. "[7] Therefore, the before mentioned global competition is a consequence of globalization and a consequence of the global market access.[8]
Nowadays, companies are under high pressure to improve and increase their innovation to be able to compete on the market. Besides the growing globalization there is more pressure concerning prices, individualization of products, changing markets and complexity of products and processes then there was before.[9] As a consequence, industrial organizations have to optimize their products, processes and structures in order to compete on the global market.
Technological advances of IT-systems have further impacts on information processes which are characterized by more transparency and higher velocities.[10] In addition, the exchange of information influences processes and guaranties their successful implementation. Information is needed for decisions and activities during every single step of a process and requires appropriate IT systems and tools to optimize the work flow and with that maximize.

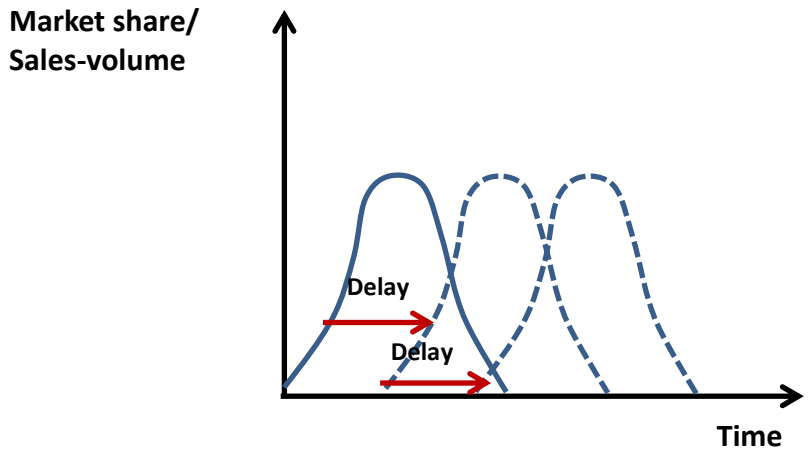

Figure 2: Delays in market entrance[11]

Figure 2 shows the market-share/ sales-volume ratio over time and the consequences of delays of ramp-ups. It is obvious that early market entrance leads to higher profits. The graph makes clear that differentiation on the market is not only characterized by the innovation and

[6] Cf. Afsarmanesh/ Camarinha-Matos (2004), p.36.
[7] Chatterji et al. (2005), p.70.
[8] Cf. Afsarmanesh/ Camarinha-Matos (2004), p.36.
[9] Cf. Risse (2002), p.1-2.
[10] Cf. Ibid., p.2.
[11] Based on Wildemann (2011), p.8.

variation of the product, but also by the velocity of internal and external the processes and the performance of the company. Therefore, shorter technological and production life cycles based on optimized ramp up processes deliver competitive advantages.[12] The ramp-up process is a process initialized by the start-up and finished at the 100% performance rate of an installation.

Another reason for the necessity of an efficient and effective ramp-up is the shift of production processes to countries with low labor costs. The amount of companies planning shifts has increased during the last years. Therefore, increasing numbers of ramp-ups in a company leads to higher complexity of the ramp-up process. The shift of production requires suitable ramp-up structures, lead factory concepts[13], international acting ramp-up teams and the transmission of structures.[14] This requires an effective treatment of this process by the so called ramp-up management[15]. An integrated and continuous ramp-up management is necessary to reduce the complexity of this process and to guarantee a successful output of the process.[16]

According to empirical studies the previous ramp-up management is becoming more important and robust ramp-up strategies are more significant.[17] New requirements and speediness of the product life cycle change the focus of management from low cost and time to just optimizing time.[18]

The changes of the product life cycle are presented in Figure 3. The new cycle is characterized by longer development phases, longer amortization time, a shorter lapse of time for the realization of profits and a shorter life cycle period.

[12] Cf. Wildemann (2011), p.8.
[13] See Abele et al. (2008), p.357: "Lead factories are responsible for the production technology development and its transfer to branch factories. They produce a limited part of the production volume temporally or permanently and act as centers of competence, train staff, optimize and improve manufacturing processes. Branch factories copy the successful production processes and get support from lead factory workers. This kind of strategy is called Lead factory concept and is characterized by either parallel or staggered production."
[14] Cf. Wildemann (2011), p.9-10.
[15] Cf. Franzkoch et al. (2005), p.405.
[16] Cf. Ibid., p.406.
[17] Cf. Wildemann (2011), p21.
[18] Cf. Risse (2002), p.1.

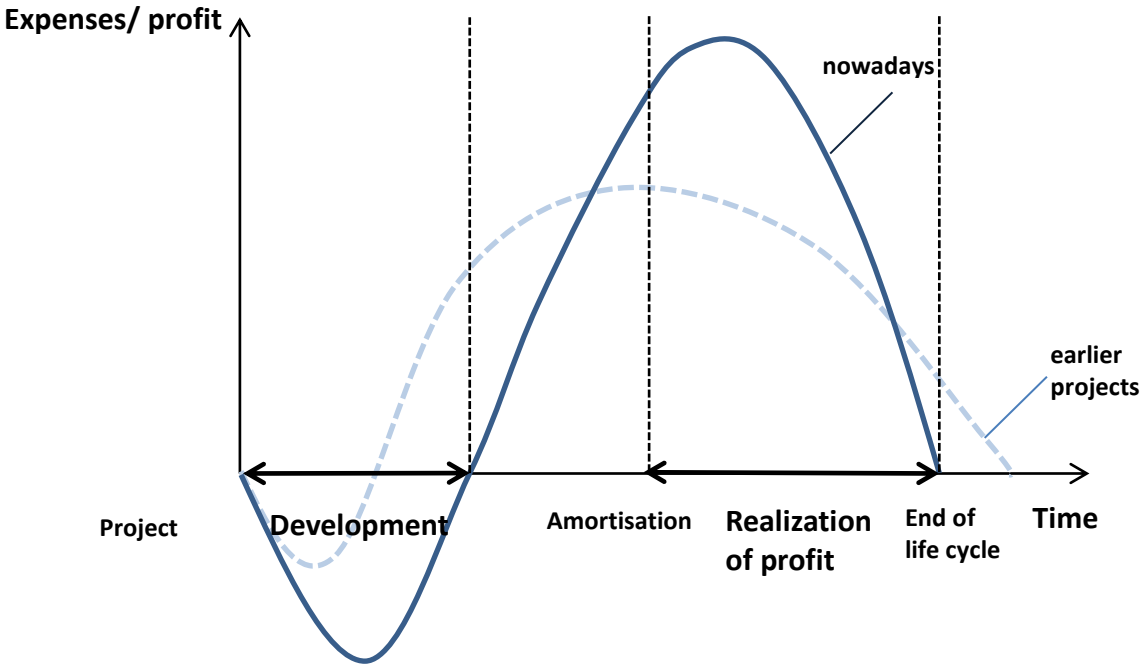

Figure 3: Changing product life-cycle[19]

Due to the fact that the velocity of processes affects the performance of the whole Supply Chain, the new focus lies on duration and handling of processes. The competition in term controls the Supply Chain, from the suppliers to the customers.[20] The whole logistics network gets more and more complex because more suppliers are integrated into the ramp-up and the resulting problem is a variety of interests. Material and information flow gets more complex and as a consequence planning and execution of logistic processes is crucial for a successful ramp-up.[21]

In addition, the focus on core competences and the outsourcing of company activities results in a higher complexity of the logistical network.[22]The complexity of the logistics network leads, among other conditions, to the necessity of the integration of suppliers since the supply of material has to meet all requirements.[23] Additionally the reduction of the range of services in the Supply Chain requires the integration of suppliers in the ramp-up.[24] The interaction between supplier and customer gains more significance and is one factor that defines the success of the ramp-up.

Customer integration during the ramp-up affects the output of the process in a positive way and decreases the process implementation time, since product requirements and needs are

[19] Based on Wildemann (2011), p.8.
[20] Cf. Wildemann (2011), p7.
[21] Cf. Herstatt (2007), p.117.
[22] Cf. Risse (2002), p.3.
[23] Cf. Herstatt (2007), p.117.
[24] Cf. Wildemann (2011), p.17.

clearer to the supplier in order to provide an appropriate product: „[…] the goal of customer integration is to identify the relevant product requirements and overriding product needs, which reveal major innovation potentials."[25]

Figure 4 shows a typical Supply Chain with the company as center of a network, surrounded by suppliers and customers.

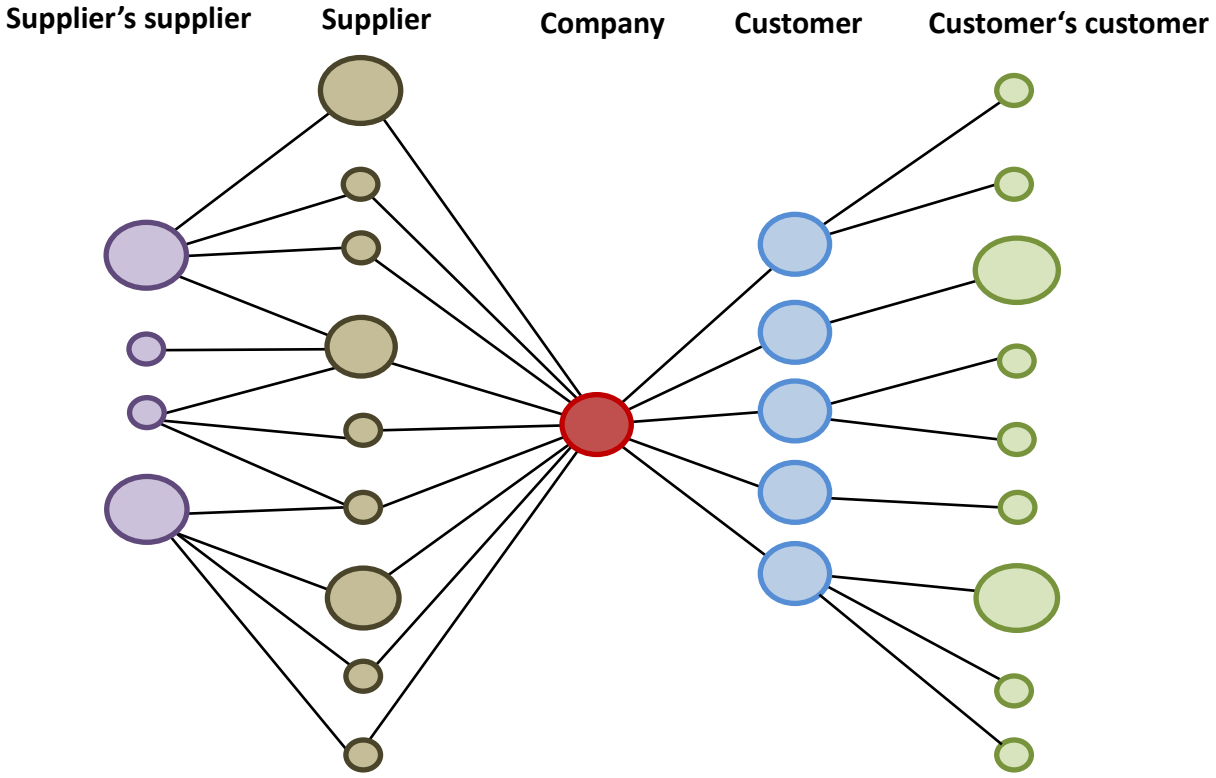

Figure 4: Supply Chain network[26]

Moreover difficulties arise as explained by the author *Herstatt*: „In contradistinction to a stable production, the ramp-up phase is characterized by a set of specific problems, such as high complexity, temporal limitations and limited availability of necessary resources. This often causes an excess of the predefined cost and time limits. "[27]

In this specific situation limited human resources can be a problem. The availability of qualified workers in the right amount is more important than employing a lot of workers that create interfaces, but do not aggregate value to this process. Consequences of wrong decisions related to this problem are redundant human resources without the right qualification, a high amount of interfaces, frictional loss and high costs for troubleshooting

[25] Sandmeier (2008), p.81.
[26] Based on Christopher, (2005), p.5.
[27] Herstatt (2007), p.117.

are appearing. An uncontrolled ramp-up reactivates troubleshooting costs and that results in lower profits.[28]

Errors during the production ramp-up and high process costs are the consequence of unstable ramp-ups. „Only Ramp-Up robust production systems avoid troubleshooting: "[29] By trial and experiment ramp-up production lots of process failures are caused. Therefore, a secure and evaluated ramp-up with the implementation of an appropriate strategy is required.[30]

Likewise, the instability of the ramp-up is caused by the connection and interaction of all objects from the suppliers that influence each other. As a result the whole system does not have a high performance and maturity yet. Fast control and verification of this process is required in order to transform the ramp-up into a stable process.[31] This means that the choice of the right strategy and the evaluation and verification of the results of this process decrease the number of problems and lead to a stable ramp-up.

The aforementioned reasons for the improvement and optimization of the ramp-up and the elimination of the variety of challenges that go with it are relevant for the output of the ramp-up. The question of how to optimize the ramp-up and how to avoid problems require further investigations. This thesis aims to research to evaluate suggestions to improve the ramp-up and with that to ensure a stable output.

1.1 Knapp Systemintegration GmbH

Knapp Systemintegration GmbH (KSI) is an Austrian company that was founded in 1995. The headquarter of the KSI is in Leoben with currently more than 200 employees. KSI is part of the Knapp Group that provides logistic solutions for automated warehouses all around the globe. Core activities are the development of overall logistic concepts that include consulting, individual solutions, simulation, and system integration.[32]

The company KSI GmbH is an international company that is known for the construction of Single Unit Picking Distribution Centers and for the implementation of automation products. Knapp develops suitable logistic solutions and offers high quality installations for customers all around the globe. The company Knapp is market leader in growing markets and present all around the world, as shown in Figure 5.

[28] Cf. Franzkoch et al. (2005), p.406.
[29] Bramley et al. (2005), p.257.
[30] Cf. Ibid., p.257.
[31] Cf. Franzkoch et al. (2005), p.406.
[32] Cf. Wogatai (2010), p.4.

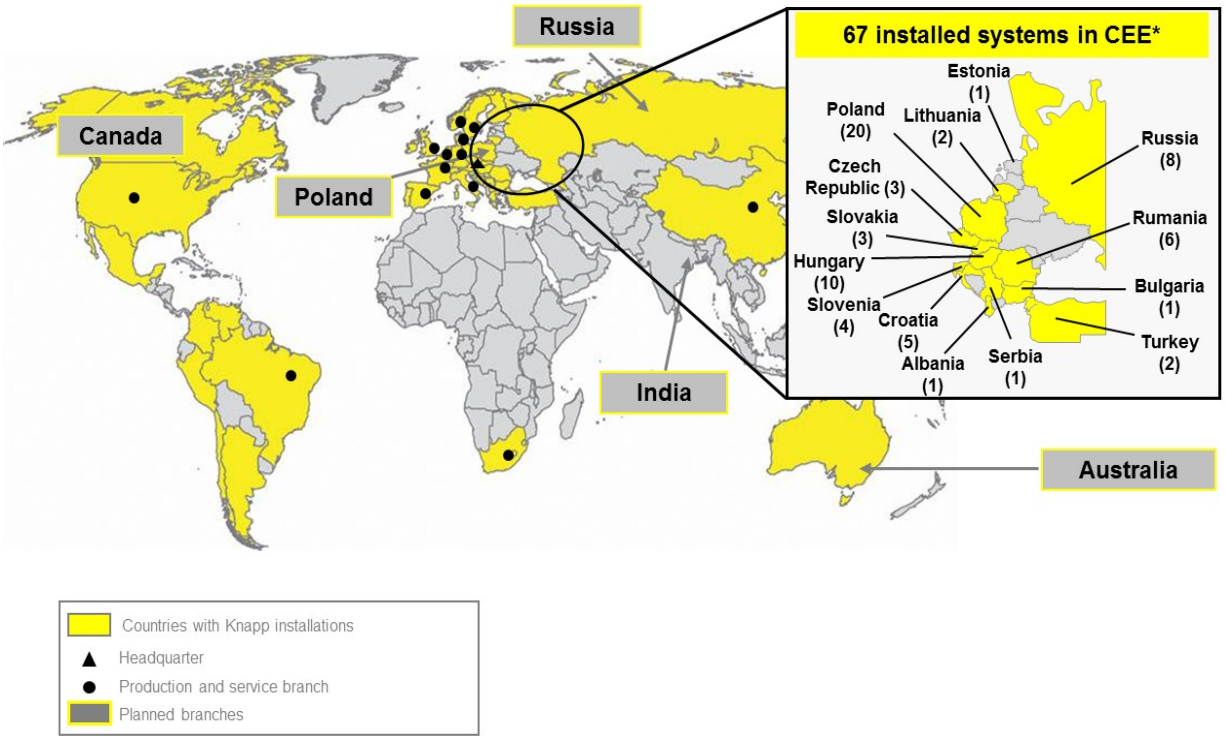

Figure 5: Knapp's presence on the world market[33]

Knapp is focusing on the industrial sectors of audio &video, office supplies & mail order, beverages & food, cosmetic, pharmacy and tooling equipment.[34]

The products of Knapp are divided in:[35]

- Storing and removal systems: high rack, small-parts warehouse, OSR (Order Storage and Retrieval)
- Pick systems: PTL (Pick to Light), RF-Terminals (Radio Frequency),
- Voice-controlled, full or half automated pick systems
- Positioning systems
- Transport control: Pallet-, carton-conveyance, tray conveyance
- Special machines: Carton erector, robots, stacking and destocking machines
- Recognition systems: Image recognition, RFID (Radio Frequency Identification)

Knapp also provides a high variety of services that include consulting where the client is advised about the best individual solution, planning of solutions, development of installations, production and assembling on-site. Furthermore, the project offer consists of

[33] Based on KSI (2011).
[34] Cf. Knapp (2012), Internet.
[35] Cf. KSI (2011).

the start-up[36], training, technical operation, 24-h-hotline and customer care as shown in Figure 6:

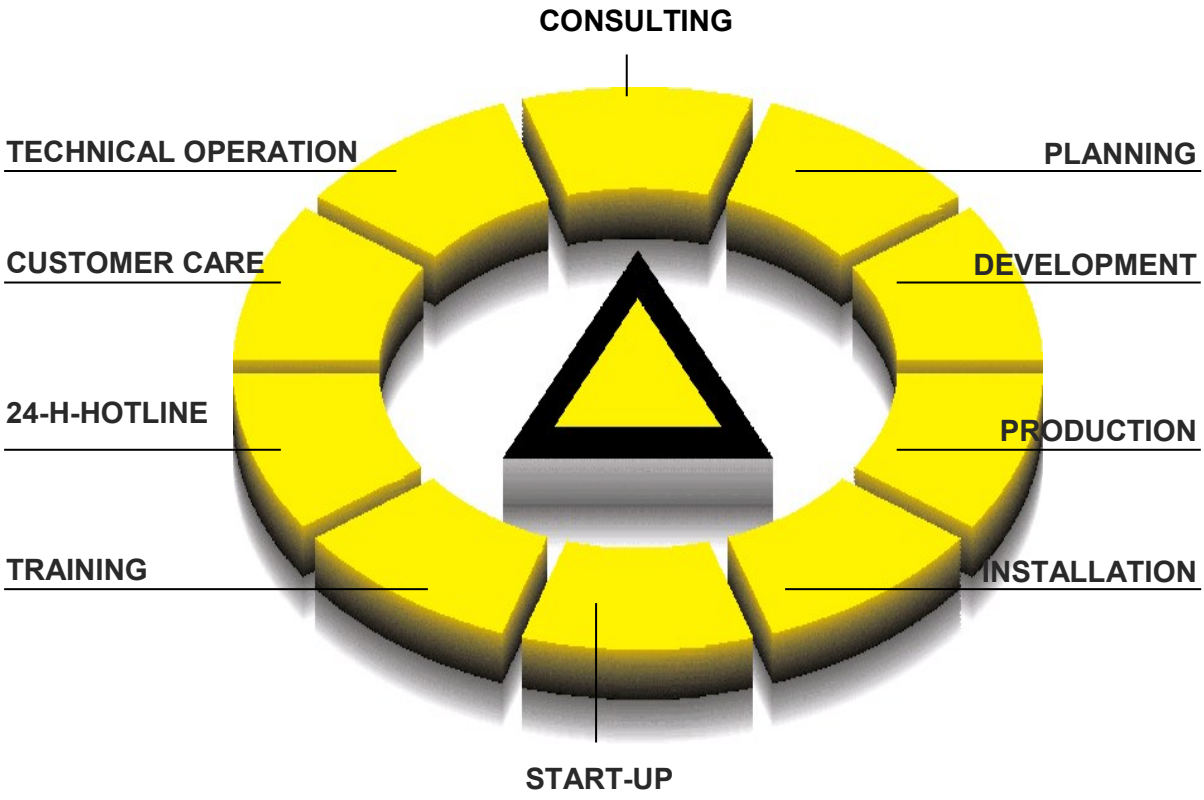

Figure 6: Offered services[37]

1.2 Initial Situation

The company is currently challenged by difficulties arising during the ramp-up of their installations in Distribution Centers. Problems in this area cause a waste of time, loss of confidence from the customer side and leads additionally to a waste of money and resources.

From time to time problems occur during the ramp-up, that's why the challenges and their causes should be analyzed in more detail. This area contains high potential for improvements to achieve faster and stable processes. However, the potential of improvements for ramp-ups in automated Distribution Centers has never been investigated scientifically by research in literature, benchmarking and best practice.

[36] Start-up = Phase before the go-live that is characterized by tests with test material before the normal production starts.
[37] Based on KSI (2011).

Automated Distribution Center

The term "automation" describes the use of automated fittings in order to implement work and production processes. Automation brings economic and competitive advantages, if the release of human labor and the implementation of more efficient work forces at high utilization degrees bring lower production costs as a result.[38]

A Distribution Center (DC) is considered to be a node in a logistical network that could be designed as an inventory or trans-shipment center, or a combination of both of them.[39] Logistic processes, such as receiving, picking and dispatch processes are carried out in order to supply various stores and clients with the required product. These centers divide orders and distribute them to the customer.

The main processes are for example in a warehouse with goods receiving, storing, and issuing (described in more detail in Figure 7):

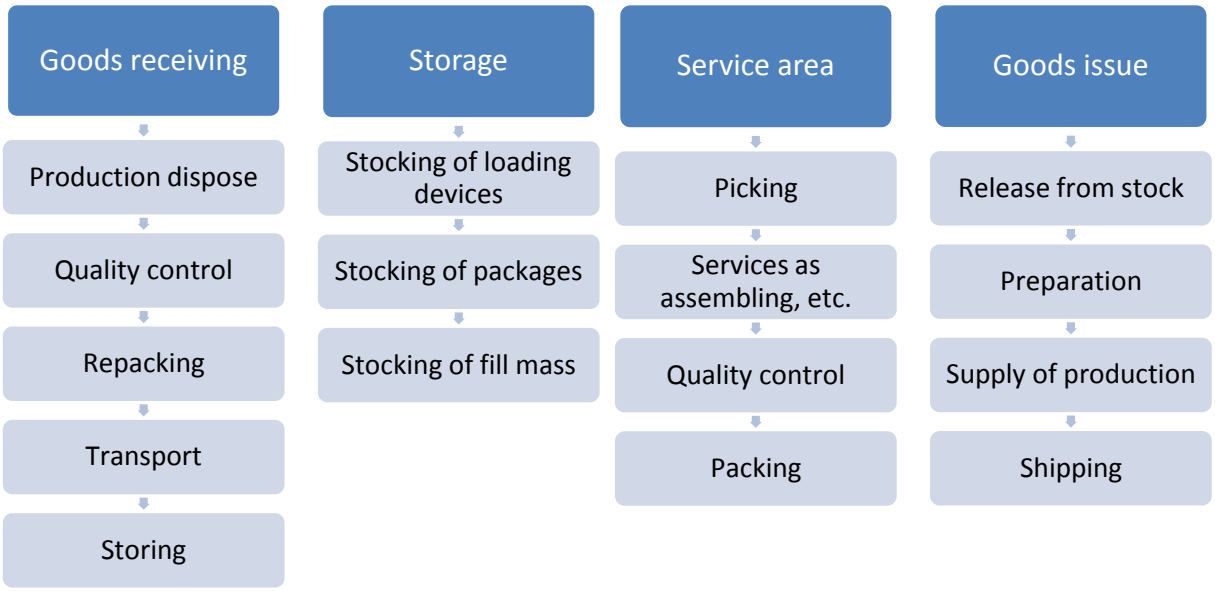

Figure 7: Areas and processes in a warehouse[40]

The difference between a normal warehouse and an automated DC is the presence of automated devices that carry out some or all of the mentioned processes and tasks.

[38] Cf. Syksa (2006), p. 91.
[39] Cf. O.V. (2012), Internet.
[40] Based on Arnold et al. (2008), p.383.

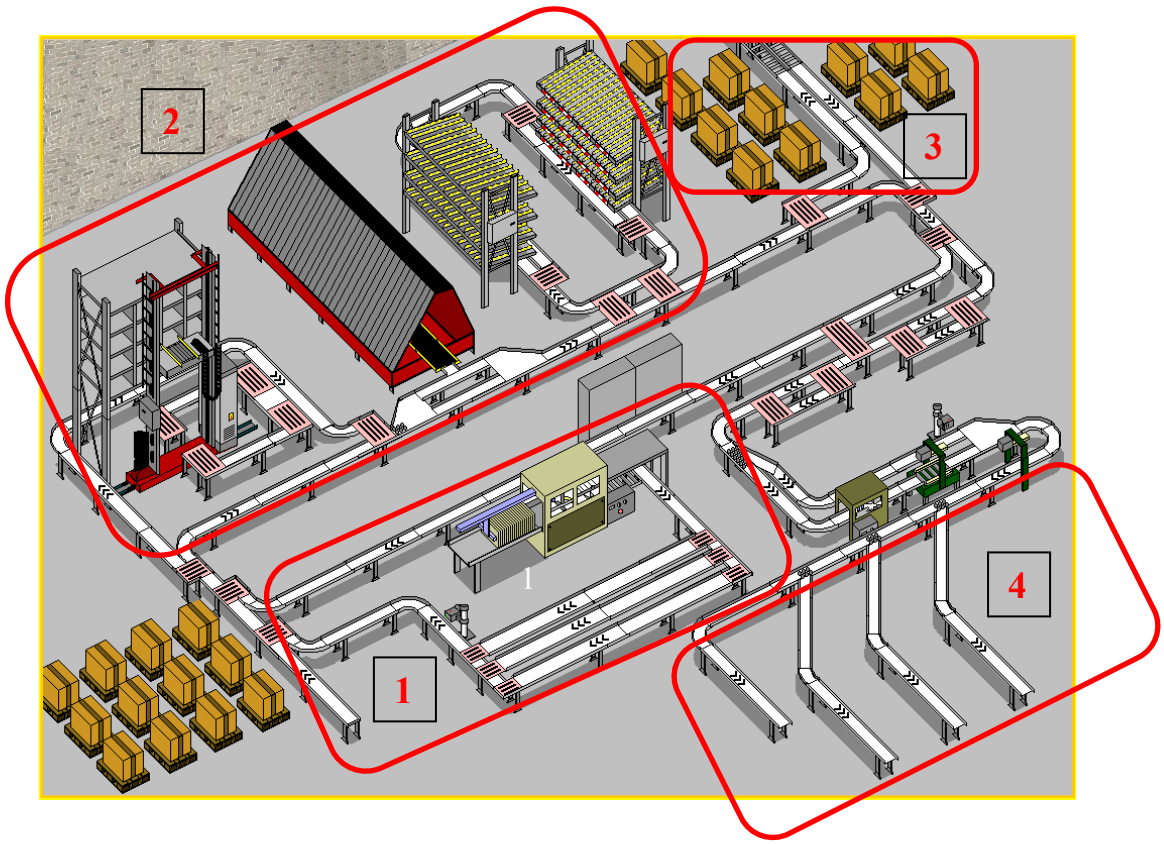

Figure 8: Overview of functionalities of an automated DC[41]

Figure 8 shows a typical installation of an automated Distribution Center. This DC consists of 4 main areas that include the order preparation (1), automatic order handling (2), manual order handling (3), and dispatch (4).[42] In the preparation area orders are received, cartons erected, labeled and identified. The automatic order handling area consists of automated devices that carry out automated picking processes. The third area shown in the picture demonstrates the area for manual order handling. The dispatch area serves to close and prepare cartons for the dispatch.

1.3 Objectives

This thesis aim is to describe a ramp-up in general theoretically. The term ramp-up is defined and the topic ramp-up is explained in detail. Existing literature is analyzed and discussed as well as empirical results are presented. Devices are described, analyzed, compared and after that evaluated by a specific ramp-up. Key figures for ramp-ups, which serve for comparison and improvement are discovered and described.

[41] Based on KSI (2011).
[42] Cf. KSI (2011).

The objective of the practical part is to analyze, evaluate and improve current ramp-ups of installations implemented by the company Knapp. The process and its challenges should be analyzed in more detail, in order to discuss main difficulties and to generate measurements for improvements that do not only affect the stability of the ramp-up, but also the ramp-up time. These challenges are analyzed from both, the company's and the customer's perspective.

The analysis of the practical part also delivers improvements according to the causes and consequences of each disorder. An evaluation of the suggested improvements leads to suggested actions in order to improve future ramp-ups. These improvements are then applied in the according phase of the project during a ramp-up on site with the target to use the full potential of resources, time and money and to avoid disorders.

After this step, the suggested improvements are applied on a specific project. At the end of the project, the efficiency and effectiveness of the implemented improvements are evaluated. Afterwards the final result is interpreted and further tasks are recommended.

A final evaluation document is created that is used to evaluate the ramp-up and the existence of all conditions in each phase of the project. This document serves as an evaluation sheet for ramp-ups.

Research questions

This thesis gives an answer to the main investigation issue:

- How can the ramp-up be managed in an efficient and effective way to become a fast and stable process of high quality?

In addition it responds to the following theoretical research questions:

- How does a typical ramp-up process look like according to literature?
- How can a ramp-up process be analyzed and evaluated?
- What key indicators should be used to measure ramp-ups?

And eventually to the following practical research questions:

- Which success factors and challenges identify experts during ramp-ups?
- Which areas cause problems (categorized according to hard and soft factors)?
- What concepts contains a ramp-up guide and which ones are feasible?

1.4 Structure

Figure 9 demonstrates the steps of the investigation process.

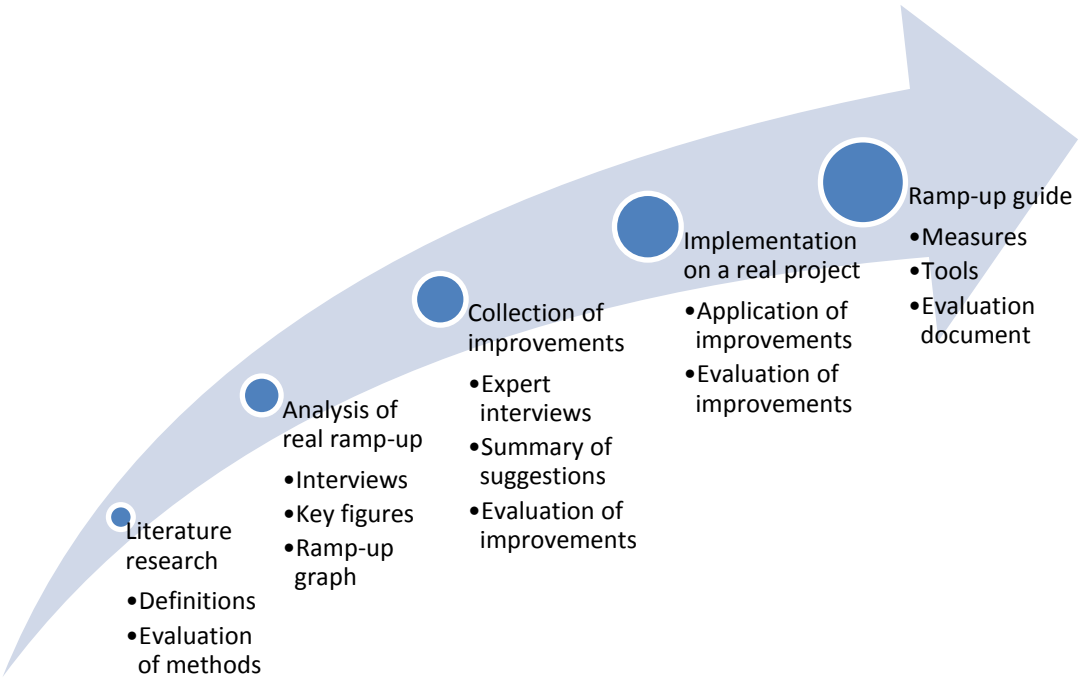

Figure 9: Structure of investigation process[43]

The first part of the thesis contains the literature study, where general descriptions and definitions of ramp-up processes are collected, analyzed and documented. Analysis and evaluation tools are created in order to evaluate ramp-up projects.

The second part includes the analysis of a specific process by interviews and the evaluation of the projects with key figures and other analyzing tools.

The third part of the thesis contains the result of expert interviews, the main challenges and improvement suggestions for a successful ramp-up. The improvements are evaluated and the results documented.

The fourth part of this investigation includes the result of the implementation of the suggestions on a real project. The evaluation of the measures and general recommendations will be the result of this part.

The last part includes the final ramp-up guide, where defined, recommended measures will be listed and an evaluation tool is offered that serves to evaluate each single ramp-up process.

[43] Own design.

2 Theoretical description of ramp-ups

The theoretical part of this thesis focuses on existing definitions, the objectives, as well as the analysis and the evaluation of ramp-up processes.

2.1 Definitions

Various definitions and explications of the ramp-up process can be found in the literature. In this chapter, the terms "ramp-up process", "ramp-up period", and "ramp-up management" will be discussed and described in more detail.

Ramp-up

According to *Wildemann*, three types of ramp-ups can be defined:

1) Serial production ramp-up
2) Service ramp-up
3) Ramp-up of installations

Ad 1) Serial production ramp-up

Serial production ramp-up refers to the integration phase of products, means of production and production systems.[44] It describes the process after the start-up to the serial production of a specific product, for instance automobiles. The ramp-up in this industry sector is characterized by a number of changing challenges and needs, which were at first characterized by high pressure according to quantity and quality, then by variety management and finally by mass production of individual products.[45]

Another definition of production ramp-up is provided by *Gronau* who says that ramp-up is the crossing point between product development and production phase. Besides he mentions that the ramp-up is characterized by implementing production tests, by an increasing output that results finally in series production with the specified output (costs/piece, quality, throughput,…).[46]

Ad 2) Service ramp-up

Service ramp-up is described as a stabilizing process of a service production to its stable state. It is characterized by the pre and final combination of internal production factors, such as employees, equipment, information and data. The final combination also contains external production factors, e.g. clients, information and data.[47]

[44] Cf. Wildemann (2011), p.23.
[45] Cf. Ibid., p.6.
[46] Cf. Gronau (2008), p.282.
[47] Cf. Wildemann (2011), p24.

Ad 3) Ramp-up of installations

The ramp-up in plant engineering refers to the increase of production volume, the acceptance of the installation and the normal operation with operating devices. The ramp-up starts with the start-up, then the increase of production volume follows subsequently to the acceptance of the installation. The target is to bring the installation on-site to a permanent rated power in agreement with personnel, organizational and technical conditions.[48]

Ramp-up process

A process is a procedure of activities in a determined order to create an object in a specific state.[49] The ramp-up process includes all activities and decisions that are required after the go-live[50] with the objective of a specific output according to the current phase. A process can be defined as a procedure that has an input and creates the input by process shaping. The input is triggered by a previous activity, a time or changing state.[51] The ramp-up process is a process triggered by the go-live that ends when the total possible production volume is reached. Input factors are resources, knowledge and production material and output factors are trained operators, improved ramp-up performance and increased production volume.

According to *Wildemann* (Figure 10) the process of plant engineering consists of the activities site-inspection to receive an overview of the situation and demand, followed by the assembly, where electrical and mechanical activities take place. After the start-up the test-operation follows that serves to verify the correct operation of the system. This phase is finished with the acceptance of the installation that is the trigger for the actual ramp-up. This step is then finished with the final acceptance by the customer. The last part is the normal operation that can be defined as stable result of the ramp-up.

Figure 10: Plant engineering[52]

[48] Cf. Wildemann (2011), p.25.
[49] Cf. Becker (2008), p.16.
[50] Go-live = acceptance of the installation and start of the normal production.
[51] Cf. Mau (2003), p.50.
[52] Based on Wildemann (2011), p.25.

The difference between ramp-up of installation and of serial production is that the ramp-up of an installation is the ramp-up of a new and unique product, adapted to the customers' requirements. Serial production ramp-up refers to the ramp-up of the same installation with high production of a new product, where a small amount of products is steadily increasing until it reaches the required output.

Since the ramp-up of an installation refers to the ramp-up of a unique installation, it differs with a high variance of possibilities from any other ramp-up project. Even if the product, the installation, might be the same there are many other influence factors such as the client, culture, knowledge about ramp-ups and user handling for instance that have a main effect on the increase of the ramp-up. Serial production ramp-ups take always place at the same place is therefore not influenced by so many factors as ramp-up of installation.

Another difference is in the operation of the system and the supply of production material. In ramp-ups of installations the supplier is not responsible for the orders, the output of the system and the supply of materials, if the system is running without technical problems. The customers are responsible for the output and supply of material themselves, while only the support and the solutions for problems are offered by the supplier.

Another important difference is the role of the supplier. While he is passive and delivers only the material for serial production ramp-ups, he is active in ramp-ups of installations since he sells the whole product and the solution to the customer.

This thesis investigates and discusses the optimization of the third type of ramp-up, namely the ramp-up of installations. The ramp-up of installations can be looked at from two different perspectives, i.e. the supplier's and customer's perspective. This thesis aims to investigate the ramp-up process from the point of view of the supplier and only a few aspects of the customer's perspective are included in order to develop a wide spread view of the ramp-up and increase customer satisfaction.

The ramp-up is a process phase that is influenced by prior phases such as the development and realization phases. The ramp-up as considered in this paper, includes both the start-up and the transfer to the normal operation. Figure 11 shows a model that describes the phases from the development of a product to the normal operation in more detail. It demonstrates each phase with the related activities that have to be implemented. It consists of the activities concerning the development and realization of the project. After those activities concerning the start-up, ramp-up and the transfer to the normal operation are required until a stable production is reached. Start-up and ramp-up include tasks such as training sessions for staff, integration tests and successive ramp-up while the transfer to normal operation includes on-site support, process optimization and permanent project controlling.

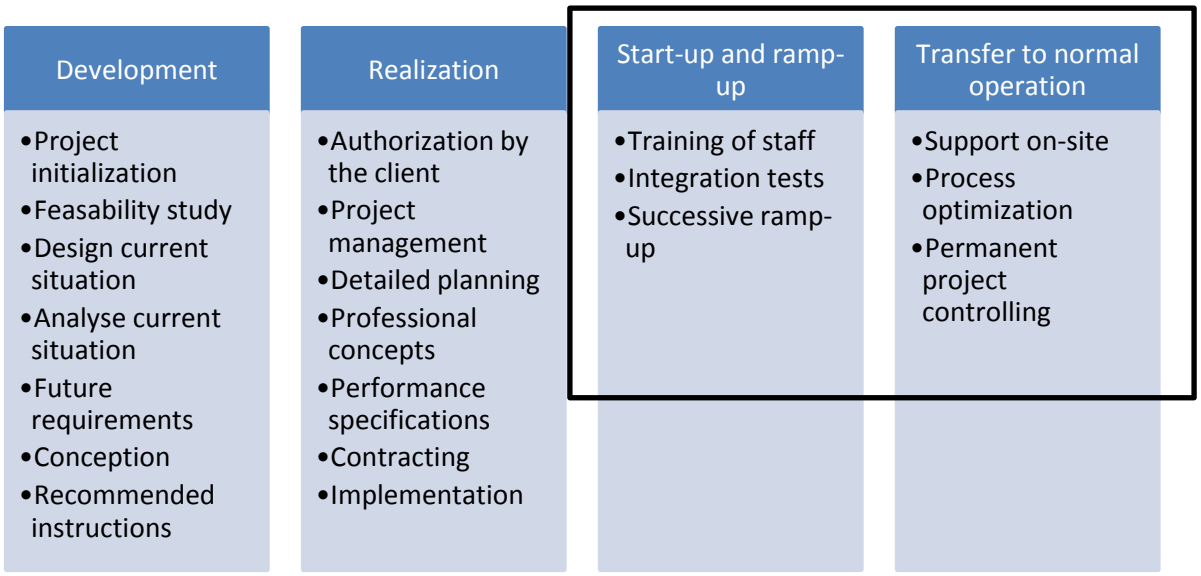

Figure 11: Ramp-up process[53]

Ramp-up period

The ramp-up period refers to the duration of the ramp-up phase from the start-up to the point at which the normal operation takes place, i.e. when the system reaches its stable state with a stable output. The ramp-up period is measured in the unit of time in days, weeks, months or even years.

Ramp-up management

According to *Jörg Risse*, the ramp-up management of serial production ramp-ups refers to planning, organization, implementation and inspection of internal and external material. Moreover, it includes information flows, involving all actors in the development of the product with the target to achieve the determined time, cost and quality, as well as the harmonization of the product, process and facility by creating transparency in the process.[54]

For the ramp-up of installations from the supplier's point of view, the same definition can be used, with the exception that the supply of production material and the operation of the installation are not part of the ramp-up management. The ramp-up-management of the provider does not include delivering production material and the production of products since the customer is responsible for these elements.

Figure 12 presents the main elements of the ramp-up management, namely ramp-up planning, ramp-up organization, complexity management, change management, quality management and knowledge management.

[53] Based on Müller-Dauppert (2005), p.85.
[54] Cf. Risse (2002), p.139.

Figure 12: Elements of ramp-up management[55]

Ramp-up planning contains planning activities related to the ramp-up. Ramp-up organization refers to the organizational structure that has to be defined for the ramp-up. Complexity management is another important part that has to be carried out in order to manage the increasing complexity of the product, the installation and its functionalities. Change management is necessary during the ramp-up given that many actions are taking place to adjust and adapt the installation to the required demand and to create flexibility. Quality management is the part of the management that verifies and assures the right quality of the installation. Problems during the ramp-up phase can be categorized according to quality, availability and capacity problems that are often causes of inappropriate knowledge management.[56] Therefore, the last part, knowledge management, is part of this management cycle. It enables and assures that the appropriate creation and transfer of knowledge about the installation and the ramp-up in order to improve the performance of the company and compete against the competition on the global market.

[55] Based on Hartel (2009), p.175.
[56] Cf. Biedermann (2008), p.13.

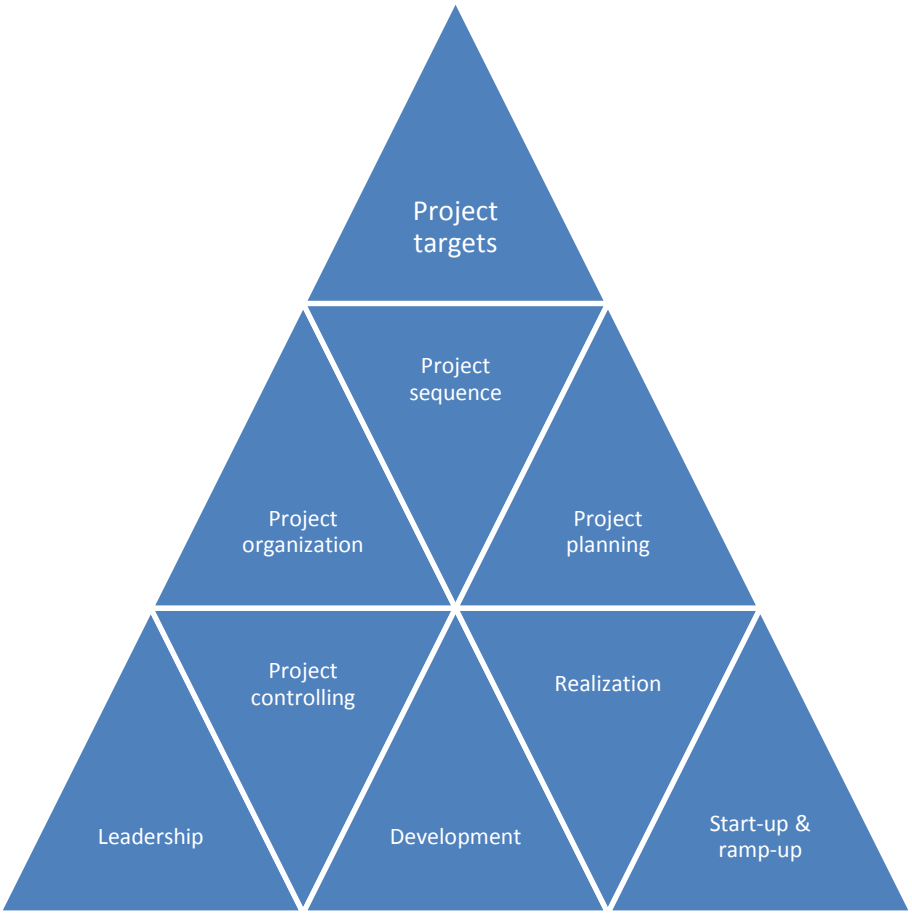

Figure 13: Project and ramp-up management[57]

Figure 13 demonstrates activities and functions of the project and ramp-up management. It presents the necessity to connect and synchronize all activities to each other in order to successfully manage even complex and extensive projects.[58]

The lowest level of the triangle, i.e. the basis, includes leadership, project controlling and development as well as the realization of the project. Also the start-up and ramp-up that play the most important role in the project are on the lowest level. Project planning and sequence include tasks that are relevant for the execution of the project and are positioned on the second level. The third part of the second level is made up of an appropriate project organization that carries out the management of the project. The project targets are the main objectives of the project.

The description of extended ramp-up management by Norbert Gronau is characterized by the integration of all parts of the installation into the production system on-site, executed under high time pressure and arising inefficiencies from previous processes just after the

[57] Based on Müller-Dauppert (2005), p.84.
[58] Cf. Müller-Dauppert (2005), p.84.

start-up. This type of management includes planning, control, implementation and supervision of the ramp-up and the production system.[59]

An appropriate ramp-up management is essential due to the arising complexity and possible problems. During the ramp-up it is necessary to administrate installation and logistical interruptions, personnel and a lack of available employees or sudden alterations of the production program. Consequences, such as unstructured activities with additional performance and higher staff expenses, can be avoided by the implementation of appropriate measures.[60]

This means that appropriate strategies and measures have to be developed to confront problems in advance and to control the mentioned process. Successful ramp-ups can just be executed by an integrated ramp-up management where all means of production, human, technology and organization are synchronized. However the requirements of the installation and its integration in the production system have to be defined clearly in order to achieve the expected result.[61]

2.2 Ramp-up objectives

The objectives mentioned in this chapter are those that have to be achieved during the implementation of the ramp-up phase. For a successful ramp-up, time (cycle time of the process), quality (quality of the process and product) and costs (process expenses and profit) are essential (see chapter 2.2.1). Further objectives of the ramp-up are high efficiency and effectiveness but these further targets that should be achieved in any ramp-up.

2.2.1Time, costs and quality

The reduction of the ramp-up period is one of the main objectives since time has a major influence on the feasibility of the investment. The reduction of ramp-up time decreases not only expenses for development and ramp-up but also higher margins are gained at an earlier moment. Last but not least, the full capacity of the system can be used sooner, which enables the use of economies of scale of fix cost digression.[62]

The second objective is to decrease ramp-up costs and expenses that are highly influenced by unplanned incidents.[63] Ramp-up costs for development, elimination of software bugs and other technical problems, changes and production support create costs that have to be well planned and considered in advance. An appropriate tool has to be developed to manage

[59] Cf. Gronau (2008), p.282-283.
[60] Cf. Ibid., p.282.
[61] Cf. Ibid.
[62] Cf. Nagel (2011), p.32-35.
[63] Cf. Ibid.

ramp-up costs and hence to observe, influence and analyze them in order to reach the second objective.

High ramp-up quality is the third main objective that must be achieved beside time and costs. As a matter of fact, it can make the difference between a leading and an average company (Figure 14).

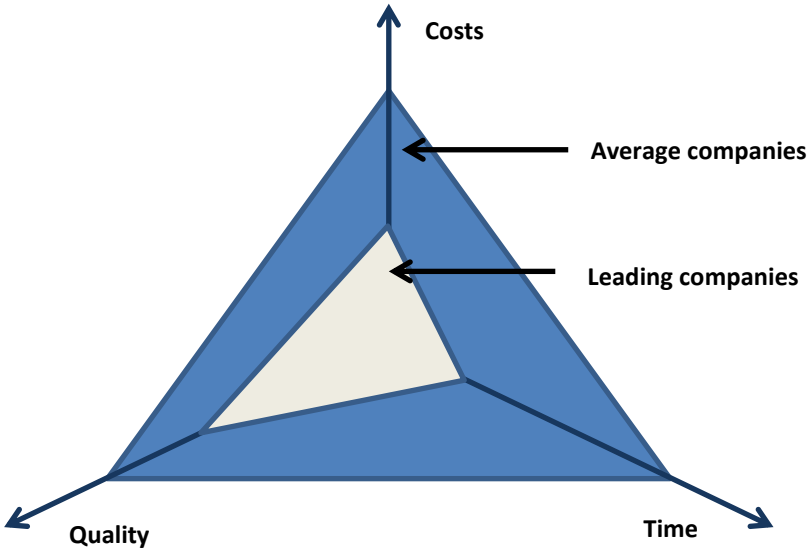

Figure 14: Objectives of ramp-up[64]

Achieving all three objectives at the same time is challenging and can create conflicts since they influence each other, e.g. if the target "less ramp-up time" is achieved, then the quality of the ramp-up could suffer, but lower costs might also be the result. The objective is to optimize the main targets in a balanced way for a successful ramp-up.

Time

According to *Nagel* a faster ramp-up has more positive effects than just the reduction of the ramp-up period. As mentioned above, it creates further positive results as higher feasibility of the investment, higher margins or avoiding loss of profit. The faster the maximal capacity utilization rate and a stable process are achieved, the more economic is the ramp-up.[65]

The reduction of the ramp-up period leads to the requirement of improved process coordination, higher demand for resources and intensive planning. Long ramp-up periods are responsible for higher expenses caused by resources, changing demand, higher costs and lower work division. It has to be mentioned that additionally to improvements in the

[64] Based on Wildemann (2011), p.30.
[65] Cf. Nagel (2011), p.32-33.

mentioned areas, the time aspect of the ramp-up can also be improved by strategic product and process development in earlier phases of the project.[66]

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Main time indicators of the production (ramp-up) are shown in Figure 15, mentioned by *Risse* related to time indicators for the time-to-market.

Main time indicators	Project organization
	Resposibilties
	System interfaces
	Spacial barriers
	Divisional egoism
	Data transparency and availability
	Customer integration
	Patency of the IT-Systems
	Communication barriers
	Motivation
	Know-how
	Changes
	Customer demand
	Specification
	Complexity
	Service level
	Development depth
	Integration of all organizations involved
	Logistic-service provider-integration of the customer

Figure 15: Main time indicators[68]

[66] Cf. Wildemann (2011), p.30-31.
[67] Cf. Ibid.
[68] Based on Risse (2002), p.84.

Figure 16 outlines the main categories of the mentioned time indicators. These categories describe the areas that are relevant for time saving strategies in order to improve the production and in addition also the ramp-up.

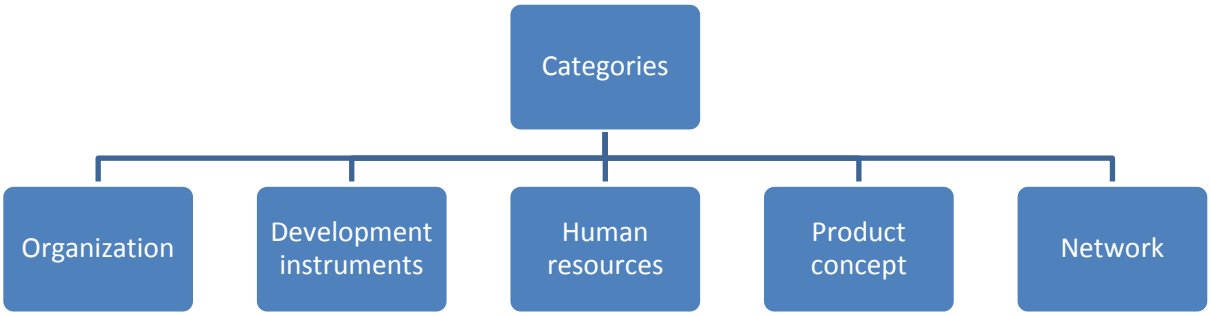

Figure 16: Categories of time indicators[69]

Organization is the first main area that can be seen as basis for a successful management and fast implementation of the ramp-up. Good development instruments are necessary to create an appropriate product of high quality and avoid waste of time. Human resources with the right knowledge and with high availability have to be present for a fast the implementation and elimination of problems. A good product concept also ensures high quality and avoids problems that were not considered in advance for a stable production. An appropriate network during the ramp-up is necessary for a fluent flow of time, material and finances in the logistics network from supplier to customer as well as an appropriate relationship between all involved partners.

Costs

Ramp-up costs include expenses caused by new requirements of procurement, production and administration as well as of higher demand for resources. The ramp-up is characterized by negative impacts that lead to higher costs than planned, such as inappropriate supply, machine breakdown or product changes. Further expenses for material, personnel, change of product/production, logistic, information technology and loss of profit lead to higher process costs than considered in the planning phase.[70]

[69] Based on Risse (2002), p.84.
[70] Cf. Nagel (2011), p.34.

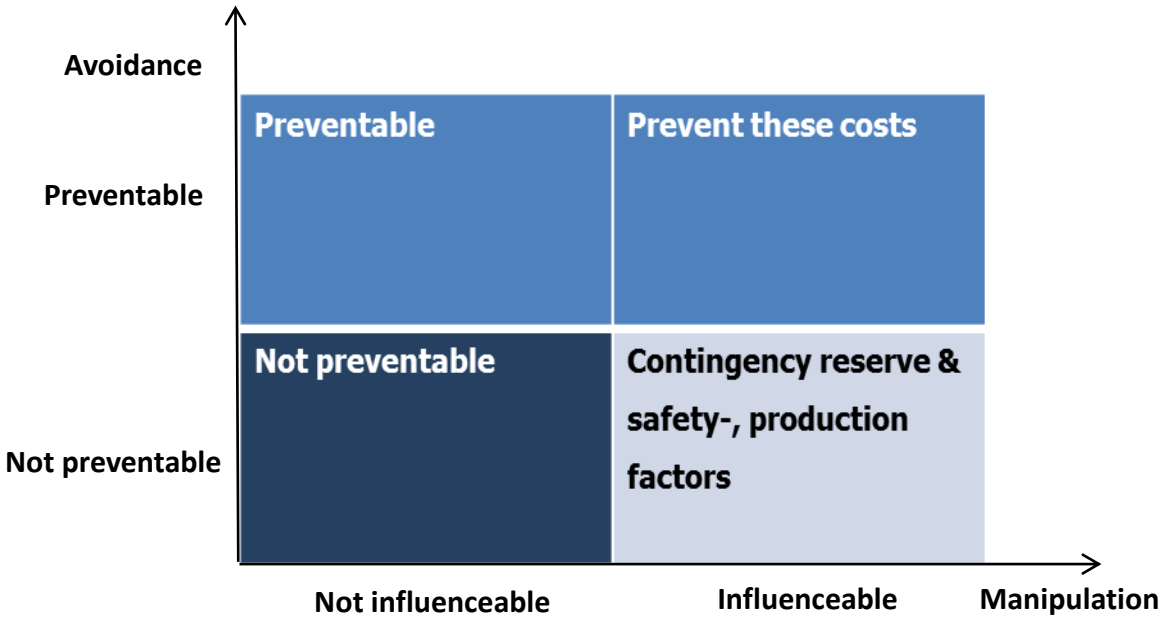

Figure 17: Decrease of expenses[71]

The decrease of ramp-up costs requires cost management, keeping in mind planned and unplanned expenses related to target costs.[72] Two factors, namely avoidance and manipulation of expenses, are shown in a table in order to categorize and influence the costs (see Figure 17).

The following steps describe how to build up an instrument in order to control ramp-up costs:[73]

1) Main logistic processes are defined (material flow and processes of the network)
2) Processes are analyzed, underlying activities defined and cost drivers determined
3) Cost drivers are transferred into key metrics
4) Key metrics are put into a hierarchical order to form a key metric system

Time vs. costs

When only the improvement of the factor time is taken into consideration, negative effects are caused on other objectives. Figure 18 shows the contradictive targets of ramp-up costs and time.

[71] Based on Nagel (2011), p.112.
[72] Cf. Nagel (2011), p.35.
[73] Cf. Herstatt (2007), p.117-118.

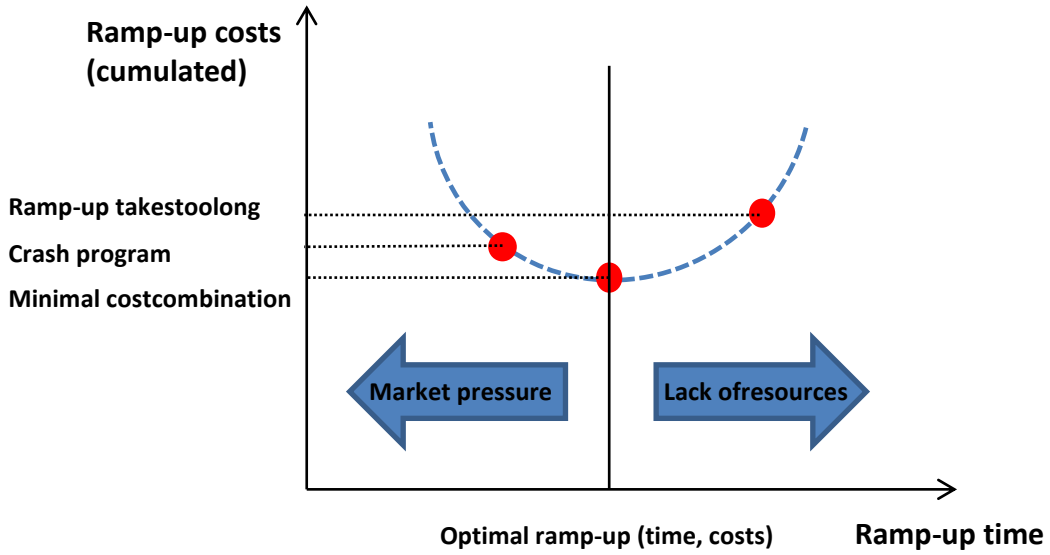

Figure 18: Objectives of ramp-up management[74]

Examples for these contradictive objectives are crash programs to enable faster ramp-ups because of high market pressure, but this strategy leads to high ramp-up costs and bad quality. Another example is the consequence of a longer ramp-up period than to the optimal one caused by a lack of resources. This case results again in higher costs than required for an optimal ramp-up.

Quality

An appropriate ramp-up quality is gained by ramp-up control. High product quality ensures high ramp-up quality, guaranteed by high process and administration quality and monitoring technical parameters. A defined process organization with defined responsibilities and tasks is necessary to achieve and maintain ramp-up quality.[75]

Quality up from the start is necessary, since corrections and adjustments result in high costs, a waste of time and personnel costs. These extra costs can be avoided if process transparency is guaranteed from the beginning on. One condition is an appropriate and available documentation and traceability of specified and additional performance of the installation in order to maintain the confidence of the provider in all cases.[76]

[74] Based on Wildemann (2011), p.31.
[75] Cf. Nagel (2011), p.35.
[76] Cf. Gronau (2008), p.284-285.

2.2.2Effectiveness and efficiency

Further objectives such as effectiveness and efficiency of the ramp-up are of great importance defined by the deployment of resources, performance and output. Effectiveness refers to the achievement of the maximal output, while efficiency refers to the optimal relation between output and input.

An important factor to achieve an efficient and effective process is the velocity of the product development process. Other factors and activities have to be considered as well in order to improve the ramp-up and achieve the mentioned objectives.[77]

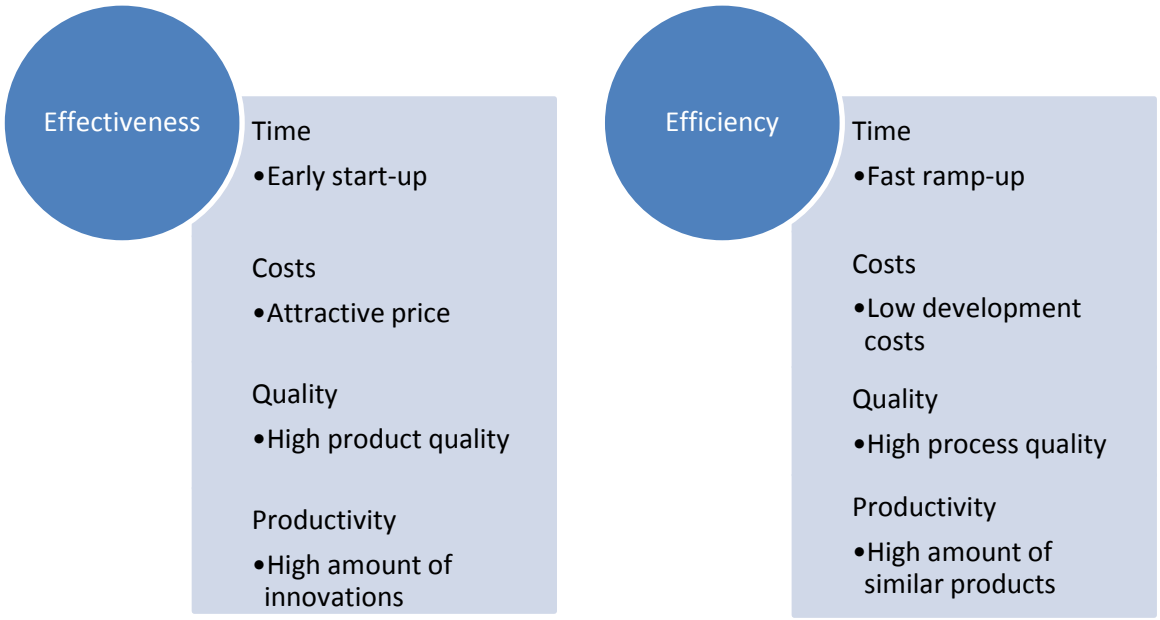

Figure 19: Effectiveness and efficiency[78]

Figure 19 shows the sub-objectives of effectiveness and efficiency related to the factors time, costs, quality and productivity in more detail. To sum up, a successful ramp-up is effective when it has an early start-up, an attractive price, high product quality and a high amount of innovations. On the other hand, the ramp-up has to be characterized by high velocity, low development costs, high process quality and a high amount of similar products sold in order to achieve high efficiency.

Effectiveness and efficiency can be achieved by treating uncertainties in advance in a fast way. The treatment of uncertainties requires the control of three areas:[79]

- Handling of complexity and non-transparency
- Appropriate control

[77] Cf. Risse (2002), p.73.
[78] Based on Risse (2002), p.73.
[79] Cf. Nagel (2011), p.43.

- Handling of disorders

Handling of complexity and non-transparency is possible through the description of a model and appropriate handling of control. In order to gain control, planning and decision processes are required. Appropriate handling of disorders is enabled by connecting with project activities during the ramp-up.[80]

Furthermore critical aspects have an impact on the efficiency and effectiveness of the ramp-up and the achievement of the main targets such as time, costs and quality. These critical aspects have to be analyzed in advance and improved in order to guarantee an efficient and effective ramp-up. According to a survey of *Norbert Gronau,* companies see the highest challenges during the ramp-up in technical alterations (81%), planning of resources (75%) and communication/coordination (75%) as shown in Figure 20.[81]

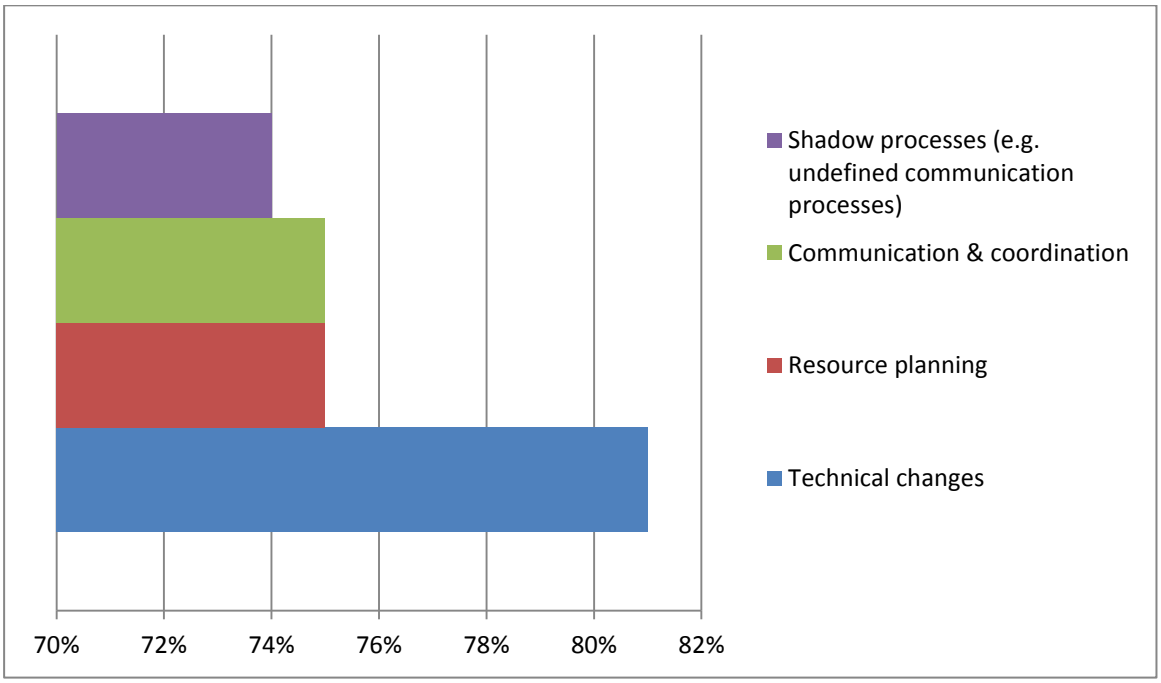

Figure 20: Challenges during ramp-up[82]

Factors for an efficient and effective ramp-up are listed below:[83]

- Way of working
- Integration of the client
- Control of mechanical processes
- Production integration
- Line complexity

[80] Cf. Nagel (2011), p.43-44.
[81] Cf. Gronau (2008), p.283.
[82] Based on Gronau (2008), p.284.
[83] Cf. Barisits (2008), p.67.

- Professionalism and quality of the ramp-up organization.

An efficient way of working has to be defined and the customer has to be integrated into the start-up and ramp-up phase in order to work effectively. All mechanical processes have to be controlled to guarantee high availability and therefore the efficiency of the installation during the ramp-up. The production has to be integrated so that the ramp-up is effective according to the needs of the customer. The line complexity has to be kept as low as possible to enable a quick, efficient and effective handling for the customer. Professionalism and quality of the ramp-up organization are a further main factor for efficiency and effectiveness during the ramp-up.

2.2.3 Optimization of ramp-up resources

A main objective of the ramp-up is the optimization of the resources and their commitment on-site. The planning and calculation are difficult tasks, especially during the ramp-up when the installation is still in an unstable state. Resources that are present on-site, such as start-up engineers and technicians, form ramp-up teams. There exist several strategies how these teams are formed, described by (the author) *Börner* and summarized in the following paragraphs. The ramp-up team structures for series production can also be applied on ramp-up teams in automated DC's with similar conditions.
The ramp-up is a period with a high amount of employees during the ramp-up. The number of required employees during the ramp-up decreases, i.e. in the beginning there are more, afterwards there are less people required. A continuously increasing ramp-up curve and finally a constant and low amount of employees are therefore further characteristics.[84]

Composition of ramp-up teams

The ramp-up process is a dynamic process that cannot be determined by designing forecasts. Therefore the dynamic process of the ramp-up requires a special operational ramp-up team. The team should consist of flexible ramp-up experts. Different tasks compared to those in series production lead to the demand for different compositions and amount of members that have to be calculated according to the ramp-up type.[85]
Generally role concepts for an interdisciplinary ramp-up team have to be defined for the ramp-up phase.[86] *Börner* mentions different types of compositions of ramp-up teams, shown in Figure 21.

[84] Cf. Börner (2009), p.54-55.
[85] Cf. Ibid., p.40.
[86] Cf. Biedermann (2008), p.14.

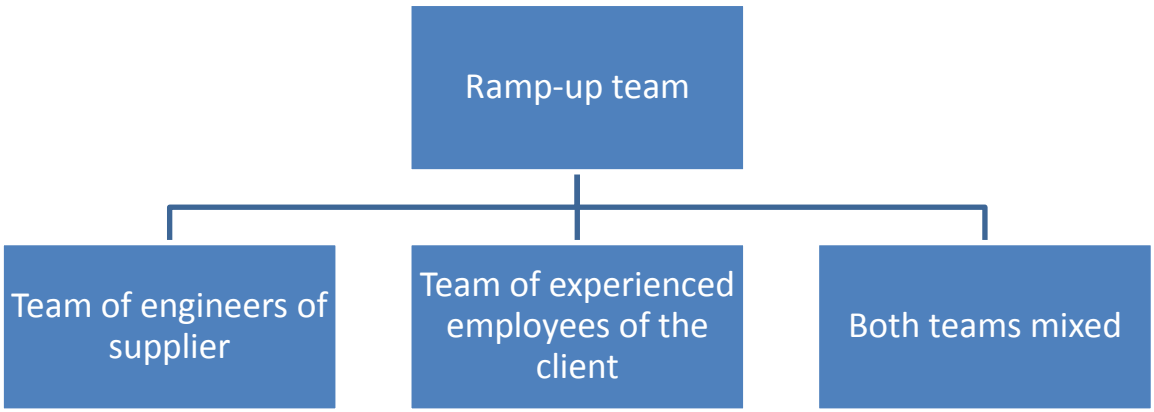

Figure 21: Composition of ramp-up teams[87]

The different ramp-up team types can be described as follows:[88]

- Team of engineers of supplier (homogenous engineer ramp-up team)

The advantage of this team is the fast elimination of problems that may affect the ramp-up period. A flexible adjustment of the number of engineers avoids resource problems. Qualified engineers eliminate problems in a fast way thanks to their knowledge.[89]
The advantages of a ramp-up team that works separately or parallel to the operators is that it works independently from the client's employees. Disadvantages: High costs for availability and qualification of the engineers. It is more difficult to transfer the knowledge to the operators after the acceptance phase since they were not involved in the ramp-up before. Operators should be integrated into the start-up and test phases to transfer knowledge.[90]

- Team of experienced employees of client (homogenous employee ramp-up team)

One advantage is that the methodical knowledge is transferred by the collection of experience. It is also possible to adjust the amount of employees in a flexible way. The disadvantages are that this team has less technical skills to eliminate disruptions. The team needs an extra internal maintenance team that possesses the right qualifications. This leads to internal resource problems if these people are needed for other tasks as well besides the ramp-up. Also, there is no use of optimizing potentials and no significant improvement of the ramp-up curve.

- Both teams mixed (heterogeneous operational ramp-up team)

The advantage is that the team possesses multi-disciplinary skills and sufficient ramp-up knowledge. Flexible adjustment of the number of people can be carried out independently from each team. A fast elimination of problems and special knowledge of the team assure a good quality of the ramp-up. The team can work separately or parallel to the operators. This

[87] Based on Börner (2009), p.41.
[88] Cf. Börner (2009), p.41-43, 99-102.
[89] Cf. Ibid.
[90] Cf. Ibid.

means that the transfer of knowledge to the operators takes place continuously or by support, training, error elimination and direct application of knowledge and know-how about methods and experience. The disadvantages are high costs for engineers and high internal resource commitment.

Ramp-up team consistency

There exist three possibilities of the consistency of the ramp-up teams, shown in Figure 22:

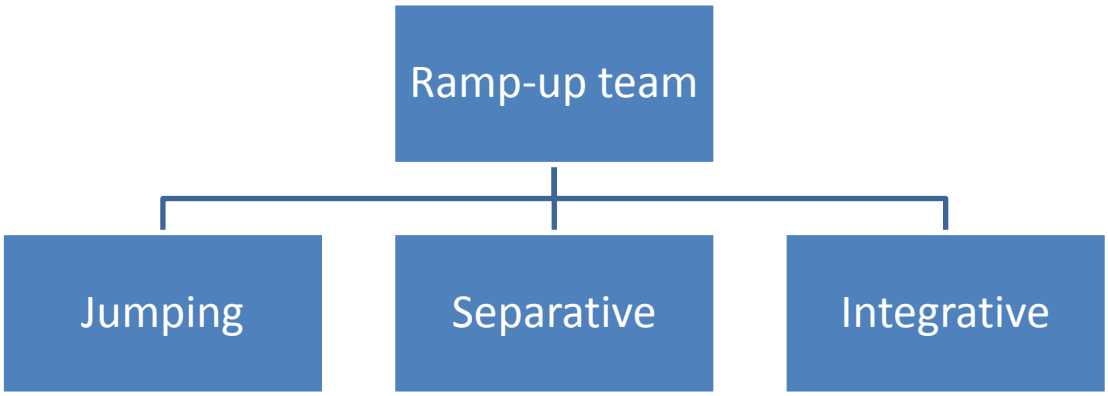

Figure 22: Consistency of ramp-up teams[91]

According to *Börner* the group's commitment can vary and that is why it is categorized in three types of teams, the jumping, the reparative and the integrative teams:[92]

- Jumping: long-term in different locations; when the system is stable

The advantage of a jumping team is that experience can be collected, positive work-psychological effects arise and the team consists of a defined number of people that leads to defined costs. The ramp-up is optimized and know-how is created. The disadvantage is that there is no building up of know-how c in the case of an external service team of engineers.[93]

- Separate: team participation during the ramp-up

Advantages are the flexible adjustment of members and adaptions that optimize costs. Other advantages are the adaption to the demand for the ramp-up, the reduction of time and the fact that there is no integration of the client's employees required are named as further positive effects. The disadvantage is that there is a reintegration required for an employee's team after the ramp-up. That means that positive effects disappear and high costs for engineers arise for services of the provider.[94]

[91] Based on Börner (2009), p.103.
[92] Cf. Börner (2009), p.103-105.
[93] Cf. Ibid.
[94] Cf. Ibid.

- Integrative: integration after the normal production

Advantages of the integrative teams are good process knowledge and training, the continuous transfer from the ramp-up to normal production, an optimized curve and a reduction of the ramp-up period. One of the disadvantages are high costs for engineers of the provider.

2.3 Analysis and evaluation of ramp-up

The objective of this work is to find a strategy to improve existing ramp-ups and in order to realize that, the ramp-up has to be analyzed before. This chapter suggests a way to analyze and evaluate ramp-ups in order to get knowledge from passed ramp-up experiences. There exist many methods to analyze ramp-ups. A few of them are presented and described in this chapter and will be applied to a practical example.

Some well-known and effective tools for ramp-up analysis are:

- Customer demand analysis
- Analysis of the open issue list
- Expert discussions
- SWOT analysis
- Fishbone analysis
- Ramp-up graphs
- Analysis of variance
- Key figure system
- Balanced Scorecard
- Benchmarking

2.3.1 Customer demand

In order to improve the product it has to be clear how the customer uses it. The total cost of ownership is the most important factor for the customer, but often value can be added by other strategies than just by improving the product.[95] "The same can also be achieved by shifting the focus of the relationship".[96] "By asking how, and if, the customer plans to use certain products can open up opportunities to add more value by changing the relationship."[97]

The relationship can only be improved if the customer requirements are clear. Fulfilling the requirements leads to a better relation with the customer and therefore also to a better

[95] Cf. Eloranta et al. (2002), p.17.
[96] Elorantaet al. (2002), p.29.
[97] Ibid.

ramp-up, since the cooperation with the customer in this phase is especially important. "In a transactional customer-supplier relationship, the classic trio of product, price, and promotion are the key factors differentiating suppliers. In a collaborative relationship, customer demand beyond individual customer orders becomes an operational concern for the supplier."[98] The supplier should know the customer's needs and try to fulfill this demand in order to enable a successful cooperation and relationship with the customer.
During the implementation of a project it is necessary to develop a cooperation with partners based on five aspects:

- Confidence (especially in the competence)
- Give and take (acceptance, compromises)
- Time frames for determined processes and objectives
- Elimination of fears
- Attention during the communication processes.

One success factor in this area is the win-win partnership that is described as a form of cooperation in which every partner reaches the company's objective. If all partners are able to gain advantages, a successful cooperation will be possible. The partnership management has the objective to give the client the necessary confidence and to eliminate risks.[99]
In sum, the supplier should never promise something that cannot be delivered or fulfilled as this might negatively affect the relationship with the customer. "Clients expect venders to be honest about what they can and cannot deliver."[100]This requires that the deliveries have to be clear and understandable already at the start of the project.

2.3.2Ramp-up graph

The ramp-up graph is a curve that shows the planned output of the process over time for the quantitative analysis of the ramp-up. Nevertheless, the ramp-up graph can also be a curve that demonstrates the real output. The ramp-up graph is characterized by three characteristics: a) an increasing output, b) limited by the capacity of the production system and c) constant during normal operation.[101]
The mathematical design of the ramp-up curve enables a better understanding of the development of the throughput during the ramp-up phase. After the determination of the design it has to be verified for each system if the increase of the throughput of the real production system coincides with the ideal ramp-up curve.[102]

[98] Elorantaet al. (2002), p.29.
[99] Cf. Edler-Pain/ Garbisch (2004), p.104.
[100] Holloway/ Seley (2008), p.16.
[101] Cf. Risse (2002), p.153.
[102] Cf. Nagel (2011), p.25.

Each ramp-up is characterized by a special behavior that influences the output of the process. The listed factors highly influence the ramp-up behavior:[103]

- Level of novelty
- Level of complexity
- Production preparation
- Qualitative work performance
- Production performance.

Theoretic calculation of the ramp-up curve

Risse calculates the output of a ramp-up of an automotive production with a power function or an S-curve. In the practical part of this investigation it will be tested if the same formula can be applied to the ramp-up of distribution centers.

1. The power function

The graph has the form of a hyperbolic curve and can be described with the power function of Equation 1.[104]

$$y_i = \alpha * x_i^b$$

Equation 1: Ramp-up graph as power function[105]

y_i= production output of product i [h/piece or Mu/piece]
x_i= time intervals [piece]
i = current time interval
α = ramp-up constant, defines the production volume of the 1st interval after the start-up
ß= ramp-up exponent that defines the inclination of the curve
E=date when 100% performance is reached (ramp-up end)

Figure 23: Definition of the variables[106]

The exponent is determined according to the inclination rate of the graph. The inclination rate of the graph can also be determined by the observation of the rate during tests. *Jörg Risse* delivers two methods how to determine the ramp-up exponent ß with (a) the Ex-Post analysis of ramp-ups of the same type $y_i = a * x_i^b$ or (b) Benchmarking with competitors that have the similar product structure.[107]

[103] Cf. Risse (2002), p.155.
[104] Cf. Ibid., p.156.
[105] Cf. Gustmann et al. (1989), p.75; cited after Risse (2002), p.156.
[106] Cf, Ibid.
[107] Cf. Risse (2002), p.161.

(a) The Ex-Post analysis of ramp-ups of the type $y_i = a * x_i^b$ that leads to Equation 2:

$$ß = \frac{\log(y_i) - \log(\alpha)}{\log(x_i)}$$

Equation 2: Ramp-up inclination[108]

y_i= production output of product i [h/piece or Mu/piece]
x_i= time intervals [piece]
i = current time interval
α = ramp-up constant, defines the production volume of the 1st interval after the start-up
ß= ramp-up exponent that defines the inclination of the curve

Figure 24: Definition of the variables[109]

The factor ß has a high variation range, it depends on the innovation level of the product, the degree of novelty of the production environment and the type of innovation transfer from the old to the new product.[110]

(b) The Benchmarking (see chapter 2.3.6) with competitors that have the similar product structure is another possibility how to determine the inclination ß. ß can be compared with competitors that have similar product structures.

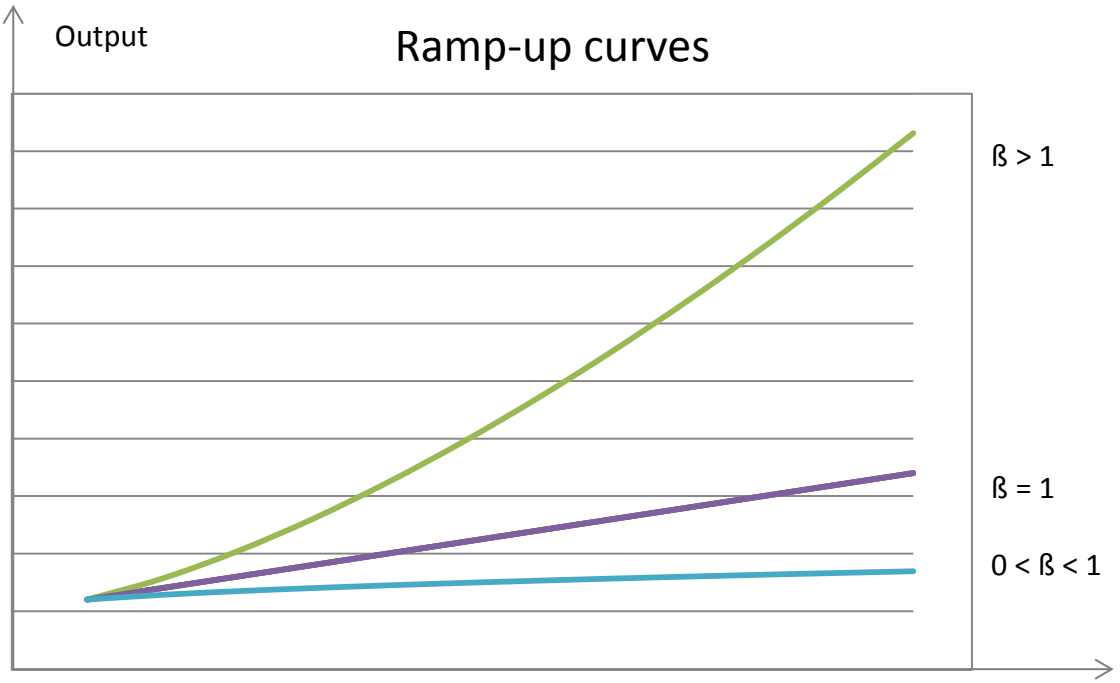

Figure 25: Ramp-up graph as power function[111]

[108] Cf. Risse (2002), p.157.
[109] Cf. Ibid.
[110] Cf. Ibid., p.161.

The graph in Figure 25 shows ramp-up curves with different values for ß. ß has a high influence on the inclination of the curve. A high inclination is better since the amortization period is shorter and the feasibility higher.[112]

2. S-curve

According to *Risse,* the ramp-up curve is characterized by a special behavior and the data applied in an application over time leads to an S-curve.[113]

After the start-up, the production throughput constantly increases due to learning processes. Better knowledge about the treatment of the installation lead to a high growth at a specific time interval. The moment when the production output is increasing in a faster way is called point of inflection. The production effort for a higher throughput is lower after this moment. As soon as there is a higher throughput, the curve changes its behavior and the growth rate becomes higher. Having reached the maximal production capacity, the graph remains constant.[114] This type of curve is shown in Figure 26:

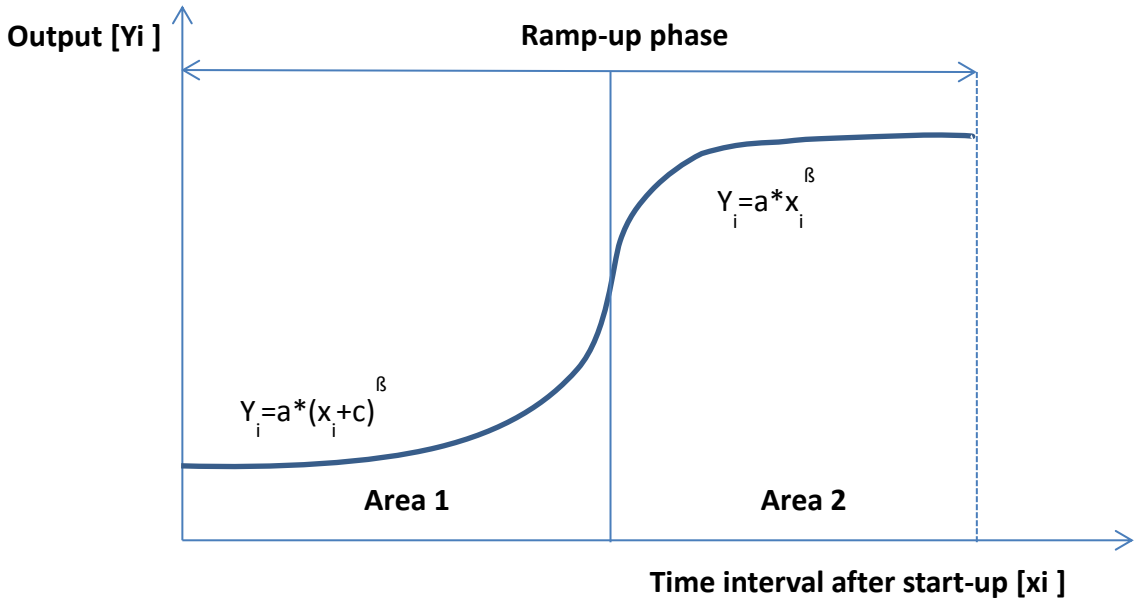

Figure 26: Ramp-up graph as S-curve[115]

In reality, ramp-up curves do not show a continuous course due to stops, unqualified workers or missing material to name a few causes that would affect the behavior of the curve. The behavior of this graph shows the similarity to a real curve, but focuses especially on the continuous learning process.[116]

[111] Based on Gustmann et al. (1989), p.75; cited after Risse (2002), p.156.
[112] Cf. Risse (2002), p.156.
[113] Cf. Ibid., p.157.
[114] Cf. Gustmann et al.(1989), p.75; cited after Risse (2002), p.158.
[115] Based on Gustmann et al. (1989), p.75; cited after Risse (2002), p.158.
[116] Cf. Risse (2002), p.159.

Correlation of input/output of the production system during the ramp-up

Companies can be seen as production systems that have an input/output system or input/throughput/output system. Input factors are objects that are available for the transformation in the beginning in order to enable the implementation of the process. Output includes those objects that leave the system and that are available after the transformation. Throughput refers to the circumstances or conditions during the transformation (see Figure 27).[117]

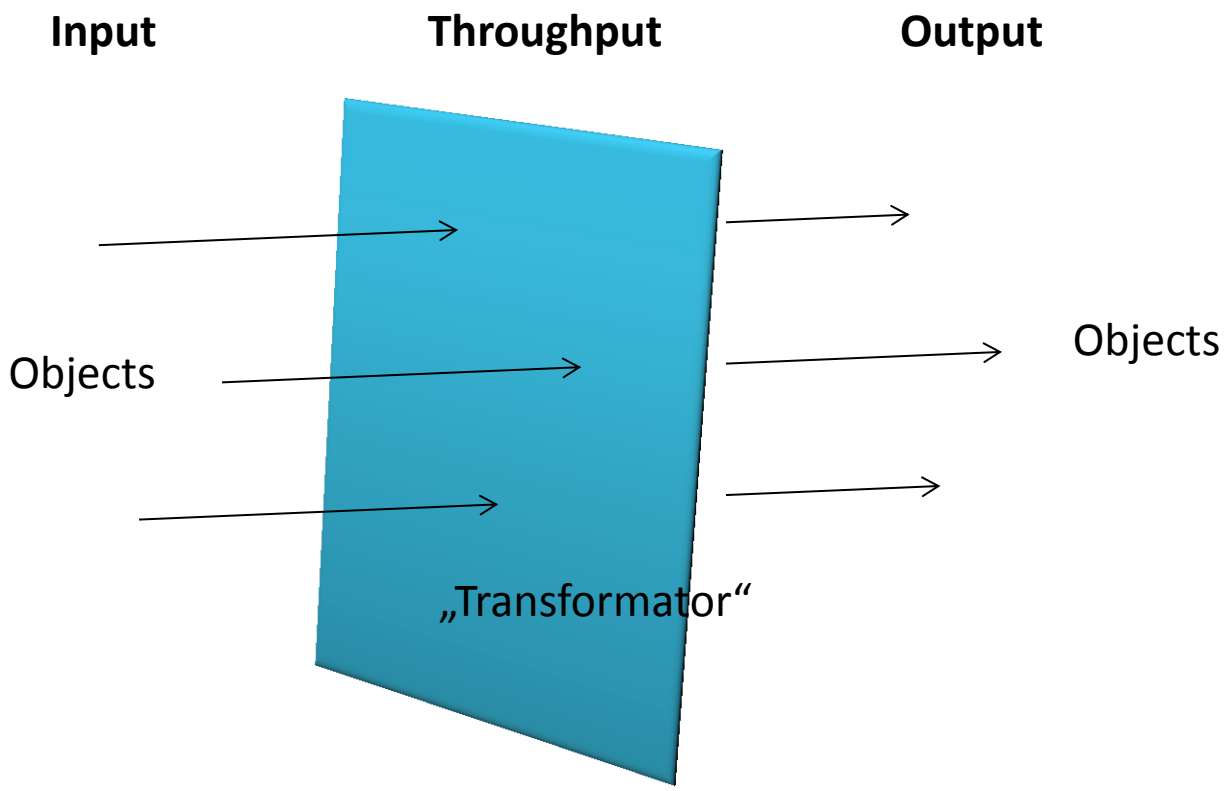

Figure 27: Transformation as Input/Output-Process[118]

In order to describe the ramp-up curve the structure order of the customer has to be considered as the input (orders) defines the output (cartons) of an installation. The isolated observation of output is not allowed since the result of the calculation will deliver wrong result.

2.3.3Analysis of variance

The analysis of variances is a method in which current data is compared to target data in order to control the attainment of objectives. The comparison of current values and target

[117] Cf. Dycklhoff (1994), p.11.
[118] Based on Dycklhoff (1994), p.12.

values serves to detect variances and their causes. The detection of causes for variances enables people in charge to get the necessary information about appropriate improvement measures. It has to be proven if the responsible person is able to influence the causes of the variance. Variances can also occur due to measurement, planning or processing errors. After an exact verification of the errors with this method, further steps can be implemented.[119]

2.3.4Key figures system

Key figures refer to data that is used to analyse and evaluate certain situations in order to achieve the success of a project. This data is used to take the right decisions related to the ramp-up and to determine future measures that can lead to improvements. Key figures represent measureable information in the form of numbers related to the topic. Each key figure can also be shown in relation to another one. The received information shows, evaluates and measures company processes, situations, as well as demonstrations, about possible future events and critical success indicators.[120]

Key figures can be absolute or relative. If key figures are independent of any other value, then they are called absolute and if they are related to other key figures, they are relative. Key figures can only deliver information when they are compared to other data or with desired values depending on the object of the comparison.[121]

Key figures and the presentation of the relation to other key figures are called key figures system. Key figure systems are systematic collections of key figures that are presented in a mathematical or factually logical relation. These collections of key figures can complement each other and are oriented on one or several targets.[122]

[119] Cf. Müller et al. (2006), p.22, 46.
[120] Cf. Vollmuth (2006), p.7.
[121] Cf. Müller et al. (2006), p.106.
[122] Cf. Ibid., p.107-108.

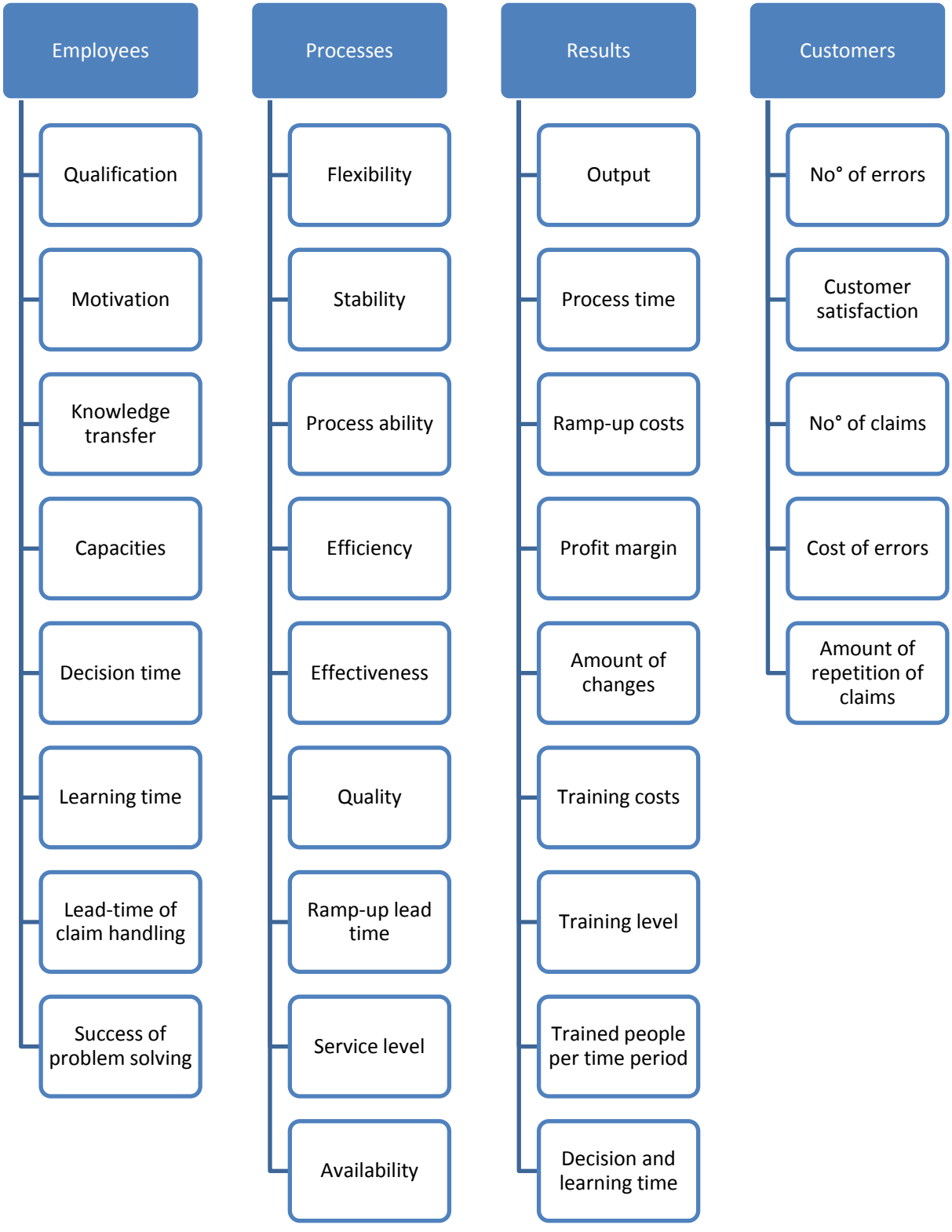

Figure 28: Key figures for ramp-up[123]

[123] Based on Nagel (2011), p.82/ Risse (2002), p.140/ Wildemann (2011), p.195.

Figure 28 shows a collection of variables that enable the evaluation of the ramp-up in automated distribution centers, categorized in four main areas. These main areas and the related key figures consist of four categories including (a) employees, (b) processes, (c) results and (d) customer related categories that are shown in form of a Balanced Scorecard (see chapter 2.3.5).

2.3.5 Balanced Scorecard

The Balanced Scorecard is a tool that supports the presentation of success factors that are responsible for the attainment of objectives. The organization can deduce guiding values from its vision and strategy measureable. These values are balanced in determined perspectives in order to indicate the right direction to the success.[124]
The Balanced Scorecard consists of the following targets:[125]

- Short and long-term targets
- Monetary and non-monetary values
- Late and early indicators
- External and internal performance perspectives.

The Balanced Scorecard can be applied for the evaluation of the ramp-up to define targets and key figures categorized in four perspectives:

1. Result perspective
2. Customer perspective
3. Integration perspective
4. Employee perspective.

Related to the ramp-up, the result perspective contains objectives and key figures related to the results that are achieved during the specific ramp-up, listed above:[126]

- Net present value (NPV)
- Break-Even-Time (delay)
- Actual cost/ planned cost (deviation of costs)
- Deviation or delay of milestones
- Throughput
- Progress/time (progress velocity)
    - Planned velocity/ actual velocity
    - Progress velocity ratio*planned time

[124] Cf. Müller et al. (2006), p.304.
[125] Cf. Ibid., p.305.
[126] Cf. Risse (2002), p.250.

- Real – planned duration (delay)

The customer perspective tries to measure and achieve an increase of customer satisfaction. Key figures to measure customer satisfaction are related to time, costs and quality objectives of the customer. The most important key figures are listed:[127]

- Ramp-up period (time goal attainment)
- Target cost orientated (price goal attainment)
- Product goal attainment
- Actual/ determined product quality
- Achievement of customer demand
- Customer satisfaction

The integration perspective measures achieved objectives with key figures related to the integration of customer and supplier. Key figures used in this perspective are listed below:[128]

- Amount of changes
- Process acceleration
- IT costs/ total costs
- Information velocity at all value-added levels
- IT interconnection degree
- Degree of customer integration
- Amount of accesses to knowledge data base
- Amount of interdisciplinary product teams
- Cross functional composition of teams

The employee perspective serves to evaluate to achieve a learning and growing organization and create the basis for the other perspectives. The key figures used are the following[129]:

- Worker potential (knowledge, experience, ideas, suggestions)
- Process output (NPV)/ no° of employees (employee productivity)
- Length of membership (employee fidelity)
- Opinion survey (employee satisfaction)
- Training costs/ no° employee (employee qualification)
- No° of improvements/ no° of employees

[127] Cf. Risse (2002), p.251-252.
[128] Cf. Ibid., p.252-253.
[129] Cf. Ibid., p.254-255.

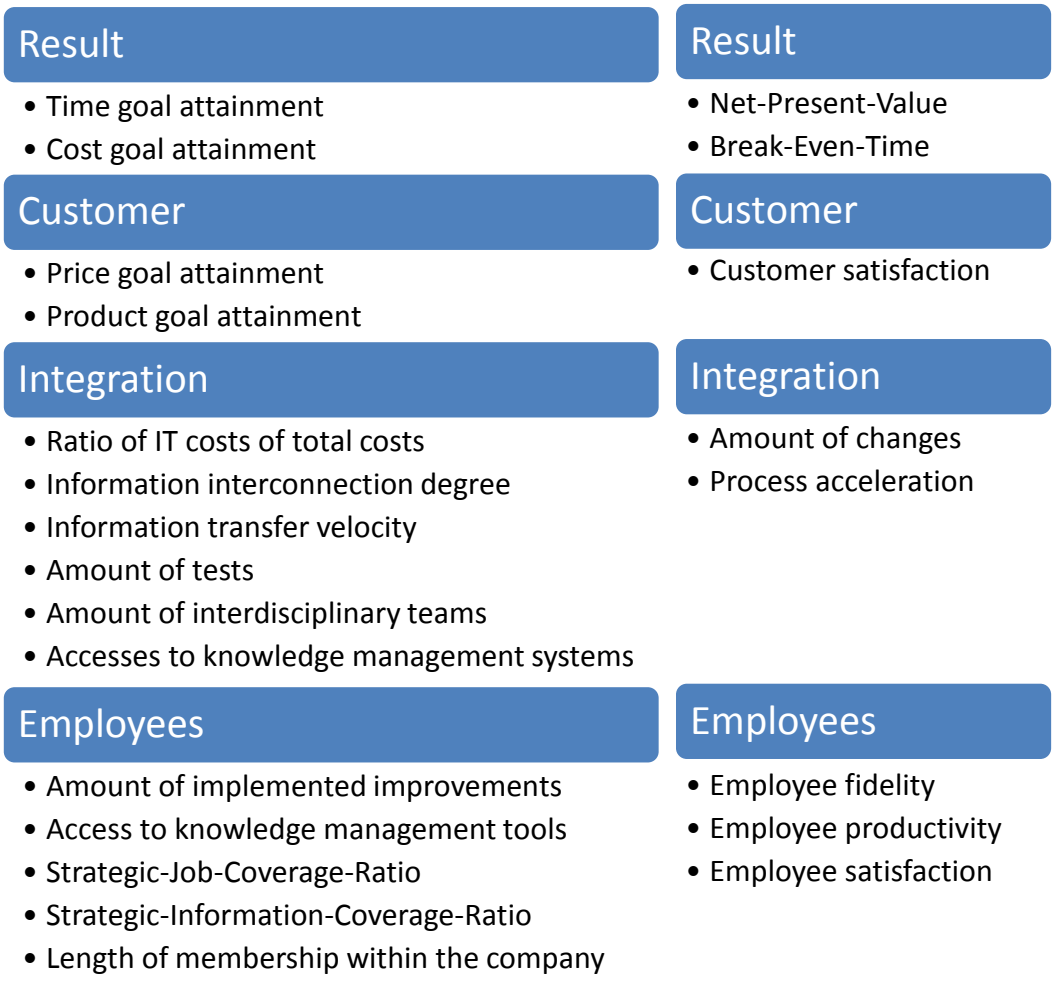

Figure 29: Balanced Scorecard for ramp-up[130]

Figure 29 shows a summary of the above-mentioned indicators for the ramp-up evaluation by using the tool "Balanced Scorecard". The key figures are divided into four perspectives related to the construction of the Balanced Scorecard, and two types of indicators which are (a) leading and (b) performance indicators. Leading indicators are indicators that help to discover early signs for ramp-up objective variances. The performance indicators demonstrate the performance of each perspective.

2.3.6 Benchmarking

Benchmarking is a method applied in companies to support the identification and understanding of successful practices. This method enables to adapt the current situation of

[130] Based on Risse (2002), p.256.

a company to the target example and implement itself. Best Practices are constructed as concepts, methods and tools or detailed processes.[131]

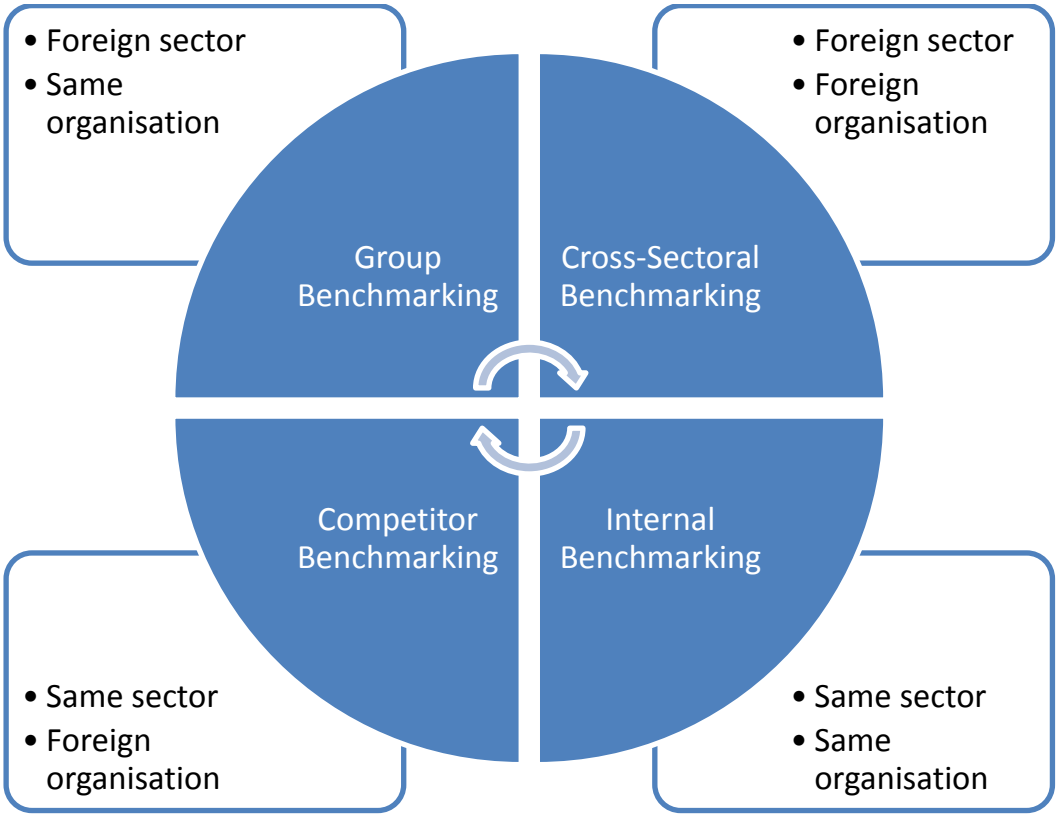

Figure 30: Types of Benchmarking[132]

There exist four types of Benchmarking, namely Internal Benchmarking, Group Benchmarking, Cross-Sectorial Benchmarking and Competitor Benchmarking, shown in Figure 30. Internal Benchmarking refers to the comparison of concepts, methods and tools or processes inside the company and the same sector. Group Benchmarking is described as the comparison of the same company and a foreign business sector. Cross-Sectorial Benchmarking is Benchmarking in different sectors and different companies. Competitor Benchmarking refers to the comparison of concepts, methods and tools or processes of the same sector related to foreign companies, i.e. the competitors.

[131] Cf. Bodmer et al. (2002), p.3-4.
[132] Based on Bodmer et al. (2002), p.13.

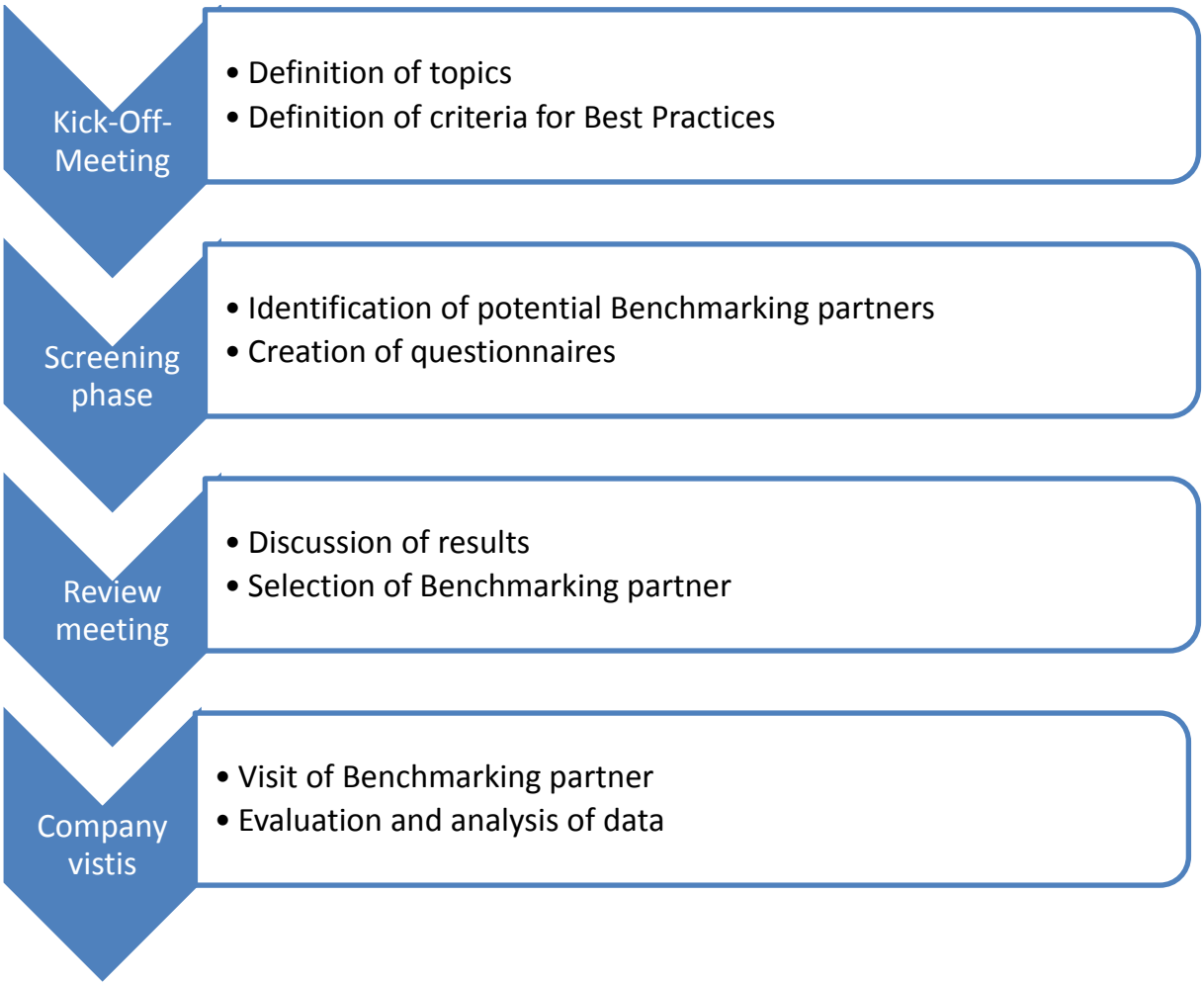

Figure 31: Benchmarking procedure[133]

Figure 31 shows the steps that are required for the Benchmarking procedure. The main phases are Kick-Off-Meeting, screening phase, review meeting and company visits. During the Kick-Off-Meeting, the topics are defined and criteria for Best Practices are determined. During the screening phase, Benchmarking partners are determined and a questionnaire is developed. In the review meeting the results are discussed and Benchmarking partners are selected. After this step, Benchmarking partners are visited and finally the results of the information received from company visits are analyzed and evaluated.

2.3.7SWOT analysis

The SWOT-Analysis is a tool that is applied in order to evaluate the situation of a company keeping in mind internal and external factors. With this analysis, the company can determine specific strategies to achieve its objectives and the combination of resources for long-term success potentials. SWOT is an acronym standing for **S**trength and **W**eakness of the

[133] Based on Bodmer et al. (2002), p.135-136.

company combined with **O**pportunities and **T**hreats respectively to the company's environment. This tool serves to analyze states as well as changes in order to take advantage of opportunities, to avoid and/ or eliminate threats, to improve the strengths and to eliminate weaknesses. The SWOT analysis refers to the present (company analysis) or to the future (potential analysis).[134]

2.3.8Fishbone analysis

The Fishbone diagram, also called Ishikawa diagram, analyzes the process respectively to variability and shows the connection between cause and effect.[135]" This variability is attributable to the M's of the process (manpower, machinery, material, method and money)."[136] Each M influences the result and has to be analyzed in more detail to determine the effect on the output. Figure 32 presents a typical Fishbone diagram and the M's that form the causes for the result that can be described as effect of the input variables.

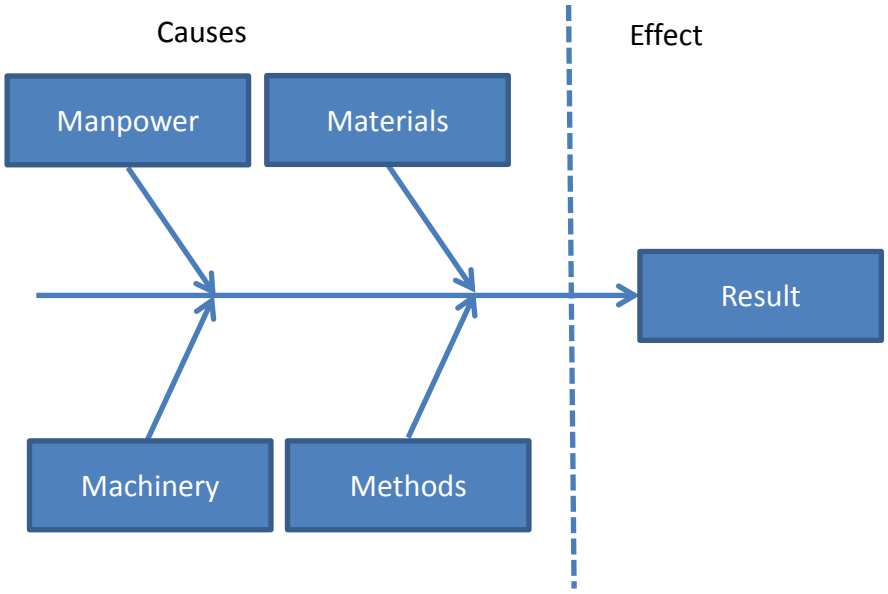

Figure 32: Fishbone diagram[137]

2.3.9Analysis of the open issue list

The open issue list is a document that contains all issues that are open for a specific project. The list has to be maintained regularly in order to have an appropriate overview of the most important task that was completed during the ramp-up. "These issues are added throughout

[134] Cf. Müller et al. (2006), p.282-283.
[135] Cf. Fryman (2002), p.195.
[136] Ibid., p.195.
[137] Based on Fryman (2002), p.197.

the sessions. Open issues are those that are not resolved after a period of discussion."[138] The open issues are noted by the supplier and customer on a list or in a software interface during the ramp-up. This is carried out during the day, after telephone calls, meetings or when they are arising. Open issues have a date, a description and somebody that is responsible for them. They are solved according to their priority by the supplier or customer, depending on where and when they were arising. "Prior to subsequent sessions, all open issues must be resolved (…)." Old issues are closed and during further sessions, new ones are added.[139]

The analysis of the open issues leads to information about the areas where most errors or problems occur. In addition it shows the time it takes to solve an open issue and the solution so that it can be avoided the next time. With this knowledge the determination of improvement steps and project phase of the improvement are determined in an easy way. With the analysis of passed issues many knowledge is gained for future projects. This way strategies and changes can be created that lead to a successful ramp-up.

2.3.10 Expert interviews

The expert interview is a method to collect data by consulting people that are involved in the investigated process.[140]

Experts are people that have knowledge about a specific topic because they were witnesses of the process that has to be investigated. They therefore have an exclusive position in the research context. The objective of these so-called expert interviews is to give the researcher specific knowledge of the situation or process by receiving explications and information of the expert's experience.[141]

The answers to the questions give the relevant information and data that is evaluated after the interview with the objective to solve the problem. There are 5 main characteristics of an expert interview: (a) the first characteristic of the expert interview is the purpose of the interview that is connected to the objective of the investigation. (b) The second characteristic is the object of the interview and (c) the third one is the type and the amount of people that are interviewed. (d) Additionally, the degree of standardization of data collection (standardized, half standardized or not standardized interviews, such as guided interview, open interviews and narrative interviews) characterize this type of the interview. (e) The fifth characteristic is the type of communication that tells more about the way the interview is carried out. Some types are for instance letters, a direct contact situation in

[138] Langer (2008), p.33.
[139] Cf. Ibid.
[140] Cf. Gläser/ Laudel (2010), p.42.
[141] Cf. Ibid., p.11-13.

which the interviewee answers the questions on paper while the interviewer is present, the phone or direct dialogue between interviewer and interview partner.[142]

Expert discussions have the objective to collect information about a given situation in order to determine forecasts of future developments. They are carried out with internal employees or external experts. Internal employees deliver knowledge about past ramp-ups, but the disadvantage is that their focus on the company may disturb finding different or new risks, problems and solutions. External experts deliver further information about the current and the future situation and related risks from another point of view. External experts are consultants, employees of research institutions or of other cooperation companies.[143]

Expert conversations are carried out at specific points of the process and they can be extended by further experts or employees. These experts or employees could be from the development and production department as well as people that are considered internal or external experts. Risk checklists can be used to structure the conversations where potential risks are discussed in an organized way. Expert teams can be created in order to increase the information flow. Challenges and weaknesses are also part of the discussion e.g. by brainstorming or other methods.[144]

3 Practical ramp-up analysis and evaluation

The analysis and evaluation of a finished ramp-up project in Brazil serve to define specific problems and challenges during this process in order to determine improvement strategies later on. This way waste of time, cost and quality are identified and further improvement potential is discovered. Several methods from the chapters above are applied in order to test the recommended evaluation methods and to find out about inefficiencies during the ramp-up.

In the following chapters/paragraphs a presentation of the project and a short description of the characteristics will be provided. After that, analysis and evaluation methods will be applied, such as the analysis customer demand, the open issue list, the SWOT and the Fishbone analysis. Also the ramp-up graph and an analysis of variance will be shown. Applied evaluation methods are key figure systems in form of the Balanced Scorecard and Benchmarking (non quantitative).

3.1 Description

The described ramp-up is about an installation in Brazil with a capacity of over 20000 cartons/ day. It will be dealt with in detail on the following pages. Figure 33 shows the mentioned installation with the existing areas.

[142] Cf. Gläser/ Laudel (2010), p.42.
[143] Cf. Nagel (2011), p.160.
[144] Cf. Ibid.

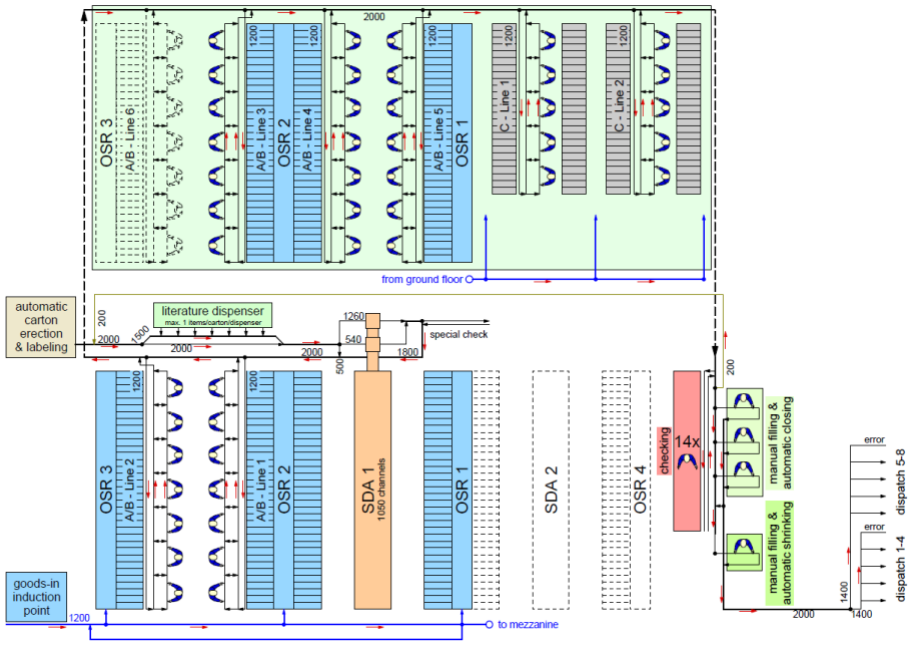

Figure 33: Flow diagram of the installation[145]

The Distribution Center consists of 5 A-lines with 7 stations each, 2 C-lines with 3 stations per line, one A-Frame (automated picking machine for fast-moving items) and 5 OSR shuttles (shuttle picking). Moreover the installation consists of 2 carton erectors and labeling machines and one literature dispenser at the beginning of the installation. One checking station, a manual filling point, automatic closing and automatic shrinking stations are positioned at the end of the line before the dispatch ramps.

3.2 Analysis and evaluation

The practical analysis of the ramp-up of the Brazilian installation leads to the results described in this chapter. In other words, this dissection aims to find results concerning problems and causes of these problems that are detected to determine improvements.

3.2.1 Customer demand

To evaluate the ramp-up satisfaction of the customer, the demand was defined. Customer interviews were carried out to find out more about customer needs and to receive further information about customer expectations before and during the ramp-up. The data collection was carried out in the form of an on-site interview with the customer. The results of these interviews are listed in Figure 34. The collected information is categorized according to demand for planning, technical and training demand, as well as cooperation, communication, support.

[145] Based on KSI (2011).

Planning demand

- Software and hardware tests
- Consultant
- Back-up of equipment

Technical demand

- High capacity and velocity of the system
- High quality of the output
- Adjustment and configuration of the installation
- Go-live on time
- Fast ramp-up (less than 3 months)
- No disruptions
- Tested functionalities
- Balanced lines
- User-friendly system

Training demand

- Training of software
- Practical training
- Training of error handling
- Retraining
- Training documents
- Evaluation of trained employees
- Training schedule

Cooperation demand

- No interface problems
- Good cooperation with customer
- Flexibility of solutions
- Customer integration
- Good cooperation with local agencies

Communication demand

- Clear responsibilities on site
- Problems are communicated and documented
- Communication of project status and chronogram
- Frequent meetings between responsible people

Support demand

- Software support on-site
- Supervision of operators
- Maintenance team on-site
- Remote support available
- Hotline support

Figure 34: Planning, technical and training demand[146]

[146] Customer's project manager (2011), Interview.

3.2.2Ramp-up graph

A ramp-up graph was approximated for the installation and the ramp-up in Brazil by applying the formula that was described in the theoretical part by *Jörg Risse*. In the practical part it will be verified if these formulas for ramp-up in series production can also be applied on the given example of the ramp-up of a distribution center.
The analysis of the ramp-up curve in Brazil was an experiment to define a practical procedure of the design of a ramp-up graph. The example that is described in this thesis serves as suggestion for the ramp-up graph approximation, calculation and design. For the following example the values do not demonstrate the reality, because of a lack of information about disruptions and production stops as well as exact knowledge about shifts and production rhythm. Knowledge about these factors is a pre-condition for any ramp-up analysis and has to be considered in any other ramp-up calculation.

Approximation of the ramp-up curve
The following procedure shows the ramp-up graph approximation for the desired output of 20250 cartons per day by applying two different formulas and by designing a weekly and daily approximation of the graph.

1. Prepare given ramp-up data

At first the ramp-up data (cartons per day) is cleared by deleting invalid numbers. The problem in this case is that the given ramp-up data is characterized by intense outliers that were also considered in order to display the data realistically. Afterwards the shifts are adjusted, whereby in this case two shifts before and three shifts after the 70 time period were found in the distribution center. The finalization degree is also considered, in this case of 60% before and 100% after the 33rd time period. It can be observed that the change of shifts and finalization degree present noticeable steps in the production output.
Factors that might influence the reachable capacity are:

- No° of shifts
- Finishing degree
- And others.

2. Define relevant variables

The ramp-up can be defined after the go-live of the installation in order to define the influencing values such as the production volume at the start and the inclination of the curve, like in the following ramp-up analysis. It is also possible to take a reference installation with the same characteristics in order to calculate these two values, but certain influences such as the order structure of the customer, customer experience and other

individual influences cannot be considered. If the reference installation has different characteristics, then influencing factors have to be determined to draw connections to the installation that has to be analyzed. These parameters have to be determined first and then the impact is calculated. For the calculation of this ramp-up curve in this analysis data related to the ramp-up was missing in order to carry out the analysis in more detail. The suggestion is to collect more information and define these variables for future ramp-up graph calculations. Like this, connections can be drawn from one installation to another and ramp-up behavior can be defined in advance.

3. Define limiting factors

Limiting factors that influence the ramp-up further were already mentioned, but they have to be considered also in the calculation of the ramp-up. Until now it is not possible to determine the degree of their influence and therefore it cannot be demonstrated in this curve. In order to analyze ramp-up data, correct output data per day and week, orders per day and week and information according to order structure, disruptions, etc. have to be available over the whole ramp-up time until the installation reaches 100% of the possible performance and reaches its stable state.

Limiting factors:

- Real and calculated capacity
- Size and quality of cartons
- Line balancing
- Software tests
- Complexity of the installation
- Order structure
- No° of developments
- Customers organization
- Learning curve of operators

4. Find an appropriate formula

A formula to be found that demonstrates the ramp-up behavior realistically. Two equations were applied to estimate the ramp-up graph in Excel and further methods were applied in Matlab. They are described below.

In Excel

The graph in Figure 36 shows the output of the application of the Equation 3: $y_i = \alpha * x_i^b$ that was defined by Jörg Risse and is marked in blue. The second formula by Jörg Risse, described in the theoretical part, did not deliver any appropriate results. The function

Equation 3 was applied instead since exponential growing was observed. This function is growing until the maximal production volume is reached, whereas the first formula grows infinitely. The trend line is a power function that was calculated automatically by MS Excel.

$$y_i = c * (1 - e^{-ß*x_i})$$

Equation 3: Exponential growing ramp-up graph[147]

y= production output of product i [h/piece or Mu/piece]
X_i= time intervals [piece]
c = maximal production volume
ß= ramp-up exponent

Figure 35: Definition of the variables[148]

In Matlab

The method "Polynomial fitting"[149] can be applied on the ramp-up data (in Matlab with the methods polyval and polyfit). For further ramp-up analysis, the methods "Ill-Conditioning"[150], "Fourier analysis"[151] and "Laplace transformation"[152] can be applied in order to further approximate the ramp-up curve. Because of the lack of appropriate ramp-up data, no example is available.

5. Design and adjust the graph (daily or weekly graphs)

It is possible to carry out the calculation with daily, weekly, monthly or even annual values. Weekly values are for instance recommended if there are weekly production rhythms that do not have to be considered. The analysis of the weekly ramp-up values was carried out the same way as for daily ramp-up values, explained in the paragraphs above. Weekly values show also string ups and downs that were caused by the order structure and other factors that should be analyzed in more detail, e.g. during Christmas there is a noticeable change in the order structure. For appropriate ramp-up analyses, it is required to know the order structure and other influence variables.

[147] Own design.
[148] Cf. Gustmann et al. (1989), p.75; cited after Risse (2002), p.156.
[149] See Lee/ Seber (2003), p.172.
[150] Ibid.,, p.165.
[151] See Shakarchi/ Stein (2003).
[152] See Schiff (1999), p.1.

In Excel

In this analysis daily values, in Figure 36, and weekly values, in Figure 37, are shown.

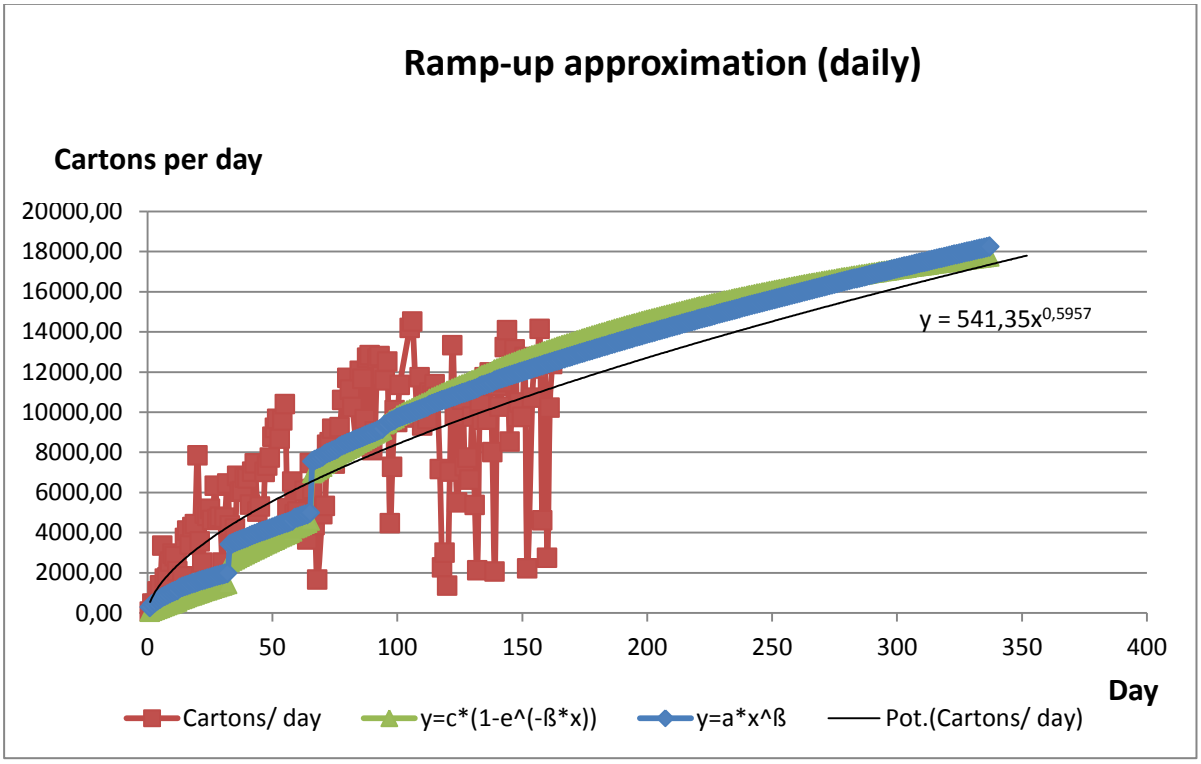

Figure 36: Approximation of ramp-up graph (daily)[153]

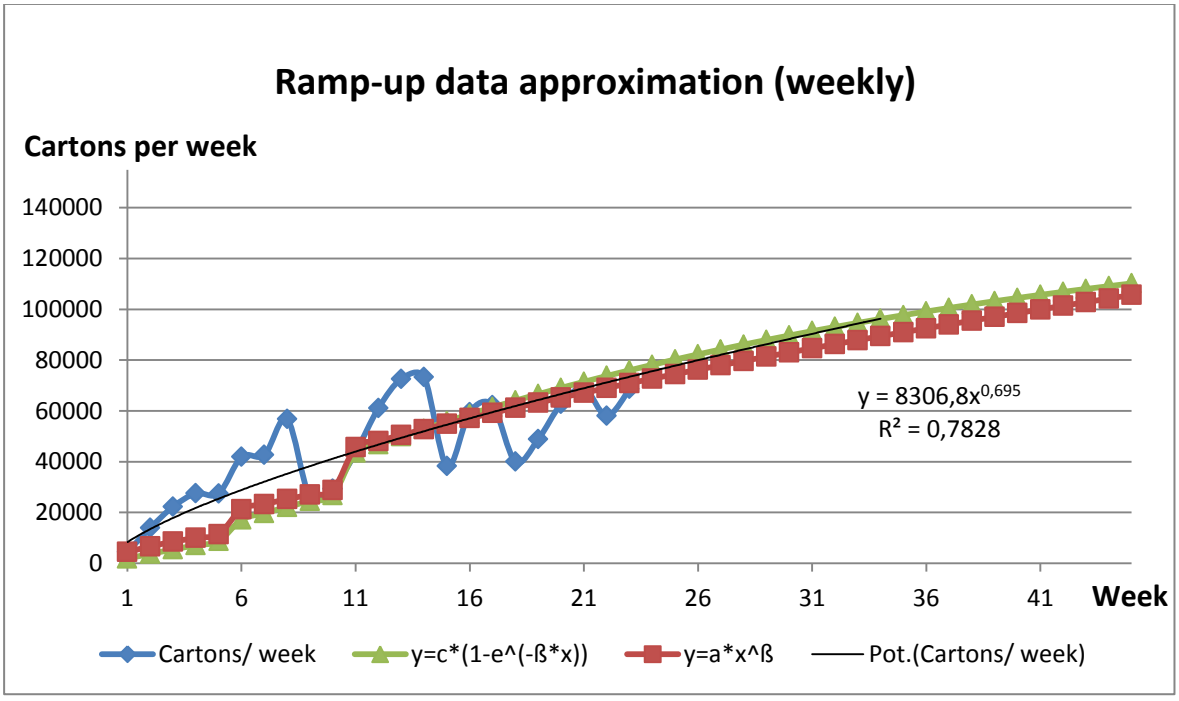

Figure 37: Approximation of ramp-up graph (weekly)[154]

[153] Own design. This serves as an example for the calculation procedure (no realistic ramp-up data).

In Matlab

The method "Polynomial fitting"[155] is applied on the ramp-up data where at first the ramp-up data is plotted (per day or week) and then fitted. The equation of the fitted curve is shown in Matlab. In Figure 38 the polynomial fitting is shown:

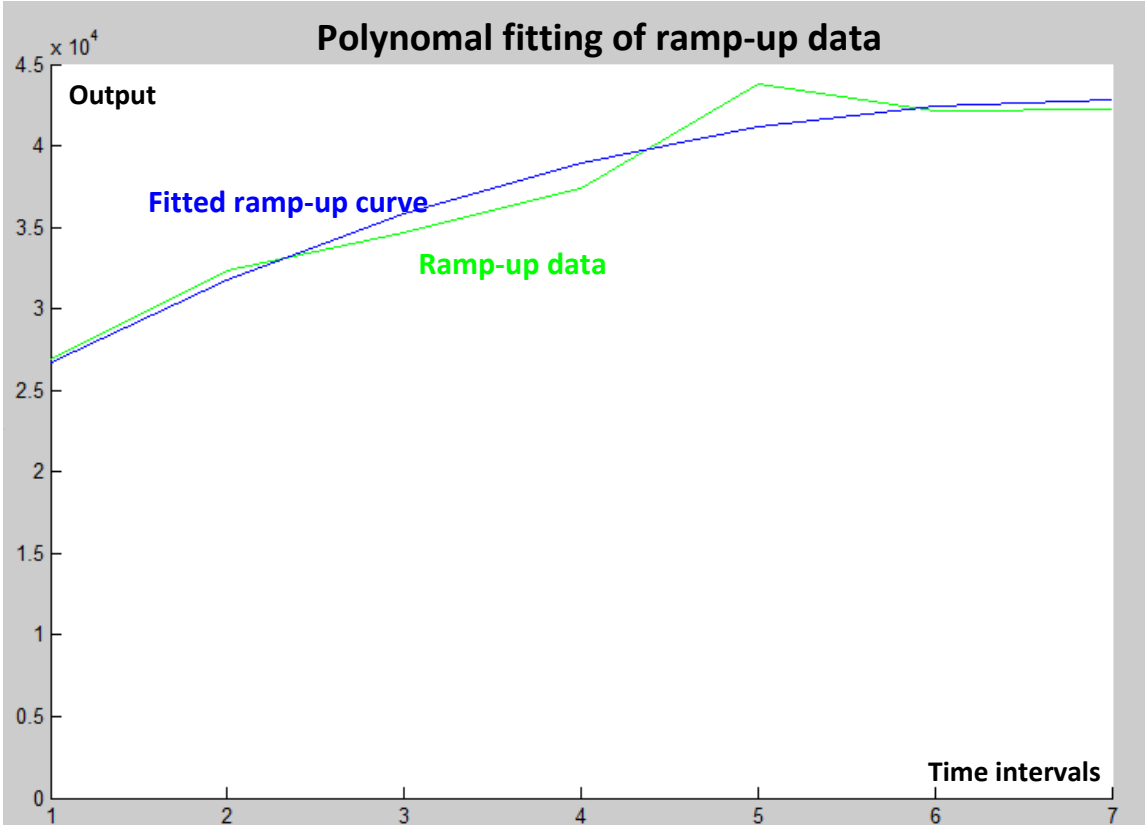

Figure 38: Fitting of ramp-up data[156]

6. Calculate the uncertainty

The application of curve adjustments with confidence interval and the determination of the uncertainty of the solution serve to deliver more information about the ramp-up behavior.

In Matlab

The application of curve adjustments with prediction intervals (in Matlab the data is first sorted and then the curve is adjusted) and the determination of the uncertainty are shown in Figure 39. The figure demonstrates a curve that is characterized by uncertainty until complex

[154] Own design. This serves as an example for the calculation procedure (no realistic ramp-up data).
[155] See Lee/ Seber (2003), p.172.
[156] Own design.

values, in this example. The reason for this fact is an installation that is still in an unstable state (ramp-up).

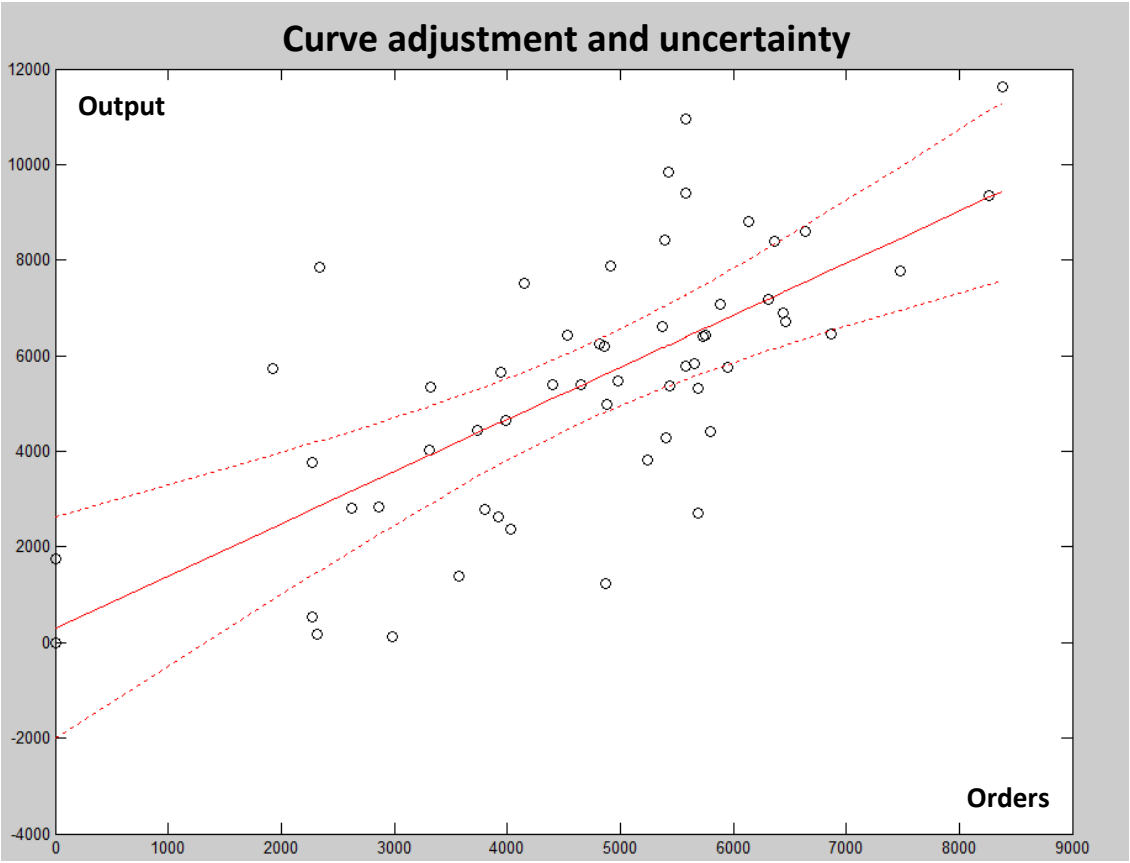

Figure 39: Curve adjustment and uncertainty[157]

7. Determine order and production rhythms

At this point, the correlation between input and input, output and output, input and output can be calculated to determine order and production rhythms.

In Matlab

This calculation was carried out in Matlab with the method xcorr. By applying this method, order and production rhythms deliver more information about the ramp-up behavior. Figure 40 shows that there exists a production rhythm since the peaks of the presented graph are repeated in specific cyclic intervals.

[157] Own design.

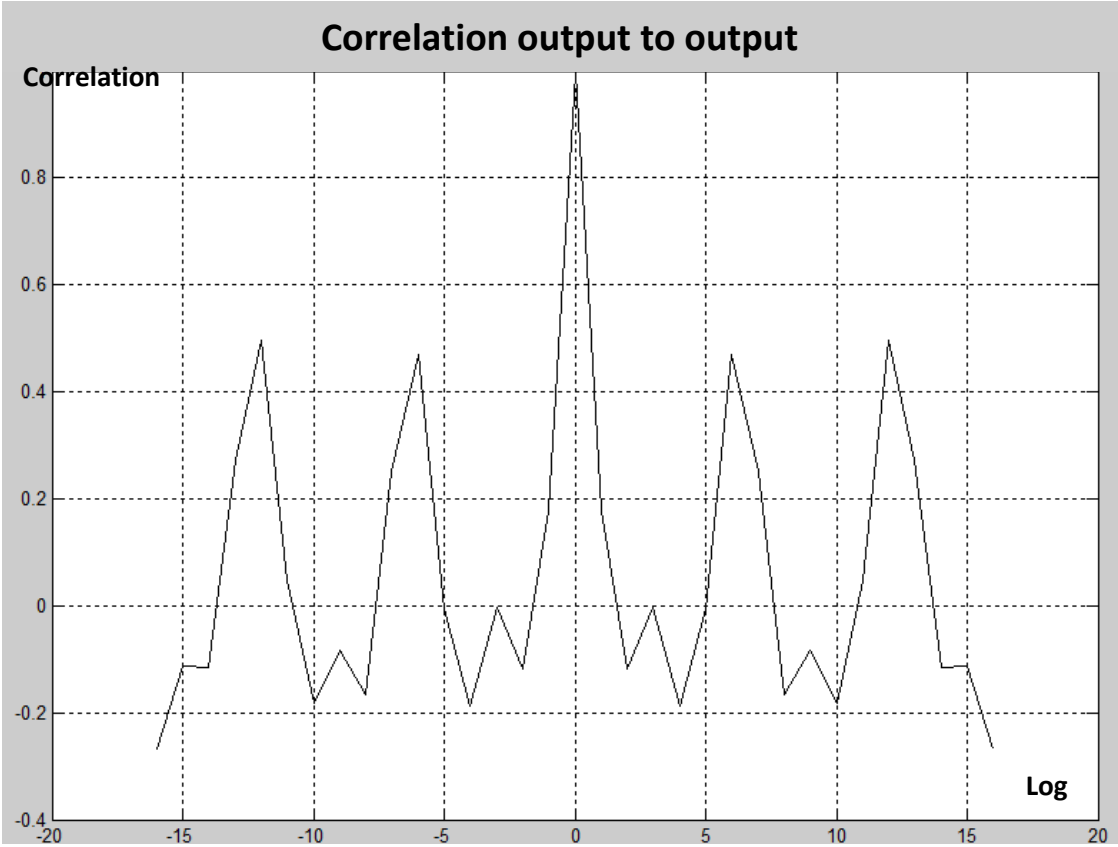

Figure 40: Correlation output to output[158]

8. Calculate resource demand

In order to calculate resources, an exact ramp-up graph has to be approximated. It is recommendable to collect more data and to investigate the demand for resources on ramp-ups and the information that ramp-up curves deliver about resource demand for a longer period of time. In this analysis the resource demand was not determined because of a lack of data related to past values and the uncertainty of given data. Further investigations have to be carried out to allow these calculations for future ramp-ups.

9. Compare the graph with the customer demand

The ramp-up graph should be analyzed in relation to the customer demand to determine the deviation of real to expected values. If a negative deviation exists, then further steps have to be determined to improve the output of the installation. For details related to this step see chapter 3.2.3.

[158] Own design.

10. Collect data

Ramp-up data and variables as well as their influence on the output of the ramp-up should be collected of many ramp-ups (minimum 10-15 installations). The data has to be analyzed in more detail as it helps to draw conclusions for futures ramp-ups.

11. Design and estimate future ramp-ups

Future ramp-up graphs can be designed based on the collected data and known influence variables. The output and inclination of the curve can be calculated and the maximum output determined.

3.2.3Variance analysis

At first the planned ramp-up output has to be designed in form of a ramp-up graph. Then the graphs can be designed in diagrams in order to determine the variance between real output and either the planned input or the customer's required demand.

Variance of planned and real output

Then the real output can be added, as well as the real production output. The difference between the three graphs are often caused by planning errors, but variances between planned and real ramp-up curves appear also because of interruptions during the ramp-up, such as unplanned incidents, disruptions, stop times and power shortages. Another reason is the learning effect of the operators that cannot be determined yet. Furthermore shift patterns und different capacity utilizations are not taken into consideration. Figure 41 shows an example of what such a graph might look like.

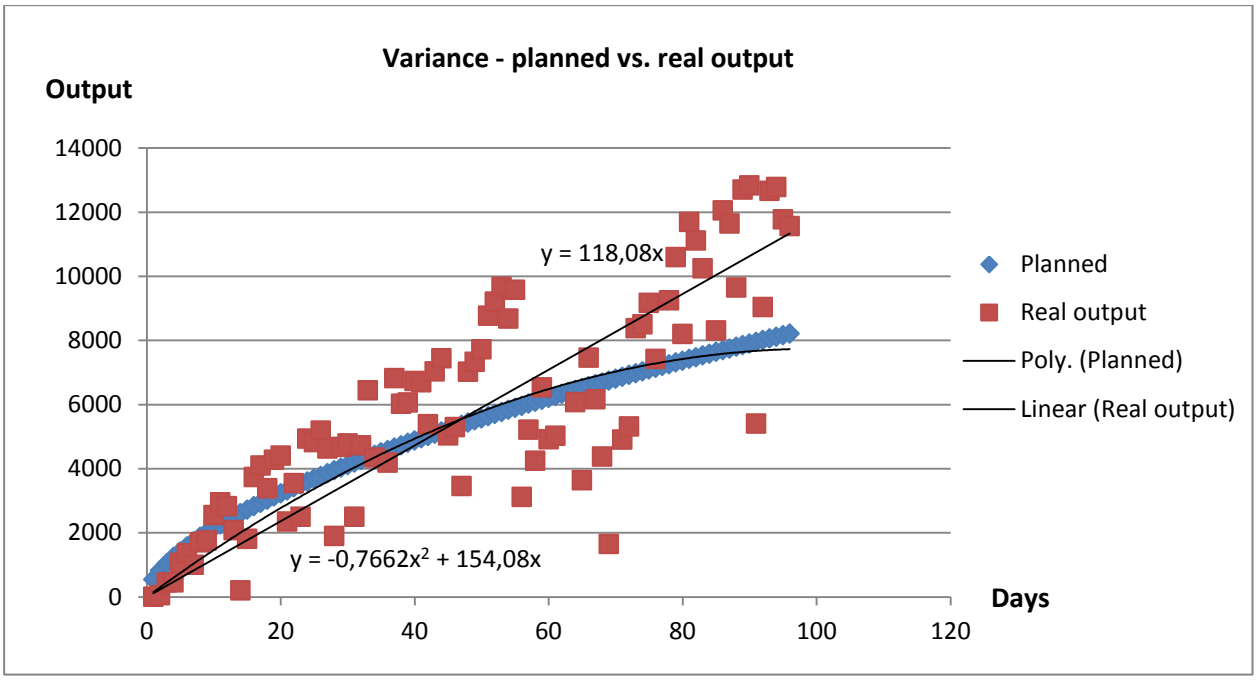

Figure 41: Variance - planned vs. real output[159]

Reasons for the discrepancy between expected and real values is the fact that the installation was calculated for a specific type of containers, but in the praxis more large than small containers were used and therefore less containers/ day are possible. Furthermore it was not considered in the calculations that all cartons go to the A-Frame, an automated picking machine that has not the required performance for cartons/ day. It was assumed that the amount of cartons in that station was lower. The line balancing is also inappropriate, e.g. A-Lines contain products that are rarely needed and products of C-Lines are used frequently. A consultant who analyzes the line balancing is suggested in order to improve the performance.

Variance of real output and customer demand

The unrealistic customer demand for the ramp-up in Brazil occurred because the customer's expectations were too high. In addition, the company could not provide realistic numbers concerning the ramp-up progress for the customer. Many specific key factors and influence variables cannot be integrated into the calculations because of missing data and knowledge about the influence on the ramp-up. These factors cause different ramp-up functions than planned and hence the real ramp-up curve shows a large variance compared to the planned graph. After the time planned for an optimal ramp-up, only half of the amount of the determined output was reached. Figure 42 shows the actual values and the customer

[159] Own design.

demand that could not be satisfied because of unrealistic expectations. An improvement measure would be to determine a ramp-up graph in cooperation (supplier and customer) so that unrealistic expectations can be avoided.

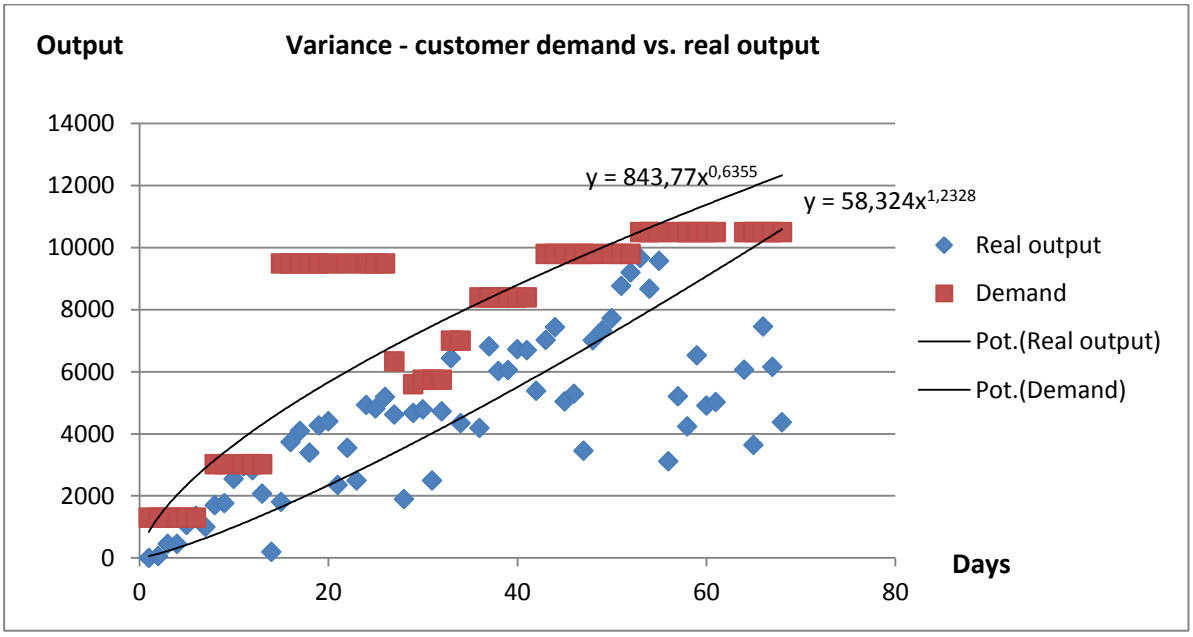

Figure 42: Variance - customer demand vs. real output[160]

3.2.4Balanced Scorecard

The following table presents the key figures system in the shape of a Balanced Scorecard. Specific key figures of the mentioned ones in chapter 2.3.4 and 2.3.5 were summarized and evaluated according to their ability to evaluate the project. The result of the evaluated key figures are summarized and presented in Table 1.

[160] Own design.

Table 1 Balanced Scorecard[161]

Customer	Result	Description
No° of justified claims	70%	Justified customer issues compared to all issues
No° of internal errors	19%	Customer issues compared to all issues
Wrong user handling	11%	User issues compared to all issues
Time goal attainment	71%	Current ramp-up period compared to planned one
Progress satisfaction	Low	Customer satisfaction with progress
Cooperation satisfaction	Medium	Customer satisfaction with cooperation
Results	**Result**	**Description**
Ramp-up costs	91%	Current to planned costs of ramp-up support
Profit margin	1300%	Unplanned compared to planned profit of support
Change costs	1%	Change costs compared to project costs
Ramp-up time attainment	89%	Current to planned ramp-up lead time
Current output	38%	Current output compared to total capacity
Processes	**Result**	**Description**
Flexibility rate	88%	Amount of implemented of all requested changes
Ramp-up lead time	50 days	Current ramp-up lead time
Quality rate	49%	Amount of open issues compared to all issues
Employees (supplier)	**Result**	**Description**
Employee‘s load factor	131%	Workload of the employees
Lead time of claim handling	18 days	Time that it takes to finish an open issue
Success of problem solving	89%	All issues minus the amount of retests

Customer satisfaction

The customer satisfaction related to the progress of the ramp-up and the cooperation with the supplier was investigated for two weeks and is presented in Figure 43. It is noticeable that customers show a high satisfaction related to the cooperation and a dissatisfaction related to the progress of the ramp-up, while the supplier’s employees evaluate the progress and the cooperation as okay.

[161] Own design (analyzed key figures serve an example of a key data system).

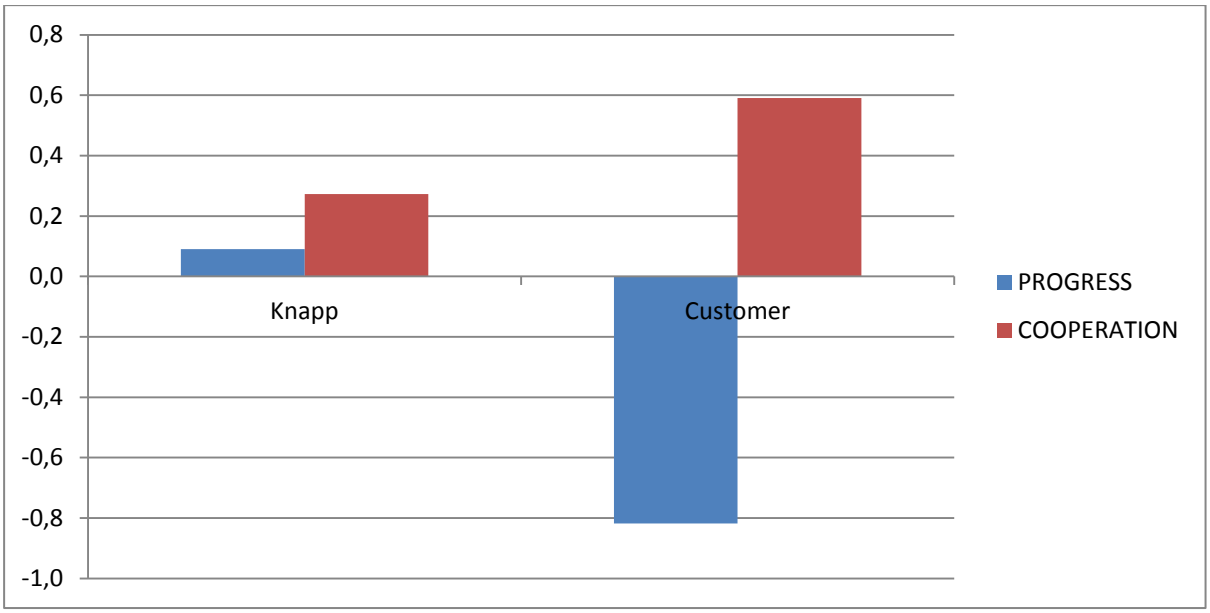

Figure 43: Customer satisfaction[162]

3.2.5External and internal comparison

Instead of an internal and external Benchmarking, the investigation of the ramp-up is carried out by comparing the performance internally and externally, with ramp-ups inside of the company and with other companies.

During the comparison, no data related to ramp-up values and duration, but information about problems and strategies related to ramp-up, was collected, analyzed and compared with information about ramp-ups from expert interviews at Knapp. The result is presented in Figure 44:

[162] Own design.

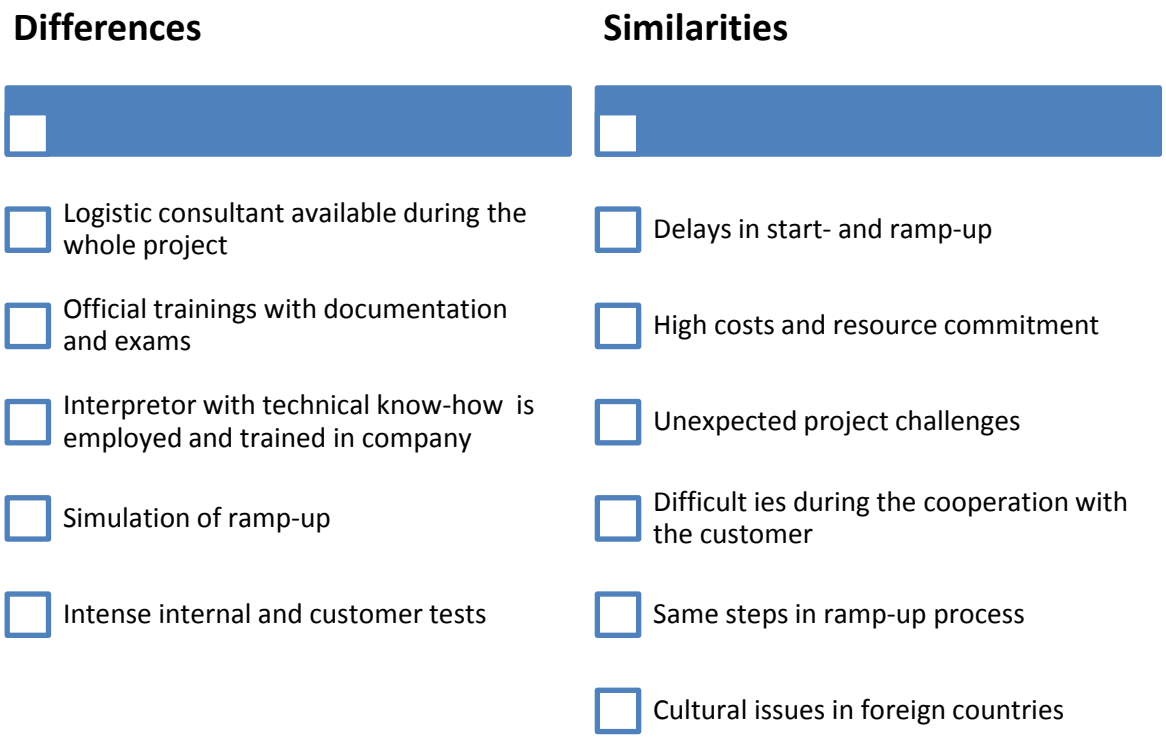

Figure 44: External comparison in the same industry sector[163]

The comparison of Knapp with other companies shows similarities related to the categories delay, costs, project administration, customers administration, ramp-up and cultural issues.
The main difference between the ramp-up of Knapp Systemintegration GmbH and the Benchmarking company is a logistic consultant during the project. He is involved from the beginning until the end of the project and helps the customer with decisions and problems.
The official training program is another important area that separates the competition from Knapp. A special training department and an efficient administration enable the improvement of the customer's operator-skills. An appropriate documentation and evaluation after the training session, e.g. exams, ensures better quality and therefore also higher performance during the ramp-up. Practical training sessions and detailed error handling lead to fewer problems during the operation to achieve less user issues during the ramp-up.
Another enormous difference is the employment of interpreters with technical know-how that are trained in the company. This way, the project and ramp-up velocity can be improved since language problems are eliminated. In addition, an appropriate and efficient discussion with the customer enables appropriate solution for demand and fast elimination of problems.
The simulation of the installation and the ramp-up performance is another important point that makes a difference between KSI and the Best Practice of the foreign company.

[163] Based on Head of department of automatisation engineering Salomon (2011), Interview.

Simulations help to deliver more information about the installation, its behavior regarding the output. Moreover, problems and bottle necks are detected earlier and efficient logistic processes are designed. Simulations can also be used to train new functionalities and tasks. Another difference is the length of internal and customer tests. The implementation of a longer test period ensures an early elimination of problems and high quality of the ramp-up.

3.2.6SWOT Analysis

The SWOT analysis of the ramp-up in Brazil serves to detect strengths and weaknesses of the company related to the ramp-up as well as its threats and opportunities. The result is demonstrated in Figure 45.

Figure 45: SWOT analysis[164]

[164] Own design.

This type of analysis delivers information about improvements in the technical area (mechanical and PLC problems), related to the software and IT. The complexity of the product has to be minimized and the communication process improved. The cooperation between the local agencies and KNAPP Austria has to be improved and clear responsibilities have to be determined on-site. Reliability should be maintained and delivery dates have to be kept. Nevertheless time has to be invested in the training program, training documentation and error handling to enable better understanding of the installation for the operators.

Threats can be avoided by preparing the supplier's employees for intercultural, language and communication issues with the customer. Better planning processes help to consider unplanned impacts (power shortages and the like) and create flexibility for changes. Improved change management can further create more flexibility. The focus on the training program has to be more intense to prepare the client for the product and avoid that these problems of the client affect the supplier. In addition the interfaces to the client have to be improved.

Opportunities, such as providing high quality training programs and consulting, have to be provided. Better cooperation with the client and the flexibility to adapt to clients' business and new solutions should be guaranteed. Knowledge management in the own company leads to improving effects since errors are no longer repeated during the ramp-up. The exact analysis of improvements and further suggestions are provided in chapter 4 and 5.

3.2.7 Fishbone analysis

During the start-up there are many influence factors that affect the functionality of the installation. These influences can be grouped into the 4 M's, namely Machinery, Methods, Material and Manpower (see chapter 2.3.8), that deliver the ramp-up result. The mentioned M's in Figure 46 are responsible for delays and problems during the production ramp-up. The objective is to detect them at every ramp-up and to create specific strategies that avoid further problems in future ramp-ups. Improvement strategies affect all 5 areas, whereby solutions for the existing factors have to be found. This analysis leads to similar results as the analysis of the open issue list and the SWOT analysis, but another result is that the ramp-up team and administration, support and supply process have to be improved.

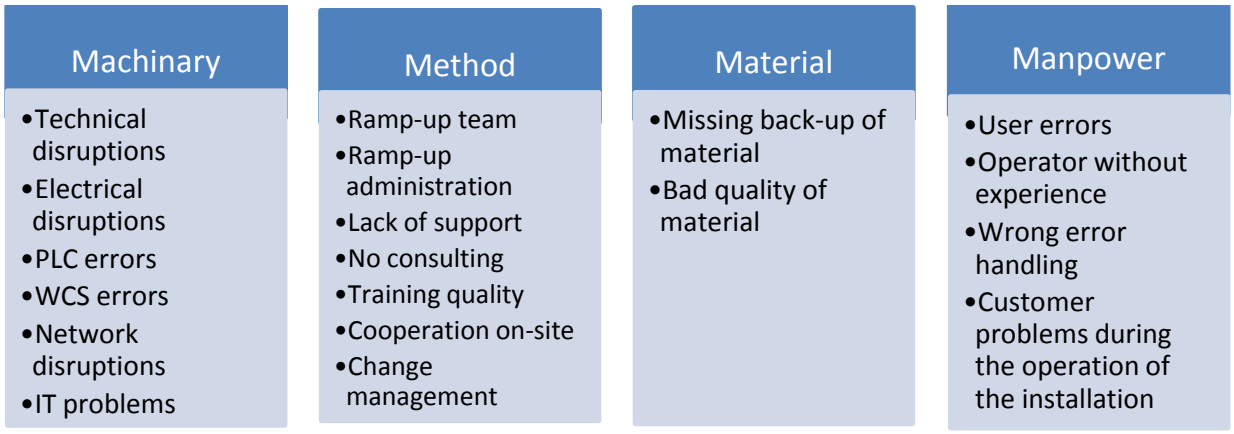

Figure 46: Fishbone analysis[165]

3.2.8Analysis of the open issues list

The analysis of the open issue list delivers more information about main and long lasting problems and important topics during the ramp-up. This enables the detection of the area where the problem occurred and the relative percentage of all listed problems. The knowledge about main areas of difficulties delivers an appropriate basis in order to find solutions that enable an efficient and effective ramp-up.

Figure 47 presents the main areas of challenges and the percentage of each area as part of all identified issues noted during the ramp-up. This analysis has to be considered with caution, since there were many issues that are identified and solved immediately like small mechanical or PLC (Programmable logic controller) issues. These were therefore not always listed when they occurred as a maintenance team was on-site. Issues of other areas took more time to solve. After the identification of the main areas of problems, an analysis of the topic is recommended in order to detect the main causes.

[165] Own design.

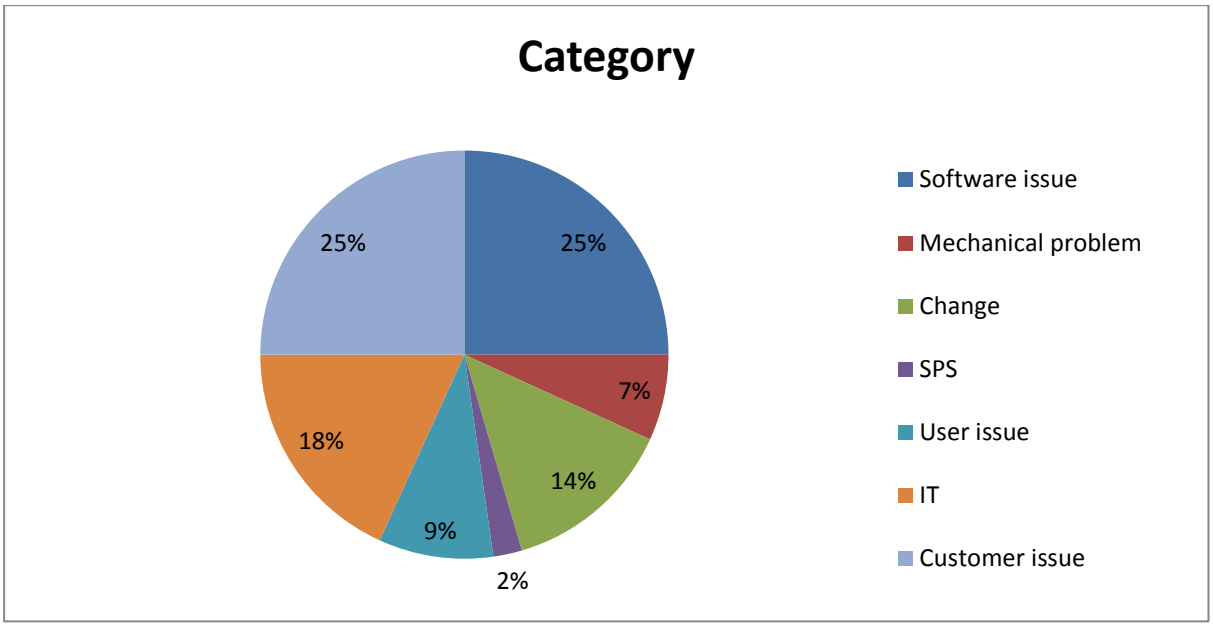

Figure 47: Open issue list analysis[166]

The main problems are software and customer issues, followed by IT issues and change requests. Further marginal problem categories are user, technical and PLC issues. This leads to the conclusion that the customer was challenged by the new product and functionalities with his own process, but also that software functionalities and bugs were frequently detected during the ramp-up. A suggestion for improvement would be to focus more on the training of the customer and to improve the tests in the start-up phase to avoid software issues and missing functionalities.

3.2.9 Expert interviews

Expert interviews related to the ramp-up in Brazil were carried out after three months of the start-up and led to the following results (See Figure 48). The results are categorized according to problems that were detected and improvements that are suggested.

[166] Own design. This analysis represents the issues of the open issue list of 3 months of ramp-up. There is no guarantee for the completeness of this data.

Problems

- Resources were taken off too early
- Many open issues that weren't closed on-time
- Customer had logistical or technical problems
- Customer was unorganized

Improvements

- Early integrate the customer's operators for training effects
- Finish open points (bugs, customer's problems, changes) before start-up
- Responsible people for the support
- Appropriate planning of the support
- Collaborative discussion of the customer's ramp-up plan
- Further observations and analysis of the ramp-up after the project end
- Customer shares demand and business data to improve the product
- Appropriate training with documents and collaborative schedule
- Technical project leader (TPL) shares experience and acts like a consultant
- Reference visits to prepare the customer for the product
- Test phase is shorter and the production support phase longer (different ratio, same costs)
- Scope of supply is extended (provide network, etc.)
- Consultant is available (if remunerated) to improve the performance
- Provide the operation of the installation by Knapp (new business model)

Figure 48: Results of expert interview[167]

3.3 Conclusion

From the analysis and evaluation of the ramp-up project the following main areas of improvement can be summarized:

- Planning phase (realistic ramp-up plan, unplanned impacts, external influences, etc.)
- Technique, software and PLC
- Training program
- Communication
- Support
- Change process and flexibility
- IT area
- Customer's organizational structure

[167] Based on Area manager KSI (2011), Interview.

- Complexity of product
- Cooperation with local agencies
- Documentation (error handling, etc.)
- Organization and transparency of Knapp
- Consulting
- Knowledge management
- Cultural adaption (language, behavior, etc.)
- Customer demand (output)
- Resource workload of employees and resource time commitment
- Closing open issues and related reaction time
- Tests and retests.

4 Analysis and evaluation with experts

The analysis and evaluation of one single project does not deliver enough results to give a general conclusion and suggestions for ramp-up improvements. The interview and comparison of the ramp-up with other companies by carrying out Benchmarking delivered further information about improvements related to ramp-ups, mentioned in the chapters above. Collecting information about ramp-ups is moreover carried out by expert interviews. The results of the interviews are shown in this chapter.

Expert interviews were carried out with guided questions in a non-standardized way. The interview did not consist of specified questions in a defined order or specified answering possibilities. The main point was the application of guiding questions that allow the treatment of special topics, but neither the exact wording of the phrase nor the order of the phrase have to be considered. Thus, various ramp-up relevant topics were planned and discussed in the interviews. Checking questions served as small tests to verify if the expert had understood the questions.[168]

The qualitative content analysis was applied to analyze the result of the interviews. The content of the interview contains the data that is extracted to find and evaluate the required information for the research problem. The objective is to reduce the content systematically by applying a search grid constructed by theoretic pre-considerations to get the core data. The relevant information is chosen by reading the text and categorizing it into specific areas according to the search grid. This method consists of four main steps, namely the preparation of the extraction, the extraction, the preparation and the evaluation of the data.[169]

[168] Cf. Gläser/ Laudel (2010), p.41-42.
[169] Cf. Ibid., p.199-202.

The mentioned expert interviews were focused on the detection of problems, their causes and improvements in order to eliminate challenges in future ramp-ups. At first, the ramp-up was defined by interviewing experts related to this topic. The second result is a list of the main key factors that are necessary for a successful ramp-up, according to experts. The third result is a list of problems that occur during the ramp-up. The problems were categorized according to two perspectives, the supplier and customer perspective. The fourth result of the interviews is a list of all important phases and relevant tasks in order to create a ramp-up guide that recommends a certain procedure that leads to the successful ramp-up (see chapter 5).

4.1 Ramp-up

After the interviews an overall process description of the ramp-up and a prior process at Knapp were defined according to the collected information (see Figure 49).

The first step after the internal acceptance is the component test to verify that every component exists as specified. The following step is the functional acceptance that should contain the acceptance of the whole system or parts of the installation. Integration tests deliver likewise information whether the whole integration of all systems was successful. Performance tests are carried out with real products and real customer data for stations, components or areas. Customer tests include tests related to the WCS (Warehouse control system)[170], WMS (Warehouse management system)[171] and PLC, and ends with the customer acceptance when the responsibility is handed over to the customer.[172]

The Go-live is an important milestone, as it is the point where the whole installation starts to produce real orders with real products and data. The production support serves to watch and supervise the customer during the production in order to eliminate problems and wrong working steps.

The transfer to normal production can be categorized according to two forms:[173]

- Reconstruction: test week, training sessions, fast ramp-up (customer is already familiar with the system)
- New installations: slow increase of performance (customer is not familiar with the system, expensive, high resource commitment, takes more time)

Availability tests are used to check if the system and all its functions are available. The final acceptance is the confirmation that everything is working as specified. This phase can be combined with other tests.

[170] Cf. Software product of KSI to control the warehouse.
[171] Cf. Ibid.
[172] Cf. KSI (2011), Interview.
[173] Cf. Head of department WMS & WCS KSI (2011), Interview.

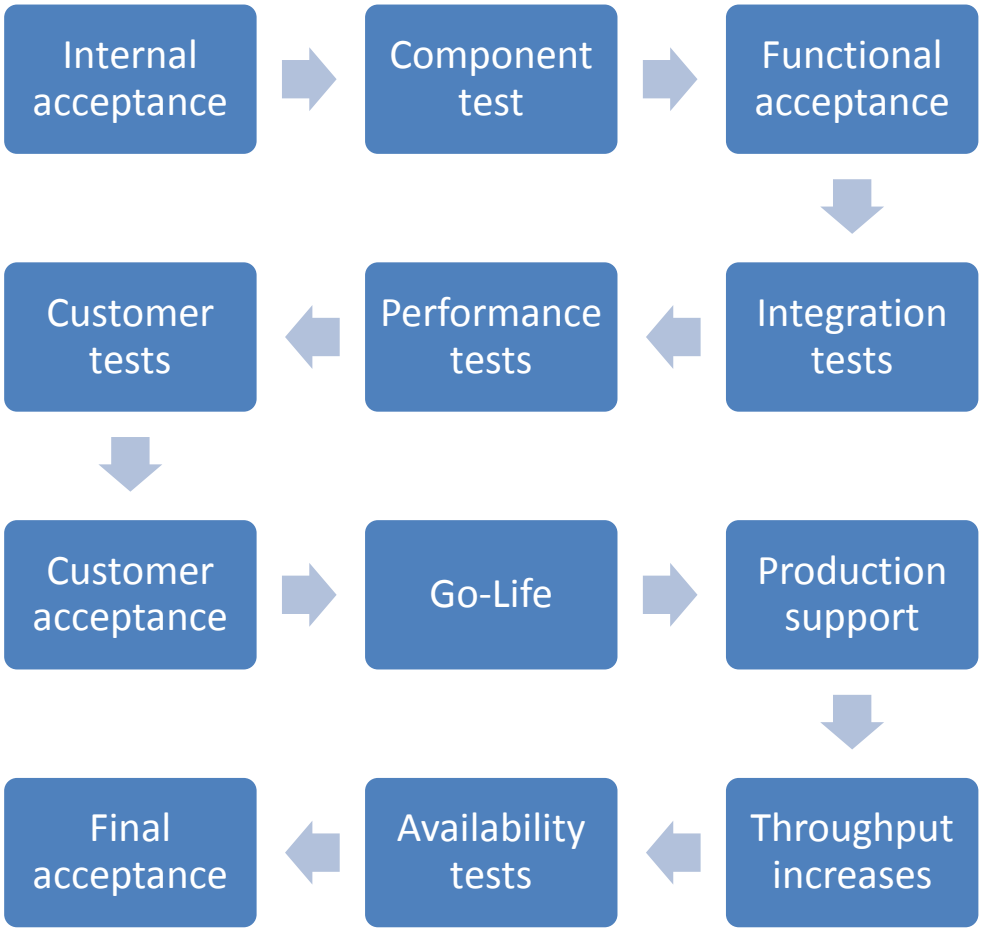

Figure 49: Start- up and ramp-up at Knapp[174]

4.2 Success factors

The success factors were defined after the expert interviews and categorized according to five main categories. These are customer, supplier, product, process and soft factors. Each of these categories contains specific factors that are relevant for the success of the ramp-up. In the category of the customer, all success factors that a customer has to possess in order to enable a successful ramp-up are listed. Then characteristics of the supplier that are important for the success are mentioned. Afterwards, the most important factors related to the product and to the implementation of the ramp-up are defined. Eventually, there is a list of soft factors that are present in successful ramp-up projects. The five categories and factors are shown in Figure 50

[174] Cf. KSI/ KAG (2011), Interview.

Customer

- Organized customer
- Prepared customer (customer knows what he wants and gets)
- Appropriate qualification of operators
- Trained operators
- Cooperative customer
- Customer processes as specified

Supplier

- Prepared supplier
- Right resources on time
- Steady team (also for changes)
- Clear responsibilities
- Know-how of employees (experience)
- Knowledge about customer's business
- Prepared for contingencies

Product

- Finished software
- Tested software
- High quality of product (software)
- No open points or issues

Process

- Small and transparent projects
- Low complexity of projects
- Defined project plan and process (realistically planned)
- Know-how and performance of project manager (claims on time, ...)
- Preparations (customer tests, ...)
- Clear test schedule
- Focused on a specific date (pressure)
- Low external influences
- Customer demand corresponds to the performance

Soft factors

- Communication strategy and skills
- Intercultural knowledge and skills
- Internal knowledge management and experience exchange
- Personality and motivation of employees
- Decisions of business administration
- Openness and cooperation

Figure 50: Success factors[175]

[175] Cf. KSI/ KAG (2011), Interview.

4.3 Main challenges

The main challenges are those categories that create most of the problems during the ramp-up and that have to be eliminated to improve the process as far as time, costs, quality, efficiency and effectiveness are concerned. The main problems are summarized and presented in Figure 51.

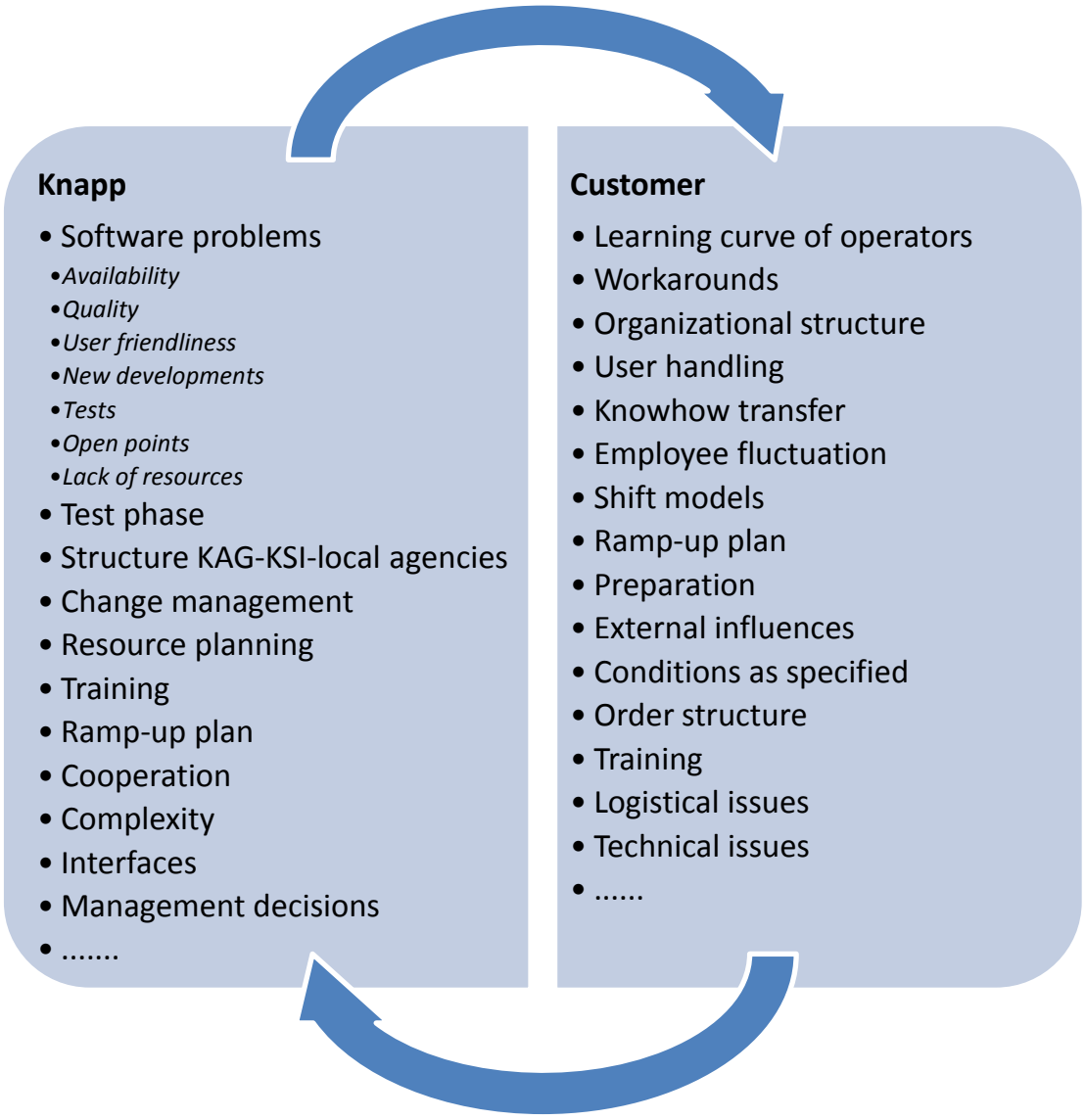

Figure 51: Main challenges[176]

[176] Cf. KSI/ KAG (2011), Interview.

The problems that were detected during the interviews related to the supplier Knapp were software problems, difficulties during tests, the correlation of Knapp with all local agencies, the change management process, resource planning and the lack of resources. Additionally, an inefficient training session for the customer, unrealistic ramp-up plans, the insufficient cooperation with the customer, the high complexity of the installations and interfaces between the system's and management's decisions that affect ramp-up projects in a bad way, have to be considered

Customer problems that affect the ramp-up are learning curves of operators, workarounds and wrong user handling. Also, an inefficient organizational structure of the client's company, inefficient know-how transfer internally after the training program, inefficient shift models that do not enable the utilization of the installation100% cause major difficulties concerning the ramp-up. Last but not least, an unrealistic ramp-up plan, insufficient ramp-up preparation, external influences of third party suppliers that influence the replenishment process, unspecified requirements, the customer's order structure and participation in training sessions, logistical issues such as line balancing and technical issues with machines.

5 Results

All suggestions for ramp-up improvement, from the analysis of the ramp-up in Brazil, the expert interviews and literature study were collected and evaluated by experts. Finally a ramp-up checklist was created that contains all required steps for a successful ramp-up and new ideas for improvement. The improvements were evaluated by the experts and new measures were marked with "*" (measures that are not yet implemented in the company). Measures that exist but which have to be enforced were marked with "+".The total ramp-up checklist evaluation by experts and the results can be found in the attachment.

In this chapter the final improvement suggestions are listed and described. Strategies and concepts marked with (*) are new ideas of employees that should be implemented in the company Knapp in order to achieve improved ramp-ups. An overview of the suggested guide is given in Figure 52, showing the main phases during the ramp-up. Improvements related to hard factors include the sales phase, design and specification phase, resource planning, software development, internal acceptance, ramp-up planning, training program, documentation, start-up (test phase), support, service, analysis of ramp-up and knowledge management. Soft factors include intercultural issues, local agencies and communication strategy.

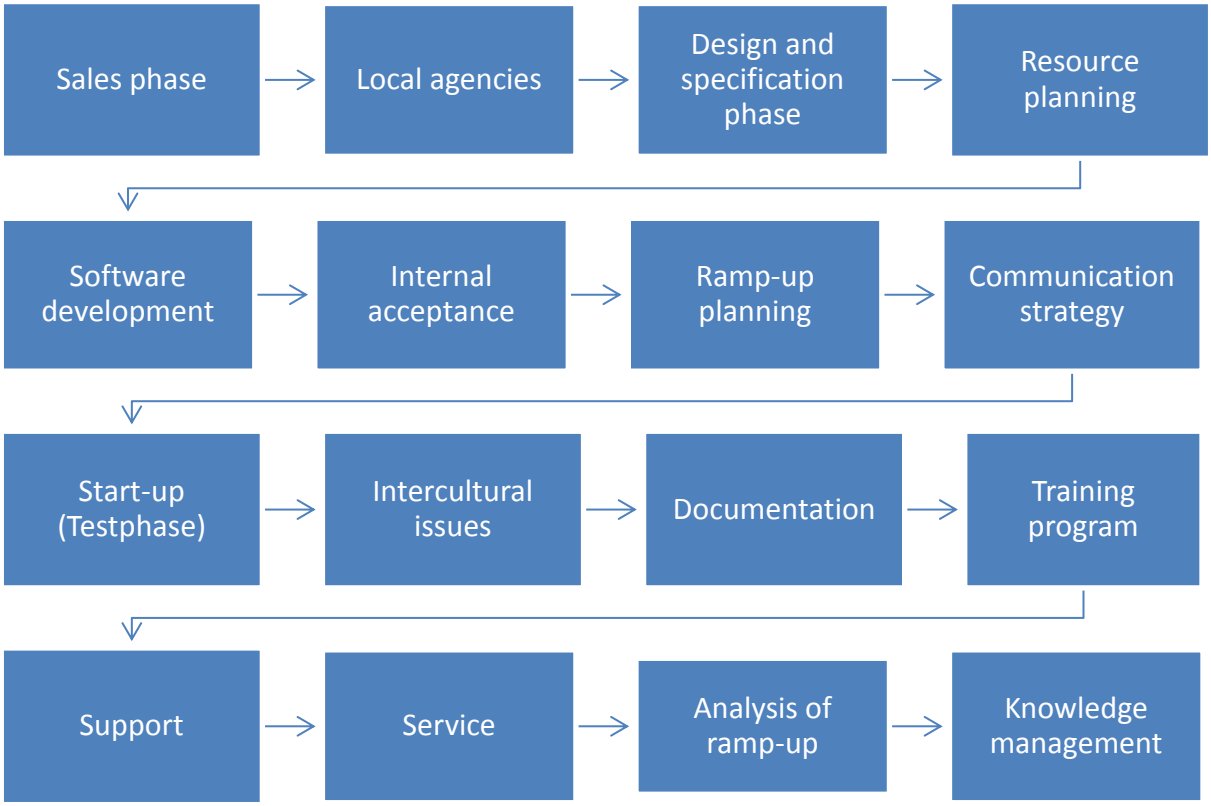

Figure 52: Main improvement categories[177]

5.1 Ramp-up improvements – Hard factors

The outcome of the expert interviews regarding the hard factors are presented and described in this chapter. Each suggestion is explained and if required, further actions are suggested to implement the improvements.

5.1.1Sales phase

Following improvements were detected related to the sales phase:

- **Provide a (logistic) consultant**

The focus of the customers changed and companies are "(…) seeking a trust partner who really listens to their requirements, is easy to work with, and helps them to meet their business objectives in a timely fashion."[178] This fact increases the necessity to become a trust partner for the client and to get enough information about the customer's requirements for a successful cooperation and relationship during the ramp-up. The supplier has to supervise and advice the customer during the ramp-up of the installation to be as fast as

[177] Cf. KSI/ KAG (2011), Interview.
[178] Holloway/ Seley (2008), p.16.

possible so that the customer receives a high margin in a short time. Discovering the customer demand and fulfilling it, is important during the ramp-up to satisfy the customer's needs and enable a steady relationship.

At the beginning of a project, all logistic processes are determined; the customer defines the demand for his business and products. In this phase, the basic requirements for the installation are defined that will have an influence on the ramp-up and the operating phase. Later on during the project, especially the ramp-up, consulting serves to advice the customer related to issues about the administration of the warehouse, the organizational structure, test responsibilities, etc.[179] A consultant is recommendable to support extremely large installations and issues concerning site-management, the coordination over all departments and customer aspects over a defined target or time.[180] Thus, the customer is supported in an appropriate way that enables a successful ramp-up.

- **Provide the operation of the installation by the supplier**

Many customers are overcharged by the new installations because they do not know how to operate and ramp-up. This fact leads to the consequence that the ramp-up period is longer and that many errors occur because of wrong user handling. The supplier's providing of the operation of the installation for special customers, which are unable to run the installation on their own, leads to shorter ramp-up periods and higher profit. If the supplier is providing the complete operation of installation, especially for the electric and technical part, the functionalities and processes of the installation will be improved.[181]

- **Provide easy functionalities and processes**

The sales phase is the most important step related to the possibility of keeping the installation and its processes as simple as possible in order to avoid complexity. Complex installations create more development time, risks and errors, longer test phases and in the end longer ramp-up periods. The level of complexity of the installation influences the ramp-up behavior and the output.[182] Easy functionalities and processes of low complexity minimize these factors and have a high effect on the duration and performance of the ramp-up. Complexity is one time indicator that the ramp-up period depends on.[183]

[179] Cf. Consultant KSI (2011), Interview.
[180] Cf. Project manager KAG (2011), Interview.
[181] Cf. Ibid.
[182] Cf. Risse (2002), p.155.
[183] Cf. Ibid., p.84.

- **Integrate the technical project leader in the sales phase**

The TPL (Technical project leader) disposes of wide-spread technical knowledge of the installation and implementable functionalities. The TPL should be present when the contract is designed.[184] The presence of the TPL in the sales phase avoids that functionalities are sold that are not implementable or that unnecessary processes and functionalities are sold that lead to complications during start-up and ramp-up.

5.1.2Design and specification phase

The ramp-up preparation and planning phase determines the success since appropriately planned time intervals and resources avoid disruptions during the ramp-up and a waste of resources. The expert interviews delivered the following results concerning improvements in this phase that are described in this chapter.

- **Integrate the customer during the preparation and design process**

During the preparation of the ramp-up the customer has to be integrated in order to know what he/she gets and to prepare himself together with Knapp for the ramp-up phase.[185]An appropriate determination and design of the installation and all processes can be reached by integrating the customer in the design process. The customer explains the requirements to the TPL in advance in order to avoid changes during the ramp-up phase.[186] Therefore the TPL of Knapp and the logistic department of the customer should work together in a close cooperation to define the processes appropriately. The cooperation between TPL and customer during the preparation phase is important and includes the integration of the customer to understand the system.[187] This way changes can also be avoided by appropriate preparations in the specification phase.[188]

- **Extend the risk management for the ramp-up**

The term risk refers to danger that can imply not achieving ramp-up objectives related to time, costs or quality.[189] The existing risk management should contain a special value system for the ramp-up to define in more detail the height of the damages, e.g. how much difficult clients cost.[190] Causes could be wrong decisions because of a lack of information or other interruptions.[191] Risks should already be evaluated during the design phase.[192] Detailed

[184] Cf. Head of department WMS & WCS KSI (2011), Interview.
[185] Cf. Ibid.
[186] Cf. Ibid.
[187] Cf. Ibid.
[188] Cf. Consultant Econsult (2012), Interview.
[189] Cf. Nagel (2011), p.56.
[190] Cf. Project manager KSI (2011), Interview.
[191] Cf. Nagel (2011), p.56.
[192] Cf. Head of department WMS & WCS KSI (2011), Interview.

information about risks during the ramp-up makes it possible to determine project costs and appropriate risk handling. Risk management should be implemented in order to reach the ramp-up goals by finding strategies against the causes of risks and for risk prevention.

Ramp-up risk management

The risk management cycle and its modules - risk analysis, risk aggregation, risk elimination, system design, monitoring and coaching as well as project management - are presented in Figure 53. These phases have to be considered in any risk management and should also be applied for the analysis of the ramp-up.

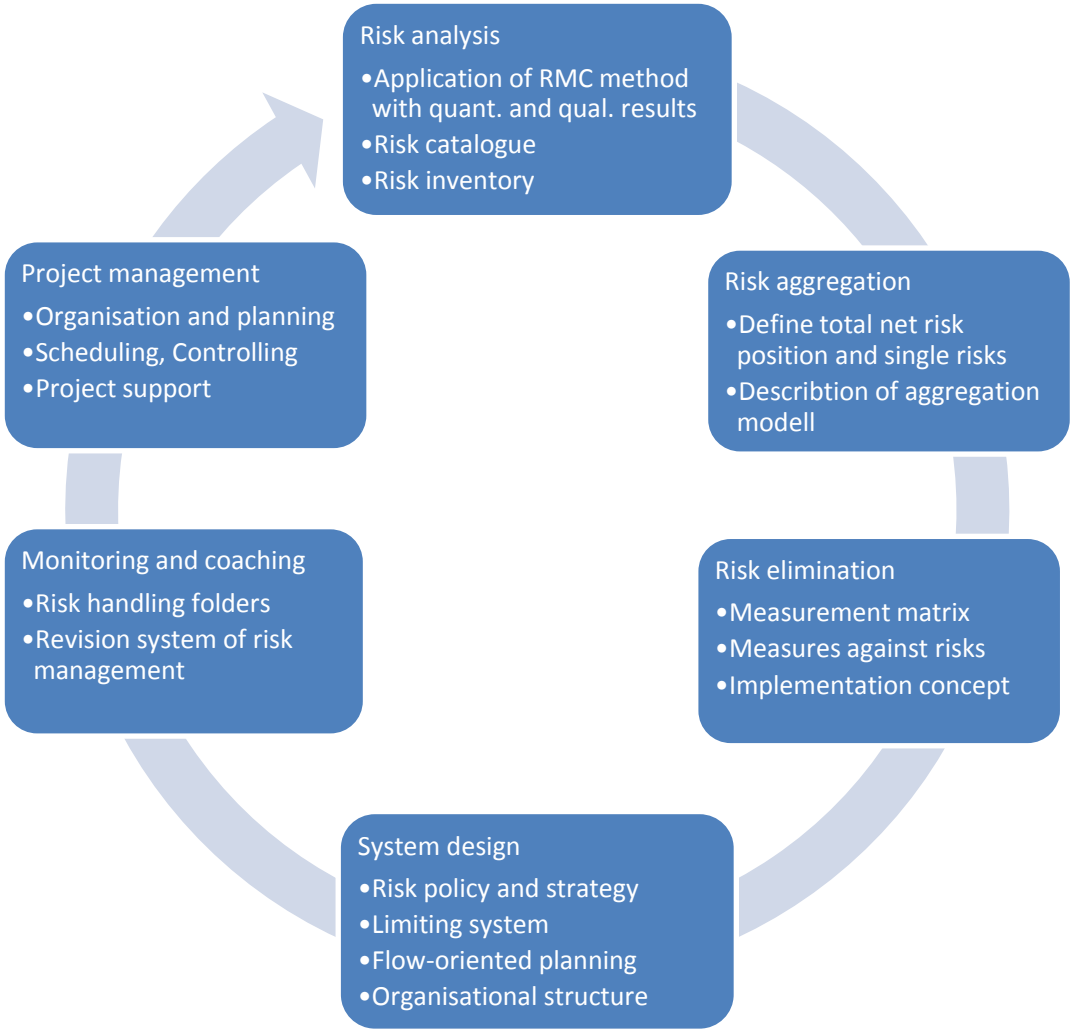

Figure 53: Modules of risk management system[193]

The requirements for an appropriate risk management for the ramp-up are:[194]

- Transparency of risks according to the entry into the market and delivery date

[193] Based on Gleißner (2001), p.33.
[194] Cf. Nagel (2011), p.56.

- Evaluation of the state of the ramp-up with indicators and the effect on risks
- Description of risks and their chronological impacts
- Warnings in case of deviation from objectives
- Decision support for preventive measures

Risk management workshop for the ramp-up

The risk management workshop serves to detect risks in an early state and to evaluate them to finally create measures against them. Risks are analyzed during the workshop and certain steps are determined to avoid them.[195] After the selection of the affected risk areas and the determination of the workshop team, a kick-off meeting is organized to deliver information about the project. Then risks are identified and structured. These threats are documented in form of a list with main risk areas, which serves as a current checklist. The single risks according to each category are identified afterwards. Then the most significant risks are selected and causes described to find appropriate measures against them. Additionally, the consequences are determined and quantified. Finally, methods and ideas are collected and evaluated related to their effectiveness.[196]

Risk checklist and risk analysis document of the ramp-up

The documents produced after the risk management workshops are the risk checklist and the risk analysis document.

(a) Ramp-up risk checklist

The application of a risk checklist for the ramp-up serves to structure knowledge about risks for the employees so that the responsibilities get a clear overview of potential disruptive factors. The list is structured into specific fields with potential challenges and risks detected during past ramp-ups. The information about potential risks can also be summarized by literature studies and expert conversations.[197]

"Where an organization produces its own specific list, ownership of the master list must clearly be defined."[198] The owner of the list has to be defined, such as an internal risk specialist that is in charge for of the list and its development.[199] Further owners could be technical project manager or the project manager.

This checklist has to be adapted to every ramp-up process, by the owners. "Since the purpose of a checklist is to ensure that lessons are learned from past experience, it must be

[195] Cf. Gleißner (2001), p. 35.
[196] Cf. Ibid., p. 37-40.
[197] Cf. Ibid., p.153.
[198] Bartlett (2004), p.124.
[199] Cf. Ibid..

kept up-to-date."[200] The content of the list has to be compared in specific time intervals regarding to the outcome of other projects.[201]

(b) Risk analysis document

This document contains the following fields:[202]

1. Risk

a. Consequences

b. Size of damage and probability of potential loss

1. Risk elimination
2. Relevance
3. Damage examination
4. Risk graph.

The first field categorizes the risk area. The second field "consequences" refers to the area in which the risk could cause harm. The next field "size of damage and probability of loss occurring" evaluates the size of the damage and how often it occurs. The third field "risk elimination" indicates current and planned measures against risks and their effects. "Relevance" shows the importance of the risk related to the damage that it causes. "Damage examination" lists historical damages and the last field "risk graph" shows the calculation of the expectancy value of the risk.[203]

- **Visualize processes in specifications**

The specification is a document with high improvement potential since this document serves as basis to understand the new processes and functionalities. Complaints from the customer demonstrate that the document is often inappropriate and unmanageable. A document with graphs and flow charts to visualize processes and the procedures are already designed, but the employment of more graphical pictures, clear descriptions and structures are recommended. In addition, process overviews in specifications will have a positive effect internally for better understanding of the processes.[204]

- **Present the systems and train employees**

A lack of knowledge about the systems and the processes of the new installation lead to the fact that the learning curve during the ramp-up is flat and that the ramp-up period takes more time than planned. During the specification phase there should be a presentation of the system and training program.[205] The presentation of the installation systems is a training

[200] Bartlett (2004), p.124.
[201] Cf. Ibid.
[202] Cf. Ibid. p.235-237.
[203] Cf. Gleißner (2001),p. 235-237.
[204] Cf. Group manager software engineering KSI (2012), Interview.
[205] Cf. Head of department of WMS & WCS KSI (2012), Interview.

session for the customer where the customer gets know-how about all systems involved and more know-how about the installation. An appropriate handling of the installation leads to increasing ramp-up curves and shorter ramp-up periods.

- **Perform reference visits for the customer**

A lack of knowledge about the installation and the functionalities leads to difficulties in the ramp-up and therefore to longer ramp-up periods, as already mentioned above. Another method of the preparation of the customer is carrying out reference visits. These visits make it easier for the customer to understand the results. Reference visits to show the customer other installations also help to prepare him/her and to share experience.[206] Such visits in the sales phase with key players that are also integrated later on avoid changes in advance.[207]

- **Extend the scope of supply**

A number of customers do not meet the specific requirements since they do not possess certain tools, e.g. customers in Brazil cannot meet the requirements for the network. This fact causes delays as well as disruptions that do not just affect the customer, but also the supplier. The extension of the scope of supply, e.g. to provide a network in this case, avoids such risks and challenges.[208] This guarantees a faster implementation of the project and fewer disruptions during the ramp-up.

- **Cooperate with customers and share business data**

Data related to the business of the customer should be shared in order to find products that correspond to the demand. Customers should share their demand and other required data.[209] This requires a close cooperation with the customer, relationship management and the exchange of business data of product qualities, order structures and business processes. If Knapp understands in an early phase what the customer really wants, what his business is and how he plans his ramp-up, risks and possible impacts of risks will be eliminated.[210]

Relationship management

During the implementation of the cooperation, the relationship and process management are equally important.[211] Relationship management is required in order to improve the cooperation with all partners where the main characteristics of the relation are partnership, good employees, openness, the development and solution finding process during the ramp-

[206] Cf. Area manager (2011), Interview.
[207] Cf. Project manager KAG (2011), Interview.
[208] Cf. Ibid.
[209] Cf. Area manager KSI (2011), Interview.
[210] Cf. Project manager KAG (2011), Interview.
[211] Cf. Krings (2004), p.93.

up.[212] Relationship management has to ensure the confidence of the partners, to be open, flexible, to own conflict ability and the ability to find solutions in order to reach the determined objectives.[213]

Success factor in this area are the win-win partnerships that are described as a form of cooperation where every partner reaches the company's objective. If all partners are able to gain advantages, a successful cooperation will be possible. With an appropriate partnership management, the client receives the required confidence and this minimizes risks.[214]

- **Integrate developers in the specification phase**

The presence of the developer in the specification phase has the advantage that the knowledge about software and development possibilities can be integrated in design and specification, and moreover standardized solutions can be developed. Standardized installations should be defined in the specification phase.[215] As the developer has knowledge about implemented projects and existing functionalities, he/she is required in order to keep the complexity as low as possible.

5.1.3 Resource planning

The resource planning is especially important for the ramp-up success. High resource commitment in this phase and a lack of resources create problems that have to be considered in advance. Appropriate resource planning is difficult since it is hard to react to all problems.[216] An appropriate planning does not only provide enough, but also the right resources in the right composition.

The planning phase consists of three steps: The first step is the design of the ramp-up project plan with defined milestones, showing all planned activities at each date and the structure of the process.[217] The second phase contains the planning of the throughput during the ramp-up and visualizing the ramp-up curve between a specific time intervals.[218] The third phase contains the planning of resources, such as work force, machines, material-and information flow as well as the budget plan.[219]

- **Plan extra developer resources for complex installations**

During the ramp-up complex installations tend to have a high amount of errors and difficulties on-site during the ramp-up phase. A lack of available resources and of developers

[212] Cf. Head of group logistic and material flow SPAR (2012), Interview.
[213] Cf. Arretz/ Bauer (2004), p.44.
[214] Cf. Edler-Pain/ Garbisch (2004), p.104.
[215] Cf. Head of department WMS & WCS KSI (2011), Interview.
[216] Cf. Ibid.
[217] Cf. Nagel (2011), p.25.
[218] Cf. Ibid., p.28.
[219] Cf. Ibid., p.23, 25, 28.

leads to resource and time problems.[220] The problem is that during the start-up, issues might arise that were not detected before and therefore developer resources should not be reserved, but requests should be planned, especially for complex projects.[221] In order to minimize these problems and to be able to develop and improve the system, extra developer resources should be planned in advance for complex projects to carry out a faster ramp-up.

- **Provide an on-site manager for the ramp-up**

During the ramp-up there is almost no time for start-up engineers or support teams to manage organizational issues during the ramp-up, e.g. write protocols and join meetings. A lack of time leads to the consequence that start-up engineers or people from support teams are not carrying out organizational issues or if, then inappropriately and with low quality. An on-site manager should be employed for the required administration on-site, for instance for daily reports, mails, etc.[222] This measure leads to more efficiency and effectiveness during the ramp-up.

- **Calculate resource demand with probability calculations (*)**

A special operational ramp-up team is required for the dynamic process of the ramp-up because it is not possible to design forecasts.[223] The lack of knowledge about resource demand during the planning process of the ramp-up phase leads to challenges and uncertainties as well as to risks. Different tasks than in series production lead to the demand for different compositions and amount of members that have to be calculated according to the ramp-up.[224] A tool that calculates the probability of resource demand per week has the advantage that the quality of the resource planning process can be improved.[225] For this calculation tool it is necessary to collect and analyze data related to the resource planning.

5.1.4Software development

The software development phase plays an important role for the ramp-up, since this phase determines if the ramp-up is on time and also the quality of the ramp-up. Finished software, tested and delivered on time, is a key factor for the success of the ramp-up.

[220] Cf. Project manager KAG (2011), Interview.
[221] Cf. Group manager software engineering KSI (2012), Interview.
[222] Cf. Project manager KSI (2011), Interview.
[223] Cf. Börner (2009), p.40.
[224] Cf. Ibid.
[225] Cf. Project manager KSI (2011), Interview.

- **Reduce new developments**

The level of novelty of the product is one influence factor on the ramp-up behavior.[226] Long development times and software bugs during the ramp-up are the consequence of new products, especially new software developments. The main problems during the ramp-up are software problems caused by new developments.[227] Further problems and "child diseases" (problems that arise when something new is implemented) arise and require higher demand for development.[228] For every requirement, the effort for development should be kept low.[229] New development should be avoided, so that for similar requirements, similar and standardized solutions should be applied in order to make the project repeatable and minimize the development effort.[230] One main objective of the ramp-up is to achieve efficiency, related to development costs and productivity by developing a high amount of similar products.[231]

- **Focus on development of main functionalities**

Software projects tend to add functionalities that are useful, but not essential for the operation. The objective is to keep development time as short as possible, to avoid too many details and complexity to ramp-up faster. The depth of developments is a main time indicator for the length of the ramp-up period.[232] The development of software with focus on the main functions is one important suggestion that improves the ramp-up.[233] This is possible if main functionalities are available on time before focusing on other "smaller" functionalities.

- **Verify the development status in small periods**

Missing verification of the software status leads to the fact that deviations cannot be forecasted and as a consequence correcting measures are not implemented on time. The verification of the development status has to be carried out in smaller time periods.[234]This leads to the advantage of faster reaction times and transparent information flow about the software status. An evaluation after three to four weeks is required to plan the software development appropriately.[235] This enables that the ramp-up can also better planned.

[226] Cf. Risse (2002), p.155.
[227] Cf. Project manager KAG (2011), Interview.
[228] Cf. Head of department WMS & WCS KSI (2011), Interview.
[229] Cf. Ibid.
[230] Cf. Ibid.
[231] Cf. Risse (2002), p.73.
[232] Cf. Ibid. p.84.
[233] Cf. Consultant KSI (2011), Interview.
[234] Cf. Head of WMS & WCS KSI (2011), Interview.
[235] Cf. Ibid.

- **Evaluate the software progress with Burn-down graphs**

Incomplete information about the software development status and progress lead to a lack of control of later project phases, like the start-up and ramp-up. Consequently delays are detected late, what makes it difficult to implement measures against it. The delays influence the go-live and the ramp-up. As a consequence, higher costs arise for the customer and the supplier. Effectiveness and efficiency can be achieved by treating uncertainties in advance which requires not only the handling of complexity and non-transparency, but includes also appropriate control and handling of disorders.[236] A tool to control the development progress and to create transparency is already employed at Knapp for this purpose. Constant evaluation of the development progress by burn-down graphs or sprints helps to evaluate the state of the software and thus to react to any deviations in advance.[237] For good software planning sprints are used to have an overview of all products to enable to react earlier with resources since they make it possible to carry out tests in small packages.[238] It is recommended to use these tools in every project, to avoid delays.

- **Design the software user-friendly**

If the software is not user-friendly then the customer cannot deal with problems.[239] The way of working is a factor that influences the efficiency and effectiveness of the ramp-up as well as the control of mechanical processes, beside others factors.[240] A faster way of working and better control of mechanical processes can be guaranteed with easy accessible information and user-friendly software, especially for error handling.

- **Integrate the customer in the development process**

The customer should be involved in the project, especially during the development and internal test phase.[241] This measure improves the knowledge of the customer related to the product and the user handling. The integration of the client in processes will avoid the dissatisfaction about the performance and lead to constructive discussions as well as to the elimination of risks which are created by black-box-effects.[242] Customer integration in the development process also helps to train customers in advance and the acceptance of the installation can be carried out in an earlier phase.[243] This implies that the customer's key

[236] Cf. Nagel (2011), p.43.
[237] Cf. Project Manager KSI (2011), Interview.
[238] Cf. Ibid.
[239] Cf. Ibid.
[240] Cf. Barisits (2008), p.67.
[241] Cf. Head of group logistic and material flow SPAR (2012), Interview.
[242] Cf. Krings (2004), p.93.
[243] Cf. Consultant KSI (2011), Interview.

user should be present at Knapp in Austria and use simulations and dialogues in order to learn how to deal with problems at an early stage.[244]

5.1.5Internal acceptance

The internal acceptance is the phase in which internal tests are carried out in order to test functionalities and logistical processes of the installation. If all tests are successful, then the internal acceptance protocol confirms that the product is working the way it was specified.

- **Test the software functionality with test groups and cases**

Every possible case in test plans has to be considered for ramp-up preparations and the determination of strategies.[245] Test cases against the requirements and tests against the specification are carried out to test the logical functionality of the software.[246] Developers or start-up engineers are generally responsible for the tests. This task should not be carried out by developers; test groups on this level could be a good solution for the internal acceptance.[247] The reason for the employment of special test groups is the fact that developers test only test cases in the way that they developed the software. In fact, test cases from other point of views, which correspond to the real use of the software is recommended. A special test group on this level is required to evaluate the general functionality of the software since the quality of the software is improved by test "experts". These tests should also include logistical processes. A special test group is able to test in a detailed way and knows also special test cases that have to be considered.

- **Perform the internal acceptance precisely**

Inefficiency during earlier phases like the internal acceptance occurs, if they are not carried out precisely and under time pressure. This leads to negative effects on the ramp-up phase because the software i not finished yet or because of inappropriate software quality. If the ramp-up team is already on-site, it occurs that the availability of the software is not yet given and that creates problems during the ramp-up.[248] Longer ramp-up periods and more open issues are further consequences and can be avoided by focusing on the internal acceptance.

[244] Cf. Group manager software engineering KSI (2012), Interview.
[245] Cf. Consultant Econsult (2012), Interview.
[246] Cf. Head of department WMS & WCS KSI (2011), Interview.
[247] Cf. Ibid.
[248] Cf. Ibid.

- **Document the internal acceptance appropriately**

Internal acceptance protocols are not always documented appropriately.[249] The quality factor of documentation is often forgotten during the internal acceptance, especially under time pressure. This point has to be improved since the documentation is required to trace the tests and working functionalities of the installation for all involved people.

- **Test software functionalities with simulations or test systems**

Separate test models, test systems and simulations are a suggestion of improvement of software tests that will influence the ramp-up phase in a positive way.[250] It is important to understand the behavior of the installation in detail and to test possible conditions that influence the output. Simulation models enable observing and testing various different cases and to deliver software of best quality. Simulations and prototypes deliver new possibilities to eliminate problems during the ramp-up phase.[251] The existing simulation models are very basic and the whole logistic process is not designable yet. Simulations for complex installations lead to better knowledge of the installation and to better test cases, and therefore also to shorter implementation times.[252]

- **Provide test constructions or prototypes for customer tests**

The late integration of the customer in the project leads to an inefficient preparation of the customer and to a lack of knowledge of right user handling. Test constructions should be used to train the customer's operators in an early phase.[253] Improvements for future ramp-ups are product tests where product influences are planned in advance on an installation with similar conditions to the customer's situation to solve errors in advance.[254]Test constructions or prototypes help to carry out tests similar to live conditions. These tests allow also integrating the customer so that he/she learns how to deal with the installation.

- **Integrate supervisors in the internal test phase**

A continuous process where the customer participates in tests helps to get to know the system step by step.[255] Training sessions can be carried out before the start-up where key players are in Austria for the training phase.[256] The customer training program gets more effective when supervisors are already trained before the go-live at Knapp in Austria. This way they learn to deal with the software and functionalities together with the supplier. The

[249] Cf. Group manager software engineering KSI (2012), Interview.
[250] Cf. Consultant KSI (2011), Interview.
[251] Cf. Head of group logistic and material flow SPAR (2012), Interview.
[252] Cf. Consutant Econsult (2012), Interview.
[253] Cf. Group manager software engineering KSI (2012), Interview.
[254] Cf. Head of department of automization engineering Salomon (2011), Interview.
[255] Cf. Head of departement WMS & WCS KSI (2011), Interview.
[256] Cf. Consultant Econsult (2012), Interview.

customer has to be convinced to invest and bring employees to Austria for the tests, for three months approximately, to get to know the system step by step.[257]

5.1.6Ramp-up preparation

The preparation for the ramp-up is carried by several methods that improve the ramp-up. The results of the expert interviews related to the preparation for the ramp-up are listed in the following paragraphs.

- **Provide workstation and job descriptions inclusive error handling (*)**

Qualitative work performance influences the ramp-up behavior.[258] Since most of the ramp-ups are characterized by workarounds and wrong user handling, many errors arise in this phase. Because of a lack of know-how concerning the operation of the installation processes, system and error handling during the operation are unclear for operators and lead to flatter learning curves. One of the main problems is that old habits of operators for special tasks lead to workarounds and to user handling errors or workarounds.[259] In order to avoid this effect and to enable fast and correct user handling during the ramp-up, it is required to provide some sheets of paper for process descriptions, working steps and an extra sheet for error handling for each workstation. This could be mounted directly on the workstations or on a board near it.[260] Another possibility is to design one A4 page per workstation in a written or graphical way.[261] Short job specification serve in addition to define what skills are expected for the operation of the workstation to make sure that there are fewer problems during the ramp-up, presented e.g. in form of a skill matrix for every job.[262]

- **Carry out workshops for ramp-up preparation & description of deliverables**

The customer is used to get plans and checklists without explications.[263] It is required to present and explain the installation and preparations in a workshop, where the systems, plans and checklists are discussed in detail. This way the customer gets knowledge about the deliverables and processes. A workshop about the ramp-up after the specification and design phases and before the construction phase should be planned in the project to eliminate risks and impacts later on.[264] This helps to improve the ramp-up and reduces customer claims. Workshops for the preparation of the customer to describe the functionalities and to prepare

[257] Cf. Consultant Econsult (2012), Interview.
[258] Cf. Risse (2002), p.155.
[259] Cf. Project Manager KAG (2011), Interview.
[260] Cf. Head of department WMS & WCS KSI (2011), Interview.
[261] Cf. Group manager software engineering KSI (2012), Interview.
[262] Cf. Group manager software engineering KSI (2012), Interview.
[263] Cf. Head of department WMS & WCS KSI (2011), Interview.
[264] Cf. Project Manager KAG (2011), Interview

the customer for the result will reduce changes.[265] This measure leads to transparency of deliveries and to higher customer satisfaction.

- **Define processes and responsibilities for the ramp-up phase**

Defined processes and responsibilities help to improve the transparency during the ramp-up.[266] Unclear processes and responsibilities on-site and a lack of knowledge of who knows what and who is responsible for what leads to delays on-site and a waste of time during the ramp-up. The definition of processes and responsibilities for the ramp-up phase improves the transparency of responsibilities and the faster implementation of solutions. High process and administrational quality has to be ensured by having a clear ramp-up organization for the production, responsibilities and tasks.[267]

- **Make sure that the customer fulfills required conditions before the go-live**

The start-up and ramp-up is often carried out even though the customer does not fulfill all conditions of the contract, e.g. before resources, material and logistic processes and an organizational structure are available. This checklist of customer conditions is not obligatory and that is the reason why some of these requirements are not available before the go-live.[268] This leads to inefficiencies during the ramp-up since important points with influence on the operation have to be verified and should exist. The organizational structure before the go-live is very important; if that structure is not available, then Knapp has to add employees in the worst case.[269] It has to be verified that the customer fulfills all conditions to prevent inefficiencies and a loss of performance.

- **Design a ramp-up plan in cooperation with the customer**

Ramp-up planning contains planning activities related to the ramp-up.[270] Ramp-up plans should be discussed together with the customer in order to avoid problems.[271] This includes besides ramp-up activities also the increase of the production output. Unrealistic expectations and calculations due to missing knowledge and experience about a realistic performance lead to wrong planning and preparations. Therefore, the customer's ramp-up plan has to be revised.[272] The TPL and logistics department of the customer should cooperate to plan the ramp-up phase.[273] The right planning is essential for a perfect

[265] Cf. Consultant KSI (2011), Interview.
[266] Cf. Ibid.
[267] Cf. Nagel (2011), p.32-35.
[268] Go-live = Production start with real customer orders and dispatch.
[269] Cf. Consultant KSI (2011), Interview.
[270] Cf. Hartel (2009), p.175.
[271] Cf. Project Manager KAG (2011), Interview.
[272] Cf. Area manager KSI (2011), Interview.
[273] Cf. Head of department WMS & WCS KSI (2011), Interview.

adjustment to realistic increase of the throughput and for the right performance during the ramp-up. When the ramp-up planning is not carried out in cooperation with the customer, unnecessary inefficiencies might be the result.[274]

5.1.7Training program

The training program is especially important during the ramp-up given that the knowledge about the installation, functionalities and the error handling are the basis for the operators and hence also for the success of the ramp-up. Operators cannot deal with the installation initially, the customer does not understand the processes yet, they have problems with their own processes and it could occur that their processes are not as specified.[275]
Up to now, the training program played a secondary role during the ramp-up. Developer and start-up engineers train the key players in order to deliver the required knowledge about the tasks and working steps. The problem is that the key players often do not distribute the knowledge internally in an appropriate way and the qualification of the operators is very poor. The, trainers are employees that are very busy during the ramp-up phase and cannot focus on training sessions. Nevertheless, the qualification of the customer's employees is an important factor for a successful ramp-up.[276] Besides there exists no official standard documentation for each training session and error handling is hardly described in an appropriate way.

- **Implement the training program appropriately by the following steps:**
  - **Organize the training program with schedules**

An organized training program is necessary for a successful ramp-up.[277] The plan has to suit the customer schedule.[278] A standardized schedule should be used that contains name of the training session, date, duration of the training session, name of the trainer, content of the training session and required position of supervisors. It is necessary to tell the customer when and which operators are required for each training session.[279] The content of the training session and the position of the required supervisor have to be defined for the participation.

  - **Train before the go-live**

The training program has to be carried out at least two days before the go-live so that the customer gets the knowledge early enough but it should not be carried out earlier because

[274] Cf. Head of department WMS & WCS KSI (2011), Interview.
[275] Cf. Ibid.
[276] Cf. Ibid.
[277] Cf. Consultant KSI/ Area manager KSI (2011), Interview.
[278] Cf. Area manager KSI (2011), Interview.
[279] Cf. Project Manager KAG (2011), Interview.

the forgetting curve of the trained employees has to be considered. Early training programs lead to an appropriate qualification of the operators.[280]

- **Provide appropriate training documents in advance**

The customer is prepared for the new functionalities and processes by official training sessions with documentation.[281] Appropriate training documents are necessary for a good training session.[282] These documents should be delivered in advance.[283] This way he can use the documents for notes and to prepare himself for the training session. The quality of the training session arises with good training documents and a better communication flow is ensured. Better documentation is required and therefore one suggestion is that the customer participates in the training sessions and writes own documents.[284] The training documents can be written by the supplier or client, but documents from the client present a more professional way of training programs since he knows the operators and their training needs more in a better way. Training documents should contain a short and clear summary of the specification, without copying the whole document of the specification.[285] Extra training documents should be designed, since the specification is not enough as basis document for training sessions.

- **Train key players and if necessary operators in small groups**

Supervisors or so-called key users are customer employees that have a main position in the company, especially in relation to the operation of the installation. The control center staff and logistic department have to be trained.[286] These people are responsible for the operation control and/or logistics and therefore they have to attend the training sessions. But not only supervisors, also logistic engineers, have to own specific knowledge about the installation and all related processes, i.e. they have to be prepared appropriately. The customer is then responsible to train the operators.[287] Key players are trained on the installation for 120% so that they can teach the end-users for 80%.[288] This fact delivers a lot of advantages, e.g. if the key players know that they have to teach the operators, they will also pay more attention.[289] These people who have a key position are responsible for the knowledge concerning the installation and the distribution of it in the company and so they are trained about all processes that run on the installation. Only three to four administrators should be trained.[290] The training session carried out in small groups of maximum five people has the

[280] Cf. Head of department of automization engineering Salomon (2011), Interview.
[281] Cf. Ibid.
[282] Cf. Consultant KSI (2011), Interview.
[283] Cf. Group Manager Software Engineering KSI (2012), Interview.
[284] Cf. Head of department WMS & WCS KSI (2011), Interview.
[285] Cf. Project Manager KAG (2011), Interview.
[286] Cf. Head of department WMS & WCS KSI (2011), Interview.
[287] Cf. Group manager software engineering KSI (2012), Interview.
[288] Cf. Consultant Econsult (2012), Interview.
[289] Cf. Ibid.
[290] Cf. Group manager software engineering KSI (2012), Interview.

advantage that everybody in the group is included and trained well to reach high efficiency and effectiveness. Training programs for key players only minimizes the effort because the training of the operators is then carried out by the customer. Nevertheless, challenges caused by employee fluctuation and a lack of know how transfer to the customer lead to problems that may have an impact on the ramp-up.[291]

Just in special cases operators should be trained on workstations, e.g. for special and difficult customers. The training session can be carried out with operational workers in a practical way on the installation.[292] This measure is just applied in certain countries or with certain customers if a training session of the key players is not sufficient because they are not able to distribute the knowledge in the company. This way the training sessions correspond to cross-product and process oriented demand.

- **Train software functionalities**

The content of the training program includes explications of the software, the administration of the software, dialogues and reports on different levels for an easy and fast user and error handling. But generally the content of the training program depends on the process and the installation.[293] The training program is about process descriptions and functionalities of the system that are required for the ramp-up and the normal operation. Training programs should contain descriptions of how to control core processes.[294]

- **Implement practical training sessions**

The installation should be presented and the practical operation should be shown. [295] Practical training sessions is elementary in order to prepare the customer for the normal operation, to eliminate wrong user handling and to improve the performance of the system. Only practical methods and examples the elimination of errors are trained to qualify the operators.[296]

- **Provide retraining sessions if required**

Retraining sessions are required during or shortly after the go-live because during the operation new questions and insecurity of operators and supervisors related to tasks, working steps and error handling may arise. Moreover, retraining sessions after the customer acceptance are required if the product was optimized and new dialogues were added to the software during the start-up.[297] In addition to that, the staff changes frequently so that retraining sessions are required in order to train new operators the installation instructions.

[291] Cf. Consultant KSI (2011), Interview.
[292] Cf. Head of group logistic and material flow SPAR (2012), Interview.
[293] Cf. Ibid.
[294] Cf. Consultant KSI (2011), Interview.
[295] Cf. Group manager software engineering KSI (2012), Interview.
[296] Cf. Head of department of automization engineering Salomon (2011), Interview.
[297] Cf. Group manager software engineering KSI (2012), Interview.

- **Supervise operators and carry out corrective training sessions**

The observation of operators, supervision and support after the training session are recommendable.[298] Training sessions with supervision are required to verify if the employees have understood the topics and also to verify if they still cause errors. Corrective training sessions should also be part of the training program.[299] This way the operators learn an appropriate execution of the processes and user handling. The difference to production support is that the supervision and the corrective training sessions are applied directly after the practical part of the training program and they are considered as part of the training program by operator observation during the operation.

- **Train error handling with simulated errors**

The qualification of the operators is important and an appropriate basis is required to teach them error cases and to show them how to eliminate errors.[300] Training sessions with simulated errors prepare the customer for probable events during the operation and guarantees that problems in processes are corrected right away/are successfully corrected.

- **Evaluate trained employees (questions/multiple choice tests) (*)**

The evaluation of operators after training sessions improves the user handling and therefore the ramp-up.[301] The evaluation of the training sessions can be carried out with open questions in an oral/ written way or with multiple choice tests. Main parts of the content can be evaluated by using examples to verify the knowledge. Training content with evaluations, training protocols, superficial control questions to check if the topic was understood and the observation of the operators by supervision and support are further required parts of the training sessions.[302] The control questions should then be discussed and solved after the test to clarify questions.

- **Certificate participants after the training session**

The employees should be certificated after the training sessions.[303] Hence, every employee gets a confirmation of the training session participation and the content so that the customer knows who to contact for particular questions related to the installation.

- **Evaluate the trainer externally (*)**

Trainer experience and knowledge of the installation are not enough trainer competences for effective training sessions. The inability to transfer the know-how in training sessions in an appropriate way can be improved by carrying out evaluations by the customer's employees regarded to the trainer's performance and the course itself. Participants of internal training sessions at Knapp have to evaluate internal and external trainers and so it is also effective to

[298] Cf. Head of department of automization engineering Salomon (2011), Interview.
[299] Cf. Consultant KSI (2011), Interview.
[300] Cf. Head of department of automization engineering Salomon (2011), Interview.
[301] Cf. Project Manager KAG (2011), Interview.
[302] Cf. Head of department of automization engineering Salomon (2011), Interview.
[303] Cf. Project manager KAG (2011), Interview.

carry out the same evaluation after customer training sessions to evaluate the trainers on-site.[304] This way the trainer's performance can be measured, inefficiencies can be detected and improvements can be determined for high training quality.

Evaluation of the training session (service quality)

The evaluation of the training session's quality can be carried out like evaluating a service. The evaluation can be carried out by the following types shown in Figure 54.

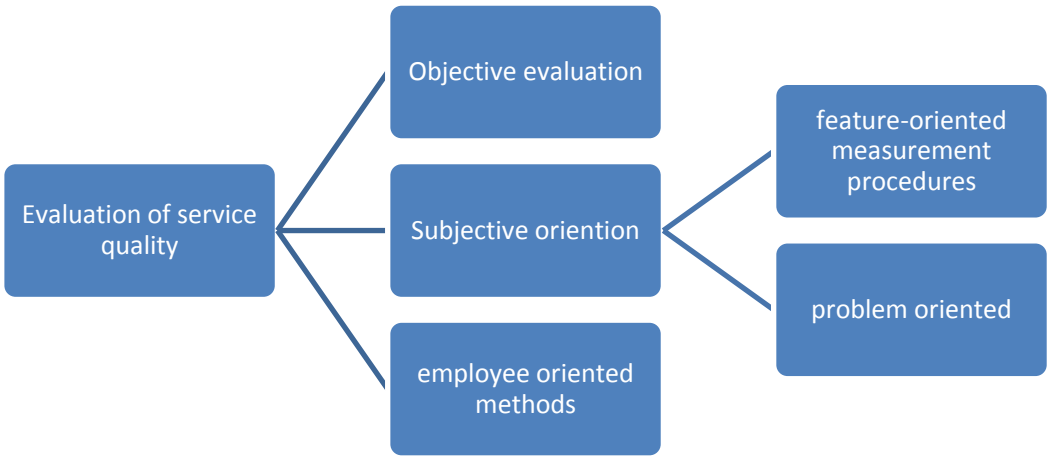

Figure 54: Overview of evaluation methods of service quality[305]

The overview of recommendable methods in order to evaluate the training sessions and trainers are:

1. Objective evaluation: the expert observation is a method in which a trained expert is observing the service without participating in order to detect inefficient performance. The disadvantage is the risk of subjectivity during the observation.[306]
2. Subjective orientation:
    a) The feature-oriented measurement procedure is a method that evaluates single performance elements. Partial evaluations are connected to a whole in order to evaluate the performance, like the so called multi attribute method.[307]
    b) Another feature-oriented measurement procedure tool is the SERVQUAL approach. 5 dimensions (tangibles, reliability, responsiveness, assurance, empathy) are reorganized into 22 items and each item has a double scale. The first scale is the expectation scale that shows the ideal situation. The

[304] Cf. Project manager KAG (2011), Interview.
[305] Based on Bruhn (2006), p.84.
[306] Cf. Bruhn (2006), p.86.
[307] Cf. Ibid., p.90.

second scale is the perception scale that shows the real situation to determine the variance from expected to observed service quality.[308]

c) Another feature-oriented measurement procedure is the decomposition method that works vice versa to the tool described before and evaluates the performance at first as a whole and subsequently as partial performance evaluations.[309]

d) A tool for the decomposition method is the vignette method. This method tries to find relevant factors for customer satisfaction, the so-called "critical quality characteristics" and evaluates them. Every factor gets a specific value and the client then evaluates the vignettes, on a range from very good to very bad. The evaluation is carried out in tables and the frequency with independent characteristics is shown together with total evaluations of dependent variables. This way the influence of the attributes on the whole quality is measured by one single coefficient. The result is a range of quality attributes and a global quality evaluation.[310]

e) A problem-oriented tool is the Frequency-Relevance-Analysis for problems (FRAP). At first, a problem list is created and then three question categories are formed on the questionnaire. The three questions are: (1) Has the problem already occurred, (2) How big was the irritation? (3) Which reactions were considered? The evaluation done by the customer concerning the frequency and relevance of the problems is measured via "Problem Scores".[311]

3. External quality measurements are employee oriented methods. An employee interview gives information about the service provider's performance as customer employees tell what they observed in a positive and in a negative way. Their evaluation and the importance of the matter to themselves, delivers further information about the service.[312]

- **Evaluate the trainer internally (*)**

Internal trainer evaluations should be carried out by the TPL, PMA (Project manager) or other colleagues participating in the course for a short time and filling out an evaluation sheet. A feedback of internal employees enables to improve the trainer's skills and knowledge about the training session quality. An assessment center where Knapp evaluates trainers internally in 15 Minutes training sessions about specific parts of KiSoft products can also be implemented if necessary.

[308] Cf. Bruhn (2006), p.97.
[309] Cf. Ibid., p.99.
[310] Cf. Ibid., p.100, 102.
[311] Cf. Bodmer et al. (2002), p.130-131.
[312] Cf. Ibid., p.140.

Besides, the trainer can be evaluated internally by carrying out the following steps:[313]

1. Determine basic skills for an appropriate training session
2. Skill evaluation is defined (0-5)
3. Skill matrix is defined
4. Current skills are evaluated
5. Qualification demand is determined
6. Qualification methods are prioritized
7. Implementation and monitoring of measures for the trainer's competence

The organization has to ensure that the trainer possesses a certain trainer competence. A description of a training conception is delivered by *Biedermann*. It consists not only of technical, but also of methodical and social competence. Good trainers have to possess these competences for appropriate training performances (see Figure 55).

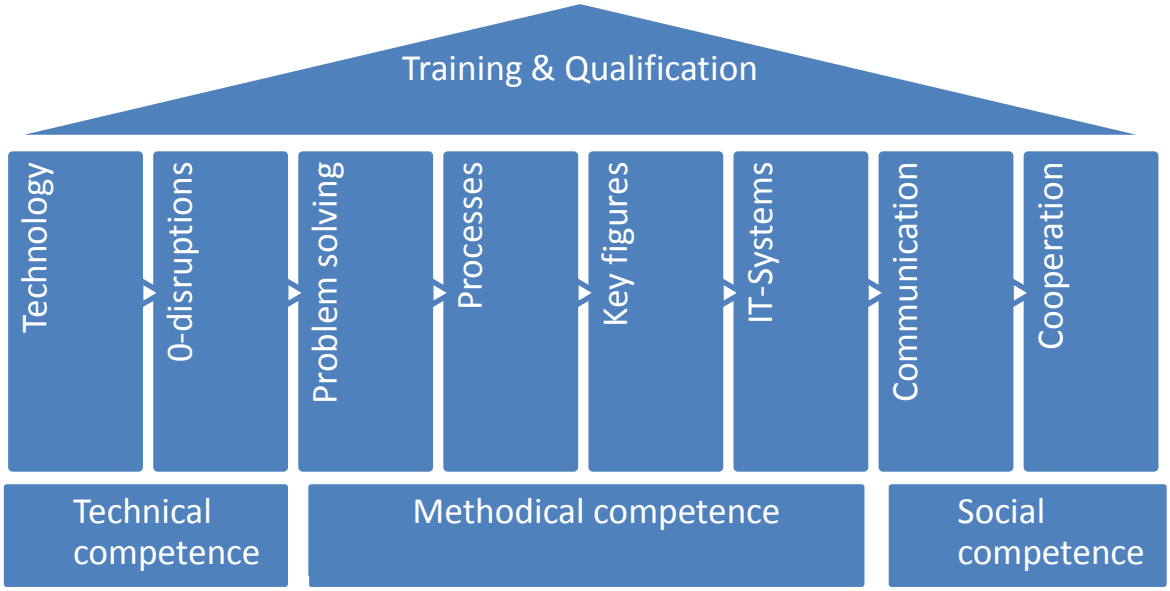

Figure 55: Training conception[314]

- **Provide rhetoric courses for trainers (*)**

Start-up engineers or people on-site that carry out training sessions often do not possess the necessary abilities for a good trainer. A good trainer has sufficient knowledge of the installation, the ability to talk in front of people and to transfer know-how to others. Trainers who do not possess these skills may have a negative impact on the training session such as demotivation, dissatisfaction and communication problems (if the topic is not understood for

[313] Cf. Bodmer et al. (2002), p.139-140.
[314] Based on Biedermann (2008), p.15.

instance). Rhetoric and communication courses for trainers and lessons about how to train would improve the training sessions.[315]Rhetoric courses for trainers and appropriate trainer competence trainings will avoid these inefficacies and guarantee the best preparation of the customer for the ramp-up.

- **Certify trained supervisors with "Installation licenses" (*)**

The installation license is a permission for working with the installation for operators that passed the training session successfully. This license lists all absolved training sessions and also the knowledge about the product. An Installation license that enables certain employees to carry out certain processes is one measure to prepare the customer for the functionalities and processes of the installation, but it requires the customer's agreement.[316] Just employees that possess this license are permitted to work with the installation in order to keep user handling errors as low as possible.

5.1.8Documentation

The documentation that is created during the ramp-up and for the customer varies from project to project. There is not yet a defined strategy for user manuals and training documentation. During the expert interviews, the following suggestions concerning the documentation were mentioned.

- **Document the ramp-up appropriately (daily reports and weekly reviews)**

The system does not possess high performance and maturity during the ramp-up and so control and verification of this process are required.[317] This is partly achieved by frequent reports and reviews so that people are internally informed about completed tasks, problems and the ramp-up status. On a weekly basis a review with the most important information of the ramp-up should be written.[318] Daily reports and weekly reviews enable an appropriate information flow during the ramp-up.

- **Perform workshops about the design of daily reports (*)**

The quality of daily reports that are designed during the ramp-up have to be improved since important information is not documented. Sometimes problems are not noted and they just deliver an overview of the situation.[319] The right information is not transferred to the people responsible and like this the communication process is interrupted. Report writing has to be

[315] Cf. Head of department of WMS & WCS KSI (2012), Interview.
[316] Cf. Project manager KAG (2011), Interview.
[317] Cf. Franzkoch et al. (2005), p.406.
[318] Cf. Consultant KSI (2011), Interview.
[319] Cf. Group manager software engineering KSI (2012), Interview.

trained, so that the main points, consequences of problems and further steps to a solution are documented.[320] Therefore meetings should be organized to show how to write good reports.[321] Good and bad reports have to be presented in the form of examples to make the requirements to the employees clear.[322] This measure leads to better quality of the ramp-up documentation.

- **Design a troubleshooting document with constant updates**

Production systems are unstable during the ramp-up; therefore ramp-up robust production systems are required to increase the stability and troubleshooting has to be employed.[323] Troubleshooting documents where all topics related to errors are noted can be used to document and ensure right error handling during the start-up and the ramp-up. A troubleshooting document should be implemented for each installation and updated constantly.[324] This way, errors can be detected in a faster way, solutions are documented and it facilitates future error handling during the ramp-up, support and service phase. The document is then the basis for start-up engineers and internal support, e.g. for the hotline to have easier access to knowledge about the installation.

- **Create a project diary to document problems**

Knowledge related to problems and difficulties during the project for the project review can be collected by creating a standardized document where problems are noted constantly. This can be in the form of a project diary where progress and problems of the project are documented in two taps of an Excel file.[325] At the end of a project it is difficult to remember the main problems that have to be discussed and this document enables the reconstruction of this knowledge after the ramp-up.

- **Note open issues in an appropriate tool**

An open issues list has to be administrated constantly to list open tasks that are required for the ramp-up.[326] Open issues and all data related to them have to be constantly documented and delegated in order to solve problems and eliminate bugs in a fast way. Information related to open issues, such as description, category, data when noted, data when solved, data when finished, priority, responsibilities, date when retested and solutions have to be collected. A standardized open issue list in Excel should be used as a standard open issue list

[320] Cf. Group manager software engineering KSI (2012), Interview.
[321] Cf. Ibid.
[322] Cf. Ibid.
[323] Cf. Bramley et al. (2005), p.257.
[324] Cf. Head of department of WMS & WCS (2011), Interview.
[325] Cf. Project manager KSI (2011), Interview.
[326] Cf. Langer (2008), p.33.

if no automated software is available. This makes it easier to administrate open issues internally and it is also available for the customer. The second possibility is a standard software tool to note all kinds of problems via internet. This has the advantage that they are administrated and easy accessible without redundancy. Secondly, a customer portal can also be created to enter open issues. A portal with information about the installation can also be used by the customer to enter open issues instead of numerous documents and organizational work.[327] This portal enables a fast handling and a transparent information flow of customer problems during the ramp-up.

- **Design a satisfying user manual with error handling**

Not all user manuals are satisfying since the documentation is often incomplete, unstructured, incomprehensible or not useable for the customer. Unfortunately, no standard for the documentation exists and currently the specification is mostly used as basis for the user manual. It would be the optimum to have screenshots of dialogues e.g. for administrators.[328] Unsatisfactory user manuals lead to the problems that the processes and functionalities are not understandable for the customer and therefore more user errors arise or the supplier is contacted very often. A standardized user manual has to be designed with an appropriate error handling for the ramp-up. The error handling in the specification document is often not sufficient as description for right user handling. Error handling and dialogues are not always indicated because the documentation is not one of those tasks that the employees are interested in.[329]

- **Determine technical editors that are responsible for the documentation**

The training documents often do not possess appropriate quality because the writers are often start-up engineers that do not have the time or knowledge to create appropriate documentations. As a consequence the content of the documents is either incomplete or documents are unstructured and hard to understand. When user manuals or other training documentations cannot be used, the supplier is contacted more often in case of problems or uncertainties. Writing training documents is a skill that needs to be trained and therefore a technical editor that also knows the products improves the quality of training documents.[330]

[327] Cf. Consultant KSI (2011), Interview.
[328] Cf. Group manager software engineering KSI (2012), Interview.
[329] Cf. Ibid.
[330] Cf. Ibid.

5.1.9Start-up

The test phase on-site contains further improvement potential with effect on the ramp-up. The following suggestions were mentioned by the experts during the interviews that were carried out at Knapp.

- **Create test cases with customer data and material**

Customer influences like goods that do not possess the specified characteristics and other unforeseen physical influences create problems during the ramp-up.[331] So customer data and material are required for the tests to avoid that. Test cases with customer data and material can improve the software and like this also the ramp-up.[332] This allows efficient tests with fewer errors during the ramp-up as well as less resource commitment. The quality of the start-up has to be improved by realistic test scenarios.[333]

- **Integrate supervisors in the start-up and test phase**

Customers are prepared for new functionalities and processes by integrating them during the start-up. The problem is that customers do not understand why their resources are required in that phase since this presents a costly measure.[334] The customer program gets more effective when supervisors are already trained practically before the go-live during the start-up. The recommendation is to integrate the operators in the start-up and test phases to transfer knowledge and skills appropriately and in a fast way.[335] One or two key players should get to know the system better and watch the start-up engineers.[336] The integration of these key players in the test phase enables to get to know the software in an early state and to improve the user handling. This way they learn to deal with the software and functionalities together with the supplier.

- **Implement performance tests for complex projects**

As far as the hand-over of the installation from the supplier to the customer is concerned, it is recommendable to verify if the installation can be handed over or not by evaluating existing errors with availability tests and performance tests. These tests form the end of the start-up and are finished by the acceptance or handover of the installation to the customer which is important to the supplier since he receives the last payment of the customer.[337] Performance tests are important in order to test if the system reaches the performance as

[331] Cf. Head of department of automization engineering Salomon (2011), Interview.
[332] Cf. Consultant KSI (2011), Interview.
[333] Cf. Project manager KAG (2011), Interview.
[334] Cf. Head of department of automization engineering Salomon (2011), Interview.
[335] Cf. Börner (2009), p.41-43, 99-102.
[336] Cf. Head of department WMS & WCS KSI (2011), Interview.
[337] Cf. Head of department of automization engineering Salomon (2011), Interview.

specified. These tests are not necessary under specific circumstances, e.g. for installations of low complexity, when the customer has not yet eliminated all his errors, when past projects with the same customer were successful, when the customer wishes a long support phase or if there is time pressure. On the one hand, these tests are a must have for complex installations if there is no time pressure, but on the other hand, these tests require a lot of time and effort. Performance tests should be specific, simple and carried out before the real production start (go-live).[338] The advantage is that they guarantee that the specified performance can be reached in case of doubts.

- **Create acceptance gates during the start-up**

A clear implementation is required until the go-live and therefore acceptance gates should be set.[339] This means that the acceptance is not carried out at once because the systems cannot always be separated from each other. Acceptance gates make it easier to detect errors and it can be guaranteed that the systems, that have already been installed, are working correctly. The acceptance of the mechanical part is followed by the electrical construction and its acceptance, the PLC and its acceptance, and finally the WCS and its acceptance.[340] The suggestion is to implement the customer acceptance of the software also in steps, so that it can be guaranteed that all basic elements of the software are working and were accepted before next features are implemented. This implementation is difficult because in reality there are always delays and lots of interactions between the systems.[341] This measure is just feasible under certain conditions if there is no time pressure and the interaction between the systems allows it. Often it is not possible to implement the project this way because of time pressure. This fact leads to the requirement of the system implementation in a parallel way.

- **Spend less time on the start-up and more on the ramp-up**

Most of the time on-site is invested into the start-up phase and little time on the ramp-up support. This situation can be improved by providing more time for the ramp-up and less time for the start-up phase so that the go-live of the installation can be carried out earlier and the error detection occurs then during the support phase where the customer is also integrated. There should be a different focus on the start-up and more quality assured for the ramp-up by spending less hours on the start-up and more on the ramp-up.[342] The start-up phase should be shortened by improving the quality of steps that are carried out before

[338] Cf. Consultant KSI (2011), Interview.
[339] Cf. Project manager KAG (2011), Interview.
[340] Cf. Ibid.
[341] Cf. Ibid.
[342] Cf. Head of department WMS & WCS KSI (2011), Interview.

such as an appropriate development and tests phase.[343] The advantage is that the customer can start to produce earlier and that more support has positive effects for the customer.

- **Carry out the start-up under special circumstances during the construction**

High time pressure and the need to keep resource commitment as short as possible request an early start-up of the installation. This means that an early start-up occurs under specific circumstances even when the construction phase is not yet finished. For instance, if one area of the installation is not yet needed and the customer agrees with this strategy. If the installation is not ready, but one part of it is not yet required then it is more important to go-live then to wait until the whole installation is finished. The condition for this "early go-live" is that the customer does not need all areas yet for the operation, so this measure always depends on the project.[344] The total capacity of the installation cannot be used yet during this phase, but advantages are gained in relation to cost saving because of an earlier start-up in a parallel way to the construction with less resource commitment.

5.1.10 Support

In order to avoid interruptions during the ramp-up enough resources and enough support have to be available after the start-up and during the ramp-up. If the personnel of the provider does not stay on-site long enough this, causes a bad reputation that may have negative effects on the company and higher costs.[345] There are different forms of support, such as on-site and remote support. If sold, the hotline (service department) also serves to support the customers during the ramp-up of the production. Improvements according to these different types of support are listed below.

- **Provide on-site and long term support for all system (1 week – 3 months)**

For the production support during the ramp-up appropriate resources have to be planned by the responsible people.[346] It is essential for a successful ramp-up that resources such as engineers, electricians, PLC (Programmable Logical Controller), HWT (hardware technicians), WCS (Warehouse Control Systems), WMS (Warehouse Management Systems) and Motion are available on-site according to the project requirements.[347] The ramp-up phase is characterized by problems, changes, user errors and the elimination of software bugs. Open issues have to be closed and the customer has to be trained to operate the system. This leads to the requirement of sufficient support for customers during the ramp-up phase. The

[343] Cf. Group manager software engineering KSI (2012), Interview.
[344] Cf. Ibid.
[345] Cf. Gronau (2008), p.285.
[346] Cf. Head of department WMS & WCS KSI (2011), Interview.
[347] Cf. Project manager KAG (2011), Interview.

duration and type of the on-site support depends on the complexity of the installation and is for complex installations up to three months and otherwise, for less complex installations maximum one week. Support is generally carried from one week up to three months[348].Support is provided longer than 3 month if there are special agreements.[349] WMS projects include longer support since these projects are more complex; maintenance teams are always available on-site.[350] Production and maintenance operators have to be integrated into the construction and development phase to avoid disruptions. The implementation of an information system that supplies ramp-up data and provides diagnosis and prognosis about disruptions is necessary. Likewise role concepts for an interdisciplinary ramp-up team have to be defined for the ramp-up phase.[351]

A ramp-up team that is working parallel to operators, has the advantages of high availability of qualified workers, higher ramp-up curve inclination, better support of operators and the use of optimization potential. Disadvantages are high costs for human resources, adjustment of work tasks and changes in the employee structure.[352]

Currently start-up engineers are just sent on-site when the project is escalating, when the customer buys extra support or when the start-up engineer stays longer acting as a consultant.[353] Complex projects should generally get extra support from developers, TPLs or start-up engineers.

Long term support is always offered to the customer, but it means resource commitment of the supplier's employees and harms the company. Long time support should be mainly carried out by local agencies since they are close to the installations.[354] This way the local agencies get more involved in the operational and technical part of the installation and high resource commitment is avoided. The local agencies have to be able to get a required training program in order to be able to offer this measure.

- **Complete the installation checklist before the departure**

It occurs that the checklist for the verification of the product is not filled out before leaving the installation on-site.[355] In order to make sure that all conditions of the product are fulfilled, the checklist of the installation has to be filled out. This ensures that nobody is leaving the installation without clarifying all important points and open issues. The consequence is an appropriate information flow and know-how transfer and a common

[348] Cf. Project manager KAG (2011), Interview.
[349] Cf. Ibid.
[350] Cf. Ibid.
[351] Cf. Biedermann (2008), p.14.
[352] Cf. Barisits (2008), p.96, 97.
[353] Cf. Project manager KAG (2011), Interview.
[354] Cf. Consultant KSI (2011), Interview.
[355] Cf. Group manager software engineering KSI (2012), Interview.

status between supplier and customer. This way support on-site is finished appropriately after the ramp-up.

- **Provide remote support (plus support via internet, Skype, etc.)**

Besides on-site support there exists remote support, support via internet, skype, etc. that is available to support the customer.[356] Via connections to the installation relevant, error data can be collected without being present on-site. This is also a cost saving strategy, but very effective. On-site, remote and hotline support exists to support the customer during the ramp-up.[357]

- **Integrate the customer in the elimination of errors**

The main optimizing potentials are the cooperation between all internal and external areas of the ramp-up and to optimize potentials by an appropriate ramp-up culture that is characterized by confidence, communication, openness related to problems and cooperation in finding solutions.[358] It is required to teach the customer how to solve problems on his own and to transfer knowledge about the operation of the installation by training sessions in a practical way including training session for error elimination.[359] The supplier will be able to leave the installation earlier since the customer can deal with the installation and the problems on his own. Integrating the customer into the ramp-up phase to improve the qualification of the operators is also recommendable for future ramp-ups.[360] This reduces the resource commitment of the supplier's employees and accelerates the ramp-up.

During the ramp-up many difficulties and disruptions arise that threaten a robust ramp-up production system. Improvements are achieved by an integrated observation of human resources, technique and organization, related to working tasks and the work organization structure. A ramp-up robust structure can consequently be reached by appropriate work structures. Adaptability and flexibility of working steps and of the organization are required in order to react to disruptions or changes.[361]

The early integration of operators into the ramp-up (in steps or at once) is recommended because of following advantages:[362]

- Operators receive better knowledge about processes
- Training of theoretic knowledge and abilities during the ramp-up
- Compensation of waiting time (time is used for training, other tasks, etc.)

[356] Cf. Project manager KSI (2011), Interview.
[357] Cf. Consultant KSI (2011), Interview.
[358] Cf. Gronau (2008), p.284.
[359] Cf. Head of department of automization engineering Salomon (2011), Interview.
[360] Cf. Ibid.
[361] Cf. Börner (2009), p.73.
[362] Cf. Ibid., p.95,96.

- Optimization of ramp-up curve by an earlier integration.

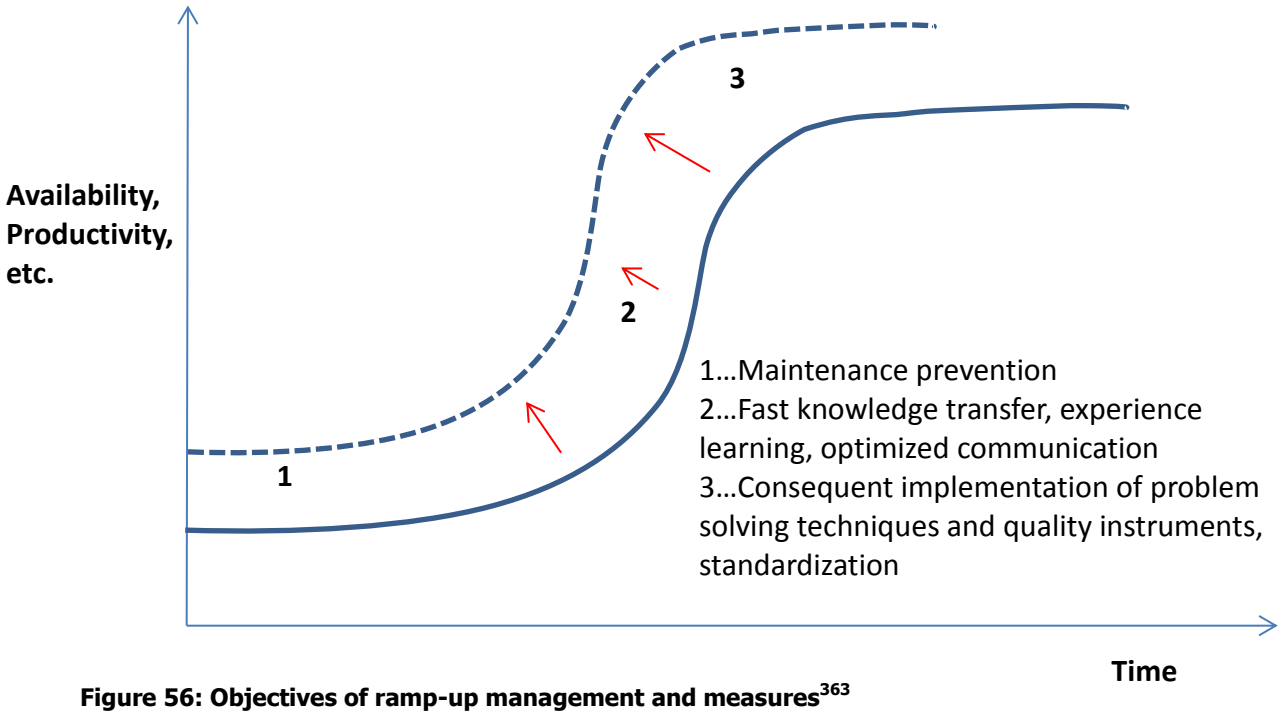

Figure 56: Objectives of ramp-up management and measures[363]

Figure 56 shows the advantages of maintenance prevention, fast knowledge transfer and implementation of problem-solving techniques. The curve gets a higher inclination, a higher throughput can be achieved and the ramp-up period is shortened.

- **Provide an experienced ramp-up manager (consultant)**

The ramp-up is a process that requires the knowledge of experts in order to be carried out appropriately. Knowledge about the ramp-up can be delivered by an experienced ramp-up manager who also acts as consultant for the client during the ramp-up. An experienced ramp-up manager can improve the ramp-up by delivering support from two to three weeks until half a year and possessing WMS, WCS and PLC knowledge. He acts like a consultant and is watching the customer's logistical processes to improve the ramp-up.[364]

- **Provide a steady ramp-up team (start-up engineers, TPL, support)**

An operational ramp-up team for the ramp-up should consist of flexible ramp-up experts of different compositions and amount of members according to the ramp-up type.[365] Lack of resources, changing team members and time pressure during the ramp-up lead to unsteady and inappropriate ramp-up teams. This has negative effects on the ramp-up since important

[363] Based on Biedermann (2008), p.14.
[364] Cf. Project Manager KAG (2011), Interview.
[365] Cf. Börner (2009), p.40.

information and data disappears and is not transferred to other responsible colleagues. A steady ramp-up team is required.[366] There is no exact determination of recommended ramp-up teams since the team composition depends on the production system.[367] But generally it can be determined that the ramp-up team should consist of customer, start-up engineers, TPL and employees for the support of operators. The core personnel have to be reserved for the ramp-up and it should stay on-site during the production support.[368] This guarantees that the information flow and knowledge about the installation lead to an improved ramp-up as well as to a better cooperation with the customer.

5.1.11 Service

The service process is an important phase after the on-site support during the ramp-up. The know-how transfer to the hotline is a fluent act since much important data or information has to be handed over as well as the responsibility and contact persons for the customer change.
In this phase it happens that information gets lost or is not handed over efficiently and effectively. Change management is part of the service process and is getting more and more important since the clients expect more flexibility according to solutions. The suggested improvements are listed below.

- **Integrate the service department appropriately and in time**

The integration of the service department takes place, when the ramp-up has already started and the handover to the hotline is very short. The information flow is often inappropriate and important information gets lost due to error handling and problems with the operation of the installation. The integration of the service department is required in an earlier phase where, e.g. employees from the service department carry out long term support to bring the know-how from the on-site team to the service department.[369] The transfer of know-how internally is one of the main problems and so the service process can be improved by being appropriate and on time.[370] The know-how transfer should be improved and verified that it is carried out in time, as specified. Certain conditions have to be fulfilled that trigger the handover, e.g. the error rate is under a certain limit. This guarantees that the responsibility changes from the on-site team to the service department correctly and in time. The change of the responsibility should not have any effect on the ramp-up and a fluent information flow

[366] Cf. Project manager KSI (2011), Interview.
[367] Cf. Börner (2009), p.53.
[368] Cf. Head of department WMS & WCS KSI (2011), Interview.
[369] Cf. Consultant KSI (2011), Interview.
[370] Cf. Ibid.

should be assured so that the service department is prepared for incoming requests of the customer during the ramp-up.

- **Reserve resources for changes**

The ramp-up phase is characterized by various challenges related to the installation and change requests. The resources for these changes are not reserved in advance and a lack of resources leads to longer ramp-up periods. Resources should be planned and reserved for these changes, while the quantity depends on the complexity of the product. This measure has the positive effect that changes can be implemented faster and by the right people.

- **Provide flexibility for the adaption to the customer's business & changes**

Customers tend to buy changes and new functionalities of the installation during the ramp-up. They are not aware of all requirements and conditions that have to be fulfilled for their business at the start of the project, especially if they are not experienced. This requires more flexibility of the supplier to adapt to the customers' business and to reserve extra resources for these cases. Resource problems, the employee's load factor and the difficulties to control issues require an appropriate change management.[371] Moreover, a clear definition and separation between open issues and changes is necessary.[372] Flexibility and disposition for changes related to software and hardware are required since the project often has to be adapted to new order structures. It should be verified if the initial conditions are changing during the project and if necessary, they have to be adapted.[373] The vast benefit is that an appropriate change management during the ramp-up accelerates the process and leads to more profit. Additionally, an optimized change management reduces the ramp-up lead time, increases the delivery fidelity and leads to the stability of the ramp-up.[374]

The amount of changes is increasing during the ramp-up and requires special logistical conditions for an appropriate coordination with industry partners. These requirements are:[375]

- Fast technical changes
- Fast settlement processes
- Effective organization
- Coordination of changes in the Supply Chain
- IT-support
- Quality of documentation
- Changes must not interrupt the production process.

[371] Cf. Project manager KSI (2011), Interview.
[372] Cf. Consultant KSI (2011), Interview.
[373] Cf. Head of group logistic and material flow SPAR (2012), Interview.
[374] Cf. Wildemann (2011), p.141.
[375] Cf. Ibid., p.130.

Figure 57 presents the main causes for the increasing amount of changes during the ramp-up. These causes could be more variants, shorter development cycles, high degree on novelty, increasing importance of electronic, more functionalities and more time for modifications.

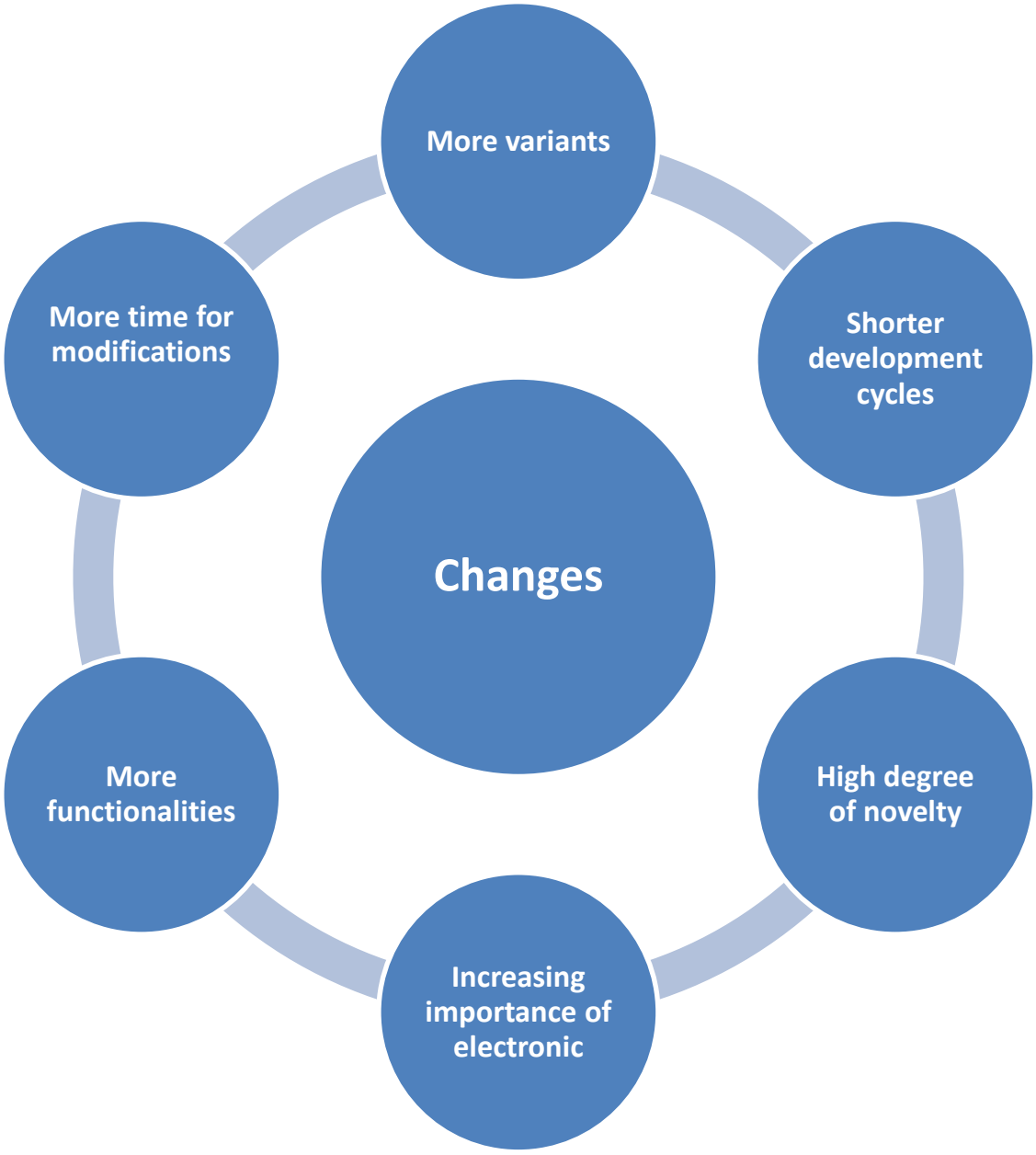

Figure 57: Causes of increasing amount of changes[376]

[376] Based on Wildemann (2011), p.130.

Change management

Figure 58 shows main advantages of an optimized change management related to the ramp-up, such as shorter lead time, increase of the delivery fidelity and higher stability of the ramp-up.[377]

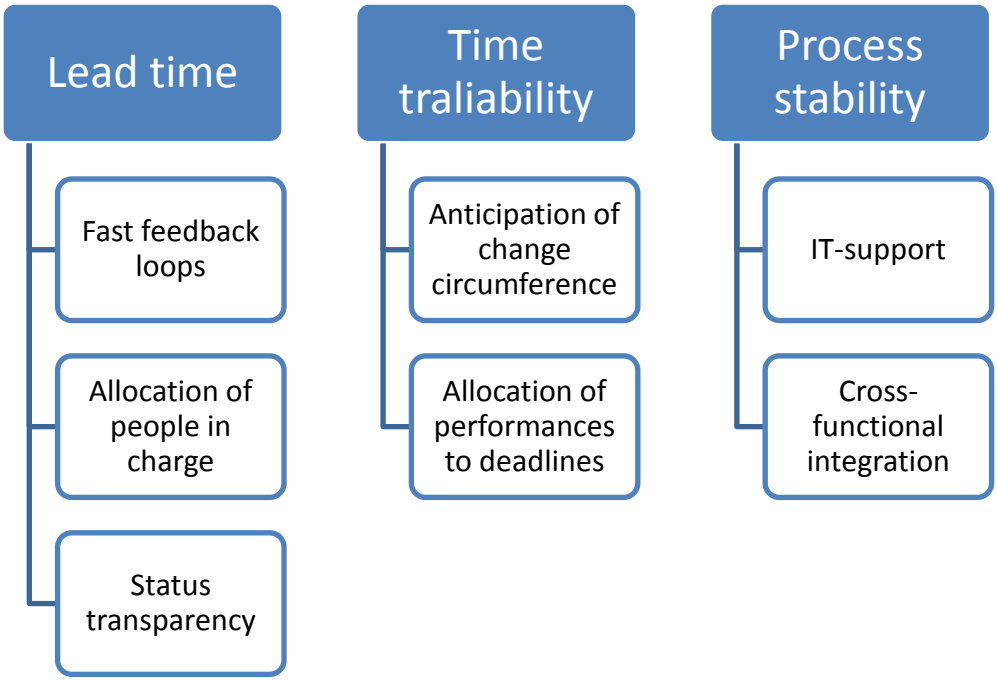

Figure 58: Positive effects of change management[378]

Options for a change management organization:[379]

- Change manager: single person that controls changes in departments
- Task force: decentralized team of change managers, central contact for change implementations
- Centralized change work (coordination): Centralized position for change implementation, distribution of tasks and control of change processes in departments, they take over just a small amount of tasks themselves
- Centralized change work (implementation): Centralized position, responsible for whole change implementation
- Permanent customer teams: Teams for customers that process all changes in addition to their daily business

[377] Cf. Wildemann (2011), p.141.
[378] Based on Wildemann (2011), p.141.
[379] Cf. Wildemann (2011), p.135-137.

Permanent customer teams lead to most advantages, but this is the option that is most difficult to implement. Change managers or task forces are generally the best solution for change management processes.[380]

5.1.12 Ramp-up analysis

The evaluation of the ramp-up is another important improvement of the ramp-up, where ramp-up data is documented, analyzed and evaluated. The analysis of the ramp-up is a recommendable improvement for future ramp-ups.[381] It delivers important information about the performance of the ramp-up and it helps to deduce conclusions and improvement measures.

- **Implement an automated tool to calculate ramp-up graphs (*)**

An automated tool to calculate ramp-up graphs serves to compare various installations and to evaluate the performance. It enables the definition of future ramp-up behaviors well as forecasts of possible performances and the duration of the ramp-up. The ramp-up graph shows the planned output over the time for the quantitative analysis of the production system.[382] The curve shows the development of the throughput and enables an analysis of the production system and the comparison with the ideal ramp-up curve.[383] An automated tool for all levels (leaders, managers, employees) to measure performance, quality and planning key figures should be implemented.[384] With this knowledge and further calculations, ramp-up curves of new installations can be estimated. Personnel and costs can be planned in a better way and the customer is prepared for the ramp-up duration. This measure requires the design of an appropriate tool and the collection of data related to ramp-ups of different installations.

- **Create external and internal key figures to measure the ramp-up**

Key figures serve to evaluate the project success in order to make decisions related to the ramp-up and to determine future measures. These figures evaluate company processes, situations and future events, and determine critical success indicators.[385] Currently, the ramp-up is not analyzed or evaluated in any way. Some project managers have their own key figures and values to evaluate the project and progress but there is no standardized evaluation of the ramp-up. In order to improve future ramp-ups it is necessary to dispose of this data and to compare ramp-ups in order to improve them. It is important to measure

[380] Cf. Wildemann (2011), p.13
[381] Cf. Project manager KAG (2011), Interview.
[382] Cf. Risse (2002), p.153.
[383] Cf. Nagel (2011), p.25.
[384] Cf. Consultant KSI (2011), Interview.
[385] Cf. Vollmuth (2006), p.7.

ramp-ups and distribute the information.[386] This requires the determination of appropriate key figures and the design of a key figure system. The positive effect will be transparent information about the ramp-up and the evaluation of the process in order to improve the performance of the employees, bottle neck identification, to reduce of open orders every day and lead-times and to control the process.[387]
No current standardized KPI's were established yet. The suggestion is to determine external and internal KPI's, related to the customer's and related to the supplier's performance.[388] The key figures should be available for all levels, for manager, customer and operator level, to distribute the right information to the right people. The most important KPI's are time, product and cost goal attainment. Additionally the progress degree of the ramp-up, the amount of changes and the amount of errors should be evaluated. KPI's such as resource commitment paid by the customer, amount of implemented solutions, time to solve an open issue and amount of retests after changes are descriptive for the ramp-up performance. Moreover, customer satisfaction, key figures related to user issues, the employee load factor and satisfaction are of importance. A constant documentation of these key figures leads to transparent information and an evaluation of the process.

- **Provide ramp-up data in the user interface (*)**

Ramp-up data should be available for the supplier and customer in a user interface. The customer should have an overview of ramp-up data that allows constant evaluation of the performance and the progress. This enables to react as fast as possible to problems or deviations of the planned performance. This measure requires the design of an appropriate tool and allows a transparent information flow during the ramp-up.

5.1.13 Knowledge management

The theoretical background of knowledge management is explained in the following paragraphs. First of all, knowledge is becoming more and more important because of three main factors:[389]

- Structural change (from work and capital intensive to information and knowledge intensive tasks): knowledge becomes a rare resource, information and knowledge markets are developed.
- Globalization (creates a different international division of labor): competition on a local and global level, faster international learning processes.

[386] Cf. Consultant KSI (2011), Interview.
[387] Cf. Ibid.
[388] Cf. Ibid.
[389] Cf. North (1998), p.14-15.

- Information and communication technologies (enable economical transactions and information transparency on a worldwide level): faster transactions and economical transaction costs.

Knowledge includes patents, processes, technologies, skills, experience of employees, information about clients, markets and suppliers of the company.[390]Knowledge and creativity lead to competitive advantages and counts as a significant production factor. Since the information content of products is increasing, knowledge becomes a product and the demand for intelligent (knowledge supporting) products is increasing.[391]

The knowledge transfer can be guaranteed by the implementation of cross functional and inter-temporary teams. The utilization of knowledge of past experiences is necessary for the ramp-up. Status reports, change requests and reports with early warning systems are some useful tools for the project implementation.[392]

Knowledge management is a type of management that tends to achieve the development of knowledge in order to apply it on products, processes or business fields.[393] Difficulties during the ramp-up and the ramp-up management often occur because of unplanned incidents and interruptions but also because of a lack of information and data; in sum, because of a lack of knowledge.[394]

The objectives of knowledge management are:[395]

- Knowledge supply
- Knowledge development
- Knowledge transfer
- Knowledge acquisition
- Further knowledge development

[390] Cf. North (1998), p.2.
[391] Cf. Wildemann (2011), p.348.
[392] Cf. Ibid., p.349-350.
[393] Cf. North (1998), p.3.
[394] Cf. Nagel (2011), p.40.
[395] Cf. Ibid., p.4.

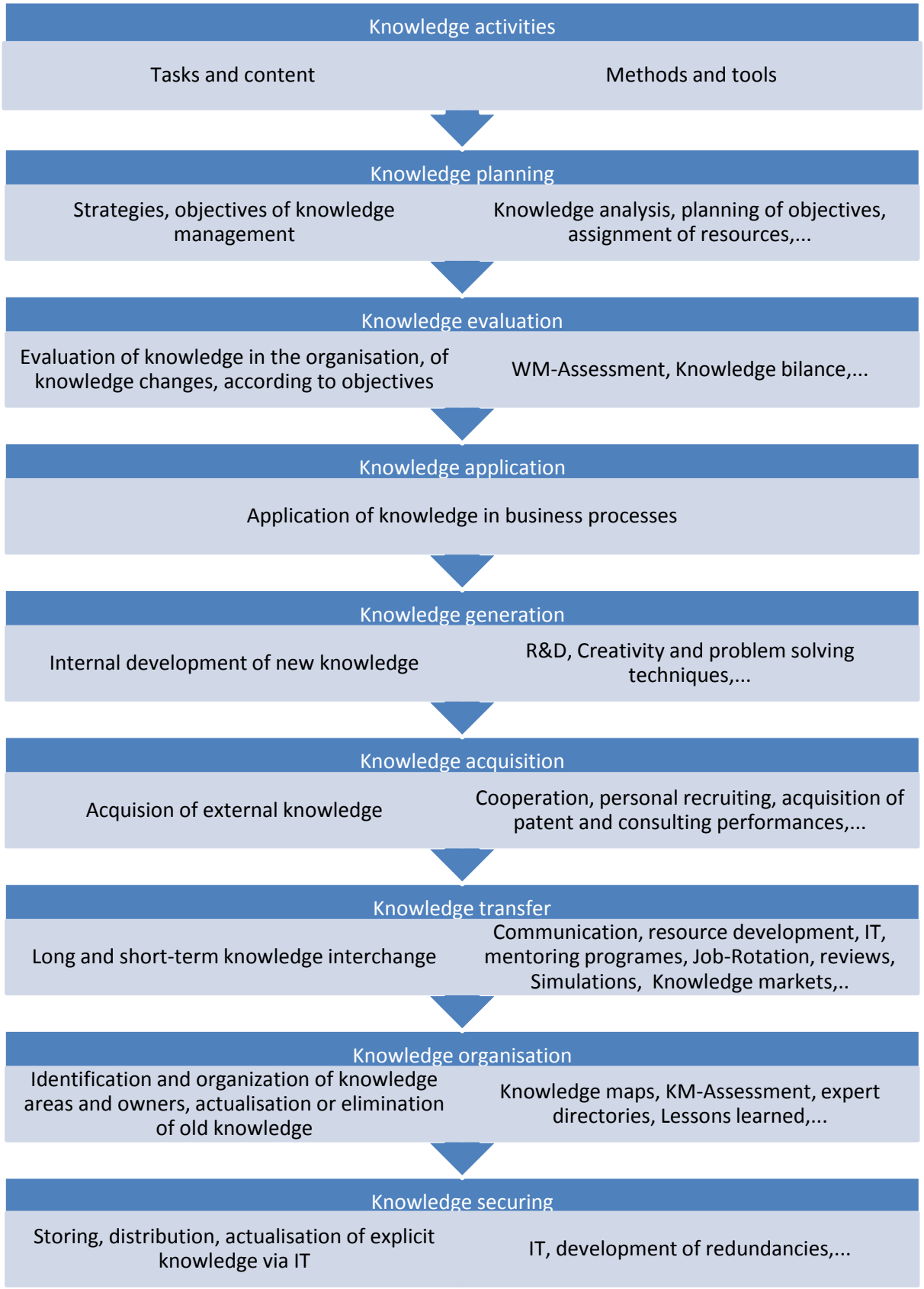

Figure 59: Knowledge management and tools[396]

[396]Based on Bauer et al. (2007), p.16, 149, 151.

Figure 59 shows the knowledge management with related tools that are needed at each step. The most useful tools that can be applied for the improvement of the ramp-up are described below in more detail.

- **Design a portal for the installation description (*)**

Documentations related to the components, functionalities and processes should be available for every installation. The measure of providing a portal that offers the description of installations, components, processes, etc. helps during the ramp-up and the preparation to deliver all required information in a fast way.[397] The advantages are faster information access and flow during the ramp-up phase by using e.g. the intranet. Apart from the intranet, collaboration technologies for knowledge management are helpful tools.[398]

- **Design a search engine or data base for experience exchange (*)**

Start-up engineers support or service employees are often challenged by similar problems that arise frequently and spend a great amount of time to find already existing solutions. A search engine would help to search for existing solutions for specific problems.[399] A search engine has the advantage that start-up engineers find solutions faster and this avoids a waste of time during ramp-up. Artificial intelligence tools like e.g. data-Mining, knowledge-Discovery in data base, expert systems, machine learning etc. are some of many available tools for knowledge management.[400] The design of a knowledge/ ramp-up data base for experience interchange, where important information related to the ramp-up of every project is found, as well as project review protocols, are examples for knowledge management. This data base should contain main problems and implemented solutions as well as other information from experienced employees related to the ramp-up. The effect of this solution is an appropriate knowledge management that will improve the performance of the ramp-up and will lead to satisfied customers.

- **Perform precise Lessons-Learned workshop (project reviews)**

The Lessons-Learned workshop includes the evaluation of the finished project in order to analyze past activities or experiences, to improve them and to apply solutions efficiently and effectively in future projects.[401] Project review should be carried out in form of Lessons-Learned workshops after every ramp-up where errors and solutions are discussed. The

[397] Cf. Consultant KSI (2011), Interview.
[398] Cf. Bauer et al (2007), p.180.
[399] Cf. Project manager KSI (2011), Interview.
[400] Cf. Bauer et al (2007), p.180.
[401] Cf. Ibid., p.155,157.

output of the project review should be a document with all lessons learned of the last project that can be improved in the future. The positive impact of this workshop on future projects leads to the elimination of errors and the same problems are avoided in future ramp-up projects.

Lessons-Learned workshop

The objectives of Lesson-Learned workshops are to analyze past events, to visualize the presence and to gain a look into the future by applying the following points:[402]

- Collect performance data to evaluate results
- Share experiences of every role during the whole process
- Eliminate damages on the team
- Visualize achieved objectives to motivate the team
- Gain knowledge about processes, procedures, leadership and the organizational culture that should be developed and implemented in the future
- Gain Organizational know-how about future tasks during projects
- Improve organizational ability to enable self-reflection
- Rootedness of results to transfer knowledge to future projects
- Resolution of the project team.

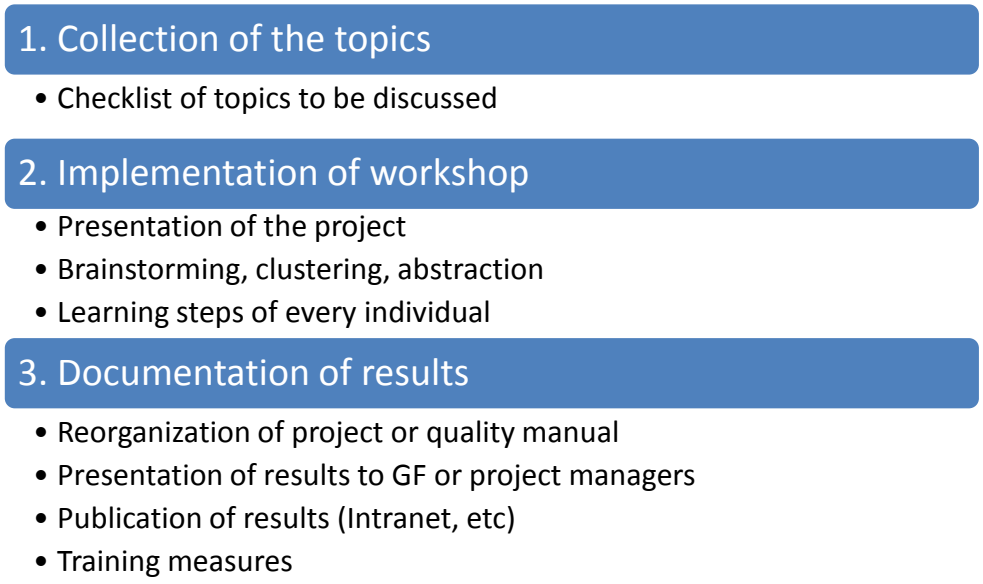

Figure 60: Procedure of Lessons-Learned workshop[403]

[402] Cf. Bauer et al. (2007), p.155,157.
[403] Based on Bauer et al. (2007), p.157, 159.

The procedure of the recommended Lessons-Learned workshop is carried out in three steps: Collection of topics, implementation of the workshop and documentation of the results. This procedure is presented in Figure 60:

The concept for a Lessons-Learned workshop for 30 people on one day includes the following questions that have to be solved during the workshop:[404]

- What was successful?
- What has to be improved?
- What should the improvement look like?
- What will I myself, as an employee, improve?
- What shall the organization improve?

- **Create an administration for project review reports**

At the end of the project there are project reviews where the project is discussed. In this review the problems during the project and ramp-up are discussed and reported. Due to a lack of time, only a few people from the original project team participate in this review. Therefore, the review and the administration of the document should be improved. A responsible review organization is required that collects review protocols and organizes them in order to distribute the information in the company.[405] This way information and knowledge of the ramp-up is distributed in the company.

- **Integrate the quality manager in reviews to improve processes**

Project reviews contain information about problems in finished projects, applied solutions, improvements and further steps. This information is useful to improve processes if the right people participate in these reviews. The Quality manager (QM) has an overview of all processes and detailed know-how of each process in the company and the responsibility to evaluate and improve processes that affect the ramp-up. Therefore the QM manager should be participating in project reviews in order to see what went wrong during the project, to evaluate and improve them.[406]

- **Guarantee the correct phase out of start-up engineers**

Start-up engineers are often phased out in an inappropriate way with the consequence that ramp-up relevant knowledge is not transferred.[407] The correct phase out of the start-up engineers is essential for the success of the ramp-like the transfer to the service department appropriately and in time.

[404] Cf. Bauer et al. (2007), p.157,159.
[405] Cf. Project manager KSI (2011), Interview.
[406] Cf. Ibid.
[407] Cf. Ibid.

- **Provide expert conversations and experience exchange**

Experience transfer serves to transfer knowledge according to decisions and actions to colleagues for individual competence and organizational learning ability.[408] An exchange of knowledge and experience of experts to new and inexperienced employees serves to transfer ramp-up relevant information internally in the company. In order to improve the performance of the supplier during the ramp-up it is necessary to teach young and inexperienced employees the most important tasks in this phase and how to quickly implement the ramp-up. This could be carried out in the form of expert conversations, e.g. with the TPL. The TPL has experience and should share this knowledge.[409]

Expert workshops and documents

The transfer of experience know-how is carried out by two methods that are described above and shown in Figure 61:[410]

1) Codification: sharing the explicit part of the experience with documentation (Experience reports, etc.) or
2) Personification: experience transfer carried out through direct contact in a more efficient way (Project data base, Expert data base, etc.).

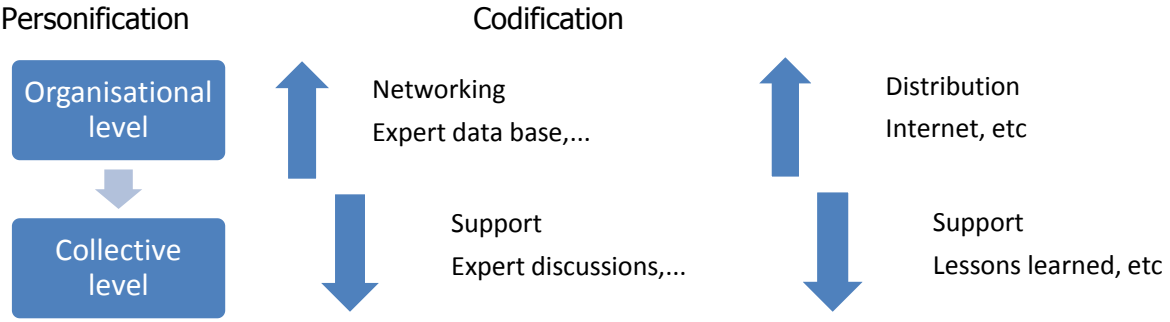

Figure 61: Experience knowledge transfer[411]

In order to transfer the knowledge of the ramp-up to new employees, codification and personification methods are recommendable. Experience reports should be maintained in an experience knowledge data base and expert discussions should be implemented to improve the ramp-up and avoid problems in the future.

[408] Cf. Bauer et al. (2007), p.151.
[409] Cf. Area manager KSI (2011), Interview.
[410] Cf. Ibid.
[411] Based on Bauer et al. (2007), p.150.

5.2 Ramp-up improvements – Soft factors

The ramp-up success depends, besides the hard factors, also on the soft factors like cultural, language and communication issues. This chapter demonstrates the main soft factors that were discovered as essential during the ramp-up and suggestions for improvement.

5.2.1 Intercultural issues

Spatial distance is not such a great issue anymore, but cultural distance remains.[412] This fact requires training sessions about intercultural competence before the ramp-up where supplier and customer are working together closely. There might also be local agencies participating during this process and so intercultural competence is required for solving problem between people with various cultural backgrounds. The evaluation of the ramp-ups and expert interviews led to the result that the following points should be carried out:

- **Inform staff about foreign cultures (folders, Intranet & crash courses) (*)**

Customers are usually from a foreign country and of another culture. This fact makes an appropriate preparation for cultural issues useful.[413] Cultural issues and a lack of preparation related to these soft factors lead to problems during the project implementation, e.g. to communication and cooperation problems with the customer. In foreign countries other ways of communication may exist and therefore the supplier's employees have to adapt to the different way of working and thinking and should know how to behave and to be dressed, for instance.[414] Moreover it is necessary to know whom to contact in countries with a hierarchic system in their companies.[415] This fact requires the formation of employees with intercultural competence. Intercultural competence is defined as the knowledge of how to interact with people of other cultures in certain situations and the ability to apply this knowledge.[416] Measures have to be determined to eliminate intercultural problems, such as intercultural competence training sessions about mentality, rules of behavior, working behavior, etc. of the foreign culture for start-up engineers, TPLs and PMAs.[417] Crash courses about foreign cultures, especially for Russia and China, avoid intercultural problems.[418] A folder of the foreign culture for the on-site team helps to extend the knowledge of how to cooperate and of how to treat the customer to finish the project as fast as possible. Information about foreign cultures available in the Intranet is another measure that makes knowledge easily accessible to the employees in order to guarantee a good communication

[412] Cf. Hirt/ Schneider (2007), p.5-6.
[413] Cf. Head of department of WMS & WCS KSI (2012), Interview.
[414] Cf. Project manager KSI (2011), Interview.
[415] Cf. Ibid.
[416] Cf. Hirt/ Schneider (2007), p.137.
[417] Cf. Head of department of WMS & WCS KSI (2012), Interview.
[418] Cf. Consultant KSI (2011), Interview.

and cooperation process with the client. The knowledge can also be transmitted by colleagues: The PMA is responsible to train the team for intercultural issues.[419] These measures have benefits on the soft factors of the employees that enable a frictionless ramp-up and cooperation with the customer. Nevertheless there are still other approaches, e.g. employees talk about the culture and an on-site folder with relevant information exist. Therefore, extra workshops are not really necessary.[420]

Intercultural competence training sessions

The term intercultural competence refers to the interpersonal aspect, the relation and processes between two people of different cultures in order to reconcile differences. This competence consists of emotional, cognitive and conative competence. The first competence, the emotional competence, refers to the knowledge about the own and foreign culture such as their values, empathy, opinions and the like. The cognitive competence describes the knowledge about other cultures and the possession of language skills and the third competence, the conative competence, refers to abilities, skills, behavior, etc. of a person.[421]

Figure 62 shows specific competences that employees should possess to deal with cultural issues on-site. The competence training program should be focused on sociable, flexibility of behavior, impartiality, objective orientation, empathy and ambiguity tolerance factors.

[419] Cf. Project manager KSI (2011), Interview.
[420] Cf. Ibid.
[421] Cf. Hirt/ Schneider (2007), p.44, 137.

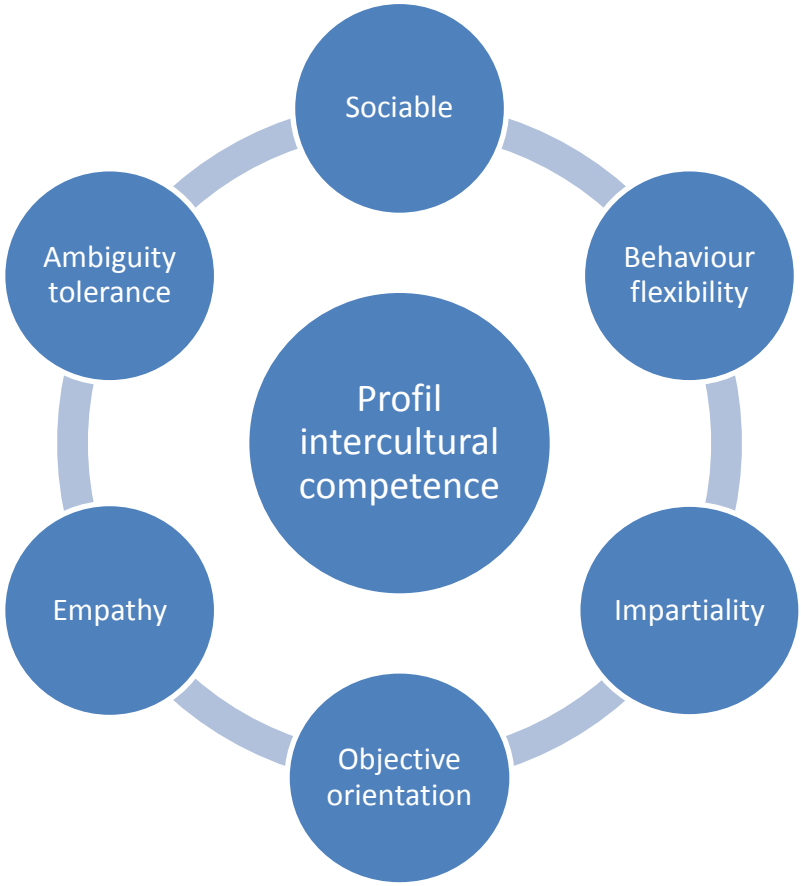

Figure 62: Profile of intercultural competence[422]

Ambiguity tolerance is the ability to handle ambiguous or unsafe situations. Sociable refers to the wish and the behavior to communicate with others. Behavior flexibility is the ability to adapt the own behavior to new situations and to learn new ones. Impartiality is the tolerance according to divergent values and norm morality of other cultures and to respect them. Objective orientation means to set high and realistic objectives, even if failures occur - the focus is still on the success. Empathy refers to the ability to familiarize oneself with others and to contact others in a sensitive way in order to understand their intentions, thoughts and feelings.[423]

There exist two main methods of how to acquire intercultural competence:[424]

1) Intercultural learning (individual process, characterized by experiences concerning social and cultural differences and comparison with other cultures)
2) Intercultural training (specific content and methods taught by a trainer) in order to get explicit intercultural knowledge and intercultural experience.

[422] Based on Hirt/ Schneider (2007), p.150.
[423] Cf. Hirt/ Schneider (2007), p.151-152.
[424] Cf. Ibid. p.171-172.

Intercultural learning can be considered as a very useful method in order to get knowledge about the foreign culture and to prepare employees for the ramp-up on-site.
Intercultural competence training programs serves to adapt the employees to the culture abroad and gives them the ability to understand certain behaviors of people from the foreign culture. A good understanding of the cultural issues can be an advantage during this cooperation between customer and supplier, but beyond that, knowledge about the way how to use and apply it in specific situations makes an enormous difference between good and bad ramp-up projects.

- **Present the Austrian culture to the customer (workshops or folders)**

Many customers are uninformed about the supplier and the Austrian culture, especially when it comes to business matters. This leads to complications and misunderstandings which increase the tension on-site of all people involved and influence the ramp-up in a negative way. These business matters are mostly related to team sizes, decisiveness, punctuality, hierarchy and others. Customers that prepared themselves before the ramp-up for cultural issues showed a different performance during the cooperation, since they adjusted themselves to the Austrian culture and way of working. This leads to the conclusion that workshops or meetings with the customer should be implemented to present the Austrian way of working. Moreover folders with information about the Austrian culture could be provided to prepare the customer. These measures lead to an efficient cooperation with the customer and to a satisfied ramp-up team.

- **Collect intercultural experiences and create a guideline (*)**

The collection of information according to intercultural issues by collecting intercultural experiences, problems and solutions for the ramp-up team is one way to create intercultural knowledge. Workshops, books or a collection of experiences increase intercultural knowledge.[425] An intercultural guideline that explains how to deal with intercultural issues, what is important, how to finish the project when intercultural challenges appear.[426] The advantages are that employees with intercultural education are able to cooperate appropriately with the customer and local agencies during the ramp-up.

- **Provide intercultural teams**

The international connection of companies, changes in the working environment, the importance of communication technologies and the contact with employees from foreign countries lead to the demand for multicultural teams. These teams consist of people from

[425] Cf. Consultant KSI (2011), Interview.
[426] Cf. Ibid.

different origin concerning nationality, language, religion and ethnic background. This leads to the fact that the actual situation during a project is interpreted differently from people of different countries. Three or more people from different nationalities and cultures are integrated in this team. It is important to consider the development steps after starting the group.[427]

- **Offer language courses for ramp-up team members**

Intercultural issues during the project and language problems could have an impact the project if the customer has no experience in ramp-ups.[428] Language issues can lead to large misunderstandings between the supplier and customer and the consequences are complications during the ramp-up and delays because certain issues cannot be solved. Improvements related to the language aspect are to offer language courses for start-up engineers, TPL and PMA, e.g. courses for the languages Spanish and English. Language courses are not only required to communicate with the customer, but also to improve the relationship management with the customer.[429].Language courses and the immediate application of the language are required.[430] So the language course should be available before or/ and during the project so that the skills can be applied immediately. For those employees that are not available regularly it is recommendable to join courses over the internet. The advantage of language courses over the internet is also the personalization for the needs of every single participant.

- **Employ technical interpreters/ local interpreters for trainings & workshops**

Language problems are solved by interpreters with technical knowledge that are trained and employed.[431] Translation agencies with technical knowledge improve the communication and language problems.[432] External interpreters with technical knowledge could also be employed for workshops and training sessions. The cooperation with local interpreter agencies with technical know-how in foreign countries keeps the costs low, but appropriate cooperation and training sessions for these interpreters is required.

5.2.2Relation with local agencies

The establishments of Knapp are trained for the sales process. They are responsible for the customer contact and communication. Improvements according to their tasks and responsibilities are summed-up as follows:

[427] Cf. Hirt/ Schneider (2007), p.275-276.
[428] Cf. Head of department of automatisation egnineering Salomon (2011), Interview.
[429] Cf. Project manager KAG (2011), Interview.
[430] Cf. Ibid.
[431] Cf. Head of department of automatisation egnineering Salomon (2011), Interview.
[432] Cf. Project manager KAG (2011), Interview.

- **Design decision portfolios for the sales process of local agencies**

Local agencies are responsible for the contact with the customer and for selling the product, but the problem is that they do not understand the complexity of the product and tend to sell functionalities and performances that are not possible to achieve.[433] Local agencies have to understand the product complexity and decision portfolios for the sales process help to improve the sales process. The development of the decision portfolio and an appropriate incentive system for local agencies are required in order to avoid these challenges during the ramp-up phase. Participating in the sales phase of local agencies is likewise an option to avoid that functionalities and performances, that are not realistic, are sold.

- **Create role definitions and clear guidelines for local agencies**

The role and tasks of local agencies are not yet specified clearly.[434] It is required to clearly understand the role of local agencies during the ramp-up in order to guarantee a successful cooperation. Role definitions should be determined.[435] All participants have to understand their tasks, does and don'ts, so that the interaction is appropriate. Generally there exists no guideline for local agencies.[436] The cooperation can be improved if people on-site get to know each other and clear role definitions exist during the cooperation with local agencies.[437]

- **Cooperate with local agencies (common appearance, strategies & targets)**

The cooperation with local agencies influences the ramp-up in issues related to punctuality and reliability, but they also possess experience and they understand the customer a bit better.[438] Currently the cooperation and coordination of Knapp Austria with local agencies has potential to be improved.[439] A lack of communication and coordination leads to inefficiencies during the ramp-up phase. This can be avoided if the supplier is aware of and understands the cultural differences and adapts the employees to the foreign culture and different regulations.[440] Meetings and personal contact with representatives of local agencies enable a better relationship with them. Common appearance of Knapp Austria and local agencies would improve the cooperation.[441] It is elementary that Knapp works together with them internally since the customer notices that Knapp Austria and local agencies are acting like separated companies. Local agencies tend to make problems by changing configurations

[433] Cf. Project manager KSI (2011), Interview.
[434] Cf. Consultant KSI (2011), Interview.
[435] Cf. Head of department WMS & WCS KSI (2011), Interview.
[436] Cf. Project manager KSI (2011), Interview.
[437] Cf. Group Manager Software Engineering KSI (2012), Interview.
[438] Cf. Head of department of automatisation engineering Salomon (2011), Interview.
[439] Cf. Project manager KSI (2011), Interview.
[440] Cf. Project manager KAG (2011), Interview.
[441] Cf. Head of department of WMS & WCS KSI (2012), Interview.

without getting the permission, but generally they are helpful during the ramp-up if they do not cross certain limits.[442] Common strategies and targets for the ramp-up have to be defined together so that it is clear that the companies are working together and have the same goals and targets. Constant exchange of information about the project status and the chronogram are required to further improve the communication process between Knapp Austria and the local agencies.

The harmonization of objectives has to be managed during the cooperation. Common objectives of the cooperation are determined, which delivers the demand for the companies' obligations so that the partners gain advantages. This cooperation can be reached, for instance, by following basic elements such as contract and confidence, rules of behavior & organizational structure, an appropriate remuneration system, constant improvements, development and finally long-term relationships.[443]

- **Qualify local agencies for the implementation of own projects and services**

It is necessary to qualify and train local agencies so that they are able to implement their own ramp-up projects and the related service, long-time support and maintenance. A project team should be developed at local agencies and the employees have to be trained and certificated.[444] The ramp-up can be carried out by local agencies, but before that the quality of the support has to be improved.[445] This measure increases the cooperation with local agencies and independency and makes it possible to improve quality of the support and service from local agencies during the ramp-up.

5.2.3Communication strategy

Relationship management is an important part during any cooperation that requires appropriate communication and relationship with the customer as well as to ensure the customer that long-term solutions for their problems will be found by the supplier. In strong relationships customers are more tolerant concerning errors.[446]The following statement is also confirmed by customers: It is a success factor if the employees have social and technical knowledge.[447]

- **Create a communication plan**

A communication plan has to be defined before the ramp-up in order to determine the frequency and date of meetings, to guarantee a fluent information flow and transparency

[442] Cf. Group manager software engineering KSI (2012), Interview.
[443] Cf. Edler-Pain/ Garbisch (2004), p.105.
[444] Cf. Consultant KSI (2011), Interview.
[445] Cf. Head of department of WMS & WCS KSI (2012), Interview.
[446] Cf. Edler-Pain/ Garbisch (2004), p.105-106.
[447] Cf. Head of group logistic and material flow SPAR (2012), Interview.

related to problems and solutions. The communication plan has to be determined to define how often a meeting is carried out as well as the team and time.[448] It is important to talk frequently, to have meetings and reviews in order to search for solutions for existing problems.[449] Daily internal meetings are necessary to discuss the requirements for every day.[450] During the support and ramp-up phase weekly internal meetings are sufficient to discuss and delegate tasks. Weekly external meetings with the customer are recommendable during the start-up and daily meetings after the go-live to discuss and solve important issues. During the ramp-up a meeting should be carried out every day, not only internally but also with the client.[451] Daily or weekly meetings with partners of the local agencies are just applied if required. There should be frequent reviews that verify if an adaption on new structures is required.[452] Meetings between TPL and PMA from Knapp and PMA's and logistic engineers of the customer are required for a good communication strategy.[453] This can be carried out once a week. The content of the meetings have to be clear, topics related to problems, their causes, consequences and solutions as well as project status, priorities and further steps have to be discussed in the mentioned meetings. Open issues should also be noted and delegated in meetings.[454] Tests, updates and stop times and other relevant information have to be communicated in advance, e.g. in meetings, so that the customer is not interrupted during the production and also to enable a good cooperation.

- **Perform workshops or meetings to determine common rules of behavior**

The identification of problems and the elimination of misunderstandings are necessary to guarantee a harmonic relationship with the partners; one solution could be to define common rules of behavior concerning activities, priorities, punctuality, mutual interests, decisions, constant improvement and the like.[455] Since the cooperation between the customer and Knapp is often marked by problems, the objectives and rules of behavior have to be defined. The definition of such rules for supplier and customer will lead to an improvement for the ramp-up phase, because it brings more transparency into the target and strategies of every association involved. A workshop or meeting can be used to determine and implement these rules. The measure avoids complications with the customer in advance and adds value to the project, but it is just implementable in certain situations.

[448] Cf. Head of department of WMS & WCS KSI (2012), Interview.
[449] Cf. Project manager KSI (2011), Interview.
[450] Cf. Consultant KSI (2011), Interview.
[451] Cf. Project manager KAG (2011), Interview.
[452] Cf. Head of group logistic and material flow SPAR (2012), Interview.
[453] Cf. Head of department WMS & WCS KSI (2011), Interview.
[454] Cf. Project manager KAG (2011), Interview.
[455] Cf. Edler-Pain/ Garbisch (2004), p.112-113.

6 Application

The suggestions made by observation of ramp-ups and collected by expert interviews, inside and outside the company as well as during customer interviews were evaluated in the company Knapp. The evaluation of each point related to feasibility, importance and existence leads to the result of a ramp-up checklist that is available in the attachment. This checklist was applied on a ramp-up in France in order to verify if the measures are applicable and they have the desired effect. The project and results after the application are described in this chapter.

6.1 Description

The installation in France consists of the systems order start (OST), OSR and OSR workstations, sorter and injection points, checking stations after the sorter, label applicator of the shipping label and expedition ramp in the dispatch area as shown in Figure 63.

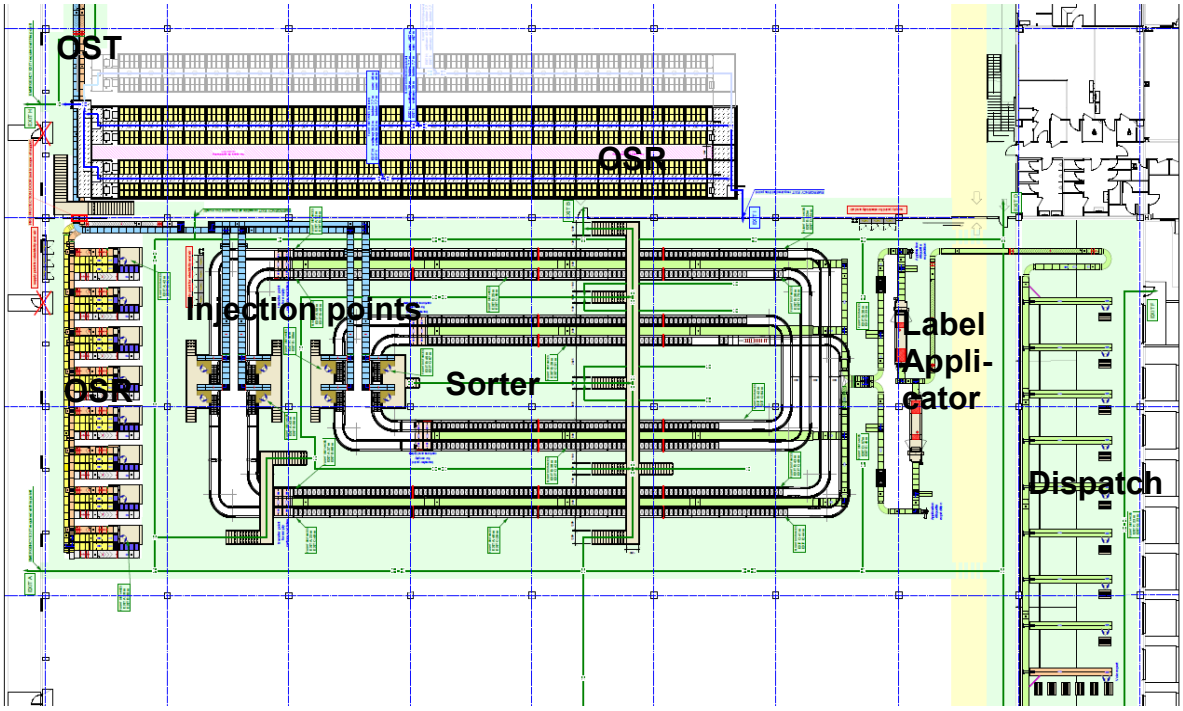

Figure 63: Installation in France[456]

6.2 Results

The application of the checklist, analysis and evaluation of the ramp-up on the project in France leads to the observation that the application of some of the new improvement measures are very time and resource intense and can only be applied if certain conditions

[456]Based on KSI (2011).

are fulfilled. The practical application also showed that certain measures are just useful for specific customers and cannot be generalized for every project. As a summary, the checklist is useful and has the advantage that it contains all ramp-up relevant factors that have to be considered. This overview of all important factors in one document serves as a good guideline for the ramp-up, but the implementation of the measures depends on the project, the customer and the resources that are available.

Sales phase

During the sales phase there was no consultant provided to the customer and the operation of the installation was not required. Easy functionalities were provided, but it was not feasible to have the TPL present in the sales phase.

Planning and specification phase

During the planning and specification phase the customer was integrated into the design process so that the final functionalities corresponded to the customer demand. Graphics were designed to visualize processes in the specifications, but procedures at working stations as well as error handling were shown graphically. This point was not considered earlier, but would have brought advantages for the description of the working stations in training documents and the preparation of the user manual. The risk analysis that was carried out before the project did not include the ramp-up phase, but after the practical implementation the conclusion is that this measure did not directly bring any advantages for the ramp-up. The systems (WMS, WCS, etc.) were explained in the planning and specification phase, but the customer was not trained yet until this moment. The basic training of the system WCS would have brought the advantage that during the customer acceptance tests the customer would were prepared in a better way. On the other hand, the information is forgotten faster if it is not repeated before the tests. Reference visits were carried out with the customer for the preparation of workstations and other functionalities. The scope of supply was extended with further points (network, etc.) that were offered, but only some of these were required by the customer. Close cooperation with the customer and the exchange of data related to the customer's business also worked successfully and was very useful for the planning and specification phase. The developer was not integrated in the specification phase since this measure was not feasible.

Resource planning

For appropriate resource planning extra developer resources were planned since the project in France is considered as a complex one. The problems were the availability of the developer and priorities of the demand for development that led to delays and harmed the customer satisfaction. Instead of an on-site manager the start-up engineer leader was responsible for the ramp-up management and documentation in addition to these normal tasks. Additionally an on-site manager for technical issues was provided by Knapp France

(KFR). An experienced ramp-up manager was available in the form of a start-up engineer with ramp-up experience but he did not perform the role of a consultant. A steady ramp-up team was provided (start-up engineers, TPL, PMA, technicians and maintenance team), whereby the maintenance team of Knapp France did not consist of a steady team since people were on holiday at the beginning of the ramp-up and could not participate in training sessions. This meant that important knowledge could not be passed from the PLC technician of KSI to those of KFR. Support for tall systems (PLC, WCS, SRC, electricians, technicians and maintenance team) was provided during the ramp-up. The calculation of resourced with probability calculations was not yet available.

Software development phase

During the software development phase new developments were reduced and the focus was always on the main functionalities. The development status was verified in small periods (3-4 weeks), but without burn-down graphs. The software was user friendly even though certain columns and dialogues could were still hidden in order to provide only the most important information. The customer was integrated into the internal test and development phase so that the functionalities corresponded to customer demands.

Internal acceptance phase

During the internal acceptance phase the software functionality was tested with a test group and test cases. The test list was not written by an expert so that some test cases were added during the test phase, but the internal acceptance was carried out with an experienced start-up engineer. The internal acceptance was not completely finished because of lack of time, but the main parts were tested to guarantee their functionalities. The test results were documented with internal acceptance protocols. Simulations were partly applied on the internal test system and tested. Test constructions and prototypes were not available at this project.

Ramp-up preparation

For ramp-up preparation descriptions and error handling for workstations were designed and small job specifications (description of workspaces and skills) were added to guarantee that people with appropriate skills were employed. This measure enabled an easy training program and appropriate documentation of working steps for the user handling. The design of the working steps should be clear and easy to understand with screenshots and procedures. Furthermore operator descriptions and error handling was designed with little text but many screenshots and pictures for easier understanding for non-native speakers. Since these operators were not used to working with the descriptions and documents, they were still asking the supervisor or Knapp's start-up engineers if working steps were unclear or errors occurred. This led to the conclusion that the general procedures and screens are sufficient for descriptions for supervisors and very effective, but that a customer (at least in

Europe) should design further operator instructions for non-native speakers himself. The customer knows his personnel better and can therefore transfer the knowledge appropriately in his own documentation. Defined processes and responsibilities for the ramp-up phase were determined and clear on-site. Verification was done in order to ensure that the customer fulfilled all conditions of the contract before the go-live of the installation. The ramp-up plan was not designed in cooperation with the customer, since the customer was not able to design ramp-up curves and plans yet at that time. Later on, some target values were transmitted to Knapp.

Training programs

Training improvements were applied, such as an organized training program with a determined training schedule. Since there was only one supervisor present during the ramp-up, there was not enough time for him to manage organizational and operational tasks. The exact training schedule was defined during the ramp-up due to the time constraints of the customer one main supervisor could not be trained appropriately. This might have effects on the user handling of this supervisor during the ramp-up. The training sessions were carried out before the go-live for key players and during the go-live for operators and supervisor for the practical training of workstations. Appropriate training documents were delivered on time, training sessions for the customer's logistic engineers were carried out successfully in small groups including descriptions of each system as well as dialogues, reports, processes and functionalities in a cross-product and process oriented way. Practical training sessions were applied, but for the supervision and corrective training there was no real demand for start-up engineers; this task was carried out by key players. Likewise error handling was trained by simulating errors, and an evaluation in the form of a test with control questions were carried out for OSR workstations and WCS. The participants received a certificate after the training session when the evaluations were successful. This leads to more concentration during the training sessions and to discussions of uncertainties as well as the resolution of the questions to guarantee that the matter was understood clearly. Trainers were also evaluated internally by the participants and externally by colleagues of KFR so that the trainer had feedback of their performance during the training session in order to improve their training accomplishment. The trainer completed rhetoric courses so that the quality of the training sessions was improved. Since the key players were integrated into the internal test phase the operators were partly trained by them and so the training expenses were kept lower for Knapp.

Documentation

The start-up engineer leader was informed before the ramp-up about which reports are used during the start-up and ramp-up and what appropriate reports look like. If more people need to be informed about this topic a meeting should be carried out, but in this case it was not

required for only one person. A troubleshooting document was not created during the ramp-up since not all elementary information was documented in the workstation descriptions and error handling documentation. For future more detailed definitions of what this document should look like and what kind of information should be given. If the workstation descriptions and user manual are sufficient then it has to be discussed if this document is really required. Besides important issues and problems were noted in some kind of a project diary for personal use in order to note the most important issues that have to be discussed in the project review, but no official document was designed. Open issues were noted on an internal Excel sheet with graphical analysis of the issues and as well delegated via an automated software tool. There was no customer portal or external open issue list available for the documentation of customer issues since it was not required during this project. For the documentation a user manual that contained clear descriptions of working steps and detailed error handling was provided. A technical editor was furthermore integrated into the design of the user manual so that a standardized document was created.

Start-up

The start-up was characterized by test cases with customer data and material. Performance tests will be applied one year after the go-live before the final acceptance of the customer. Tests were carried out in cooperation with the customer during the customer acceptance phase. At first, internal tests had been implemented where errors and bugs of the software were eliminated, but due to time pressure they were not completed. A part of the system, the sorter, was not tested appropriately in the start-up phase even though the system and its functionalities did not show correct behavior. Since the start-up included parallel customer tests of already working stations, the start-up engineers were under high pressure. Since many functionalities were still missing and bugs of the software were detected, the customer was unsatisfied since he wanted to have the system perfectly working during his test phase. In the end, internal tests were completed by the customer during the user acceptance phase (customer integrated in test phase). This leads to the conclusion that parallel testing to the customer in order to shorten the start-up and ramp-up period is possible, but under the condition that one workstation is tested after another and that enough resources are present to support the customer and to implement internal tests. Furthermore the customer has to be conscious that "tests" mean that errors could still arise or bugs, but these are eliminated in this phase. The advantage was that the key players of the customer were well trained for the system during the integrated testing phase which had positive effects on the ramp-up. Acceptance gates were implemented for technical parts of the installation and for the software acceptance there was a checklist of test cases available where the customer confirmed that the specific functionalities were working. In this project more time was spent

on the start-up than on the ramp-up support. This enabled most of the errors and bugs to be eliminated before the go-live in to ensure that the installation was working appropriately.

Support

The support during the ramp-up included the presence of start-up engineers for a period of two weeks after the go-live. Since the production volume was very low after the go-live because of problems of the customer with the WMS, the support should were planned for a later phase of the ramp-up. Long time support was offered, but not sold to the customer. A maintenance team of KFR is present and stays for two years. Extra support of the TPL and developer was planned and carried out. Remote support during the start-up and ramp-up were required and carried out appropriately. The customer was involved in the elimination of errors when they appeared. The checklist of open points was completed after the departure of the start-up engineers.

Service

The service department should were integrated early in the project by being on-site during the ramp-up due to the complexity of the product, but this point was finally not implemented. The transfer of know-how to the service department was carried out by explaining the layout, processes and the system design. Furthermore the service department was involved in error elimination during the ramp-up. There were no resources reserved for changes due to the lack of resources. Flexibility to adapt to the customer's business is available.

Ramp-up analysis

The analysis of the ramp-up was carried out by calculations described in this thesis (see chapter 2.3). Ramp-up performance related to various levels and areas was calculated in the BSC and collected in a performance sheet where the increase of the output was graphically shown. There was no automated tool available for these calculations and the ramp-up data was not provided to the customer. The data was shared internally and compared with other projects in order to draw conclusions about the performance of the product and ramp-up.

Knowledge management

A portal for the description of the installation was available in the internal intranet (sharepoint) for appropriate knowledge management. Search engines or review administrations were not available. Furthermore lessons-learned workshops were carried out in the form of project reviews. The quality manager was present in the project review in order to improve internal processes if required. Start-up engineers were phased out appropriately by transferring knowledge to the TPL and service department. Expert conversations and experience interchange were carried out with the TPL or other experts before the ramp-up and when problems arose.

Intercultural and language issues

Intercultural issues were avoided since the TPL was of the same culture as the customer and start-up engineers cared for information about this topic by themselves about the foreign cultures and cultural issues. The customer was not informed about the Austrian culture. An intercultural "team" was available since the TPL was a French citizen and start-up engineers with intercultural skills were on-site. Furthermore intercultural issues were documented for the project review. French courses were completed by start-up engineers over the internet before and during the start-up and ramp-up in order to solve language issues and guarantee an appropriate cooperation with the customer. The fact that the TPL was a French citizen enabled the communication and cooperation process with the key players and PMA's. Interpreters of Knapp AG were available for training sessions which assured the quality of the training sessions. The fact that, besides the on-site manager there was just one start-up engineer present with English and French skills lead to further pressure on start-up engineers since they were responsible for constant translation and delegation of any issues during the ramp-up in addition to their normal tasks. This should be considered in advance so that enough time and resources are provided to enable that this does not affect the daily business of these employees.

Relation with local agencies

Local agencies understood the product complexity for the sales process since it was sold by an employee with work experience at KSI. There is no decision portfolio for KFR. The cooperation with local agencies was characterized by knowledge about roles as well as by cooperation and appropriate coordination during the project. Comprehension for the behavior of local agencies was observed during the cooperation and constant contact with them was maintained. The common appearance with local agencies as a team could still be improved, but it was not required to determine common strategies for the ramp-up in this project. Exchange of information and open issues were carried out daily without the requirement of extra meetings. Local agencies offered long term support of a maintenance team and are qualified in hardware issues and have knowledge about workstations. Still, KFR is not able to implement its own projects.

Communication strategy

The communication strategy did not include defined communication plans. The information exchange worked in this project without defining specific meetings. Since the project was small it was possible to contact people directly without organizing meetings, even though it was exhausting to get the information on a daily basis from the customer and other people involved. Generally all responsible people on-site were constantly sharing information and problems as well as open issues. In summary, daily meetings with the customer to close open issues and to talk about further steps and the production progress would were useful

but was not always necessary in this project since the customer was not able to carry out such meetings frequently. Internally there was constant contact with the TPL and experts at KSI and Knapp AG if problems arose. The contact with the PMA was rare (approximately once a week). On-site responsibilities were also determined and communicated. Common strategies and rules of behavior were not defined due to lack of time.

7 Conclusion

The ramp-up becomes a fast and stable process by implementing the improvement strategies and concept mentioned in chapter 5 and summarized in the ramp-up checklist. What measure is applied exactly and how the implementation is carried out depends on the project and customer.

According to literature, the start-up and ramp-up contain training programs of staff, integration tests and successive ramp-up. Furthermore the transfer to normal operation includes support on-site, process optimization and permanent project controlling.

The ramp-up can be analyzed by determining the gap between deliveries and customer demand, by analyzing the open issues list, by carrying out expert interviews, by applying the SWOT Analysis and Fishbone analysis, by calculating the ramp-up graph and variance analysis. The evaluation of the ramp-up is carried out by calculating key indicators of the Balanced Scorecard and by carrying out Benchmarking.

Key indicators that should be used to measure the ramp-up performance are time goal attainment, product goal attainment (output), demand attainment; complain rate (justified) and customer satisfaction of progress and cooperation as well as user issues are related to the customer area. Key figures related to results are ramp-up progress, time goal attainment of support, resource commitment by customer, cost goal attainment and further unplanned resource commitment (paid). The area of integration includes the measurement of change cost attainment, amount of errors, amount of implemented solutions, reaction time (flexibility) and amount of retests after changes. The area of employees (ramp-up team) includes key figures related to the employee satisfaction with the progress and cooperation as well as the employee's load factor.

The success factors and challenges that identify experts during ramp-ups are categorized according to five areas, related to the customer, supplier, product process and soft factors. The top success factors of the customer are an organized customer, a prepared customer (who knows what he wants and gets), the qualification of employees, trained operators, cooperative customer and customer processes as specified. A supplier should be preparing himself for the use of the installation, planning the right resources on time, providing a steady team (also for changes), having clear responsibilities, providing appropriate know-how of employees, understanding the customer's business and being prepared for

contingencies. The product should include finished and perfectly tested software, high quality of the product and no open points or issues. Process related success factors are small and transparent projects of low complexity, clear defined project plans and processes (realistically planned), know-how of project manager and claims on time, preparation for tests (customer tests, tests with customer), clear test schedule, employees focused on a specific date (pressure), low external influences, customer demand is fulfilled and no interface problems arose. Soft factors are communication strategy and skills, intercultural knowledge and skills, internal knowledge management and experience exchange, personality and motivation of employees, decisions of the business administration, openness and cooperation to solve problems together with the partners.

The main areas that cause problems during the ramp-up can be categorized according to hard and soft factors. For these areas certain feasible strategies and concepts were developed in order to eliminate problems and enable an improved ramp-up. The concepts of the hard factors category includes improvements related to the sales phase, design and specification phase, resource planning, software development, internal acceptance, ramp-up preparation, training, documentation, Start-up (test phase on-site), support, service, ramp-up analysis and knowledge management. Soft factors include improvement suggestions of the intercultural and language issue, relation with local agencies and communication strategy categories.

The analysis and evaluation of past ramp-ups deliver especially important information for the improvement of ramp-ups. The control and constant observation of the ramp-up are required to determine strategies and actions for a fast and stable ramp-up of high quality.

7.1 Discussion

Suppliers of automated distribution centers are forced to not only improve their products but also the construction, implementation of their products and service process so that the customer achieves a stable production in a fast way. This implies the confrontation with the topic "ramp-up".

In the presented thesis the ramp-up was analyzed, evaluated and improvement measures have been developed. The analysis and evaluation tools, such as the BSC and ramp-up curve have further developed and data related to ramp-ups has to be collected. The practical application of these tools has to be verified in further ramp-ups. An automated tool has to be created to keep the expenses for the analysis and evaluation as low as possible.

The expert interviews were focused on main problems and improvement concepts related on quality, but with less focus on time, resource and cost saving. The evaluation of the improvement measures was carried out by an evaluation of all concepts related to existence in the company, feasibility and importance. The result showed that the application of almost all concepts is required and feasible. In the end it could not be determined which are the

best five measures that should be implemented in the company. Furthermore this decision also depends on the business administration.
Since many improvement areas and measures were discovered, the most important ones should be determined for the evaluation process. It turned out that the radius of questions was too wide and so too much time was required from experts for the evaluation process.

7.2 Future steps

After theoretically reflexing the investigation results the following steps should be considered for further developments:

- Benchmarking should be implemented by comparing and evaluating ramp-up time, costs and quality in exact numbers.
- The ramp-up curve has to be investigated in more detail by collecting ramp-up data of five to ten installations (orders, output, open issues, ramp-up relevant information, such as disruptions, stop times and power shortages, their causes and consequences). Analysis and evaluation of the ramp-up curves is required in order to determine the ramp-up behavior in more detail.
- Influence variables and their effects on the ramp-up should be determined and calculated to forecast future behavior for installations during the ramp-up.
- The ramp-up guide should be a standard document for every project.
- The most efficient and effective measures have to be determined and implemented by the business administration.
- Ramp-up key figures have to be measured frequently and tools have to be implemented that enable the fast handling and distribution of this data.

Abbreviations

DC = Distribution center
HWT = Hardware Technicians
KAG = Knapp AG
KAG = Knapp Sudamérica
KSI = Knapp Systemintegration GmbH
NPV = Net Present Value
OSR = Order Storage and Retrieval
PLC = Programmable Logic Controller
PMA = Project Manager
PTL = Pick to Light
QM = Quality Manager
RFID = Radio Frequency Identification
RF-Terminals = Radio Frequency Terminals
SRC = Storage Retrieval Controller
SWOT = Strengths, Weakness, Opportunities and Threats
TPL = Technical project leader
WCS = Warehouse Control System
WMS = Warehouse Management System

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[457]All names known at the department of Industrial Logistics.

Attachment

Expert interview about Ramp-up

1. In what kind of ramp-up processes do you already have experience in and what were their main characteristics?
2. What are the main problems during the ramp-up?
3. What are the main causes and sources of problems?
4. What solutions are applied, are they successful?
5. What methods are used to eliminate risks and impacts (in advance)?
6. What improvements would be recommendable for future ramp-up processes?
7. How can the flexibility be improved during the ramp-up phase?
8. How can costs during the ramp-up be minimized?
9. How can the ramp-up period be shortened?
10. What factors characterize a successful ramp-up process?
11. What characteristics had the best and the worst ramp-up?
12. How can the amount of changes and the change process during the ramp-up be improved?
13. How is the customer prepared for functionalities and processes of the installation?
14. What kind of support exists during the ramp-up and what would be recommendable?
15. What strategy is recommendable concerning the hand-over of the installation?
16. How does the cooperation with local agencies look like and how can it be improved?
17. How does a successful communication strategy on-site, with the client and the local agencies look like?
18. What kind of cultural issues appear during the project and how are they solved?
19. Did communication and language issues have any impact on the project?

Customers' expectations of the ramp-up process

1. What are your objectives concerning start up, ramp-up and final delivery of the installation?
2. What characteristics have a successful start-up and ramp-up in your opinion?
3. What are your expectations from the company Knapp of the start-up and ramp-up process of the new installation?
4. What actions can Knapp take during this phase to support you maximal?
5. What are your expected challenges during start up and ramp-up?
6. What aspects of Knapp's performance during the mentioned processes would be unsatisfying to you?
7. Do you already have some experience with consulters and would you consider this help as useful during the start-up and ramp-up process?

Results of ramp-up improvements evaluation

Scale:

Importance	**Feasibility**	**Existence**
0=Not important	0=Not feasible	0=Doesn`t exist
1=Nice to have	1=Feasible under certain conditions	1=Exists, not applied
2=Important	2=Feasible	2=Exists, sometimes applied
3=Very important		3=Exists, applied

Category	Importance	Feasibility	Existence
1. Sales phase			
Provide operation of installation by Knapp	1,83	1,50	1,40
Provide a consultant until the end of the project	2,33	1,83	1,67
Keep functionalities and processes easy; prevent complexity whenever possible	2,50	1,17	1,67
2. Planning & specification phase			
TPL is present in sales phase	2,33	1,17	1,67
Developer is present in specification phase	1,67	1,00	1,67

Category	Importance	Feasibility	Existence
Integrate customer (PMA & logistic department) in design process	2,67	1,50	2,33
Provide reference visits for the customer (for the key players)	2,00	1,67	2,33
Extend the scope of supply: provide network, etc.	1,50	1,83	2,33
Presentation of systems (WMS, WCS, etc.) & training in specification phase	2,00	1,50	1,50
Job specification for operators: description of work space & skill matrix	1,50	1,17	0,00
Close cooperation with customer: he shares information about his business	2,67	1,33	2,33
Risk management: better value system for risks (difficult clients cost x€, etc.)	2,67	1,67	2,17
Specification: contains graphical pictures like graphs to visualize processes	2,40	2,00	2,00

3. Construction phase

Set acceptance: Mechanic construction and acceptance then electrical construction and acceptance then PLC and acceptance then WCS and acceptance	2,50	1,67	2,33

4. Software

Reduce new developments: similar requirements → similar solutions	2,83	1,83	1,83
Realistic planning process	3,00	1,83	1,67
Focused on main functions	2,33	2,00	2,33
Burn-down graph/ Sprints → progress evaluation	2,67	1,67	2,00
Verify development status in smaller periods (evaluation after 3-4 weeks)	2,83	1,83	2,17
Special test group on this level to test the general functionality of the software (instead of the developer testing it)	2,67	2,00	1,67
Customer acceptance of software in steps	1,83	1,33	1,50

5. Preparation for ramp-up

User manual has a defined standard and is satisfying	2,33	1,83	1,17
The user manual contains all necessary information about error handling (+troubleshooting document for each installation which should be written and extended during the installation and production support)	2,33	1,83	0,83
Process description & error handling are available for each workstation- 1 A4 page	2,00	1,67	0,17
Customer fulfills all conditions of the contract before ramp-up	2,50	1,50	2,00
Workshop: describe installation → functionalities & processes, prepare customer for what he gets/ does not get	2,67	1,67	2,33
Design ramp-up plan with customer	2,50	1,50	2,00
Define processes and responsibilities for the ramp-up phase	2,50	1,50	2,00
Must haves for customer before go-live: Organizational structure has to exist	2,83	2,00	2,33
Flexibility exists to adapt to customers business for changes, etc.	2,33	1,50	2,50

Category	Importance	Feasibility	Existence
6. Tests			
Test department for logistic processes (person who is responsible for testing projects generally)	1,83	1,33	0,00
Integrate customer in test phase	2,17	1,50	1,50
Test cases with customer data & material	2,50	1,67	1,83
Simulation models	2,33	1,67	1,83
Start-up even when construction phase is not finished (if 1 area is not yet needed and under time pressure)	1,50	1,00	2,33
No performance tests under specific circumstances (low complexity, customer did not yet eliminate all his errors, time pressure)	2,00	1,50	2,17
Performance tests for all complex projects (if there is enough time)	2,67	1,50	2,17
Internal acceptance are carried out precisely even under time pressure	2,67	1,50	1,50
Internal acceptance protocols are documented appropriately	2,50	1,83	1,83
Test construction/ prototypes to carry out tests together with customer	2,17	1,50	1,67
7. Resources			
Extra developer resources are planned for complex installations	2,83	1,67	1,67
Steady ramp-up team exists (customer, start-up engineer, TPL, support for operators)	2,17	1,67	1,67
Tool exists to calculate probability for the demand for one person in the 1st week	1,00	1,17	0,50
Support includes engineers, electricians, PLC, HW technicians, WCS, WMS, Motion	2,67	1,67	2,67
Support starts 3-4 months after start-up	1,20	1,00	0,83
8. Training			
Supervisors are integrated during tests & development phase in Austria	1,50	1,17	0,83
1-2 key players are integrated in start-up	2,33	1,17	1,50
Training only of small groups(~5 people)	1,67	1,83	2,50
Training only of end users/ operators	1,17	1,33	1,67
Training only of supervisors	2,83	1,83	3,00
Training of logistic engineers of customer	2,83	1,67	1,17
Training before Go-live (~2 days)	2,17	1,67	1,67
Training is organized (schedule)	2,67	1,83	2,83
Content of training: explications of dialogues, reports, processes, key figures	2,67	2,00	2,50
Practical training	2,83	1,67	2,33
Appropriate training documents are available in advance	2,67	1,67	0,80
Technical editor exists for the documentation	2,00	1,83	1,50
Evaluation with questions & examples	2,17	1,33	0,67
Certification after the training	1,83	1,67	1,00
Evaluation with Multiple Choice test	1,50	1,50	0,00
Evaluation of the employees 1-2 days after the training	1,50	1,50	0,00
Immediate evaluation	1,67	1,67	0,33

Category	Importance	Feasibility	Existence
Penalties for bad evaluation results	1,33	0,67	0,00
"Installation license" for operators (a permission for working with the installation that receive those operators that pass the training successfully)	2,00	1,50	0,00
Supervision & corrective training	2,50	1,67	0,83
Rhetoric courses for trainer	2,50	1,83	0,00
Evaluation of trainer by customer's staff	2,00	1,67	0,33
Evaluation of trainer by internal staff	2,00	1,83	0,00
Train error handling	2,67	1,67	1,83
Training with simulated errors	2,50	1,67	1,50

9. Support

Defined responsibilities on-site	2,83	1,67	2,33
On-site manager (for daily reports, etc.)	2,83	2,00	2,33
On-site support is only carried out by local agencies	1,83	1,17	2,17
Offer long time support	2,33	1,67	2,17
Provide an experienced ramp-up manager (2-3 weeks - ½ year) with WMS, WCS & PLC know-how ~consultant	2,17	1,67	0,50
Remote support (Internet, Skype, notes)	2,67	1,67	2,67
Maintenance team is available on-site	2,67	1,83	2,00
Support for the ramp-up of a complex installation is up to 3 months	2,33	1,67	2,17
Less complex installations get max. 1 week of support	2,33	1,83	2,67
Support is longer than 3 month only if there are special agreements	2,00	2,00	2,67
WMS projects include longer support	2,67	2,00	2,67
Departure from on-site only possible if checklist for the documentation of the open points is filled out appropriately	2,50	1,83	1,67
Complex projects get extra support from developer, TPL and start-up engineers	2,83	1,67	2,33
Problems are solved in cooperation with customer (integration in error elimination)	2,67	1,83	2,50

10. Service

Integrate service department in an earlier phase & longer	2,67	1,50	2,00
Transfer know-how from on-site team to service department appropriately on time	2,83	1,50	1,67
Reserve resources for changes	2,83	1,50	1,33
Changes are only implemented by experienced employees (in a fast way)	2,17	1,17	1,83
Transfer responsibility to service department if all conditions are fulfilled	2,83	1,83	2,83

11. Analysis of ramp-up

Measure ramp-up with key figures	2,33	1,83	1,83
Distribute information about ramp-up values once a week	2,00	1,67	1,83
Internal KPI's of ramp-up	2,50	1,83	1,00
External (customer's) KPI's	2,17	1,50	1,33

Category	Importance	Feasibility	Existence
Measure customer satisfaction	2,00	1,17	0,17
Measure key figures related to user issues	2,17	1,33	0,33
Measure product goal attainment	1,67	1,17	0,33
Measure the attainment of customer demand	1,67	1,17	0,33
Measure the time goal attainment	2,33	1,83	1,00
Measure resource commitment paid by customer	1,83	1,50	1,17
Measure cost goal attainment	2,33	1,83	1,67
Measure progress degree of ramp-up	2,00	1,67	1,17
Measure amount of changes	1,83	1,67	1,00
Measure amount of errors	2,17	1,67	1,33
Measure amount of implemented solutions	1,80	1,60	0,20
Measure reaction time to solve an open issue	2,17	1,83	1,17
Measure amount of retests after changes	2,00	1,83	0,50
Measure Knapp's employees satisfaction during the ramp-up	1,33	1,00	0,17
Measure employee load factor	1,60	1,40	0,40
Automated tool to calculate ramp-up graphs	1,33	1,67	0,00
Ramp-up data is available in user interface	2,00	2,00	0,67
Tool with key figures for all levels (leaders, managers, employees)	2,50	2,00	0,67
Calculation of duration of ramp-up & demand for resources	2,00	1,50	1,00

12. Knowledge management

Portal: info available about installation, components, description of processes	2,33	1,83	0,33
Portal: customer enters open issues	2,17	1,67	0,83
Project diaries daily in the Intranet (2 tabs of project progression & problems)	2,17	1,83	1,00
Reflection of project → responsible review administration for collection	2,83	2,00	1,50
Search engine: type in problem and get the answer with solutions	2,50	2,00	0,50
QM manager is in every project review to evaluate & improve processes (supply, etc.)	2,33	1,83	0,67
Correct phase out of start-up engineers → transfer knowledge, connections	2,33	1,67	2,17
Troubleshooting document for each installation & constant updates	2,50	1,67	1,33
Lessons-Learned-Workshops	2,50	1,67	0,83
Expert conversations/ Experience interchange	2,17	1,67	0,67
Data base for experience interchange	2,00	1,50	0,33
Standardized document in the Intranet for notation of problems in advance to make project review easier	2,33	1,83	1,17

13. Establishments

Their role & tasks of all participants are specified clearly	2,60	1,60	1,50
They do long term support and service	2,20	1,40	1,50
Are qualified in implementing own projects (with trainings, etc.)	2,00	1,20	0,67
Cooperation and constant coordination between Knapp in Austria and local agencies	2,50	1,67	2,00

Category	Importance	Feasibility	Existence
Meetings & personal contact with Knapp in Austria and local agencies	2,17	2,00	2,17
Constant interchange of information, status of the project and chronogram	2,17	1,67	1,83
Common appearance of Knapp in Austria & establishments in front of the client (as a team)	2,50	1,67	1,67
Clear guidelines of cooperation	2,33	1,83	1,83
Establishments have decision portfolios for the selling process	2,60	2,00	1,80
KSI is integrated into the sales phase of establishments	2,25	2,00	1,50
Establishments know the branch well & understand the complexity of products	2,20	1,60	2,00
People in charge of the establishments have responsibility for the success of the project after the selling it	2,20	1,80	1,00
Knapp understands and reacts to the foreign culture & habits of the local agencies	2,20	1,60	1,80
Create and define common objectives of Knapp in Austria and establishments	2,40	1,80	1,80
Common strategies/targets for ramp-up of Knapp and establishments	2,20	1,80	1,20

14. Communication strategy

Determination and communication of responsibilities (presentation of people on-site, transparency, etc.)	2,50	2,00	2,17
Daily internal meeting	2,50	2,00	2,17
Daily meeting with customer	2,33	1,83	2,17
Daily meeting with people in charge of the establishments	1,50	1,67	1,50
Daily meeting with customer & people in charge from establishments together	2,00	1,50	1,83
Communication plan for ramp-up phase	2,33	2,00	1,67
Weekly meetings between TPL & PMA from Knapp and customers PMA & logistic engineers (key players)	2,33	1,67	2,17
Content of meeting: problems (and their causes, consequences, solutions) status, priorities, further steps (issues, problems, new features)	2,50	1,67	2,17
Note constantly open issues & delegation of them (issues, problems, new features)	2,83	1,83	2,50
Test, update and stop times, etc. are communicated to the client in advance	2,33	1,83	2,17
Determined schedule for start-up	2,67	2,00	2,67
Standardized open issue list	2,33	2,00	1,83
Open issue list in Excel	2,50	2,00	2,67
Open issue list with automated software	2,00	1,83	1,00
Daily reports have a high quality (contain only most important points, etc)	2,50	1,50	1,50
Workshop/ meeting exists to learn how to write reports	1,83	1,83	0,00
Employees are aware of the difference between good and bad reports	2,33	1,83	0,50

15. Cultural aspects

Presentation of Austrian culture	1,83	1,67	1,00
Folder with info about Austrian culture	1,50	1,33	0,00

Category	Importance	Feasibility	Existence
Provide flexibility to adapt to culture (for delays, etc.) for remuneration	2,33	1,50	1,33
Intercultural team for communication, etc	1,67	1,17	0,83
Determine common manners for supplier and customer (penalties?)	1,67	1,33	0,50
Train Knapp's employees about culture for the stay in the foreign country	1,83	1,50	0,50
Crash course about culture for start-up engineers, TPL, PMA (mentality, rules of behavior, etc.)	2,00	1,33	0,00
Folder of foreign culture for on-site team	1,83	1,67	0,00
PMA → trains the team for cultural issues	1,50	1,17	0,17
Info about foreign cultures available in the Intranet	2,00	1,67	0,17
Collection of intercultural experiences, problems and solutions exit	1,50	1,67	0,17
Guide: how to deal with intercultural problems in order to finish the project?	1,83	1,50	0,17
English & Spanish course are offered	2,50	1,67	2,03
Official course offer for languages	2,33	1,67	1,50
Interpreters → employ them & train technical knowledge	1,67	1,50	1,33
External interpreters with technical knowledge for workshops and trainings	2,00	1,17	1,33
Cooperation with local translation agency with technical know-how from foreign country	1,50	1,50	0,67

Evaluation of success factors

Scale: 1 -5 (5 = best)

Category	**Check**
Customer:	
Organized customer	
Prepared client	
Customer's knowledge about functionalities (he knows what he wants & gets)	
Qualification and training of employees	
Cooperative client	
Customers processes as determined	
Supplier:	
Prepared supplier	
Appropriate resources	
Resources on-site on time	
Steady team (also for changes)	
Clear responsibilities	
Know-how and experience of employees	
Knowledge about customer's business	
Prepared for contingencies	
Product:	
Software is finished	
Tested software	
Quality of product	

Low number of open points/ issues	

Project:

Small and transparent project	
Low complexity of product	
Clear project plan (realistically planned)	
Know-how & performance of project manager	
Preparations (tests, etc.)	
Appropriate tests on time	
Everybody focused on a specific date (pressure)	
Low external influences	
Customer demand fulfilled	
No interface problems	

Soft facts:

Communication strategy	
Intercultural skills and cultural knowledge	
Knowledge/ experience exchange internally	
Personality + motivation of employees	
Decisions of business administration	
Cooperation between all partners	

Result (% of max. points): **0,0%**

Ramp-up guide

Scale:

Importance:
I=Important
II=Nice to have

Novelty:
"****"=not yet available
"***"=new
"**"=improve
"*"=exists

No.	Category	Measure	Weight	Novelty
1.1	Sales phase	Provide a (logistic) consultant for the whole project	I	**
1.2	Sales phase	Provide the operation of the installation by Knapp	I	**
1.3	Sales phase	Provide easy functionalities and processes	II	**
1.4	Sales phase	Technical project leader is present in the sales phase	II	**
1.5	Sales phase	Extend the scope of supply with further offers	I	**
2.1	Design and specification phase	Extend the risk management (include the ramp-up)	I	**
2.2	Design and specification phase	Perform reference visits to prepare the customer	I	**
2.3	Design and specification phase	Integrate the customer in the design process	I	**
2.4	Design and specification phase	Design graphics to visualize processes in specifications	I	**
2.5	Design and	Make sure that the customer provides business data	II	**

No.	Category	Measure	Weight	Novelty
	specification phase			
2.6	Design and specification phase	Integrate the developer in the specification phase	II	**
2.7	Design and specification phase	Present the systems (WMS, WCS, etc.) and train employees	I	**
3.1	Resource planning	Plan extra developer resources	I	**
3.2	Resource planning	Provide an on-site manager for the ramp-up	I	**
3.3	Resource planning	Provide an experienced ramp-up manager (consultant)	I	**
3.4	Resource planning	Provide a steady ramp-up team (customer, IBN, TPL, support)	I	**
3.5	Resource planning	Calculate the resource demand with probability calculations	II	****
4.1	Software development	Implement existing solutions to reduce new developments	I	**
4.2	Software development	Evaluate the development status all 3-4 weeks (Burn-down graphs/ Sprints)	I	**
4.3	Software development	Integrate the customer in the development process	I	**
4.4	Software development	Design the software user friendly	I	**
5.1	Internal acceptance	Test of software functionality by test group	I	**
5.2	Internal acceptance	Perform the internal acceptance precisely	I	**
5.3	Internal acceptance	Document internal acceptance protocols appropriately	I	**
5.4	Internal acceptance	Test the software functionality with simulations (test systems)	I	**
5.5	Internal acceptance	Test together with customers on test constructions/ prototypes	I	**
5.8	Internal acceptance	Carry out the customer acceptance of the software in steps	II	**
6.1	Intercultural preparation	Provide intercultural crash courses/ trainings for IBS, TPL, PMA	II	***
6.2	Intercultural preparation	Provide folders of the culture/ info (in the Intranet, etc.)	I	****
6.3	Intercultural preparation	Provide info of Austrian cultures and determine rules of behavior (folder, workshops, meetings, etc.)	II	**
6.4	Intercultural preparation	Provide intercultural teams (PMA, TPL, on-site manager, etc.)	II	**
6.5	Intercultural preparation	Collect intercultural experiences and solutions	I	***
6.6	Intercultural preparation	Solve language issues:		*
6.6.1	Intercultural preparation	Provide language courses for employees	I	**
6.6.2	Intercultural preparation	Employ internal/ external (technical) interpreters for trainings/ workshops	I	**
6.6.3	Intercultural preparation	Cooperate with local (technical) interpreters on-site	I	**
9.1	Cooperation with local agencies	Create role definitions and clear guidelines for local agencies	I	**
9.2	Cooperation with local agencies	Participate in the sales process of local agencies	I	**
9.3	Cooperation with local agencies	Make sure sales decision portfolios exist and responsibility for project success	I	**

No.	Category	Measure	Weight	Novelty
9.4	Cooperation with local agencies	Perform meetings and personal contact with local agencies for info exchange	I	**
9.5	Cooperation with local agencies	Create common strategies and targets and show common appearance as a team	I	**
9.6	Cooperation with local agencies	Make sure that local agencies offer support (maintenance team, etc.)	II	**
9.7	Cooperation with local agencies	Qualify local agencies by training participation	II	**
10.1	Communication strategy	Determine and communicate responsibilities	I	**
10.2	Communication strategy	Create a communication plan for the ramp-up phase:	I	**
10.2.1	Communication strategy	Perform internal meetings daily (start-up)/ weekly (ramp-up)	I	**
10.2.2	Communication strategy	Perform meetings weekly (start-up)/ daily (ramp-up) with the customer	I	**
10.2.3	Communication strategy	Make sure that local agencies take part in meetings	I	**
10.2.4	Communication strategy	Perform weekly meetings with TPL/ PMA of Knapp and PMA/logistic engineers of the customer	I	**
10.2.5	Communication strategy	Make sure that the meeting topics includes problems, status, open issues	I	**
10.3	Communication strategy	Collect and delegate open issues	I	*
10.4	Communication strategy	Communicate test, update, stop times, etc. in advance	I	**
10.5	Communication strategy	Create daily reports and weekly reviews	I	*
11.1	Documentation	Design a satisfying user manual with error handling	I	**
11.2	Documentation	Design a troubleshooting document with updates	I	**
11.3	Documentation	Create a project diary in the Intranet to note problems	I	**
11.4	Documentation	Use a standardized open issue list in Excel	I	**
11.5	Documentation	Use Optics to delegate open issues	I	**
11.6	Documentation	Make sure that the customer enters open issues in a dedicated portal	I	**
11.7	Communication strategy	Perform workshops about the design of daily reports	I	***
12.1	Ramp-up preparation	Provide descriptions and error handling for each workstation	I	***
12.2	Ramp-up preparation	Add job specifications for each workstation	II	***
12.3	Ramp-up preparation	Implement a workshop for ramp-up preparation	I	**
12.4	Ramp-up preparation	Define processes and responsibilities for the ramp-up phase	I	**
12.5	Ramp-up preparation	Make sure that the customer fulfills all contract conditions before the go-live	I	**
12.6	Ramp-up preparation	Design the ramp-up plan in cooperation with the customer	I	**
13.1	Start-up	Create test cases with customer data and material	I	**
13.2	Start-up	Integrate supervisors in the internal test phase	II	**
13.3	Start-up	Create acceptance gates during the start-up	I	**

No.	Category	Measure	Weight	Novelty
13.4	Start-up	Carry out tests in cooperation with the customer	II	**
13.5	Start-up	Carry out the start-up parallel to the construction phase	II	**
13.6	Start-up	Spend less time on the start-up and more on the ramp-up	I	**
13.7	Start-up	Implement performance tests	I	**
14.1	Training	Carry out professional trainings:		*
14.1.1	Training	Define the training schedule	I	*
14.1.2	Training	Train just before the go-live	I	**
14.1.3	Training	Provide appropriate training documents at the training	I	**
14.1.4	Training	Train the customer's logistic engineers, supervisors, key players	I	**
14.1.5	Training	Train the end users/ operators	II	**
14.1.6	Training	Train only small groups of max. 5 people	I	*
14.1.7	Training	Train dialogues, reports, processes, functionalities	I	*
14.1.8	Training	Train cross-product and process oriented	I	**
14.1.9	Training	Implement practical training with real data and material	I	**
14.1.10	Training	Implement supervision and corrective training	I	**
14.1.11	Training	Train error handling with simulated errors	I	**
14.1.12	Training	Training evaluation with control questions/ multiple choice tests	II	**
14.1.13	Training	Certificate the participants after the training	I	**
14.1.14	Training	Provide retraining if necessary	I	**
14.1.15	Training	Evaluate the trainer externally	I	***
14.1.16	Training	Evaluate the trainer internally	I	***
14.2	Training	Make sure that trainers participate in rhetoric courses	I	***
14.3	Training	Make sure that trainers participate in competence trainings	I	**
14.4	Training	Certify the customer with an "Installation license"	I	****
14.5	Training	A technical editor is responsible for the training documentation	I	**
15.1	Support	Perform the on-site support effectively:		*
15.1.1	Support	Provide ramp-up support from 1 week up to 3 months	I	**
15.1.2	Support	Provide special agreements with longer support	I	*
15.1.3	Support	Offer long term support	I	**
15.1.4	Support	Provide a maintenance team	I	**
15.1	Support	Provide extra support (developer, TPL and IBS)	I	**
15.2	Support	Complete the checklist of open points before the departure	I	**
15.3	Support	Provide remote support (plus support via internet, Skype, etc.)	I	*
15.4	Support	Integrate the customer in the elimination of errors	I	*
15.5	Support	Provide on-site support by local agencies	II	**
15.6	Support	Support for each system & maintenance team	I	*
16.1	Service	Integrate the service department in start-up/ ramp-up	I	**
16.2	Service	Transfer know-how to the service department appropriately	I	**
16.3	Service	Reserve resources for changes (to provide flexibility)	I	**

No.	Category	Measure	Weight	Novelty
17.1	Ramp-up analysis	Design and update ramp-up curves	I	****
17.2	Ramp-up analysis	Provide ramp-up data in the user interface	I	****
17.3	Ramp-up analysis	Measure and distribute ramp-up key figures once a week	I	**
17.4	Ramp-up analysis	Calculate the duration of the ramp-up and resource demand	I	**
18.1	Knowledge management	Update installation descriptions (components, processes, ...) in the Intranet	I	****
18.2	Knowledge management	Administrate project review protocols	I	**
18.3	Knowledge management	Integrate the quality manager in reviews to improve processes	I	**
18.4	Knowledge management	Perform Lessons-Learned workshop (project review) precisely	I	**
18.5	Knowledge management	Guaranty the correct phase out of start-up engineers	I	**
18.6	Knowledge management	Organize expert conversations and experience interchange	I	**