A case study on inter-organisational technology transfer in the defence industry

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Abstract

Purpose

This paper aims to establish a systematically constructed defence offset technology transfer (TT) process description and to identify the process pain points and critical success factors from the supplier perspective.

Design/methodology/approach

A novel integrated case study and Straussian grounded theory approach under the interpretative assumptions and purposive sampling in a global defence industry organisation are presented.

Findings

The TT is approached from the process modelling point of view, and a detailed operations description covering the end-to-end TT process across a defence industrial participation project is presented. The findings suggest that local recipient's management, financial resources and planning, supply chain management and local production planning are the main factors of an efficient process.

Research limitations/implications

This is a single case study, only reflecting the supplier view. Future research could explore the other dimensions of the process to confirm the identified factors playing a role over time.

Originality/value

To date, the body of TT research has focused on the factors influencing the technology absorption and the identification of meta mechanisms between the supplier and recipient organisations in a context of a multinational corporation and as an intra-firm activity, providing little insight to the actual practical operational level TT process. This study seeks to fill this gap by advancing a more profound understanding of the process activities and the main factors through which the local recipient organisation can best influence the project's success and manage the inter-organisational TT operations more effectively in a highly technologically complex operational environment.

Keywords: Qualitative, Strategic alliance, Defence, Knowledge acquisition, Technology transfer, SCOR, Offset, Integrated case study and Straussian grounded theory method, Inter-organisational

Introduction and background

Global military spending was estimated at $1.8tn in 2018, where most countries include offset requirements in their defence contracts (Tian *et al.*, 2019). As one of these governmental instruments, the defence industry technology transfer (TT) occupy a particular but significant niche of technological capability acquisition through the supply chain. The purpose of the TT in the defence offset context is twofold:

1. to enable the receiving country industry to independently produce and maintain the product under the armaments contract in a warfare situation (i.e. strategic role); and
2. to compensate and justify the high cost related to the armaments procurement by transferring part of the related work for the receiving country industry (i.e. political role).

Technology is also a critical input requirement for economic development where the acquisition of capabilities may lead to increased productivity, innovation and a broader economic development (Bengtsson and Dabhilkar, 2009; Lyles and Salk, 2007; Bachelor and Dunne, 2000; Kumar *et al.*, 1999; Cohen and Levinthal, 1990; Contractor and Sagafi-Nejad, 1981).

As a part of the offset, the foreign defence suppliers are typically required to manufacture all or part of their contract products locally in the purchasing country. Thus offset agreements develop industrial relationships through production and knowledge transfer from the foreign supplier to their local partners. The major defence suppliers often have distinctive capabilities to manage their inter-organisational TT, and these capabilities are recognised as strategic and as a corporate competitive advantage.

The defence industry partnership between the foreign supplier and the local partner is typically a non-equity partnership. The foreign supplier is a globally operating defence industry organisation with high capabilities in their specific product portfolio. In contrast, the local partner may represent a wide variety of different types and sizes of companies (e.g. defence and non-defence industry related, small to large). Furthermore, partnerships in their traditional sense are considered to be formed between companies with complementing portfolios. Still, defence industrial partnerships may also be formed between fierce competitors in certain markets with similar products and offerings and yet sharing their core technologies and knowledge in other markets.

Typically the local recipients do not have extensive prior experience on the TT. Consequently, they do not have existing effective routines to manage all the aspects of the process. Also, to date, there are no systematically constructed best practices or process guidelines available despite the significant role and economic weight of the technology acquisition. Instead, the body of research has focused on the factors influencing the technology absorption (Malm *et al.*, 2015; Knudsen and Madsen, 2013; Simonin, 1999; Grant and Gregory, 1997; Szulanski, 1996; Zander and Kogut, 1995; Cohen and Levinthal, 1990) and on the identification of meta mechanisms between the supplier and recipient organisations (Capasso *et al.*, 2005; Stock and Tatikonda, 2000; Albino *et al.*, 1999; Lyles and Salk, 2007; Lasserre, 1982), providing very little insight into the actual operational transfer process between the supplier and the receiver.

This study seeks to fill this gap by advancing the understanding by establishing a systematically constructed level 2 Supply Chain Operations Reference (SCOR) model map and by identifying the defence offset TT process pain points and critical success factors from the supplier point of view. We argue that a global defence supplier with extensive TT experience with numerous projects and operating with multiple recipients has valuable insight and relative objectivity to assess and analyse such factors and identify general operational steps in a TT project. As a result, the defence industry organisations and economies involved in defence contracting can better plan and manage their related industrial participation TT activities.

A novel integrated case study and Straussian grounded theory approach under the interpretative assumptions and purposive sampling in a global defence industry organisation is applied for this study (Palinkas *et al.*, 2015; Thai *et al.*, 2012; Halaweh *et al.*, 2008). Case studies are typical for defence studies with high access restrictions, but grounded theory applications are not previously applied in this field.

Following the Introduction, the theoretical background is discussed in the Literature Review. Next, the methodology and validation are presented in more detail, followed by the results, their discussion, research and managerial implications and the conclusion.

Literature review

Acquisition of technological capability in the offset context

Competences, as the industrial development and innovation capability, for example, are anchored in the technologies an organisation possesses. These technologies can systematically be built and acquired to improve an organisation's economic performance and enable technological upgrading and competitiveness. However, it is essential to note that technology acquisition does not automatically lead to increased capabilities (Reddy and Zhao, 1990).

The TT of knowledge in the international defence industry supply chain is established based on the offset requirements between two organisations: the foreign supplier and the local partner. TT is imperative to support and secure the self-reliance in defence technology in a wartime situation, leverage the local defence industry capabilities and support the local defence industry economically. To fulfil these objectives, learning through TT must be successful. These alliances are typically one-way learning environments where the local partner is the only receiver. Unlike the typical definition for an alliance (Choo and Bontis, 2002), they are also involuntary arrangements as the alliance is only taking place because of the objective to win the supply contract under the condition of local manufacturing requirement.

In general, the objective of the acquisition is to gain possession of relevant technology in the form of firm-specific information regarding the production process and product design. Hence, the technology can be defined as an intangible, tacit, often uncodified knowledge about a specific application accumulated in a firm over time (Zhao and Reisman, 1992). The leading management theorists, such as Porter (1985), consider this technology a firm-specific valuable strategic asset that can as a competitive advantage even alter an entire industry's structure (Porter, 1985). Zander and Kogut (1995) similarly argue that the innovation capabilities rest on replicating the production and sales capability of a new product or a

service. However, replication alone cannot form a sustainable basis for the long-term development of competitive advantage and innovation capabilities. Still, it can build the necessary technological capability of the recipient. (Zander and Kogut, 1995).

Reddy and Zhao (1990), in their literature review on international TT, identified several typologies of technological capabilities such as operational, duplicative and innovative capabilities (Reddy and Zhao, 1990). Again, companies do not acquire skills to imitate and replicate but increase their capabilities, competitive advantage and the ability to innovate. This acquired ability to create better value is at the core of offset. Capasso *et al.* (2005) discussed that in their aspiration of value creation, the organisations enter a strategic network to pursue valuable information exchange. Thus organisational networks allow companies to access critical resources. Unlike in the systems of firms, the focus of strategic networks is on the company opposite to the network level.

Technology transfer

To effectively manage TT and both individual and organisational learning, a view of the process and related sequences of activities is needed (Cusumano and Elenkov, 1993). There is, however, a limited research coverage explicitly focusing on the aspects of the international inter-organisational TT process, mainly on the meta-level processes involved (Fredriksson, 2018; Malm *et al.*, 2015; Knudsen and Madsen, 2013; Mariotti, 2012; Ivarsson and Alvstam, 2005; Albino *et al.*, 1999; Szulanski, 1996; Wei, 1995; Mansfield, 1975) and the conditions stimulating and facilitating learning during the transfer process (Easterby-Smith *et al.*, 2008; Inkpen, 1998; Szulanski, 1996; Zander and Kogut, 1995; Mansfield, 1975). Of these, Szulanski (1996) provides a best practice perspective, the most comprehensive TT process description that is based on four stages, namely, *the initiation* (including all the events leading to the decision to transfer), *the implementation* (where the relationship between the parties is established and the resources and practices are being transferred), *the ramp-up* (where the recipient begins to apply and use the transferred knowledge) and finally *the integration* (when recipient's practices stabilise and become institutionalised). Similarly, three meta-level steps have been identified to be involved in a defence offset specific environment, including *the initial assessment*, *industrialisation* focusing on the capability gaps and *ramp-up* (Fredriksson *et al.*, 2018; Malm *et al.*, 2015). These both outline the main operational level, but we argue it does not build further understanding across the different operational areas nor provide a basis for detailed process documentation and enable systematical and standardised management. The primary value in Szulanski's study relies upon further identifying factors causing internal stickiness, i.e. the sources of difficulty in transferring knowledge, such as the low recipient absorptive capacity, the causal ambiguity and the arduous relationship between the parties (Szulanski, 1996). The results further indicate that organisations' difficulties in transferring technology might have less to do with motivational factors and more on that *organisations do not know how to* (Szulanski, 1996). Thus, the organisations must better understand the transfer process and develop mechanisms to foster inter-organisational learning. Only an adequately detailed process model can provide a baseline for projection, reviews, streamlining and overall efficient management of the process and, as a result, bring the best results. Based on the literature examination, we can find that this question has not been adequately addressed in previous scientific studies.

To conclude, the current literature offers a relatively narrow economist driven meta-level perspective to the inter-organisational TT where the TT mechanism is seen as dependent on the relationship between the supplier and the recipient as well as the absorptive capability of

the recipient and presented in a context of a multinational corporation and as an intra-firm activity (d'Agostino *et al.*, 2019; Lorell *et al.*, 2002; Bachelor and Dunne, 2000; Davidson and McFetridge, 1985; Mansfield and Romeo, 1980; Contractor and Sagafi-Nejad, 1981; Mansfield, 1975). This study argues that this perspective needs to be also extended to include systematically developed and communicated operational practices (the processes and management of operational activities). Hence, this case study builds towards that theoretical context that is now lacking.

Collaboration dynamic

This study framework is built on several concepts and not a single theory owing to the lack of robust critical literature linked to the phenomena under the study. The defence industry related to the TT literature does not provide a single well-developed theory but is instead fragmented into isolated case based concepts. The collaboration dynamics and the accumulation of technological capability can be analysed from the incorporated perspectives of characteristics promoting the cross-border relationships (Lorell *et al.*, 2002), the offset success factors and the transformation success factors (Kiss, 2014). These three perspectives cover the whole process of a domestic defence company developing into international cooperation and partnerships, being able to actively and efficiently receive knowledge, capabilities and other benefits through an offset programme and lastly transforming into a commercially successful corporation and away from being just a fully government subsidised nationalised asset. Lastly, these three perspectives are also reflected against the context and lessons learned from the South African defence industry transformation (Dunne and Haines, 2006).

As a result of the synthesis, the study's key TT sustainability success factors emerge, and their relationship is illustrated in Figure 1. The local recipient's overall attitude, abilities and management capabilities form a precondition for the overall project to determine how successful the technology absorption and utilisation can be. The level of preparation and planning, on the other hand, predicts the efficiency of the TT execution. The following execution focus, involvement of the supply chain partners and strong financial support from the government further enable the best value creation and sustainable outputs.

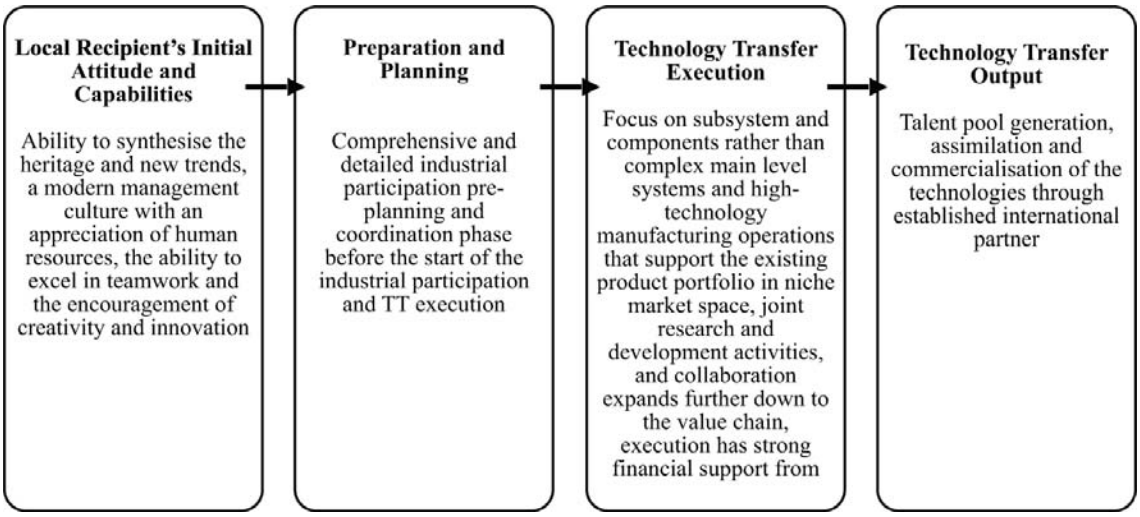

Figure 1. Relationship between the key success factors

Method

The research objective is to analyse the inter-organisational capability transfer process in a defence industry offset environment from a global technology supplier's perspective. As a result, the study aims to:

- develop a SCOR level 2 TT process model in a defence industrial participation context; and
- identify the related pain points and critical success factors from the supplier's point of view.

The research is based on a novel integration of a case study and Straussian grounded theory methods under interpretative assumptions with a purposive sampling approach (Palinkas *et al.*, 2015; Thai *et al.*, 2012; Halaweh *et al.*, 2008). A single revelatory case study allows to learn more in-depth from this specific environment of interest (Walsham, 1995; Yin, 1994) and the constant comparative data analysis through the Straussian approach continue to apply to data irrespective of the case number (Halaweh *et al.*, 2008; Scott, 2004; Corbin and Strauss, 1990). Case studies are typical in defence studies with high access restrictions, but grounded theory applications are not previously applied. A specific focus group of eight people representing the most extensive experience of multiple international inter-organisational TT projects and the highest knowledge on the research area with a comprehensive, in-depth understanding of the process, its requirements and possible issues negatively affecting the transfers is selected. Owing to the sensitive industry nature, the research is anonymously conducted where any identifying factors related to the organisation or the participants under the study are not released.

A cross-sectional data generation and collection are conducted through a semi-structured questionnaire with both structured and open-ended questions that are sent to the focus group in 2019, providing a rich and deep insight into the complex phenomena under investigation as well as anonymity (Creswell and Creswell, 2018; Leedy and Ormrod, 2015; Thai *et al.*, 2012). The use of literature forms a basis for establishing questions and comparing and contrasting findings (Creswell and Creswell, 2018; Leedy and Ormrod, 2015; Thai *et al.*, 2012; Halaweh *et al.*, 2008). The questionnaire is distributed by email where the questions overlap each other to increase the reliability to achieve adequate saturation without conducting multiple rounds.

The data analysis incorporates qualitative and quantitative elements to provide more in-depth analysis and understanding of the case. The different components are in constant interaction, and their outcomes are integrated throughout the study. The qualitative analysis is a continuous comparative process following the Straussian approach on applying the open, axial and selective coding methods (Tie *et al.*, 2019; Thai *et al.*, 2012; Halaweh *et al.*, 2008; Walker and Myrick, 2006; Corbin and Strauss, 1990). The first cycle involves breaking down the data and looking for similarities and differences, forming initial tentative and provisional codes and concepts (Saldaña, 2016; Corbin and Strauss, 1990). The second cycle axial coding approach studies the relationships of categories and their subcategories and how they are relating to each other, focusing on the conditions or situations in which the phenomena occur, the actions or interactions of the people in response to what is happening in the circumstances and the consequences or results of the action (Saldaña, 2016; Halaweh *et al.*, 2008; Walker and Myrick, 2006; Corbin and Strauss, 1990). The last selective coding cycle involves selecting a central category representing the main theme of the study and reflecting how the

other categories relate to this central category as well as to each other to form an integrated and refined model (Tie *et al.*, 2019; Saldaña, 2016; Halaweh *et al.*, 2008; Walker and Myrick, 2006; Corbin and Strauss, 1990). The quantitative data analysis includes the preparation of descriptive and inferential statistics. After the overall data analysis is finalised, a meta inference is completed to synthesise the results.

The Straussian grounded theory approach is an inductive methodology in nature, where the objective is to let the data lead the construction of theory and form the basis for the theory discovery in the context the phenomena under study occurs, rather than the research process be led and, to some extent, restricted by an existing theoretical framework (Donald, 2014). However, the theoretical literature base assists in developing the initial focus group questionnaires and the final reflection of data gathered and conclusions made. Hence the existing theories, in this case, have been used for explanatory purposes as the conceptual basis for understanding and connecting the researcher to the current knowledge.

Sampling

Grounded theory research typically involves a recommended sample of 20–30 and a case study a sample of 3–10 (Creswell and Creswell, 2018). Owing to the sensitive nature of the defence industry and the high access restrictions to any information within such organisations, a purposeful sampling approach is applied to:

- learn more in-depth from this specific environment of interest;
- efficiently use all the available sources of information due to limited access; and
- choose a particular focus group of people who represent the most extensive experience and highest knowledge on the research area, and that can answer the research question (Tie *et al.*, 2019; Leedy and Ormrod, 2015; Palinkas *et al.*, 2015).

Thus, every TT specialist involved in the TT operations (sample size = 8) are engaged in the research to achieve appropriate saturation within the case organisation. Furthermore, the eight representatives all have 15–20 years of individual experience of multiple international inter-organisational TT projects and a comprehensive, in-depth understanding of the process, its requirements and possible issues negatively affecting the TT. They also represent all organisation levels, from the operational activities to the mid-management up to the executive level. As a result, using a purposive sample increases the consistency and homogeneity, narrows down the variation and focuses on similarities, assists in describing, illustrating and generalising what is typical in the inter-organisational TT process from the supplier point of view (Palinkas *et al.*, 2015). Strauss and Corbin (1998) emphasise that grounded theory research is about discovering information rather than testing it. Hence, the sample size does not need to follow statistical sampling principles but theoretical sampling (Strauss and Corbin, 1998).

Data validity and reliability

Several internal and external validity strategies are implemented to ensure the qualitative validity, reliability and interpretative rigour of this study. The study results are treated anonymously to decrease the likelihood of external expectations and opinions affecting the outcome and increase the probability of the actual views being gathered. For triangulation purposes, the literature review is used as a basis for the questionnaire and reflects the results. The data collected from the respondents represent different perspectives through different

hierarchies and operations within the organisation. To determine the findings' accuracy, the final report is presented to the respondents to determine whether the respondents feel that the results are accurate as final approval and commenting round for this study.

This research is conducted in a globally operating defence industry organisation with large-scale strategic capabilities in the international TT field. Global defence organisations are diverse in their culture, practices and characteristics, but their knowledge acquisition and TT processes often follow similar operational patterns. This study is restricted to a well representative sample of case respondents with a particular set of characteristics (in-depth knowledge in the TT process and related activities and operations in many TT projects in different countries).

Results

Inter-organisational technology transfer process

To effectively manage their inter-organisational TT, the case organisation follows a systematic process developed, established and adjusted over the years based on previous experiences and lessons learned. A questionnaire is used to construct and illustrate the process used by the target organisation. The preliminary information and access to the target organisation process illustration supplemented with the literature review information form a questionnaire base. The participants are required to confirm or reject activities taking place during the TT process. Further open-ended questions provide more insight into the process operations. The scope covers both the product-related technology (i.e. proprietary product know-how through product designs and technical specifications) and the process related TT (operations associated with the manufacturing of the product). A time horizon of five years represents a conventional contractual TT timespan, bridging from the development to the industrialisation phase, as illustrated in Figure 2.

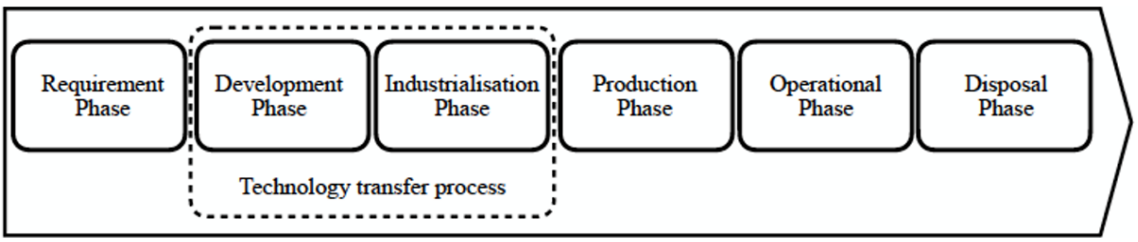

Figure 2. Main defence procurement project phases

The main TT process phases are outlined in Figure 3, where the impulse from marketing, in the form of a new potential supply contract, initiates the start of the TT process, followed by the preliminary local participation analysis, the planning, contracting, delivery and implementation and last the closure phases. The main level can further be divided into sales and marketing, and the delivery, which starts only after the confirmation and signing of the supply contract.

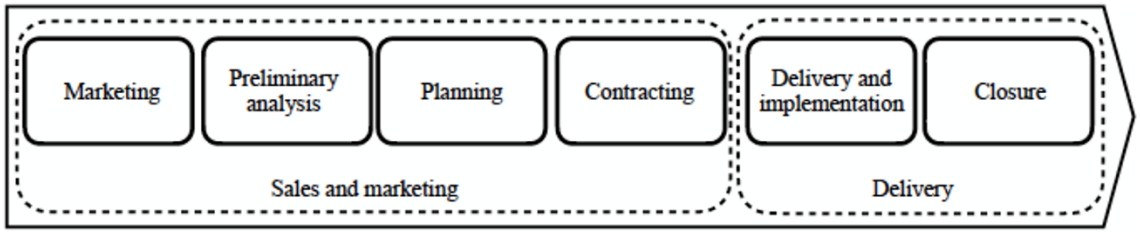

Figure 3. Main phases of the TT process in an offset context

Further exploration of the sub-processes identifies more specific activities and actions involved in the TT. The process is initiated when marketing input is received about an activated marketing project involving a local participation requirement. The TT team receives the local participation requirements, offset legislation and regulations and other possible customer requirements. The local partnering possibilities and the industrial capabilities are analysed to establish what is technologically feasible to produce locally and determine the local production cost level. A preferred local partner is proposed to the executive board for approval. The work distribution and the TT content will be negotiated with the selected local partner.

Further industrial participation survey is used to map the local supply network and its ability to supply products and components in terms of quality, cost and delivery times. Based on the data gathered, a preliminary local participation plan is established, which further forms part of the overall winning concept, i.e. an offer to win the contract. A TT plan specifies how the product and its production technology knowledge is transferred to the local partner, i.e. the local recipient. This will involve a detailed inspection of the local recipient's production and testing facilities and an analysis of their development potential, mapping resources, equipment and technologies and other local production bases. The overall TT cost and schedule are estimated for the contract offer. The project risks are evaluated in terms of their probability and weight. The nature of the project, the customer requirements and the local partner characteristics are the key factors defining the TT plan. However, a typical TT plan always entails the following essential elements: schedule, the work distribution and the TT content, responsibilities between the parties, resourcing, required training (number of people, training days and the broad overview of the training content), support plan and need for specialised tools. The TT content in the form of work packages typically includes the design, manufacturing, tooling, quality control and supply chain management elements. This planning phase output is a detailed scope of work in terms of work distribution and content, and schedule. The TT team supports marketing and sales in the main contract and offset agreement negotiations. The objective is that both the local participation contract, the main contract and the offset agreement are signed parallel. After the contracts have been signed, an internal contract review is organised to establish a standard view regarding the content and the set requirements among the overall project execution team. Similarly, the TT delivery starts with an external contract review involving all the relevant parties and the key personnel from both the supplier and the receiver organisations.

The TT requirements are fulfilled in the delivery and implementation phase, starting after the local participation and offset contract signing, continuing until all the systems have been delivered. It is possibly even longer providing that the relationship between the supplier and local recipient has developed into a genuine business and value creation-based supply chain partnership. In addition to the delivery, the supplier's local participation also supports the local partner in preparing and managing the further life cycle support services. In all, the

supplier's local participation support is available throughout all the defence procurement project phases, mainly focusing on the TT but often also including general support for the local partner's project organisation, manufacturing and procurement activities. Depending on the project, the supplier provides support from abroad or relocates personnel to the project country. After receiving the relevant training and support, the local partner's production capabilities are reviewed, and when acceptable performance is demonstrated, the production permit is awarded. The production activities are further regularly monitored, analysed and reported. After stabilised conditions have been achieved, the local production will be offset registered and credited based on the production reports. This may also lead to the identification of additional support needs. After the TT has been completed, the local recipient has reached the required product and process knowledge and the technology to manufacture the contract product independently. A manufacturing readiness review and the local partner will receive a serial production approval once its manufacturing processes and facilities fulfil both the supplier and the contractual requirements. The completion of the TT is also reported and claimed as a defence industrial offset. Any possible corrective actions, approval negotiations or negotiations of possible schedule extension are part of the offset delivery. After the customer approval and the procurement contract finalisation, the supplier completes a comparison between the actual and initially planned outcomes, completes the internal closure activities and conducts the lessons learned for future purposes.

When examining the participant responses, the statistical frequency analysis confirms these to be in close proximity to each other, reflecting an overall slight standard deviation ranging from 0.46291 to the individual responses being entirely identical and demonstrating a strong consensus between the respondents. Only the activities related to the local production analysis and reporting, to taking possible corrective actions after the official offset registration, crediting and reporting, and to the comparison of actual and planned in the final reporting phase divided the respondents, the percentage of each response is only 50% out of total responses. According to the respondents, these activities have an essential role in the process. Still, these activities were often not efficiently or entirely executed in the target organisation, which is reflected in the responses.

A SCOR model was further used to illustrate the TT process. The SCOR model is a cross-functional framework that provides a standard terminology to facilitate communication and a tool for the management to design and configure a supply chain to synchronise the alliance dynamics and achieve the desired performance (Delipinar and Kocaoglu, 2016; Huan *et al.*, 2004). To be successful in a highly dynamic TT environment, the companies involved cannot operate as individual entities but as network or chain partners. An industry-standard SCOR process description provides a working platform for an efficient alignment (Huan *et al.*, 2004). Furthermore, companies involved in TT activities should integrate their processes and compare them with other companies in the field for benchmarking and evaluation purposes (Delipinar and Kocaoglu, 2016). It is important to notice that the SCOR model presents each process element and how they are configured, but it does not attempt to describe every activity in detail (APICS, 2017). The first hierarchy level of the model comprises the five fundamental processes, namely, plan, source, make, deliver, return and enable (APICS, 2017). The level 1 TT process describes the three main independent organisations of foreign TT supplier, local TT recipient and the governmental end customer that is typically represented by the Ministry of Defence and/or the Defence Forces the defence offset related TT supply chain. Owing to the nature of the supplied product, i.e. the knowledge to be transferred, there are no Source or Return activities involved. The intangible knowledge is

already existing in the supplier organisation, and the return once supplied is impossible (Figure 4).

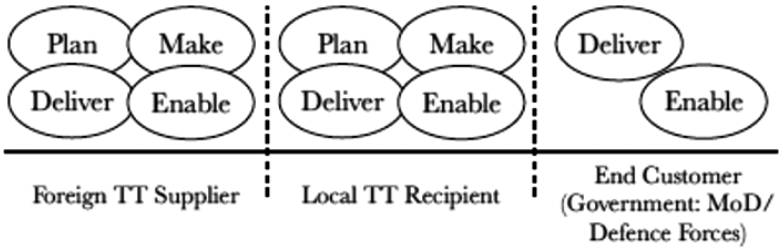

Figure 4. Level 1 TT processes

The level 2 SCOR model illustrated in Table 1 further describes how the TT supplier typically performs its operations in the Make and Deliver execution processes. The execution is supported by the strategic and long-term Plan and Enable processes. This study does not expand to level 3 owing to the restricted access to more detailed process information.

The customer-focused performance attributes of reliability and responsiveness are prioritised. The reliability addresses the ability to perform tasks as required. It focuses on predicting the outcome of a process, where the responsiveness addresses the speed at which tasks are performed (APICS, 2017). The supplier's TT process performance metrics focus on the internal efficiency in terms of achieving the contractual requirements by optimising the use of resources and the effectiveness in terms of how well the required results are achieved. Hence, the key performance indicators focus on productivity, decreasing costs and increasing profits, directly linked to the supplier's Balanced Scorecard system. There are often also further contractual capacity and quality indicators measuring the amount of acceptable contractual products that the local recipient must be capable of producing after the completion of the TT process. This quality measurement method focuses on the manufacturing output's performance and covers the supply of materials and components. Hence, the overall measurement of TT is based on three typical project pillars: cost, quality and time.

Related technology transfer process pain points and critical success factors

In addition to understanding the process, there has to be an understanding of the most significant impact factors. Hence, the factors creating barriers or preventing the efficient knowledge exchange between the organisations and, on the other hand, what factors amplify the efficiency of the transfer. In terms of the SCOR approach, these factors are points of "disconnect" in the process that negatively affect the supply chain efficiency and reliability through the generation, misinterpretation, usage or absence of information, plans, schedules, personal capabilities and/or products (APICS, 2017).

Following the Straussian procedure, first, the open coding is applied to identify the initial tentative concepts and to categorise the data by focusing on the main ideas in sentences and paragraphs, as well as to discover the conceptual properties and dimensions further and thus establish the relationships between the categories (Saldaña, 2016; Thai *et al.*, 2012; Halaweh *et al.*, 2008; Walker and Myrick, 2006; Corbin and Strauss, 1990). A particular emphasis is placed on searching and identifying processes, actions that have causes and consequences (Saldaña, 2016). The category names are derived from the participants' words and phrases and reflected in the literature. Hence, the open coding, also called inductive coding, creates

Table 1. Level 2 defence TT process SCOR map

S = Supplier **R = Local recipient** **C = Customer**	**Plan (P)**		**Make (M)**	**Deliver (D)**	**Enable (E)**					
TT process element	**P3**	**P4**	**M3**	**D3**	**E2**	**E4**	**E7**	**E8**	**E9**	**E10**
The preliminary analysis										
Establishing organization and responsibilities						S				
Collection of data							S			
Analysis of local participation rules and regulations								S		
Mapping of potential local partners										S
The planning										
Cost analysis		S								S
Risk analysis									S	
Establishing the work distribution and the technology transfer content		S				S, R				
The contracting										
The local participation contracting										S. R
Offset contracting										S, C
Contract review (internal)										S, R
Contract review (external)										S, R, C
The delivery and implementation										
Establishing the organisation and resources	S, R	S, R								
Local partner assessment			S, R							
Finalising the local participation plan	S, R									
Training and support				S						
Local production			S, R	S, R						
Local production analysis and reporting					S					
Local production registering and offset crediting				S, C						
Identification, analysis, planning and implementation of additional local support needs					S, R, C					
The closure										
Offset registration, crediting and reporting of local production				S, C						
Possible corrective actions					S, C					
Approval negotiations, or negotiations of possible schedule extensions				S, C						
Approval				S, C						
Final reporting, comparison of actual and planned					S					
Closure and lessons learned					S					

Table 2. Open coding table

Open codes				
(1) Ability to implement improvement suggestions	(11) Cultural differences	(21) Material availability	(31) Partnership	(41) Supplier selection
(2) Access control	(12) Development potential	(22) Middle management	(32) Personal capabilities	(42) Supply chain management and control
(3) Access to information	(13) Equipment	(23) Openness to receive information	(33) Planning	(43) Supply chain network
(4) Appropriate components, parts and services	(14) Facility layout and space	(24) Organisation	(34) Politics	(44) Synchronising
(5) Artesans/blue collar work/floor work	(15) Financial issues	(25) Organisational ability to adapt to new operation models and methods	(35) Previous TT experiences	(45) Top management
(6) Available time for development	(16) Financial planning	(26) Organisational culture	(36) Procurement	(46) Training
(7) Blurred organizational boarders	(17) Hidden agenda	(27) Organisational maturity	(37) Production	(47) Transparency
(8) Commitment	(18) Hidden corruption	(28) Over confidence	(38) Real time information	(48) Trust
(9) Communication	(19) Inadequate decision-making powers	(29) Partner's attitude	(39) Resourcing	(49) Unpaid invoices
(10) Cooperation	(29) Information security	(30) Partner's competence level	(40) Scheduling	(50) Working methods

codes based on the qualitative data itself without a preset codebook; all codes arise directly from the participant responses (Saldaña, 2016). In this "microanalysis," the total number of codes generated in the open coding phase is 50 and are not yet assigned to any category. These codes are listed in Table 2 in alphabetical order. The responses were grouped with the same themes under the same code, even when they did not use the same wording. Owing to the manual coding process, the overall objective was to keep the code frames flat and hierarchical, and as a result, the codes to be suitable for a different context and be easier and faster to use and to be more powerful and better organised (Saldaña, 2016; Corbin and Strauss, 1990).

The theoretical sensitivity is achieved through questioning and systematic comparison to identify possible participant subjectivity and bias as well as possible researcher errors in categorisation and by using the literature to examine the interpretations related to the environment based on the researchers' experience from the environment (Walker and Myrick, 2006; Strauss and Corbin, 1998).

In the second axial coding phase, the fractured data is connected back together by thinking systematically and relating it to each other (Halaweh *et al.*, 2008; Walker and Myrick, 2006). The conditional relationships are analysed by asking questions what, when, where, why, how and with what throughout the process, the result or consequence revealing the pattern behind the concepts and categories (Scott, 2004). Furthermore, axial coding extends the open coding in determining what codes are the dominant and important ones to best represent the phenomena under the study and specifying the contexts, conditions, interactions and consequences of a process (Saldaña, 2016). In this phase, the total number of concepts and categories generated is 15. These axial codes are listed in *axial coding categorisation table* and also presented in relation to the open codes.

Axial codes
[Related open codes]

Hidden agendas and political motivations hinder the execution of TT
[8, 10, 17, 18, 34, 45]

High transparency between the organisations minimise problems and develop trust
[1, 2, 3, 7, 9, 10,20, 25, 26, 47, 48]

Cultural differences are difficult to manage
[9, 10, 11, 23, 24, 25, 26, 27, 29, 48]

Top management commitment is critical for the project success
[8, 10, 12, 16, 19, 22, 23, 25, 26, 28, 29, 35]

Over optimistic management's expectations regarding the ability to adapt
[9, 10, 12, 16, 19, 22, 23, 24, 25, 28, 29, 30, 31, 32, 33, 35]

Adequate financial resources from the start of the project are critical for the TT execution
[15, 16, 21, 28, 29, 33]

Typically TT problems are associated with the supplier network not supplying due to unpaid invoices
[15, 16, 21, 36, 39]

The available finances determine the learning capability
[4, 6, 12, 13, 15, 16, 25, 32, 36, 39, 41, 42, 43, 45, 46, 49]

Issues with the materials procurement cause most of the challenges and delays
[15, 16, 21, 33, 36, 41, 43, 45, 49]

Early resourcing and planning of SCM critical
[6, 12, 21, 22, 30, 32, 33, 36, 39, 41, 42, 43, 46]

Axial codes
[Related open codes]

Creating a local supply network requires typically more time than initially anticipated
[6, 28, 29, 30, 32, 33, 36, 41, 42]

Local partner typically needs significant assistance in their supplier selection
[10, 21, 23, 28, 29, 30, 36, 41, 42, 43, 46]

Local availability of material often an issue
[4, 13, 15, 16, 21, 36, 41, 42, 43]

An overconfidence exists towards the local supplier network capabilities
[4, 12, 28, 33, 36, 41, 42, 43, 45]

Initial planning typically would require more time and resources than what is allocated
[6, 25, 28, 29, 30, 33, 35, 38, 39, 40, 44, 45, 46}

The axial coding categorisation table:

The third and last selective coding cycle integrates and refines the model created around the primary theme, i.e. central core category (Saldaña, 2016; Halaweh *et al.*, 2008; Walker and Myrick, 2006; Corbin and Strauss, 1990). The emergence of the critical properties and understanding of the consequences indicates reaching theoretical saturation (Scott, 2004). As a result, a reflective coding matrix is created that further contextualises the primary theme by extending the coding, focusing on the conditions and consequences of the phenomena (Walker and Myrick, 2006; Scott, 2004). The results are then returned to the individual participants for a review with a possibility to suggest adjustments. A finalised reflective coding matrix is completed after a consensus (defined as >70% agreement) is achieved, as illustrated in Table 3.

The emphasis on model building coding cycles is to explain how the TT works and how it compares to other contexts ("how") and why TT activities take place in certain conditions ("why") (Saldaña, 2016). The efficient inter-organisational TT consists of four processes by which the local recipient organisation can best influence the project's efficiency and success: management, financial resources and planning, supply chain management and local production planning. All the participants consistently bring up these processes. The role of management through the commitment and openness to the inter-organisational learning (75% weight) together with the resources and competence building of supply chain management and the establishment of local supply network (80% weight) are seen as the most crucial, typically creating the highest barriers and obstacles for the TT execution.

From the supplier perspective recipient's top management's openness and commitment to the TT project is considered unquestionably paramount (75% weight). It is, however, highlighted that the motivation to learn and develop operations grew when going down in the organisation. The blue-collar floor workers typically demonstrate the highest interest in learning and adopting knowledge. The management usually is the least committed of all organisational levels and often not seemingly understanding or grasping the attainable development potential. Further, the training and support are the easiest activity to conduct from the supplier's point of view. The overall relationship between the TT team and the recipient floor workers is typically relaxed and uncomplicated. Supplier representatives brought up that the recipient management's hidden agendas and political motivations often hinder the execution of the TT contract. The recipient management trust and resulting operational transparency between the two organisations are typically difficult to achieve. As a

Table 3. Reflective coding matrix for the main factors of an efficient inter-organisational TT process

Reflective coding matrix				
Core category	**The main factors of an efficient inter-organisational TT process at the receiving local partner organisation**			
Properties	**Management**	**Controlling**	**Organising**	**Planning**
Processes	Management	Financial planning and resources	Supply chain management	Local production planning
Dimensions	Hidden agendas and political motivations hinder the execution of the TT contract. High transparency between organisations minimise challenges and problems to occur (develop the trust). Cultural differences are challenging to manage dispute training. Top management willingness and commitment critical for the project success Senior management is typically least committed of all organisational levels to TT and does not see nor grasp the development potential. The ability to learn depends on the corporate culture and previous experiences in TT. Management is typically over-optimistic in their estimations of how quickly their organisation can adapt to new and how much of the work share they can do in-house. The operational TT team is often equipped with inadequate decision-making power that hinders the operations	Adequate financial planning from the start crucial for the TT success Typically TT problems are associated with financial issues (unpaid invoices to the supplier network). The available finances and resources to implement the development suggestions determine the overall attitude and learning capability at the local receiving organisation	Issues with the materials procurement cause most of the challenges and delays Adequate resourcing and planning of procurement and SCM required at an earlier stage (securing material availability, training and support of the supply chain network) Creating a local supplier network requires resources and time (minimum of two years). Local partners typically need extensive assistance in supplier selection. Local availability of materials often an issue Overconfidence regards the local supplier network capabilities to supply new parts and assemblies from the project's very beginning	Reserve more time and give more focus on detailed planning at the beginning of the project Adequate scheduling and resourcing critical, needed resources typically underestimated Access to local partner's production information such as operations and scheduling critical (transparency) Efficient communication difficult, especially regards real-time issues and problems experienced, needs high emphasis and detailed planning Synchronising the schedules between the supplier and receiver of TT often challenging
Context	Authority over operationalisation and operations development	Facilitator of operations	Sufficient materials and other resources for manufacturing operations	Conditions of the operations; parameters, requirements and interdependencies
Strategies for understanding the consequences	The organisation is open to cooperation, and its goals are aligned to facilitate learning	Sound financial commitment with understanding that a successful TT requires long term investments and financial resources	Required cooperative supply chain strategies and collaborative product and process planning require time, resources and in-house capabilities building	The TT implementation success rate is directly linked to the quality of the initial planning phase

result, the TT team is often equipped with inadequate decision-making powers to execute the local participation plan. Based on the supplier responses, the cultural differences throughout the organisation are difficult to manage despite the extensive training. The management should continuously highlight these factors throughout the process, not just in the beginning. Based on supplier experiences, the recipient's ability to learn depends on the overall organisational culture and previous experiences in TT and similar projects, all factors driven mainly by the management. To assist and advance the TT, the recipient management as the highest authority over operationalisation and operations development should be more open to cooperation. The organisational goals should be aligned to facilitate the development through inter-organisational learning.

Typically, the TT problems are associated with financial issues, most commonly to unpaid invoices to the supplier network, resulting in production disruptions due to material non-deliveries (58% weight). Adequate and appropriate financial resources allocation and planning is a fundamental process. Still, as the local partners typically are financially restricted or struggling business entities, the available resources are often in imbalance to the project needs from the start. The available finances and resources to implement the supplier's development suggestions further determine the local receiving organisation's overall attitude and learning capability. A sound financial commitment with understanding that a successful TT requires long term investments and significant financial resources forms a baseline for the recipient to facilitate the necessary operations.

The supplier representatives agree that the recipient's materials procurement-related issues cause most of the TT process's challenges and delays (80% weight). Adequate resourcing and planning of the procurement and supply chain management (securing material availability, training and support of the supply chain network) are required at the beginning of the process. It is estimated that creating a local supplier network requires a minimum of two years to build together with adequate resources as the local recipient typically needs extensive support in supplier selection and the development of supply chain management capabilities. The recipient is generally overconfident at the beginning of the TT process regarding the local supplier network capabilities to supply new parts and assemblies at a tight schedule. However, based on global project experiences, the local availability of materials is typically an issue in defence industry projects. Sufficient materials and other resources for manufacturing operations require cooperative supply chain strategies, and collaborative product and process planning requires time, resources and in-house capabilities building at the recipient organisation.

The TT implementation rate is directly linked to the quality of the initial local production planning phase that determines the conditions of the operations and the parameters, requirements and interdependencies. The supplier participants suggested that the local recipient reserve more time for detailed planning of the project, focusing on synchronising scheduling between the supplier and receiver and securing adequate resourcing for the project (64% weight). Transparency through knowledge sharing is critical as the supplier needs to access the local partner's production information, such as operations and scheduling. This is often experienced as challenging because of trust issues echoing from higher management. Overall, efficient communication from the recipient to the supplier is difficult; the recipient is usually struggling to communicate problems and challenges in real-time, typically resulting in constant process delays.

In addition to the open-ended questions answered, the participants were presented with a structured list of TT related problems and possible "disconnects" and requested to select the ones they have encountered in the TT process. The problem list was constructed based on the previous studies and reflected against the researcher's knowledge of the environment (Ivarsson and Alvstam, 2005; Capasso *et al.*, 2005; Szulanski, 1996; Zander and Kogut, 1995; Galbraith, 1990; Lasserre, 1982; Contractor and Sagafi-Nejad, 1981; Davies, 1977; Teece, 1977; Mansfield, 1975; Baranson, 1970). The participants could also add problems outside the list. The TT teams are relatively small, and typically, the same people are involved in multiple TT projects from start to finish. Furthermore, the managerial and executive responsibilities are also centred, which decreases the need to conduct extensive studies overarching the entire supplier organisation. Hence, with this study sample, it was possible to reach both the operational, managerial and executive-level feedback related to the TT execution and its issues.

The statistical frequency analysis of the structured questionnaire presented a relatively small variance between the results of different respondents reflecting the most prominent challenges encountered related to four segments as follows:

1. the knowledge to be transferred (i.e. codifiafibility, complexity, ambiguity and tacitness);
2. the pre-transfer planning;
3. the recipient abilities and characteristics; and
4. the cultural and language differences.

Notable is that the segments with the least issues experienced are related to the following:

- recipient's overall competence and retentive capacity; and
- floor level workers' competence, motivation and ability to communicate.

Discussion

When the case TT process is compared and reviewed to the process descriptions found in the existing literature, several intersecting points emerge, reflecting similar conditions and environment to this case study. The literature, however, provides a less detailed macro view to the different metal-level aspects of the TT phenomena and its generic concepts. It is imperative to have a systematic process in place to manage the inter-organisational TT process effectively. As the systematically constructed base cases in the defence offset context are rare and typically only outlining the macro-level activity, our level 2 SCOR TT process model advances the more profound understanding of the more efficient TT operation management (Fredriksson *et al.*, 2018; Malm *et al.*, 2015; Ivarsson and Alvstam, 2005; Simonin, 1999; Albino *et al.*, 1999; Szulanski, 1996; Wei, 1995; Cusumano and Elenkov, 1993; Reddy and Zhao, 1990; Mansfield and Romeo, 1980). When looking for patterns, repeated relationships and grouping the data accordingly, the emerging model can represent the theoretical position of inter-organisational TT in this case context.

Figure 5 illustrates a typical receiving local partner's operating scenario seen from the supplier viewpoint where the TT barriers and obstacles are formed by management that is not fully committed and open to learning, the inadequate financial support and planning, the rushed execution of supply chain management with insufficient resources and capabilities building elements and finally the inadequate local production planning. These barriers lead to

the low performing TT project and unused development potential. The overall focus is on defence product capabilities building, replicating the supplier's processes without more profound learning objectives.

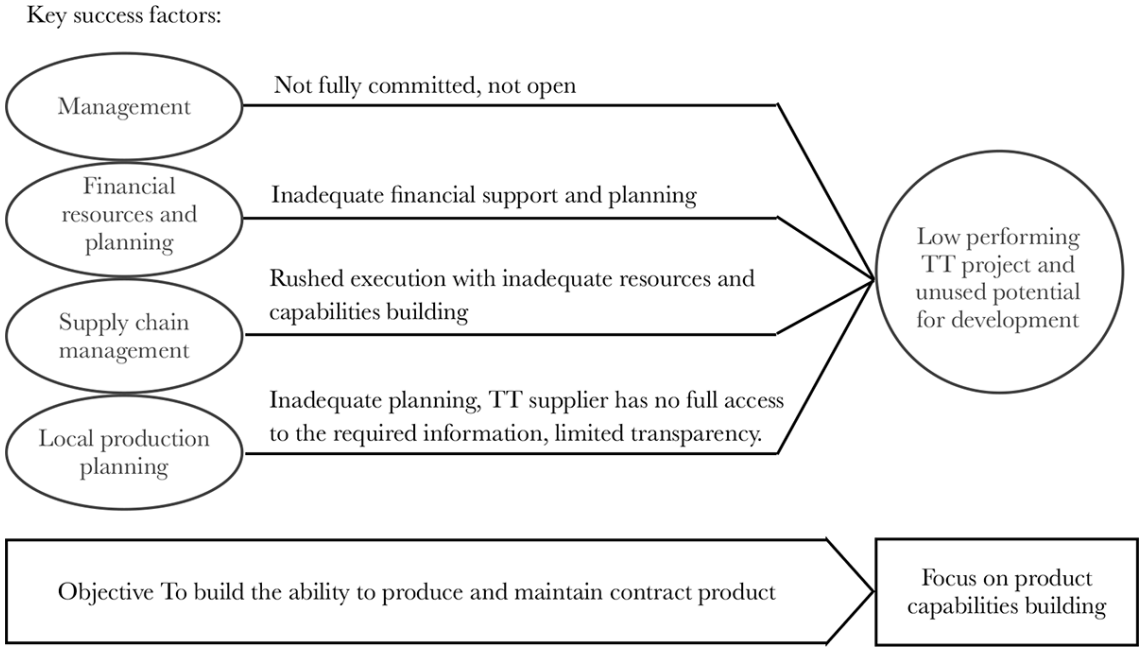

Figure 5. Receiving local partner's typical operating scenario

Figure 6, on the other hand, illustrates receiving local partner's ideal operating model, an optimal operating environment. The objective is two-dimensional, to build the ability to produce and maintain the contract product and support innovation and organisational learning, developing future capacity and capabilities. This is achieved through management that is open to cooperation and organisational goals to facilitate learning, sound financial commitment and planning throughout the project, adequate time and resources allocated for the in-house supply chain management capabilities development and lastly, adequate local production planning with transparency between the supplier and recipient organisations. This leads to a successful project with added knowledge absorption and organisational learning capability. These presented models can be reflected the conditions of a successful inter-contextual best practice transfer where well-defined preconditions and planning regarding practices, performances and time and a strong and stable managerial commitment are the most relevant factors for a successful TT (Capasso *et al.*, 2005). The recipient cannot be passive and expect an automatic increase in the capabilities. Instead, the approach must be more strategic and enable a long term deep relationship with the supplier (Ivarsson and Alvstam, 2005; Reddy and Zhao, 1990). In all, businesses form inter-organisational alliances to gain access to resources and competencies, to learn (Edmondson and Harvey, 2017; Edmondson, 2012; Capasso *et al.*, 2005). The core manufacturing and best practice knowledge transfers, replications and relocations through international strategic alliances are critical strategic decisions when organisations seek more flexible manufacturing approaches and growth (Johnson *et al.*, 2017; de Holanda Schmidt Squeff and de Assis, 2015; Kiss, 2014; Axelson and James, 2000).

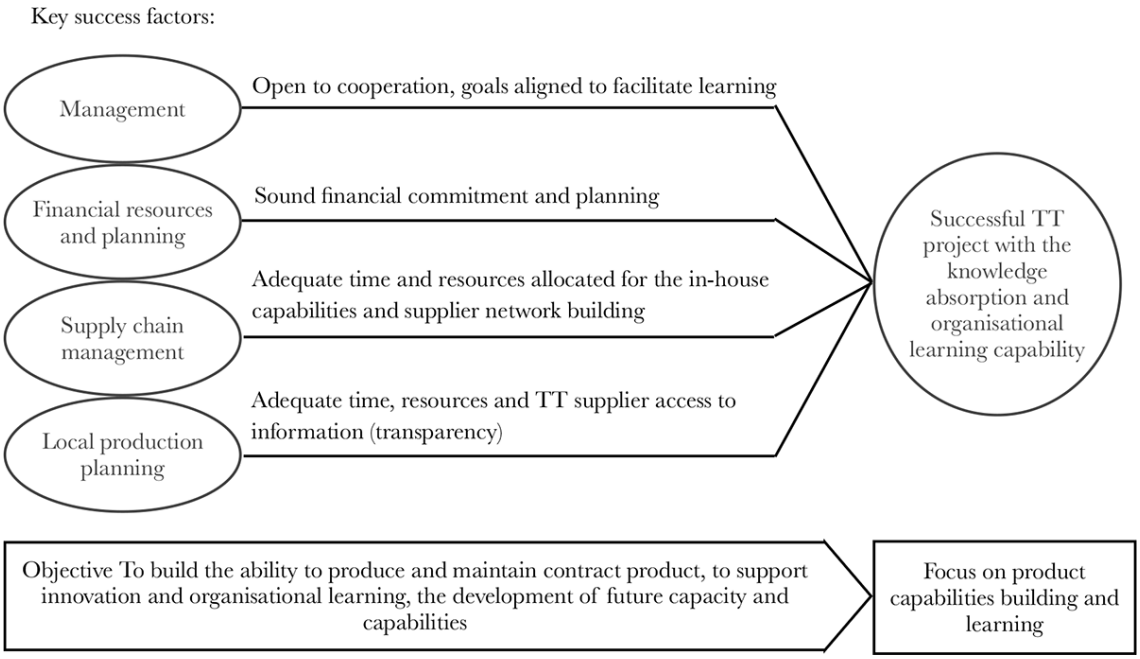

Figure 6. Receiving local partner's ideal operating model

This case study results can be reflected in the literature review where the local recipient's initial attitude and capabilities, preparation and planning and the TT execution are variables to the TT outputs (Lorell *et al.*, 2002; Kiss, 2014). Hence, the results build new knowledge by validating theoretical assumptions. As illustrated in Figure 1, the local recipient's overall attitude, abilities and management capabilities form a precondition for the overall project to determine how successful the technology absorption and utilisation can be. The level of preparation and planning, on the other hand, predicts the efficiency of the TT execution. The following execution focus, involvement of the supply chain partners and strong financial support from the government further enable the best value creation and sustainable outputs such as commercialising the technology acquired and establishing strategic international level partnerships. Hence, the local recipient's initial attitude and capabilities, preparation and planning and the TT execution are variables to the TT outputs.

Overall the different sources tend to all agree in their conclusions on the fact that the governments should increasingly focus on becoming intelligent customers (Lorell *et al.*, 2002; Kiss, 2014). Simultaneously, these sources provide relatively little practical guidance for these companies on how this will be efficiently achieved and managed. Based on this case study, to truly capitalise on the TT's benefits, the local participation strategy must reach beyond a single contract scope and build sustainability by engaging parties in long-term mutually beneficial ways and incorporating the whole supply chain network.

Governments represent the highest procurement authority in the defence industry ecosystems, setting the regulations and policies under which the defence contract operates. Governments seek to support the local defence industry and strategies through industrial participation. Thus, an efficient and successful TT from the foreign entity to the local recipient is a high priority to attain benefits in capabilities building and possible future innovations. However, the long-term outcomes of the industrial participation activities are generally challenging to monitor. The transfer process is often also influenced by alternative motivations and

underlying politics affecting the TT process's inter-organisational cooperation and execution. In general, political emphasis is often on the short-term benefits of providing work and building capabilities to maintain the contractual product in warfare situations, rather than trying to grasp the long term benefits in the form of organisational learning and innovations capabilities building. Industrial participation comes with a high price tag without real possibilities for significant future returns through the potential industry innovations and evolving.

Governments should engage in activities to enable efficient knowledge absorption and organisational learning. The critical governmental focus should be to ensure that the local recipient has adequate financial status throughout the project and allocate the necessary time for detailed pre-planning between the foreign supplier and the local recipient. The local recipient should build links to both the government authorities better to understand the operational requirements and the foreign supplier to enable a management-led open and cooperative TT environment from the start. The positive effect of a successful TT would not be limited to the local recipient only. Still, the positive ripple effect may reach several local industry actors through the supply network collaboration.

In terms of performance metrics, standard measurement and assessment should be established to focus on the execution of the critical success factors and the knowledge absorption and organisational learning capability. However, devising such a measurement method within the TT process is not easy as there is no tangible output. How do you assess the quantity and quality of knowledge when the transfer is more qualitative than quantitative exercise? The TT process objective is to establish the related local participation contract that focuses on enabling the local serial production phase rather than the long-term potential intangible benefits. Furthermore, the TT process performance measurement cannot be integrated into and managed as a part of the production phase as presented in Figure 2 owing to the different aims and nature of these individual phases. Hence, TT and production must have their independent performance measurement approach.

Currently, the TT process is measured only during its execution phase, focusing on its operations and activities. The TT supplier indicators are focused on managing productivity, decreasing costs and increasing the profitability and possible capacity and quality in terms of the acceptable contractual products that the local recipient must be able to produce after the completion of the TT process. A possible measurement for the TT process output's success could involve incorporating the quality and timeline aspects – the quality in terms of the local serial manufacturing output's performance in the production phase. Quality assurance would be involved from the beginning of the production, assessing the quality of the end product and the supply of materials and components for the production. Secondly, the time in terms of production time and how long it takes to assemble the subsections and the end product. As the technology owner, the TT supplier has an already established baseline that can be used to reflect against what should be achievable in the local serial production phase. If the production takes too much time, it indicates that the local recipient is not as efficient as possible.

Research and managerial implications

A novel integrated case study and Straussian grounded theory approach under the interpretative assumptions and purposive sampling in a global defence industry organisation is applied for this study (Palinkas *et al.*, 2015; Thai *et al.*, 2012; Halaweh *et al.*, 2008). Case

studies are typical for defence studies with high access restrictions, but grounded theory applications are not previously applied in this field.

This research aims to assist the local recipient companies involved in the defence offset TT projects to establish and manage their TT projects more successfully and sustainably. The conceptual framework presented in this paper suggests that TT management is complex and calls for efficient management, especially of the SCOR model "Plan" process practices and a corporate culture that genuinely facilitates learning. Even though planning activities exist in all companies, they should be considered a strategic tool for its success in the defence TT context. Related to that, a successful knowledge absorption is accomplished by having a management team that is open to cooperation and applying organisational goals that facilitate learning, through having a sound financial commitment and planning throughout the project life cycle, through the allocation of adequate time and resources for the development of the supply chain management and lastly through thorough local production planning with a commitment to transparency between the supplier and recipient organisations. This receiving local partner's ideal operating model is illustrated in Figure 6. The role of the local recipient's management through the commitment and openness to the inter-organisational learning as well as the resources and competence building of supply chain management and the establishment of the local supply network is identified as the most crucial, typically creating the highest barriers and obstacles for the TT execution and thus preventing the knowledge exchange from the supplier perspective.

Furthermore, the TT key success factors' management and the systematic development of the knowledge absorption and organisational learning capability also require the implementation of an efficient performance management system. However, devising a measurement method within the TT is challenging because the output is intangible to a great extent. The SCOR framework could provide a good baseline that can be customised to specific TT needs. In general, the SCOR method should be further investigated if it would be possible to extend it to cover these intangible and qualitative aspects. The SCOR model was initially designed for the manufacturing sector (Delipinar and Kocaoglu, 2016), and as Legnani (2011) and Di Martinelly *et al.* (2009) point out, the SCOR model sometimes is too general and that certain adaptations that are more targeted to the environment of individual supply chains are necessary.

The possible broader implications of the present research were that the governments setting the regulations and policies under which the defence contracts operate should engage in activities to enable efficient knowledge absorption and organisational learning and build future innovation capabilities. The key focus should be on ensuring that the local recipient has sufficient financial resources throughout the project and the necessary time for detailed pre-planning.

This study does not answer all the possible questions related to the defence industry TT process, nor does it attempt to. This study extends the few SCOR defence industry applications presented by Bean *et al.* (2009) and represents activities typical for global defence TT supply chains. While not a comprehensive answer to all the multifaceted challenges, the identified 'Plan' process key success factors provide practical field guidance and direction for future research.

This study had several limitations, which also offer avenues for future research. The data was based on a single case study, only reflecting the supplier view and did not capture the local

recipient's views or the broader industrial participation environment. Therefore, future research could explore the other dimensions of the process and analyse them over time as a longitudinal study to better understand the interaction between the supplier and the recipient and other factors playing a role over time. Despite the limitations, this study reported actual experiences from a global TT supplier perspective, giving new insights to limited literature of inter-organisational TT in a complex high technology defence environment.

Conclusion

The main contribution of this paper is the advancement of the understanding of defence TT through the construction of a TT process SCOR model and the identification of this process' pain points and critical success factors through a novel integrated case study and Straussian grounded theory approach. This process arose out of lessons learned from the best practices in a global defence TT supplier company. As a result, the defence industry organisations and economies involved in defence contracting can better plan and manage their related industrial participation TT activities. To date, the body of research has focused on the factors influencing the technology absorption (Malm *et al.*, 2015; Knudsen and Madsen, 2013; Simonin, 1999; Grant and Gregory, 1997; Szulanski, 1996; Zander and Kogut, 1995; Cohen and Levinthal, 1990) and to identify meta mechanisms between the supplier and recipient organisations (Capasso *et al.*, 2005; Stock and Tatikonda, 2000; Albino *et al.*, 1999; Lyles and Salk, 2007; Lasserre, 1982), providing very little insight into the actual TT process and activities taking place between the supplier and the receiver under a defence offset contract. This study sought to fill this gap by advancing the operational level understanding by presenting a systematically constructed best practices case study based TT SCOR process map as illustrated in Table 1 and identifying this process's pain points and critical success factors. As a result, this study also sought to assist the local recipients in better planning and managing their related industrial participation TT activities with the technology supplier. The participating local organisations typically do not have extensive prior experience on TT. Consequently, there are typically no effective routines to manage all the aspects of the process to the extent that the transfer often requires *ad hoc* solutions. As a result, the learning opportunities are not used effectively.

The general objective of defence industrial TT is two-dimensional, firstly and mainly, to build the local ability to produce and maintain the contract product in a wartime situation. Secondly, to support innovation and organisational learning in the long run, the development of local defence industry sustainability through future capacity and capabilities for the local industry players to compete in a global marketplace. This case study advanced the theoretical position of local recipient's management, financial planning, supply chain management and local production planning as the main factors that the local recipient organisation can best influence to enhance the project's efficiency and success.

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Appendix

Questionnaire Template

Question: From supplier's point of view, the generic main phases of technology transfer in a local production and offset context is presented below. Please check the activities that you agree are part of the process based on your experience.

Marketing and negotiation phase (before the main supply contract is signed)

Preliminary study:

- ☐ Determination of person in charge and organisational responsibilities
- ☐ Collecting base data and information
- ☐ Analysis of industrial participation regulations and requirements
- ☐ Local partner survey and selection
- ☐ Preliminary industrial participation plan

Preparation:

- ☐ Contract preparation and preliminary industrial participation execution planning
- ☐ Cost analysis
- ☐ Risk analysis
- ☐ Determining work share and technology transfer content
- ☐ Contract preparation

Negotiation and contract:

- ☐ Contract negotiation and signing
- ☐ Contract review (internal)

Contract delivery phase (after the main supply contract is signed)

Execution:

- ☐ Contract review
- ☐ Establishing the organisation and allocating the resources
- ☐ Establishing the industrial participation execution plan
- ☐ Training and support
- ☐ Production permit
- ☐ Industrial participation analysis and reporting
- ☐ Industrial participation claiming and crediting
- ☐ Analysis and review of possible additional support needs, and their planning and execution

Completion:

- ☐ Industrial participation analysis and reporting
- ☐ Claiming, crediting and reporting
- ☐ Possible corrective measures
- ☐ Industrial participation approval negotiations, or possible negotiations for extra time if not fulfilled on time
- ☐ Approval
- ☐ Final reporting and review to the planned
- ☐ Closure and lessons learned

Question: Based on your experience from the contract delivery phase, please list the activities that are the most problematic to manage and control with the recipient, and please elaborate the main reason(s) for the issues experienced.

Question: Based on above question, what do you think should be done differently at recipient's end to decrease the problems experienced and to improve the efficiency of technology transfer process?

Question: Based on above question, is there clearly a one activity that is causing most of the problems in the technology transfer process?

Question: Based on your experience from the contract delivery phase, please name typically the most successful activities, in the technology transfer process.

(Continued)

Question: Is there any form of evaluation taking place before the selection of the local partner (i.e. the recipient of the technology transfer)?

- ☐ Yes
- ☐ No

If your answer is yes, are the evaluation processes and/or procedures standardised?

- ☐ Yes
- ☐ No

If your answer is yes, please also elaborate what kind of evaluation is taking place:

_____
_____
_____
_____

If your answer is yes, please check if any of the following factors is included to the evaluation:

- ☐ Global ability
- ☐ Management style
- ☐ Quality systems
- ☐ Logistics
- ☐ After-market services
- ☐ Current product and process competence
- ☐ Product development
- ☐ Finance
- ☐ Non of the above

Question: Is the local partner provided any suggestions how they could improve their operations before the technology transfer takes place?

- ☐ Yes
- ☐ No

If your answer is yes, please provide some typical examples of the improvement suggestions:

_____
_____
_____
_____

If your answer is yes, based on your experience, how is local partner's attitude towards possible improvement suggestions received from the supplier? Are the suggestions for corrective measures and development ideas implemented?

_____
_____
_____
_____

If your answer is yes, based on your experience, on a scale from 0 to 5 how is local partner's attitude towards improvement suggestions received from the supplier?

- ☐ 0 - not at all interested, negative attitude
- ☐ 1 - not at all interested, neutral attitude
- ☐ 2 - slightly interested
- ☐ 3 - somewhat interested
- ☐ 4 - very interested

(*Continued*)

☐ 5 - extremely interested

Question: Based on your experience, are the local partners typically committed and interest to learn and improve their operations?

_____
_____
_____
_____

Question: Is the local partner regularly evaluated by the supplier during the technology transfer phase?

☐ Yes
☐ No

If your answer is no, why do you think the local partner is not regularly evaluated by the supplier during the technology transfer phase?

_____
_____
_____
_____

Question: Based on above question, if your answer was yes, is there any feedback and technological or other assistance provided to the recipient in identified problem areas?

☐ Yes
☐ No

Question: Please check if the local partner (i.e. the recipient of the technology transfer) is involved in any of the following activities before the main supply contract is signed:

☐ Preliminary industrial participation planning
☐ Cost analysis
☐ Risk analysis
☐ Determining work share and technology transfer content

Question: Is ad hoc solutions often required throughout the technology transfer process?

☐ Yes
☐ No

Question: Based on your experience, do you think the recipients of technology transfer typically have effective routines in place to handle all the aspects of a knowledge transfer and the collaboration with the supplier ?

☐ Yes
☐ No

Question: Please see the list below and check the problems you have encountered in the technology transfer process.

☐ Knowledge codiafibility (i.e. the extent the supplier could articulate the knowledge in a documents and softwares such as blueprints, procedural task descriptions, etc.)
☐ Knowledge complexity (i.e. technical complexity and technological sophistication of new features and concepts in a technology to be transferred)
☐ Knowledge ambiguity (i.e. the uncertainty or doubtfulness of the meaning of language, when the language is capable of being understood in more than one way by a user)
☐ Knowledge tacitness (i.e. the kind of knowledge that is difficult to transfer to another person by means of writing it down or verbalising it)
☐ Supplier problems to identify local recipient needs
☐ Inadequate pre-transfer planning
☐ Inadequate post-transfer control

(*Continued*)

- ☐ Recipient's employee's teachability and absorptive capacity (i.e. the case at the individual level by which knowledge can be taught to new workers and new technological practices can be adapted)
- ☐ Availability of qualified technical and managerial personnel with critical skills and know-how
- ☐ Recipient's lacking retentive capacity (i.e. ability to preserve the routine use of the new technological practices)
- ☐ Recipient problems achieving a satisfactory local production performance
- ☐ Recipient's lacking performance review and evaluation of their operations under the technology transfer
- ☐ Recipient's lacking ability to analyse and evaluate their organisational performance
- ☐ Recipient's lacking ability to implement improvement suggestions received from the supplier
- ☐ Recipient's lacking use of management methods
- ☐ The level of recipient employee's competence
- ☐ Recipient's management lacking motivation
- ☐ Recipient's floor level workers lacking motivation
- ☐ Recipient's lacking prior experience and understanding in the contract technology
- ☐ Recipient's lacking prior experience and understanding on the technology transfer process
- ☐ Cultural differences
- ☐ Language differences
- ☐ Communication issues on management level
- ☐ Communication issues on floor level
- ☐ Geographical distance between the supplier and the recipient

Question: Based on your experience, what are typical manufacturing start-up problems experienced with the recipient?

_____
_____
_____
_____

Question: Is supplier's manufacturing procedures adapted to local conditions?

- ☐ Yes
- ☐ No

Question: Based on your experience, please check what of the following categories of technological support, assistance and collaboration are typically offered to the local recipient.

Assistance related to product technology:

- ☐ Provision on product designs and technical specifications
- ☐ Provision, advice and/or financial assistance to obtain raw materials and components
- ☐ Regular feedback on product performance to improve existing production technology
- ☐ Technical consultations on product characteristics to master new product technology
- ☐ Organised R&D collaboration in product related areas

Assistance related to production technology:

- ☐ Provision, advice and/or financial assistance to obtain machinery and equipment
- ☐ Technical support to improve existing production technology
- ☐ Technical consultations on machinery operations to master new production technology
- ☐ Advice on production layout and organisation
- ☐ Assistance with quality assurance systems (e.g. ISO certification, TQM, etc.)

Training programmes for employees:

- ☐ In-plant training for managers and/or technicians at the recipient
- ☐ In-plant training for workers at the recipient
- ☐ In-plant training for managers and/or technicians at the raw material and/or component supplier(s)
- ☐ In-plant training for workers at the raw material and/or component supplier(s)

☐ In-plant training for managers and/or technicians at the supplier
☐ In-plant training for workers at the supplier

Question: What type of training is provided:
☐ None
☐ On the job (e.g. training provided at the workplace, practical training)
☐ Formal (e.g. classroom instruction, web-based training, e-learning, workshops, seminars, etc.)

Question: Based on your experience, check what type of training you think is the most important (i.e. has the highest impact on learning and competence development), and please elaborate your answer.
☐ On the job
☐ Formal
☐ Combination of both on the job and formal

_____
_____
_____
_____

Question: Which of the following range of techniques typically have been made available to the recipient?
☐ All techniques and manufacturing procedures controlled by the supplier
☐ Only those techniques relevant to the broad range of activities undertaken by the recipient
☐ Only those techniques relevant to the delivery contract

Question: How it is identified/decided what activities, operations, and/or information is to be transferred to the recipient?

_____
_____
_____
_____

Question: Elaborate how is the typical organisational relationship between the supplier and the recipient? What are typical problems?

_____
_____
_____
_____

Question: How could the recipient increase the success and adaptation of the technology transfer within their organisation?

_____
_____
_____
_____

Question: Based on your experience, on a scale from 0 to 5, how probable you think it is that the local recipient of the technology transfer is able to utilise the gained manufacturing capabilities in their future contracts?
☐ 0 - It definitely will not happen
☐ 1 - Not likely
☐ 2 - Neutral
☐ 3 - Likely
☐ 4 - Very likely
☐ 5 - I cannot say

Question: Based on your experience, on a scale from 0 to 5, how often does the local recipient end up being part of supplier's global supply chain after the technology transfer?
☐ 0 - It does not happen
☐ 1 - Not often
☐ 2 - Neutral
☐ 3 - Often
☐ 4 - Very often
☐ 5 - Always

Figure A1