Knowledge management in SMEs and MNCs: Matching knowledge mobility mechanisms to supply network configuration profiles

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Abstract:

While 'knowledge mobility' presents significantly different challenges for SMEs and MNCs, it is strongly influenced by two common factors: the type of knowledge to be integrated and the configuration of the operations network. Only by understanding the various types of knowledge and how they - and the configuration profile of the network (Nascent, Emerging, or Mature; Local, Regional, or Global; SME or MNC) – affect how knowledge is shared, can a proactive and integrated approach to knowledge management be developed.

This study specifically examines knowledge transfer mechanisms in knowledge-intensive manufacturing firms and across their networks. Here, both SMEs and MNCs are required to make critical decisions about the 'level' of collaboration and knowledge sharing with network partners - whether it should be purely transactional or more strategic.

A network configuration framework is extended to incorporate knowledge-specific dimensions of analysis, derived from the academic literature on stages of emergence and knowledge transfer theory, and supported by a review of knowledge integration mechanisms in practice. This was supported by benchmarking exercises involving a series of multi-organisational network cases with different types of SME-SME and MNC-SME interactions, and gaining insights on factors that will affect future Knowledge Mobility Configurations through a series of industrial case studies. The resulting Knowledge Mobility Configuration (KMC) framework was tested and refined using five case studies indicative of a growing shift towards information and knowledge-intensive activities – involving production and supply network 'partners' - in both SME and MNC contexts.

In terms of contribution, there has been limited empirical research to-date into the determinants of successful knowledge transfers in MNC-SME network contexts. The network configuration element of the KMC framework provides insights on how such networks evolve, and how specific knowledge mobility profiles may evolve over time. Our findings demonstrate the critical role of knowledge management in internationalisation, and that skills, knowledge, technology and organisational processes are integral to any emerging network design criteria and/or 'capability' acquisition assessment. The choice of integration mechanism is not only

influenced by the type of knowledge being 'mobilised', but also by industrial context and the maturity of the network within which the knowledge is being shared. This more nuanced approach may be used as a basis for a proactive and differentiated approach to knowledge mobility and integration across SME and MNC networks.

Keywords: Knowledge Management; Knowledge Sharing; Knowledge Mobility; Network Configuration; MNCs; SMEs

1. Introduction

The importance of knowledge as a critical element of modern organisational performance has been widely reported in the academic literature (e.g. Grant, 1996; Novins and Armstrong, 1998; Drucker, 1999; Birkinshaw, 2001; Yang, 2008; Durst and Edvardsson, 2012; Aboelmaged, 2014). Collaborative networked organisations are emerging that seek access to new skills, knowledge, markets and technologies to meet emerging market needs - through sharing risk, integrating complementary competencies and leveraging specialist capabilities (Romero and Molina, 2011; Dooley, Kirk, and Philpott, 2013; Harrington and Srai, 2016)

This study looks to develop a knowledge management methodology that can be used by networked organisations and their partners, to exploit the synergies available from better network coordination. While advances in knowledge management usually focus on the needs of larger organizations (Gupta and Govindarajan 2000), there has been little systematic empirical investigation into the determinants of successful knowledge transfers in MNC-SME network contexts. Furthermore, while the benefits of implementing knowledge management strategies have been proven, research has largely focused on technology as a solution – often neglecting critical relational factors (Harrington et al., 2012; Pawar and Rogers, 2014; Harrington et al., 2016).

For both SMEs and MNCs, an ability to identify and re-organise around future 'capability' requirements has also become increasingly important, especially where 'knowledge' plays a critical role in network partner selection and future organisational design (Harrington and Srai 2016). Inefficient use of resources, and ineffective operations and supply chain procedures are often cited as causes of failure for both SMEs and MNCs (Gold et al., 2001; Ates et al 2013; Cerchione et al, 2015, Gunasekaran et al, 2000; Lee and Klassen, 2008; Harrington and Srai 2017). While larger organisations, with a history of international operations, are much more familiar with the problems of knowledge integration, few – if any – claim to have overcome those (Fleet et al., 2014).

A key determinant in better understanding the success or failure of any knowledge initiative is the identification and assessment of the context in which 'transfer' or 'sharing' takes place and the preconditions that are necessary for the effort to succeed (Gupta and Govindarajan, 2000; Gold et al, 2001). Organisations need to make decisions about the 'level'

of collaboration and knowledge sharing that should exist between partners - whether it should be purely transactional or strategic (Harrington and Srai 2016).

An overview of knowledge transfer theory is presented to inform the development of a Knowledge Mobility Configuration (KMC) framework, which combines network configuration aspects of knowledge within multi-partnered contexts, with knowledge transfer mechanisms. Through analyzing and integrating different determinants of knowledge networks and how they support or enable sharing processes, this research contributes to the body of knowledge by providing a holistic understanding of the dimensions, their relationships, and the impact of different network configurations at various maturity levels. Network case studies, that were indicative of the growing shift towards *knowledge-critical* activities, were specifically selected to test and refine the KMC framework. The cases involved a series of regional suppliers (SMEs) and global manufacturing networks (MNCs), and enabled an examination of real knowledge sharing networks in practice today. The research also explored the relationship between management and engineers as well as comparing these opinions with the perceived ideals for knowledge mobility for production lines at various states of maturity. The KMC framework enables the 'matching' of optimal knowledge mobility mechanism(s) to specific supply network configuration profiles of MNCs and SMEs. It can provide practitioners with a visual representation of the current state of knowledge sharing within their organisation and wider networks, and an approach to assessing potential future states and mechanisms.

The paper is structured as follows. Section 2 introduces the research domains, providing background information, describing the research area and scope, and reviewing the existing literature on knowledge, knowledge mechanisms, and network configuration. Section 3 presents the prototype Knowledge Mobility Configuration framework, derived from outputs from the literature review. Section 4 summarises the research methodology and case studies. Section 5 reviews the findings from the study including application and test of the prototype framework for Knowledge Configuration Profiling. Section 6 summarises the final framework following refinement, and discusses instructive insights from the 'real' case studies. Section 7 concludes with a summary, identifying limitations and areas for further work.

2. Literature review

Good knowledge management practices integrates organisation, people, processes and technology with the ultimate goal of improving organisational performance (O'Dell and Grayson, 1998; Wiig 1999; Wang and Plaskoff, 2002). To better understand the critical dimensions of *knowledge management* in MNCs and SMEs, it is necessary to develop a clear picture of how various knowledge areas are related and how 'mobility' is facilitated or impeded by various configurational and other factors. This section summarises the key literature in the domains of knowledge mobility and network configuration to inform the development of the KMC framework.

2.1. Developing a Model of Knowledge Mobility

Knowledge is integral to any emerging network design criteria (Harrington and Srai 2016). Activities related to knowledge management, including knowledge acquisition and knowledge sharing, are defined here as *Knowledge Mobility* (K*Mob*). K*Mob* is understood as the communication or shared understanding of knowledge (Szulanski, 2003), and is costly, time consuming, labour intensive and difficult, and requires a certain level of trust (Szulanski, 1996; Durst and Edvardsson, 2012; Landryová and Irgens, 2006; Liu et al, 2014; Hora & Klassen, 2013; Argote et al, 1999; Harrington and Srai 2016). However, it is only by understanding the various types of knowledge - and how these affect how knowledge is shared - within the configuration profile of a network (Nascent, Emerging, or Mature; Local, Regional, or Global; SME or MNC) can a proactive and integrated approach to knowledge management be developed.

To aid frame the development of the KMC framework, Figure 1 illustrates a model for K*Mob* showing key linkages in a manufacturing mobility context, and the key areas of focus for this research, namely:

- Network configuration and maturity
- MNC and SME perspectives on knowledge
- Knowledge types and knowledge mobility mechanisms

Manufacturing choices and knowledge influence the choice or specification of process equipment which may radically alter the specification of the production process, innovation capability, value network, and supply chain partners required in delivering an end product (Harrington et al., 2017; Delbufalo, 2017). In any assessment, decisions regarding the network also require a certain body of knowledge as changes in any decision area will affect choices ‘upstream’ and ‘downstream’, in addition to the application of appropriate knowledge management concepts locally and globally (Di Gregorio et al, 2009; Fleet et al., 2014). This is true for both MNCs and SME networks, irrespective of size and global reach. Hence, in the case of MNCs and SMEs, the type of knowledge being transferred largely influences the choice of knowledge mobility mechanism, as does the network configuration - and the maturity of the network - within which the knowledge is being mobilised or integrated. Sections 2.2-2.5 now examine K*Mob* mechanisms in the context of network configuration and knowledge type.

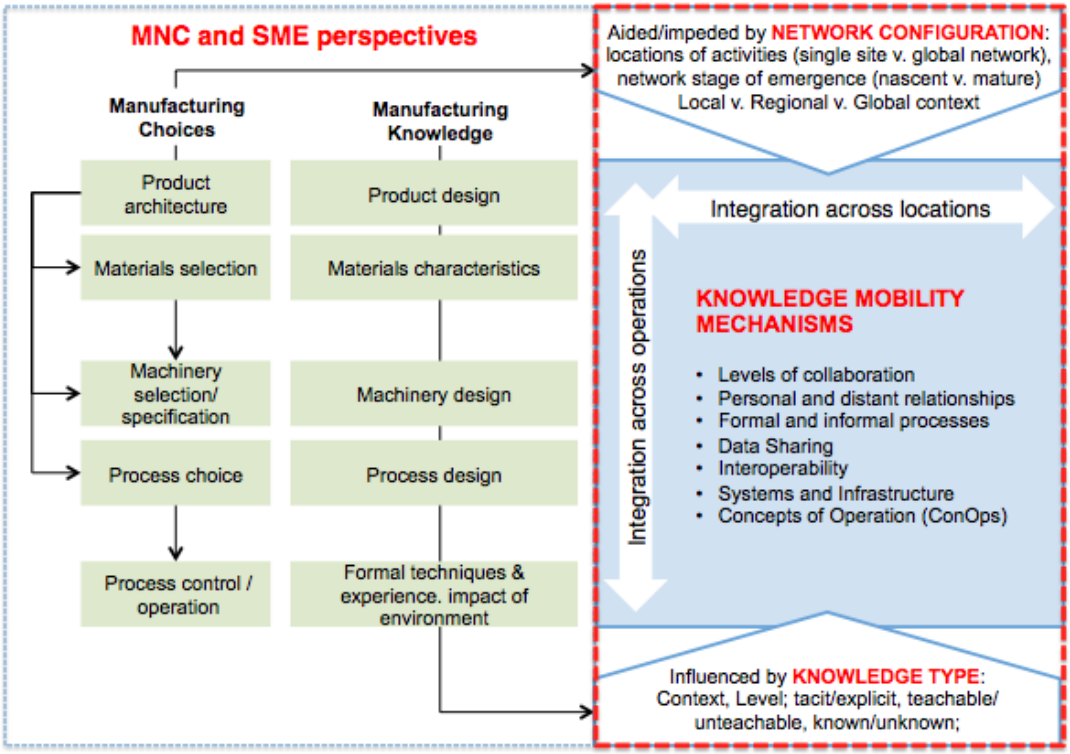


Figure 1. *Model for Knowledge Mobility showing key linkages in a manufacturing mobility context (adapted from Grant 1999; Minshall 1999; Pongpanich 2000; Harrington et al., 2012; Fleet et al., 2014; Harrington and Srai 2016; Harrington and Srai 2017)*

2.2. Network Configuration

Different types of network configurations - with distinguishable strategic objectives, specific target markets, critical resources and certain operational behaviours - differ based on their characteristics and purpose (Srai and Gregory, 2008). Van Waarden (1992) described networks, as *patterns of relations between actors* that are extremely dependent on the relationships that are in existence between the organisations involved and the structure of the networks in which they operate.

Product architecture is one such characteristic that has a strong influence on the configuration of the operations network, and by extension, the knowledge that needs to be managed and shared (Srai and Gregory, 2008). For SMEs and MNCs, architectures may range from weak, initial product focus and definition, to alpha-product development, to mature products. Nevertheless, organisations have some degrees of freedom (options) in selecting and reconfiguring their network configuration, and they may have more or less well-developed capabilities and mature networks to manage it (Harrington et al., 2012). This is an area of growing importance, given the argument that a supply network never reaches true ‘maturity’ (Harrington and Srai, 2017). One reason for this is the increasing dynamism with which today’s ‘industrial enterprise’ is engaging with recent advances in technology, for example,

the Internet of Things (IoT) and digitalisation (Harrington and Srai 2016). Here, organisations need to make decisions about the 'level' of collaboration and knowledge sharing that should exist between partners. Hence, 'capability' features such as skills, knowledge, technology and organisational processes are integral to any emerging network design criteria and/or capability acquisition assessment (Harrington et al., 2015; Harrington and Srai 2016).

2.2.1. Network Maturity

Innovation and knowledge transfer has moved from a corporate model of knowledge production towards a new distributed, inter-organisational, innovation model (Thether, 2005; Hewitt-Dundas, 2012), where certain environments will support a learning culture more than others. Characteristics such as networks with an entrepreneurial, learning or innovation focus, having the stability or tendency to change, and facilitate the mobility of personnel can show very different impacts (Cummings 2003). By examining knowledge mobility mechanisms within the context of network maturity, this research examines how both the knowledge task and also the available knowledge mobility mechanism are modified by network maturity and industry context. This more nuanced approach may be used as a basis for a proactive and differentiated approach to knowledge integration within the network.

Knowledge management, mediated by innovation, can have an effect on operations performance (Aboelmaged, 2014). Different approaches to the classification of phases and stages have been widely reported in the academic literature from an innovation perspective. (Utterback and Abernathy 1975; Rogers 2003; Hansen and Birkinshaw 2007). Although there are some approaches which pertain to a network view (in terms of business structure and organisational archetype) few have considered the role of network configuration and maturity, in the context of managing knowledge. As here are significant structural differences between SMEs and MNCs, this study on knowledge mobility considers networks in three distinct 'phases' of emergence linked to network configuration dimensions and sub-dimensions, derived for nascent and emerging contexts from the academic literature (Harrington and Srai 2017). From a knowledge perspective, different knowledge types at each stage will require tailored mechanisms for transfer for both MNCs and SMEs– see figure 2.

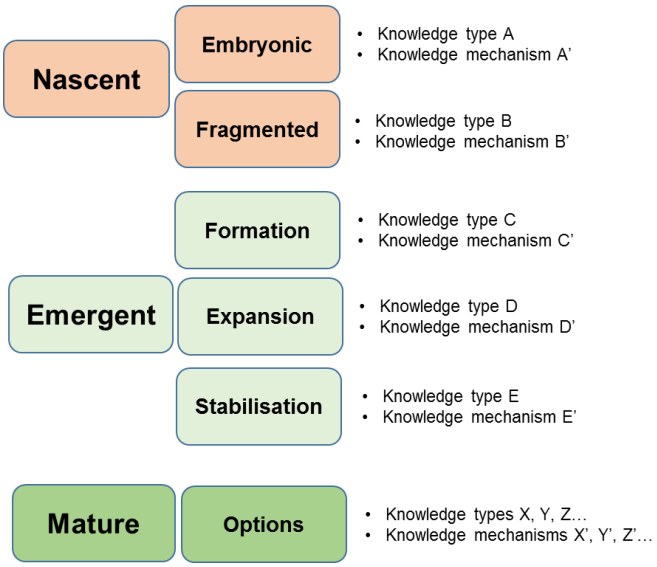


Figure 2: *Phases and sub-phases of supply network emergence (adapted from Harrington and Srai, 2012, 2017) – different knowledge types at each stage will require tailored mechanisms for transfer*

2.3. SME and MNC perspectives

Even though the results are often difficult to quantify (Davenport, 2002), the benefits of improved knowledge management within organisations, and knowledge integration across partner networks, is well documented in the literature (Deitz and Ellershaw 1999; Durst and Edvardsson, 2012; Harrington et al., 2012). In practice, only a few organisations who have identified the benefits of KM and are actively working on establishing in-house KM solutions believe that they were accomplished at processes within their organisation (Ruggles, 1998).

The adoption of new knowledge from external sources, and from other industries, is a growing source of innovation (Alexander and Childe, 2012; Phillips, Harrington and Srai, 2017). Hence, the ability to effective mobilise and integrate knowledge across global value networks of diverse specialist players is arguably becoming a strategic differentiator (Fleet et al., 2014; Liu et al, 2014). Here, it is crucial for both MNCs and SMEs to invest in KM, as great competitive advantage can be achieved by managing knowledge between their units and subsidiaries, and efficiently combine knowledge from global resource pools (Doz and Prahalad 1991). It is challenging to establish such an environment for effective information and knowledge exchange as there is no “one size fits all” policy and what might work in one company or one subsidiary might not necessarily be as effective in another (Lucas, 2006).

For single-site SMEs many issues of knowledge integration may be dealt with relatively simply, and even informally (Fleet, et al., 2014). Information in the production function may be passed between different teams or shifts by face-to-face contact (shift change-over meetings, for example) or through log books and documentation. Integration between different functions is similarly straightforward and may entail the exchange of documents and emails. SMEs tend to consider their flexibility and ability to react quickly to customer needs as a competitive advantage in comparison to large firms (Carson & Gilmore, 2000). In the context of organisations and the wider network, Ambrose et al (2010) have investigated predictors of success in high value buyer supplier relationships and suggest that communication is the sole significant factor. For SMEs engaging for the multi-organisational network partnering for the first time, *proximity* helps in communication and in quickly detecting and resolving misunderstanding. For SMEs internationalising for the first time, the problem of knowledge integration is often far more important than the concerns they have about specific issues regarding a new location. Linking knowledge and information in this context to concepts of communication and dependency, 'asymmetry' across SMEs and the participating parties often leads to uncertainty, resulting in a shorter-term orientation with SMEs who then focus less on key performance indicators, with longer-term effects on performance (Premkumar 2006; Ates et al., 2013). As social interactions and transfer of tacit knowledge is becoming more frequent than in the past, tailored transfer channels have become more important and there is a need to extend the performance indicators beyond commercial aspects like patenting, licensing and spin-offs. These latest mechanisms, although important, are an incomplete representation of the wide process of knowledge exchange (D'Este & Patel, 2007), especially in the case of SMEs.

In a multinational company, knowledge integration may be viewed as being much more complicated. Sharing knowledge across different production sites is hampered not only by distance, potentially by language, culture and different equipment or operating conditions. Even Intel Corporation's "copy exactly!" philosophy - enabling delivery of product from multiple production sites (in effect operating as a "virtual factory" that performs consistently and independent of the manufacturing source site) - has exceptions to the rule - as some of the ways of doing things on one site may not work on another (author, personal communication). When a production process is first transferred from one site to another it may expose gaps in knowledge about critical conditions (such as humidity, temperature and air pressure) for the process that may previously have been taken for granted. If it is difficult to integrate knowledge across different sites performing the same function, it is arguably even more challenging to do so across multiple sites and different functions – given the divergent perspectives of the various functional groups (Fleet et al., 2014).

The twin concepts of "clustering" and "reach", often used when examining regional manufacturing capabilities or emerging industries (Schilling and Phelps, 2007) can be directly applied to assessing collaborative resources for MNC-SME networks. By measuring the number of links that each critical supplier has to others (clustering ability), and the distance

through which information has to travel in order for exchange to occur (reach), it is possible to develop measures that directly address how collaborative resources are in their ability to exchange information (Schilling and Phelps, 2007), for example, *Data Sharing* (Information Transparency; Data Capture; Data Quality), *Interoperability* (Shared language; Knowledge Transfer; Common Tools), and *Efficient IT Systems* (Network Connectivity; Real-time Data Exchange; Efficient IT Infrastructure), in the case of multi-organisational networks (Harrington et al., 2012)

2.4. Knowledge Mobility Mechanisms

It is important to define various types of knowledge before designing the network, and selecting an appropriate mechanism to mobilise that knowledge. Building on sections 2.1-2.3., this section summarises the extant literature in the domain to inform the development of an integrated network-knowledge configuration framework.

2.4.1 Knowledge types

Objectivists understand knowledge as a static phenomenon, which can be managed as information, whereas, constructivists see knowledge as highly contextual - embedded either in a process, product or person (Kedia and Bhagat, 1988). As it is processed through a re-creation process in the mind of the 'recipient' (El Sawy et al., 1998; Alavi and Leidner, 2001), it cannot be separated from its 'source' (Cook & Brown, 1999). As knowledge is also linked to actions, knowledge is obtained through organisational tasks, in specific settings, which may be unique to the individual organisation (Dixon, 2000). Conversely, knowledge is also embedded in unique organisation processes, practices, norms and routines (Davenport and Prusak, 1998). The gained knowledge can be conceptualised, captured and transferred depending on its characteristics (Dixon, 1994; Sarker et al., 2005) and may provide the foundation for evaluating and incorporating new information and experiences, and in developing 'absorptive capacity' (Davenport and Prusak, 1998). Fosfuri and Tribo (2008) propose 4 stages in the development of such 'knowledge capacity'. It starts with the acquisition of [tacit] knowledge, followed by assimilation of the aforementioned knowledge (stage 2). The third stage involves the transformation of *tacit* knowledge, i.e. codification into *explicit* knowledge. Finally, competitive advantage is achieved by exploitation of this knowledge. For example, results show that the exchange of tacit and explicit knowledge in the context of a relationship between a supplier and a customer has a positive impact on the supplier's operational performance (Nagati and Rebolledo, 2013).

2.4.1. Mechanisms for transfer

In the context of this research, knowledge mobility mechanisms refer to the systems, methods, procedures or processes through which knowledge is transferred from the source to

the recipient (Chai et al., 2003). Embedded in a complex, interdependent system, these mechanisms are dependent on the network configuration as well as the characteristics of the knowledge being shared. This is often dependent on multiple autonomous players with varying technical cultures (affecting knowledge mind-sets), managerial background (affecting decision knowledge) and supply chain management exposures (affecting knowledge sharing attitudes) (Wadhwa and Saxena, 2007) . Different transfer mechanisms will be more or less effective in different network configurations, and it will require different sharing mechanisms to transfer different types of knowledge.

In the literature, knowledge transfer has been defined as the identical or partial replication of knowledge from one place to another (Kostova, 1996; Szulanski, 1996), which can be replication (identical replication) or adaption (adapting existing knowledge to some degree). Transfer can also be intentionally structured (specific plan), accidentally unstructured (no framework) or diffuse (Berryman, 2005). Szulanski (1996), Dixon (2000), Gupta and Govindarajan (2000) and Berryman (2005) also focused on factors affecting knowledge mobility mechanisms. The following elements, described as dimensions of knowledge transfer, are regarded as having most impact in accelerating or inhibiting the outcome (ibid):

- **Message (Knowledge):** Content, Tacit - Explicit, Characteristics
- **Source (Source of Knowledge):** Profile, Attributes (Age, Size, capability), Motivation to share, Resource capacity
- **Receiver (Recipient of Knowledge):** Profile, Attributes (Age, Size, capability), Level of experience, Motivation, Effort, Absorptive capacity
- **Channel (Organisational Context):** Characteristics, Cultural differences, Organisational impact scope, Economic incentives, Environment factors, Broad task environment, Task frequency, KT experience, Activities and modes transferring knowledge.

These dimensions provide a basis for understanding the communication processes involved, by characterising the individual parameters affecting the process. As successful knowledge sharing is seen as including a process of learning interactions (Szulanski, 2003), further dimensions are considered here – in moving to a more complete model capturing the individual parameters as well as their relationships. In his comprehensive literature review on knowledge sharing, Cummings (2003) identified five primary contexts that can affect knowledge internationalisation, e.g. the relationship between the source and the recipient, the form of the knowledge, the recipients learning preposition, the knowledge-sharing capability of the source, and the broader environment of the knowledge sharing process. Furthermore a series of key factors were highlighting which affect the outcome of the sharing activities (ibid), namely:

- **Environmental factors:** focus on economic, cultural, political, industrial and institutional trends and drivers that influence relational, knowledge, source and recipient contexts (Allen 1977; Tushman 1977; Hedberg 1981; Sagafi-nejad 1990; Almeida and Grant 1998; Yeung et al. 1999; Kostova, 1999; Kim and Nelson 2000; Harrington and Srai 2012)

- **Relational factors**: Organisational distance; Physical distance; Institutional distance; Knowledge competence; Relationship distance. Focus on partnerships dependent on structure, location, governance mechanism and expertise (Graham 1985; Hofstede 1980; Ouchi 1980)
- **Recipient and Source factors:** focus on the multi-organisational network partners participating in the knowledge sharing process – in terms of Motivation; Capability; Absorptive and learning capacity: Collaborative experience; Knowledge experience; Credibility; Retentive capacity; Learning culture (Cohen and Levinthal 1990; Doz 1996; Powell et al. 1996; Hamel 1991; Szulanski 1996; Dixon 2000; Simonin 1997; Prusak 1999)
- **Knowledge factors:** Explicitness; Embeddedness

Tacitness and embeddedness have mostly been referred to in the literature when reviewing knowledge characteristics and complexity (Doz and Santon 1997). It is well understood that it is easier to transfer explicit knowledge than tacit knowledge and - for this reason - it is desirable to convert tacit knowledge to explicit knowledge wherever possible (Fleet et al., 2014). In terms of definitions, Chai et al, (2003) summarised these dimensions as follows:

- **Explicit Knowledge**: Low tacitness and low embeddedness; Codified or verbalised and less context specific
- **Experimental Knowledge:** High tacitness and low embeddedness; Acquired through experience and practice
- **Endemic Knowledge:** Low tacitness and high embeddedness; Articulated but only meaningful when fully understood
- **Existential Knowledge:** High tacitness and high embeddedness; Acquired through experience and practice but only meaningful in a particular environment as it is less applicable outside this specific environment.

Lam (1997, 2000) also defined four types of knowledge, in relationship to their tacitness, but instead of looking at the embeddedness of the message, he analysed where the knowledge is held, if within an individual or a group of people. Chen and McQueen (2008) summarised the four types as follows and extended to capture insights about levels of knowledge experience (see figure 3):

- **Embrained Knowledge:** Individual and explicit; Dependent on the skills and abilities of an individual able to be articulated (e.g. Theoretical knowledge)
- **Embodied Knowledge:** Individual and tacit; dependent on individual experience and practice and is complex to transfer (e.g. practical experience)
- **Encoded Knowledge:** Collective and explicit; articulated, accumulated knowledge from groups of individuals (e.g. written procedures)
- **Embedded Knowledge:** Collective and tacit; Accumulated knowledge from groups of individuals which is embedded in organisations rules and procedures (e.g. routines)

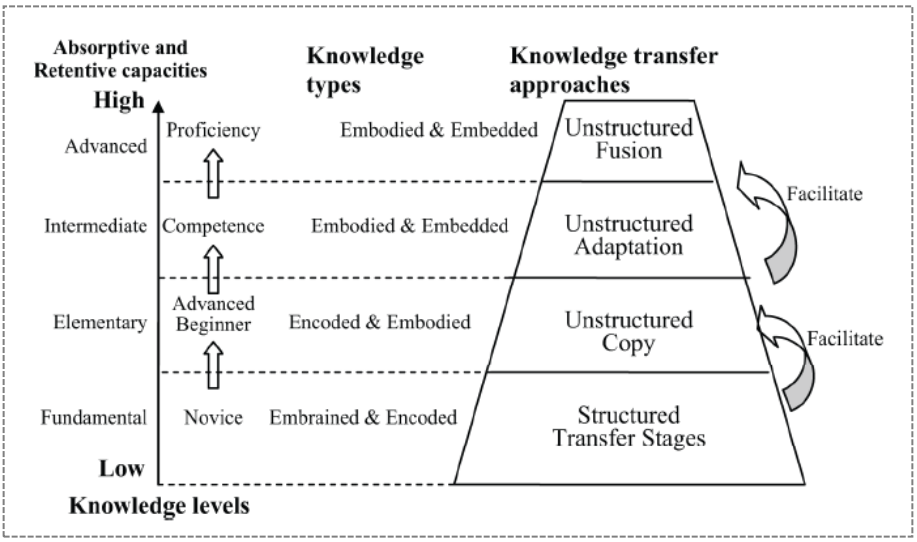


Figure 3: Knowledge Transfer Type Adoption Model (from Dreyfus and Dreyfus 1986, Chen and McQueen, 2008)

Chai et al. (2003) summarised knowledge sharing mechanisms identified in the management literature, as well as their characteristics within the dimensions of reach and richness. Table 1 summarises examples of knowledge transfer mechanisms (adapted from De Meyer 1991; Chiesa and Manzini 1996; Almeida and Grant 1998; Chai et al., 2003; Chen and McQueen, 2009) aligned with different types of knowledge, levels of knowledge, characteristics, and how they may affect K*Mob* processes (barriers and opportunities), to inform development of the KMC framework.

Table 1: Examples of Knowledge Transfer Mechanisms

Mechanism	Definition	Advantage (+) Disadvantage (-)	Knowledge type	Example
Transfer of people: expatriation	Transferred source works in recipient site for fixed period, allowing 'one-to-many' expert interactions	(+) One-to-many potential; high richness (-) Limited to sources knowledge; low reach	Experiential	Transfer: Technical know-how, how-why, know-who (e.g. problem solving skills)
Transfer of people: overseas training	Recipient sent to lead site to learn knowledge from multiple experts (many-to-one)	(+) Different knowledge perspectives (-) High knowledge loss risk	Existential	Transfer: Technical know-how, how-why, know-who (e.g. specific operating skills)
Forums: Conferences, meetings	Periodic meeting (often annually) of technical staff working in similar areas from different locations	(+) Creating informal employee networks; creating awareness of knowledge (-) Can be costly; Difficult to quantify gains	Endemic	Awareness, Transfer: Technical knowledge (e.g. specific set-up procedures)
International teams	Teams with members from different locations engaged in improvement activities, working on a specific project.	(+) Stable structure for further practice (e.g. development of playbooks by virtual teams) (-) Can be costly; Difficult to quantify gains	Endemic	Awareness, Transfer: Innovations, procedures, technology
Boundary spanner	Interfaces, improving technical knowledge transfer; collecting and broadcasting information (improvements, skills, knowledge)	(+) Filtering and channelling (-) Additional resources required	Explicit	Awareness: No transfer, connecting source and recipient
Audit	Data collection exercise on location performance	(+) Creates awareness; High reach (-) Resource consuming; No tangible return guaranteed	Explicit	Awareness: Know-who, know-what (e.g. FMEA)
Benchmarking	Location visits to learn about mechanisms and improvements at other sites (e.g. annual forum)	(+) Effective, wide application range (-) Costly; time and resource consuming	Endemic	Transfer: Know-how, know-why (e.g. specific set-up procedures)
Best practice guidelines; Standard Operating Procedures (SOP)	Collection and dissemination of knowledge through the transfer of identified best practices	(+) Cost effective; High reach; Knowledge loss protection (-) Large effort required to keep up-to-date (revision control); Potential of low richness (lacking background insights and context)	Explicit Endemic	Transfer: Process guides, step-by-step troubleshooting guides, virtual team playbooks SOPs, rules, manuals, standards (e.g. Intel 'copy exactly' philosophy)
Periodicals, reports	Internal periodic publications (journal, newsletter) with articles on technological knowledge development	(+) Cost effective; High Reach (-) Information overload; Language issues	Explicit Endemic	Awareness, Transfer: Technical know-how 'what can be done', who's who (e.g. problem solving methods, specific set-up procedures)
Electronic linkages	Intranet: stores and disseminates information Groupware: Guidelines, plant performance, meeting minutes, procedures, journals, discussion forums, project schedules Tele/video conferencing: overseas communication Email: Weekly reports, problem solving advice guidelines Fax: Technical drawings, blueprints Chat: Problem solving (advice), networking, discussion	(+) Cost effective; High reach (-) Information overload; Language issues	Explicit Endemic	Awareness, Transfer: Know-who, know-what, know-how, know-why (e.g. problem solving methods, FMEA, specific set-up procedures)

3. Prototype Framework Development

Based on outputs from the literature review section in section 2, three dimensions of Knowledge Mobility Configuration (KMC) were defined as:

1. **Network Configuration:** The network in which the transfer takes place in, capturing the 'source' and 'recipient' as well as all other aspects of the network and their relationship
2. **Knowledge Context:** The message which is being transferred and its characteristics
3. **Knowledge Mobility Mechanism:** The transfer processes and their characteristics

This framing provides a basis to develop a broad perceptive of the individual dimensions of knowledge mobility - and their relationship to network configuration - in order to develop a framework to be further refined through application and test using a series of case studies (see table 2). The different aspects of network configurations affecting knowledge mobility processes are captured as *Structure*, *Network Dynamics*, *Governance and Coordination*, *Support Infrastructure*, *Relationships*, and *Maturity Level*. Knowledge Mobility Configuration emerging dimensions of analysis, derived from the literature review, are presented in table 3. This approach allows for an overall structure for a KMC framework, providing a holistic view of all dimensions and their relationship. The following research questions have also been defined to inform this research study, namely:

(1) Network Context: What dimensions need to be captured and how are these utilised to ensure maximum effectiveness of the knowledge transfer?

(2) Knowledge Context: What knowledge mobility mechanisms should be used to transfer different types of knowledge?

(3) Knowledge Mobility Mechanism: What knowledge mobility mechanisms should be used to transfer the different types of knowledge, and how are these best employed to support different network configurations?

Table 2: Knowledge Mobility Configuration - Prototype framework and dimensions of analysis

Network Configuration			
Network Phase	**Nascent**	**Emerging**	**Mature**
Supply Network Stage	**Embryonic Fragmented**	**Formation Expansion Stabilisation**	**Established**
Dimensions			
Structure	Explore emerging dimensions influencing Knowledge Mobility processes - Geographical footprint of a network, including the dispersion (shape, levels of vertical and horizontal integration) of network units and their interdependence (partnerships, ownership, flexibility) - Strategic orientation on process, material and information flow - Governance systems and mechanisms - Infrastructure supporting process, material and information flow - Maturity Levels: Emergence of product line and establishment of the network See Table 3 for additional details		
Network Dynamics			
Governance and Coordination			
Support Infrastructure			
Relationships			
Knowledge Context			
Knowledge Characteristics	**Fundamental Knowledge**	**Moderate Knowledge**	**Advanced Knowledge**
Tacitness	Low	Low/High	High
Embeddedness	Low	Low/High	High
Individual-Collective	Individual Embrained	Collective Encoded	Individual and Collective Embodied and Embedded
Type	Explicit	Experimental Endemic	Existential
Examples	Theoretical knowledge, written rules, procedures	Practical experience, written rules, procedures	Practical experience, routines, norms
Knowledge Transfer Mechanism	Explore mechanisms of transfer in terms of Awareness, Transfer. Level etc. Mechanisms are dependent on the network configuration as well as the characteristics of the knowledge being shared. Different transfer mechanisms will be more or less effective in different network configurations, and it will require different sharing mechanisms to transfer different types of knowledge - See Table 1 and section 2 for supporting details		

Table 3. Prototype Knowledge Mobility Configuration framework – emerging criteria

Network Configuration Dimension	Network Configuration Sub-dimension	Definition	Examples of contributing literature
Structure	Dispersion	Shape of network with respect to levels of knowledge integration	Tushman, 1977; Granovetter, 1985; Uzzi, 1996; Argote, 1999; Liu et al., Harrington and Srai, 2017
	Interdependence	Self-sufficiency of subsidiaries, based on relationship and flexibility	Phene et al., 2005; Zhao and Luo, 2005
	Organisational context	Organisational structural arrangements (e.g. joint ventures); Institutionalisation or internalisation - degree to which the recipient obtains ownership of, commitment to and satisfaction with the transferred knowledge	Granovetter, 1985; Argote, 1999; Cummings, 2003
	Subsidiaries location	Physical distance between locations	Jacobs, 1969; Galbraith, 1990; Davenport and Prusak, 1998; Wheeler, 2001
	Knowledge transfer network	Range, members, roles and responsibilities Dependence or independence on the knowledge and the knowing subject	Dreyfus and Dreyfus, 1986; Doz and Prahalad, 1991; Von Krogh and Roos, 1995; Berryman, 2005; Harrington and Srai, 2016
	Source abilities	Establishment in terms of reputation, practice and motivation; capability to make use of external knowledge	Cohen and Levinthal, 1990; Hamel, 1991; Szulanski, 1996; Dixon, 2000 Zahra and George, 2002;
	Recipient abilities	Establishment in terms of motivation, intention, practice and developing capacity	Bandura, 1986; Argyris, 1990; Hamel, 1991; Yeung et al., 1999; Prusak, 1999; Pfeffer and Sutton, 2000; Fosfuri and Tribo, 2008
Network Dynamics	Standardisation	Strategic orientation of manufacturing processes and key activities	Peteraf and Shanley, 1997; Harrington and Srai, 2012
	Production line	Production planning; Strategic orientation and management of manufacturing, material and information flow	Guinery and MacCarthy, 2009; Harrington and Srai, 2012
	Knowledge status	Definition (individual or collective) and value of knowledge and knowledge sharing within the organisation; management at key interfaces	Hedberg, 1981; Dixon, 1994; Nonaka and Takeuchi, 1995; Kostova, 1999; Alavi and Leidner, 2001; Guinery and MacCarthy. 2009
Governance and Coordination	Commercial control	Governance and coordination systems around commercial activities	Sagafi-nejad, 1990; Yeung et al., 1999; Harrington and Srai, 2012; Harrington and Srai, 2017
	Engineering control	Governance and coordination systems around engineering activities	Andrews, 1971; Barney, 1991; Harrington and Srai, 2012; Harrington and Srai, 2017
	Performance measures	Variables determining success; effectiveness of the knowledge transfer and its institutionalisation (embedding knowledge within receiving organisation); “Stickiness” - degree to which knowledge is lost during transfer	Barney, 1991; Cowan and Foray, 1997; Lehr and Rice, 2002; Szulanski, 2003; Harrington et al., 2012
	Economic labour/IP incentives	Governance and coordination systems impact	Baliga and Jaeger, 1984; Argote, 1999
Support Infrastructure	Engineering systems and manufacturing capability	Engineering systems supporting manufacturing operations and efficiencies	Von Hippel, 1988; Appleyard, 1996; Harrington and Srai, 2012;
	Engineering resources and people skills	Engineering resources supporting manufacturing operations and efficiencies	Hofstede, 1980; Graham, 1985; Almeida and Kogut, 1999; Harrington et al., 2012
	Knowledge transfer systems	Mechanism in place, and usage, across the whole network	Szulanski, 1996; Davenport et al., 1996; Hansen et al., 1999; Lev, 2001; Wadhwa and Saxena, 2007

	Culture	Cultural establishment between subsidiaries (country and organisational culture)	Schein, 1985; Hofstede, 1997, 2001; Cullen, 2002; Harrington et al., 2012
	Language	Status on agreement on common language	Enright, 2000; Almeida and Phene, 2004; Song et al., 2013
Relationships	Partnership – supplier	Linkages between network members, their relationship and value sets	Andrews, 1971; Barney, 1991; Harrington et al., 2012; Harrington and Srai, 2016; Delbufalo, 2017
	Partnership – customer	Linkages between multi-organisational network members, their relationship and value sets	Allen, 1977; Tushman, 1977; Romero and Molina, 2011; Harrington et al., 2012; Dooley et al., 2013; Harrington and Srai, 2016
	Intensity of connection	Inter-relations and time period of previous connections	Etzioni, 1961; Ouchi, 1980; Dixon, 1994; Hansen, 1999; Bresman et., 1999
	Contact frequency	Frequency and purpose of contact and how it is initiated	Nonaka, 1994; Dixon, 1994; Iansiti, 1998; Yeung et al., 1999
	Power distance	Relationship between parties; perceptions of inequality and symmetry	Allen, 1977; Almeida and Kogut, 1999; Almeida and Phene, 2004; Phene et al., 2005; Enright, 2000; Hofstede, 2001; Song et al., 2003
	Masculinity	Willingness to promote societal values	Kedia and Bhagat, 1988; Zander and Solvell, 2000; Gargiulo and Benassi, 2000; Phene et al., 2005; Zhao and Luo, 2005
	Individualism	Degree of self interest	Kedia and Bhagat, 1988; Triandis, 1995; Hofstede, 2001; Gargiulo and Benassi, 2000
	Uncertainty avoidance	Reluctance to deal with ambiguity and lack of willingness to embrace change	Doz et al., 1981; Gupta and Govindarajan, 1991; Kostova, 1996; Hofstede, 1997; Almeida and Kogut, 1999
Product	Configuration	Production stage, product differentiation and portfolio	Srai and Gregory, 2008; Harrington and Srai, 2017

4. Research Methodology

This section presents an overview of the research study' methodological approach. A mixed methodology was employed, involving expert panel input (interviews and benchmarking), followed by a multiple case study method. This multiple case study strategy is in line with Yin's definition (2003) of it being an empirical inquiry that investigates a contemporary phenomenon both in-depth and within its real-life context. The approach is particularly appropriate here as this study seeks to explore both practice-based (where the insights of key industrial stakeholders are critical) and emerging phenomena when research and theory may be at an exploratory or formative stage (Yin 2003; Hartley 2004). The overall research process is outlined in figure 4.

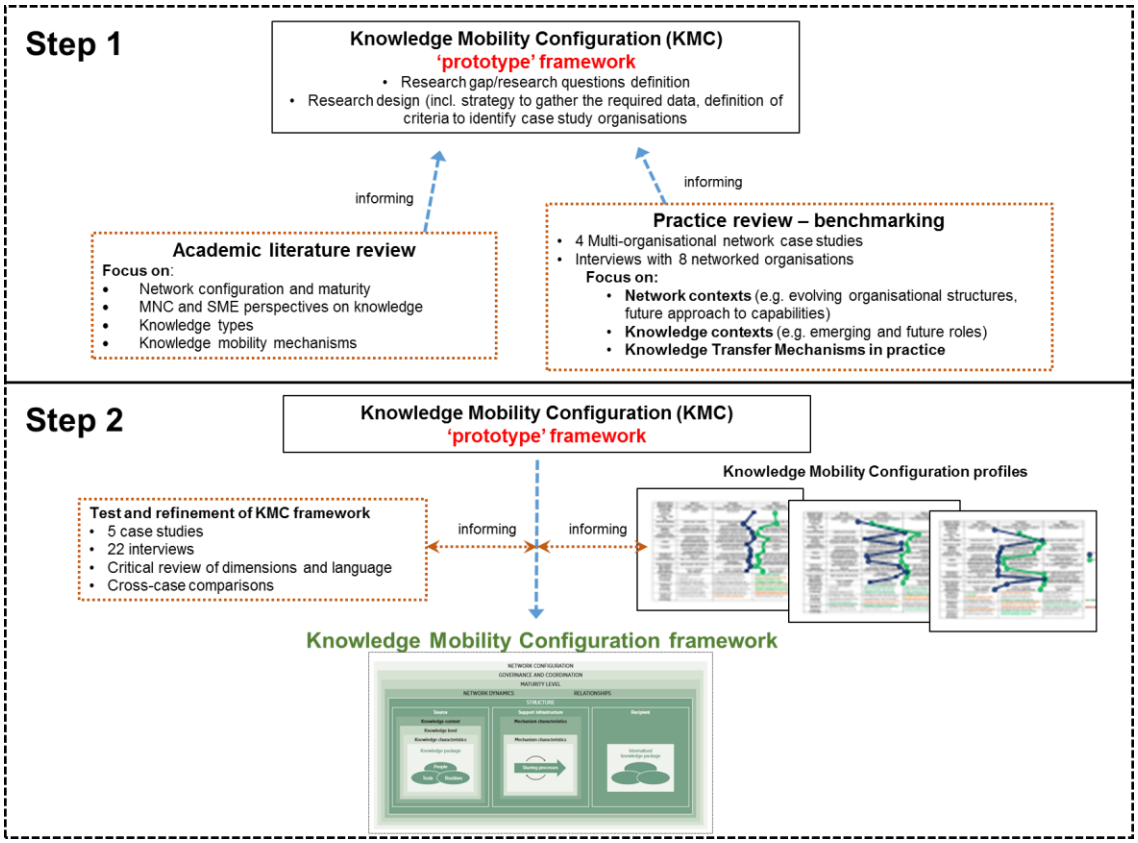


Figure 4: *Research Design (adapted from Yin, 2003)*

The first step, involved the design of an initial prototype framework, based on the literature review and discussions with industry experts. The research gap and associated research questions were defined, and an appropriate research design was established, highlighting the strategy to gather the required data, as well as defining criteria to enable organisations to be identified, and first contact established. This step also drew on findings from two benchmarking exercises:

(1) Indicative of the growing shift towards information and knowledge-intensive activities involving multiple 'partners', a series of multi-organisational network cases were selected to examine different types of SME-SME and MNC-SME interactions. These spanned four industry sectors (Aerospace, Maritime, Energy, and Telecoms), took a network perspective, with multiple 'partners' involved in managing an increasing flow of knowledge and data, and activities across their geographically dispersed networks. The case studies were designed as semi-structured interviews and enabled dimensions from the literature review to be tested and, more importantly, brought into the industrial context. In summary:

- Two SMEs engaged in a dyadic collaboration, cooperating in an attempt to build better 'products' (Key insights across the cases included data availability and management, and communication plans; mechanisms to encourage trust and open-mindedness)
- Organisation historically acting as the more powerful party within a relationship (requiring large control over its supply chains and SMEs, thus creating dependency),
- Two firms selected from a legacy supply chain in order to investigate the complex nature of longer-term relationships and knowledge sharing (key insights across the cases centred on: intended reporting relationship to upper levels of management, and intended horizontal relationships with other units; conflict of interests, and resolution processes), and
- Case chosen due to a specific focus on aligning 'values' within an enterprise and extending these to its SME partners.

(2) Processes required to support both inter-firm and intra-firm knowledge network integration were explored through seven industrial case studies, and assessed in terms of evolving organisational structure, future approach to capabilities, and emerging and future roles:

- A review of models in current practice (e.g. capability and process models, enterprise architecture models, and 'lines of development'), roles and responsibility-type methodologies and activity definitions also examined where individual organisations and their knowledge networks had developed specific operational guidance, tactics, techniques and procedures, (Harrington and Srai 2016).
- Theoretical inputs from the academic literature that further informed knowledge design criteria, e.g. networked organisation (Zhang, Gregory, and Neely 2016), matrix structures (Kuprenas 2003), roles, responsibilities and disposition (Goold and Campbell 2003), and the emergence of more distributed systems (Srai et al., 2016).

The second stage involved examination of the prototype framework dimensions and definitions using five case studies. Table 4 summarises the case organisations involved in this study, and the characteristics of their knowledge network under investigation. Selection criteria for the case studies, derived from step 1, included:

- 'Lead' location and case study location were located in different countries and are part of a wider global production network
- The case studies ideally would involve three product lines – with a 'lead' location in the EU or US, at least one production plant in the EU and/or US, with further locations in Asia as part of a global manufacturing network
- Knowledge and knowledge transfer activities were highly regarded and evidence that knowledge management mechanisms had been in operation within the organisation for at least five years.
- Access to different products with similar initial setup (type of product, 'lead' location in the same region) were available
- Availability of access to SMEs linked to MNC network and product type

For the five cases (MNC and SME), all product lines serve a similar application area, with the different case study products and their supply networks at different maturity levels. 15 senior engineers, three managers as well as four directors across MNC and SME case studies were interviewed (22 respondents in total).

Table 4: List of Case Organisations

Case	**Lead Location Established**	**'Server' Location**	**Number of Production lines**	**Network Locations**	**Classification (Product/Production line/supply network)**
Network A	2001	2001	10	4 (EU, US, Asia x 2)	Mature/Mature/Mature
Network B	2005	2012	13	5 (EU x 2; US, Asia x 2)	Established/Emerging /Emerging
Network C	2006	2013	4	4 (EU, US, Asia x 2)	Early Established/Emerging /Nascent
Network D	2010	2013	1	1 (UK)	Emerging/Emerging /Nascent
Network E	2010	2013	1	3 (UK; EU; Asia)	Nascent/Nascent /Nascent

The purpose of the interviews included, not only mapping of the different cases using the KMC framework, but also the refinement of the framework. The process explored the research questions set out in section 3, and gathered the following information:

1. Background information on the organisation and its K*Mob* activities
2. Background information on the product and supply network (local v. regional v. global perspectives)

3. Current state Knowledge Mobility Configuration Profile - individual perceptions
4. Collective feedback on the different dimensions and their classifications
5. Overview of the different KT Mechanism applied and their application range
6. Perception on the ideal state for the current and future state of the knowledge mobility configuration

5. Knowledge Mobility Configuration Profiling

The case studies selected provide this study with examples of MNCs and SMEs collaborating in an emerging industry context, where novel end products are being manufactured using a hybrid of traditional techniques with emerging technologies. It is comprised of new entrants driving innovative manufacturing processes, coupled with more established firms looking to diversify their product portfolios. This section summarises application and test of the prototype framework. Limitations of space constrain the full graphical presentation for each *Knowledge Configuration Profile* generated through testing the prototype framework Figures 5, 6 and 7set out partial profiles for three of the cases (A, B, and C). In the summary of the findings (section 6.2), tables 6-8 provide a summary of a comparative analysis involving all five cases

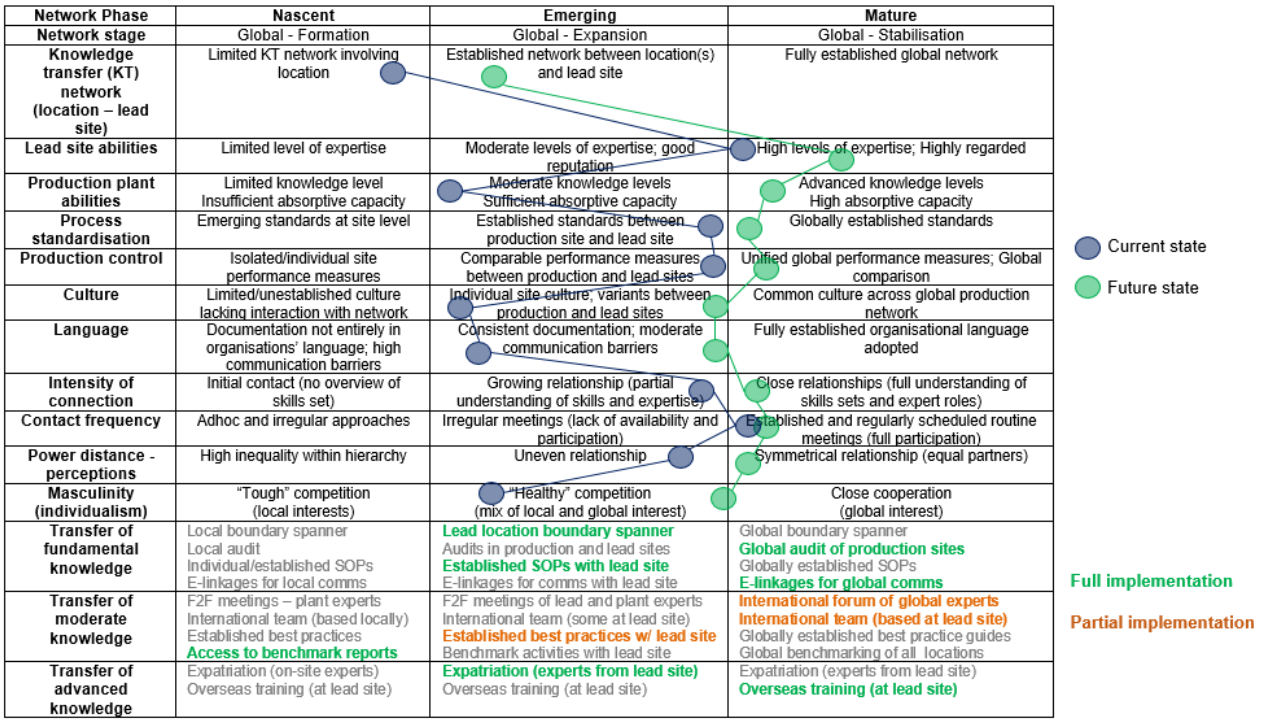
Network Phase	Nascent	Emerging	Mature
Network stage	Global - Formation	Global - Expansion	Global - Stabilisation
Knowledge transfer (KT) network (location – lead site)	Limited KT network involving location	Established network between location(s) and lead site	Fully established global network
Lead site abilities	Limited level of expertise	Moderate levels of expertise; good reputation	High levels of expertise; Highly regarded
Production plant abilities	Limited knowledge level Insufficient absorptive capacity	Moderate knowledge levels Sufficient absorptive capacity	Advanced knowledge levels High absorptive capacity
Process standardisation	Emerging standards at site level	Established standards between production site and lead site	Globally established standards
Production control	Isolated/individual site performance measures	Comparable performance measures between production and lead sites	Unified global performance measures; Global comparison
Culture	Limited/unestablished culture lacking interaction with network	Individual site culture; variants between production and lead sites	Common culture across global production network
Language	Documentation not entirely in organisations' language; high communication barriers	Consistent documentation; moderate communication barriers	Fully established organisational language adopted
Intensity of connection	Initial contact (no overview of skills set)	Growing relationship (partial understanding of skills and expertise)	Close relationships (full understanding of skills sets and expert roles)
Contact frequency	Adhoc and irregular approaches	Irregular meetings (lack of availability and participation)	Established and regularly scheduled routine meetings (full participation)
Power distance - perceptions	High inequality within hierarchy	Uneven relationship	Symmetrical relationship (equal partners)
Masculinity (individualism)	"Tough" competition (local interests)	"Healthy" competition (mix of local and global interest)	Close cooperation (global interest)
Transfer of fundamental knowledge	Local boundary spanner Local audit Individual/established SOPs E-linkages for local comms	Lead location boundary spanner Audits in production and lead sites Established SOPs with lead site E-linkages for comms with lead site	**Global boundary spanner** **Global audit of production sites** **Globally established SOPs** **E-linkages for global comms**
Transfer of moderate knowledge	F2F meetings – plant experts International team (based locally) Established best practices Access to benchmark reports	F2F meetings of lead and plant experts International team (some at lead site) Established best practices with lead site Benchmark activities with lead site	**International forum of global experts** **International team (based at lead site)** **Globally established best practice guides** **Global benchmarking of all locations**
Transfer of advanced knowledge	Expatriation (on-site experts) Overseas training (at lead site)	Expatriation (experts from lead site) **Overseas training (at lead site)**	**Expatriation (experts from lead site)** Overseas training (at lead site)

Current state
Future state
Full implementation
Partial implementation

Figure 5. Knowledge mobility network configuration profile A – MNC (US-Global)

Profile A: Case A has been operational for many years and displays many of the characteristics of a mature knowledge network. However, while management and engineers agreed on many points, gaps were identified where the perceptions of management and

engineers differed in terms of improving their ‘knowledge sharing’ network, and in bringing their product line closer to ‘maturity’ in terms of absorptive capacity. Owing to the maturity of the product line, it is unsurprising that there are many global knowledge mobility mechanisms in use today. Interestingly, some are less implemented at this location given that there is significant local knowledge. This has resulted in elements of certain sharing mechanisms deemed surplus to requirements. This was recognised as being high risk to certain large product lines as the knowledge share of vital information could be slowed by an assumed knowledge from locations, thus leading to isolation.



Network Phase	Nascent	Emerging	Mature
Network stage	Global - Formation	Global - Expansion	Global - Stabilisation
Knowledge transfer (KT) network (location – lead site)	Limited KT network involving location	Established network between location(s) and lead site	Fully established global network
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Process standardisation	Emerging standards at site level	Established standards between production site and lead site	Globally established standards
Production control	Isolated/individual site performance measures	Comparable performance measures between production and lead sites	Unified global performance measures; Global comparison
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Contact frequency	Adhoc and irregular approaches	Irregular meetings (lack of availability and participation)	Established and regularly scheduled routine meetings (full participation)
Power distance - perceptions	High inequality within hierarchy	Uneven relationship	Symmetrical relationship (equal partners)
Masculinity (individualism)	“Tough” competition (local interests)	“Healthy” competition (mix of local and global interest)	Close cooperation (global interest)
Transfer of fundamental knowledge	Local boundary spanner Local audit Individual/established SOPs E-linkages for local comms	**Lead location boundary spanner** Audits in production and lead sites **Established SOPs with lead site** E-linkages for comms with lead site	Global boundary spanner **Global audit of production sites** Globally established SOPs **E-linkages for global comms**
Transfer of moderate knowledge	F2F meetings – plant experts International team (based locally) Established best practices **Access to benchmark reports**	F2F meetings of lead and plant experts International team (some at lead site) **Established best practices w/ lead site** Benchmark activities with lead site	**International forum of global experts** **International team (based at lead site)** Globally established best practice guides Global benchmarking of all locations
Transfer of advanced knowledge	Expatriation (on-site experts) Overseas training (at lead site)	**Expatriation (experts from lead site)** Overseas training (at lead site)	Expatriation (experts from lead site) **Overseas training (at lead site)**

Figure 6. Knowledge mobility network configuration profile B – MNC (US-Regional)

Profile B: Case B’s product line has been in global production for several years, with an expectation that the location (and its local suppliers, including SMEs) should play a leading role in future global product line development, scale-up, and transfer. This is reflected by the high expectations dictated by management in the knowledge configuration framework with gaps expected to close once more confidence and interaction between locations and network partners intensifies. Case B presents a typical illustration of a new product line within a global network context, involving the focal firm and its SME partners. The variation of knowledge mechanism use reflects the different stages that the engineers and managers are experiencing and operating in, indicating that these mechanisms greatly influence the specific product line and type of knowledge being transferred between partners, and vice-versa. Two

main areas of concern are the lead location supplying insufficient knowledge, and language difficulties when interpreting original documentation.

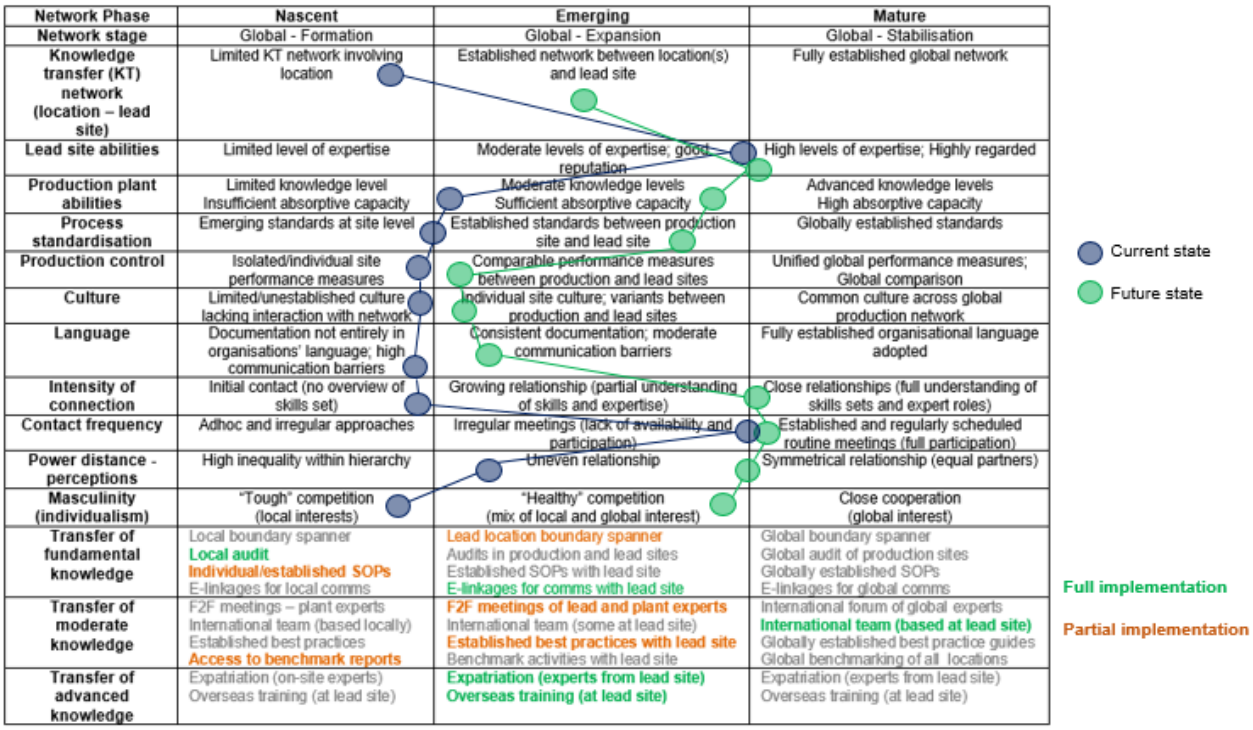

Figure 7. Knowledge mobility network configuration profile C – MNC (US-EU)

Profile C: Case C involves a production line, which is in its early stages of development and transfer, with a team heavily concentrated on gathering as much knowledge from the lead location as possible. In addition the specific line is currently being rolled out to multiple locations, which some at further stages of development than others, with more heavily reliant on a local SME supplier base. The lead location is also finding it difficult to allocate sufficient resources to assist this location. As this production line is in the early stages of implementation, there is little surprise that knowledge mechanisms have a large influence on the team. The main focus is on information at this stage, but this is due to change when other locations begin to come on-line, requiring more sharing of knowledge on their experiences.

Profile D: Case D is a developer and manufacturer, established in 2010. Benefiting from its high-speed manufacturing capability and low fabrication costs, the SME has seen its network dispersion grow from a single location to have a global reach in less than 12 months. In addition to increased dispersion, the strength of its partnerships has also increased and stabilised. It is focused on growing actors for development and production, who cover the entire value chain and complementary sectors. Future focus areas for the SME, identified using the framework, is the assessment of innovation and education activities that have a

structured mentoring and networking programme, for example, leveraging their MNC networks to gain professional training combined with hands-on experience, engaging in SPOCs (Specialized Private Online Courses) tailored to the specific demands of the SME, and using 'rotating elevator' workshops with network partners for knowledge sharing.

Profile E: Case E is an SME whose specialised capability lies in ultra-thin and low-cost flexible microcircuits that may be incorporated into mass-market objects and packaging. With a well-developed regional customer-base in the UK, it is becoming increasingly affected by global customer pull, with no mature supply network structure to support this opportunity. Case E is heavily focused on managing internal capabilities at present, where many issues of knowledge integration may be dealt with relatively simply, and even informally. Here, new actors and enterprises fail to adequately coordinate the external resource capabilities, core non-technical activities, and knowledge they will require in growing a business. However, in developing a longer-term network strategy view there is growing awareness of established networks for which case E could leverage in terms of knowledge and capability. One of the main challenges SMEs face is affordable access to targeted and meaningful education and training in their particular field. Future focus areas for the SME, identified using the framework, included knowledge management, social media, and virtual teams linked to Knowledge Innovation Communities (KICs) and the emerging assets commonly utilised in this space - Massive Open Online Courses (MOOCs) and SPOCs (Specialized Private Online Courses), and Moodle as a flexible Virtual Learning and knowledge exchange tools.

6. Summary of findings

Previous studies have largely focused on large, well-established, market driven MNCs, their established products and their extended networks. In terms of theoretical contribution, this study informs knowledge mobility mechanisms for both networked SMEs and MNCs, which currently provide only limited detail on configuration elements and options on engagement with their extended networks. The research presents instructive results from case studies on the application of knowledge management approaches based on real world applications, and is organised in two sub-sections. Section 6.1 summarises the key findings from the benchmarking exercises. Section 6.2 provides a summary of the comparative analysis involves the five cases and then sets out the final KMC framework.

6.1. Benchmarking

This section summarises outputs from the benchmarking studies, in terms of insights involving multi-organisational networks involved in knowledge-intensive activities (*6.1.1*), and operational practice inputs involving future knowledge network configurations (*6.1.2*).

6.1.1. Insights on factors affecting future Multi-Organisational Networks

Findings suggest that defining and aligning *value sets* of MNCs and SMEs operating within collaborative networks is crucial as it represents a means of assessing effective knowledge network integration and operational objectives. A number of dimensions have been identified. The importance of a series of dimensions that define value sets (and by extension knowledge) within a network context varied depending on both the nature of the service contract and partnering agreement (for example some networks identified cooperation, trust, commitment to objectives, commonality of objectives, defined roles, responsiveness to partners/problems, communication and equal rewards to be key, other networks valued respect of IP, and data security). In summary:

- Key insights across SME-SME cases engaged in dyadic collaborations included data availability and management, and communication plans; mechanisms to encourage trust and open-mindedness
- Key insights across MNC-SME cases involving longer-term relationships and knowledge sharing centred on: intended reporting relationship to upper levels of management, and intended horizontal relationships with other units; conflict of interests, and resolution processes)

6.1.2. Insights on factors affecting future Knowledge Mobility Configurations

Drawing on dimensions of network configuration from section 3, industrial context, potential network configuration options and stages, and the processes required to support both inter-firm and intra-firm knowledge network integration were explored through seven industrial case studies. Table 5 summarises insights on key factors affecting future knowledge mobility configurations, in terms of:

- Evolving Organisational Structure
- Future approach to Capabilities
- Emerging and Future Roles

In summary, organisations with similar configuration characteristics, as currently set up, are looking to improve project delivery and grow new capabilities by increasingly moving towards partnering with other organisations (SMEs and MNCs), which is resulting in new roles emerging. Those organisations also seeking to adopt a similar future configuration have the

following features of improved networking to offset skills imbalances, and transferring staff into other functions to broaden skills and knowledge of the wider business. As part of the ‘futuring’ process, new learning and career structures will be needed to encourage mobility, which may pose a significant challenge as resources may be reluctant to move across boundaries, in some cases. Moving to a virtual team model is a change management process and needs to be managed as such. Hence, cultural change is encouraged to develop a more flexible skill set and knowledge base, and at an organisational level, recognition that what is best for a ‘virtual team’, may not be best for a particular location.

Table 5. Benchmarking

Insights on 'future' Knowledge Mobility Configuration	Organisation A	Organisation B	Organisation C	Organisation D	Organisation E	Organisation F	Organisation G
Evolving Organisational Structure	Configuration heavily driven by partnering, drivers recognised as being resource-people-location-cost, with cost not the major driver. Responsiveness to the market and dynamics seen as critical.	Configuration heavily driven by Global network. Location driven by closeness to customer. Speed to market critical (de-centralised) viewed as more important than cost savings (centralised). Use of Competency Centre-type concepts popular with Strategy and/or Global Teams linking these global networks.	Governance largely central. Location driven by closeness to manufacturing sites with development of a global mind-set e.g. global communities of practice.	Configuration heavily driven by skills mismatch. Key issue is the potential surplus of engineering skills in traditional markets versus.a shortage of qualified experienced people in new markets.	Competitiveness seen as being driven by network configuration dimensions identified e.g. Structure, Network dynamics, Governance and coordination, Support infrastructure, and Relationships between network members including customers, suppliers and users	New approach to Configuration with less contact/lower synergies between R&D and Manufacturing. Stronger links between R&D, Marketing & other technology groups	Configuration model based on shift of selected 'engineering' activities to low cost locations. Given IP concerns outsourcing unlikely to feature. Future need for increased servitization will change the nature of operations (from OEM to a greater service footprint)
Future approach to Capabilities	Approach to capability is leading to global, virtual and functional engineering communities of practice with greater emphasis on responsibility allocation.	Critical to benefit from expertise in various regions. R&D also working more extensively with the rest of the business - All IT enabled.	Internal partnering considerable with focus on adapting internal processes	Location skills used as a source of global capability. Multiple sites supported by central engineering function with best practice transfer using a Centre of Excellence (CoE) model.	Established capabilities and capability targets are based on target locations. Greater focus on relationships, individuals and working towards more strategic long-term partnerships.	In terms of capability, moving from internal competencies towards e.g. 'Intelligent purchasers' - Individuals/teams with ability to understand the technology and work closely with partners.	Capability focus – gaining familiarity with common systems given a need to increase engineering knowledge in areas outside of specific specialisms (move to services). Continuation of engineering teams working with external parties/different cultures.
Emerging and Future Roles	New roles of functional specialists capable of networking across an organisation emerging	Large focus on people working in partnerships	New roles emerging particularly related to co-ordination, reflected in growing importance of softer skills	Engineer transfer to other functions to do different role (e.g. services), a favoured approach	Cross functional teams/roles in operation led by Engineering e.g. Transformation project team/product delivery team.	Engineering roles – shift from 'technical specialist' to 'partner working ', need for people with both technology and relationship skills. "More EQ (Emotional quotient) than IQ".	Engineering will continue to be project driven: with added need for an appreciation of other disciplines and ability to handle customer interface. No new positions beyond those of e.g. product lifecycle management

6.2. Comparative analysis based on application of the KMC framework

Although there are many ways an organization can acquire knowledge, there is broad consensus in the literature that organisational learning is a problem-solving process triggered by gaps between actual and potential performance (Pisano 1994). In terms of knowledge networks, there is often a wide disparity here, with SMEs focusing their knowledge activities on resolving technical issues, developing prototypes and securing investment. On the other hand, MNCs look to leverage existing capabilities, processes and techniques developed within their core industry. Tables 6-8 provide a summary of a comparative analysis involving all five cases, in terms of:

- Supply Network Configuration Profile – conventional dimensions of analysis
- Knowledge Mobility Configuration Profile – emerging dimensions of analysis
- Knowledge Mobility Configuration Profile – Knowledge Transfer Mechanisms

Table 6. Supply Network Configuration Profile – conventional dimensions of analysis (extant theory)

Network Type	MNC (US-Global) - Product Assembler	MNC (US-Regional) - Product Assembler	MNC (US-EU) - Product Assembler	SME (UK) - Product Assembler	SME (UK) – Component Manufacturer
Network Phase	Mature	Emerging	Nascent	Emerging	Nascent
Network Stage	Established	Expansion -> Stabilisation	Formation -> Expansion	Fragmented -> Formation	Embryonic
Structure Dispersion Interdependence	Fully integrated (intra-firm), perception of unity; Independent and autonomous	Superficial intra-firm integration (Perception of a contractor relationship); Partially dependent (shared responsibilities)	Defined inter-firm relationship (Joint Venture); Dependent ('Lead' location remains 'responsibility' owner)	Fast growing diversity; Increasing, flexible linkages	Little structure, co-location
Network Dynamics Standardisation	Globally established standards	Established standards between location and 'lead' location	Emerging standards at 'location' level	Fragmented with some customisation	Hybrid of customised and established processes
Governance and Coordination Commercial Control Engineering Control	Control at the production location level ('internal')	Control at the 'lead' location level ('external')	Control at the organisation level (centralised)	VC Investment; Critical capability driven; Technology-driven	Growing customer pull; Critical capability driven
Support Infrastructure Engineering Systems Engineering Resources Culture	Identical systems across the production network, based on 'lead' location specifications; Common culture across global production network	Adjustment and modification of lead location systems (format of specific documents); Individual site culture, variations between 'lead' and locations	Bespoke plant systems (due to different measurement units); No established culture, lacking interactions with other parties	Bespoke systems/tools; Critical resources scale-up; Trust moving to commercial proposition	Inter-system translation, small scale production; Critical resources only; Trust-based
Relationships Partnership-supplier Partnership-customer	Partnerships different depending on location, new and established with local suppliers/customers	Mix of partnerships as per lead site, and new local suppliers/customers	Same partnerships as per 'lead' location	Partner selection; First wave customer partnering	Partner selection; Project specific/ group partnerships

Table 7. Knowledge Mobility Configuration Profile – emerging dimensions of analysis

Network Type	MNC (US-Global) - Product Assembler	MNC (US-Regional) - Product Assembler	MNC (US-EU) - Product Assembler	SME (UK) - Product Assembler	SME (UK) – Component Manufacturer
Network Phase	Mature	Emerging	Nascent	Emerging	Nascent
Network Stage	Established	Expansion -> Stabilisation	Formation -> Expansion	Fragmented -> Formation	Embryonic
Product *Form* *Maturity* *Configuration*	Mature product line; No product design difference between location and 'lead' location product portfolios	Emerging/established product line; Modular product design changes between location and 'lead' location product portfolios	New/emerging product line; Different product designs between location and 'lead' location product portfolios	Alpha product lock-in; Proof-of-concept	Consolidation of concepts, technical flexibility; Licencing
Structure *Organisational Context Capabilities (Technology transfer experience; Levels of knowledge and expertise; absorptive capacity)*	Fully established Knowledge Network Globally; Technology transfer experience (including previous transfer of production line to other locations); Sufficient absorptive capacity (demonstrated independently)	Established Knowledge Network between 'lead location' and case study location; Evidence of previous technology transfers (other product lines); Often sufficient absorptive capacity (demonstrated only when requested)	Limited Knowledge Network between 'lead location' and case study location; 1st technology transfer in progress; Limited levels of knowledge and expertise; Insufficient absorptive capacity	Actors for development and production Increasing visibility on potential partners who cover the entire value chain and neighbouring sectors. Leveraging innovation centres responsible for building regional open-innovation communities	Initial partnership arrangement with potential customer/suppliers Growing an awareness of e.g. innovation centres, who have established networks
Network Dynamics *Production Line*	Fully automated	Semi-automated	Labour intensive, limited automation	Batch to Continuous Flow	Continuous flow
Governance and Coordination *Production Control (KPIs) External influences*	Unified and Global KPIs, international comparisons; Limited external influence (apart from e.g. safety regulations)	Comparison of production KPIs (location v. 'lead' location); Moderate level of external influence (labour incentives)	Isolated and individual KPIs in production plant; High level of external (government) influence (IP incentives)	Determining what success look like (measurement)	Focus on managing internal capabilities
Support Infrastructure *Language (Organisational, native tongue)*	Fully established organisational language adopted globally	Consistent documentation, some language and communication barriers	Leveraging knowledge cross-category/region. People will be starting from different points	Recognising different cultures Putting support Infrastructure in place	Developing a common understanding/language v. different interpretations
Relationships *Intensity of connection Contact frequency Power distance Masculinity (individualism)*	Close relationships (defined roles and responsibilities); Established and regular routine of meetings scheduled (full participation); Perception of symmetrical relationships (equal partners); Close cooperation (global interest)	Growing relationships (partial understanding of who is who and who does/knows what); Irregular meetings (limited availability and participation); perception of un-even relationship v. 'lead' location; "Healthy" competition (mix of location and global interests)	Selecting the correct people who can deliver on the skills and capabilities albeit with effective training	Assessing Innovation and education activities that have a structured mentoring and networking programme	Focus on delivery

Table 8. Knowledge Mobility Configuration Profile – Knowledge Transfer Mechanisms

Network Type	MNC (US-Global) - Product Assembler	MNC (US-Regional) - Product Assembler	MNC (US-EU) - Product Assembler	SME (UK) - Product Assembler	SME (UK) – Component Manufacturer
Network Phase	Mature	Emerging	Nascent	Emerging	Nascent
Network Stage	Established	Expansion -> Stabilisation	Formation -> Expansion	Fragmented -> Formation	Embryonic
Transfer of Fundamental Knowledge	• Global Boundary Spanner • Global audit of production plants (partial) • Global and established standard operating procedures (SOPs) • Electronic linkages for Global communication	• 'Lead Location' Boundary Spanner • Global audit of production plants • 'Lead location' standard operating procedures (SOPs) • Electronic linkages for Global communication	• 'Lead Location' Boundary Spanner (partial) • Local audit • Hybrid of individual and copied standard operating procedures (SOPs) (partial) • Electronic linkages for communication with 'lead' location	• Electronic linkages for communication	• Many issues of knowledge integration may be dealt with relatively simply, and even informally
Transfer of Moderate Knowledge	• International forum - face-to-face meetings of Global experts (partial) • International teams (global team located at 'lead location') • Global and established best practice guidelines • Global benchmarking of all production plants (partial)	• International forum - face-to-face meetings of Global experts (partial) • International teams (global team located at 'lead location') (partial) • 'Lead location' established best practice guidelines (partial) • Access to benchmark reports	• Meeting of production plant and 'lead' location experts (partial) • International teams (global team located at 'lead location') • 'Lead location' established best practice guidelines (partial) • Access to benchmark reports (partial)	• Leveraging MNC network to gain professional training combined with hands-on experience • Emerging assets increasingly utilised in this space e.g. SPOCs (Specialized Private Online Courses)	• Affordable access to targeted and meaningful education and training in particular domain • Massive Open Online Courses (MOOCs)
Transfer of Advanced Knowledge	• Expatriation of Global experts at production location (partial) • Overseas Training at 'lead location' (partial)	• Expatriation of 'lead plant' experts at production location • Overseas Training at other Global production locations	• Expatriation of 'lead plant' experts at production location • Overseas Training at 'lead location'	• Interactive SPOCs tailored to the specific demands of the SME • Rotating Elevator Workshops with network partners	• 'Facilitator' role often useful • Moodle as a flexible Virtual Learning and knowledge exchange tool

Our findings demonstrate the critical role of knowledge management in internationalisation, and that skills, knowledge, technology and organisational processes are integral to any emerging network design criteria and/or ‘capability’ acquisition assessment.

The framework extends the network configuration approach to incorporate knowledge-specific dimensions of analysis and associated knowledge integration mechanisms, derived from the academic literature and practice. The literature review identified key gaps and themes, which included: the need for a common framework that captures the overall structure of knowledge transfer frameworks, providing a holistic view of all dimensions and their relationship (existing research tends to focus on a specific aspect of the knowledge mobility process); a better understanding of the different aspects of knowledge, and different dimensions of the network configuration and their relationship, overview of best practices mechanisms, and what knowledge types they transfer most effectively. The choice of integration mechanism is not only influenced by the type of knowledge being ‘mobilised’, but also by industrial context and the maturity of the network within which the knowledge is being shared.

This nuanced approach has been used successfully as a basis for a proactive and differentiated approach to knowledge mobility within any network. In summary, between the recipient and source, the *knowledge context* element of the refined framework requires:

- **Knowledge Level:** Level of knowledge to be transferred
- **Knowledge Characteristics:** Dimensions defining the type of knowledge
- **Knowledge Package:** the message which has to be delivered
- **Internalised Knowledge Package:** Level of knowledge recipient has acquired

Between the recipient and source, the *network context* element of the framework consists of conventional dimensions, plus emerging dimensions, from the knowledge literature, in terms of: Structure; Network Dynamics; Relationships; Governance and Coordination; Maturity Level.

Integrating these contexts, figure 8 sets out the final Knowledge Mobility Configuration framework, which captures the critical role of knowledge context, network configuration and transfer mechanism in the success of the transfer. Here, between the recipient and source, the knowledge transfer mechanisms best employed to support different network configurations should be used to transfer different types of knowledge.

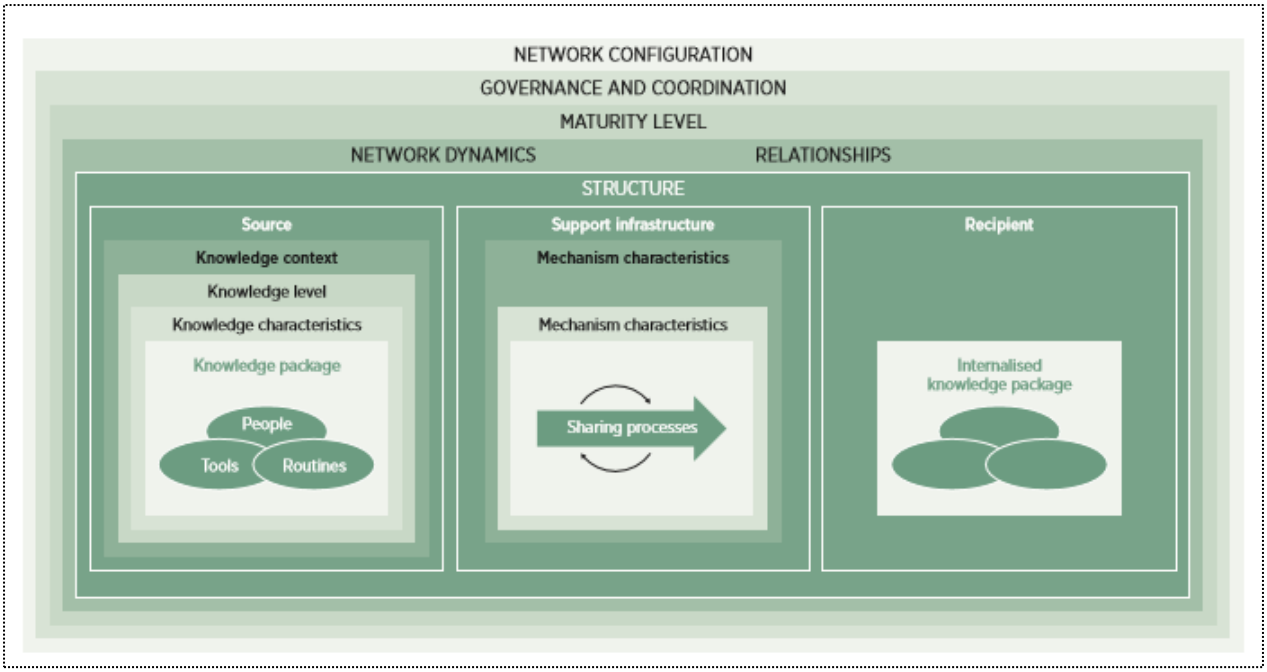

Figure 8. Knowledge Mobility Configuration framework: Network configuration framework extended to incorporate knowledge-specific dimensions of analysis and associated knowledge integration mechanisms, derived from the academic literature and practice

The refined framework serves to reduces complexity, and combines both configuration aspects of the knowledge network, as well as insights on optimum knowledge transfer mechanisms in practice today - offering a visual representation of the current state of the knowledge transfer network configuration within an organisation or network. Our results suggest that there is an active knowledge-sharing network and that multiple levels of employees understand the requirement for such a network and how their line integrates with the network. In summary:

- Knowledge configuration profiles capture the knowledge context, describing the knowledge level and their characteristics, the network configuration in terms of product maturity and their appropriate knowledge mobility mechanism.
- Maturity of the product greatly influences the success of transfers, and the more established the network the more streamlined the knowledge transfer process.
- Structure, abilities and relationship status of the transfer parties greatly impact the knowledge sharing process.
- Different knowledge mobility mechanisms will be better suited then others for the transfer of different knowledge characteristics and levels.
- Depending on the network configuration, different knowledge sharing mechanisms will be available and can be designed to fit specific purposes (for example, concepts of operation for ‘virtual teams’ versus communities of practice).

As every company has its own culture, dimensions may need to be defined using an internally accepted company language. There are limitations to the user's level of influence, as some stakeholders will be able to influence different dimensions more than others that need to be better understood. Our research supports the assertion that absorptive capacity, the ability and capability of organisations to make use of external knowledge is an important phase of the process and that the effectiveness of absorption, embedding and diffusion may have an influence in selecting and managing future collaborations. It was found that SMEs often have limited resources in knowledge management and need confidence to adopt any initiative, which can be built up by improved approaches tested in SMEs. Knowledge transfer here may be enhanced through the adoption of collaborative resource sharing, and cross-pollination of knowledge, even when the supplier is 'locked-in' to a customer and not co-supplying a competitor.

7. Conclusions and directions for future research

Knowledge management theories and practices that are implemented in large organisations may not always be best suited to smaller companies. This study addresses a need to conduct empirical research to develop theoretical frameworks for a deeper understanding and a platform for the future development of the field. The methodology, developed as part of this study, focuses on the capture of tacit knowledge and the establishment of dynamic knowledge transfer network configurations.

By examining knowledge mobility mechanisms within the context of network maturity, the research examines how both the knowledge task and also the available knowledge mobility mechanism are modified by network maturity and industry context. A literature review within the domains of knowledge transfer and network configuration revealed a research gap in the exploration of knowledge 'mobility', in terms of network configuration. Existing literature remains largely descriptive and only considers a very narrow window when looking at the different dimensions affecting the transfer. In order to address this research gap this study looked to explore how best to capture knowledge configuration profiles in MNCs and SMEs.

The extant literature revealed different approaches discussing the dimensions of knowledge sharing and how they promoted or inhibited transfer effectiveness. The approach of Cumming (2003) formed the basis for a prototype framework, which used emerging dimensions specific to knowledge and transfer characteristics, as well as stages of network emergence. The knowledge mobility configuration profile of five case studies captured current (and future desired) states of knowledge management within the networks under investigation

This research has made valuable contributions to the analysis of knowledge: analysing the different determinants of knowledge networks and demonstrating how they support or enable sharing processes. This research unites the different determinants of knowledge mobility, providing a holistic understanding of the dimensions, their relationship and implementation within different network configurations and maturity levels. In summary:

- The overview of the different dimensions and sub-dimensions of knowledge network processes enables a better understanding of their different characteristics, and their relationship affecting knowledge transfer activities.
- The network configuration element of the KMC framework provides insights on how global product networks mature, and how their knowledge mobility profiles may evolve over time.
- The characterisation of different mechanisms for each stage of emergence informs existing literature and provides an understanding not only on which mechanism are applied within industry also how these mechanisms are utilised within different network maturity levels.

One of the benefits of applying research in practice is that it helps identify and solve problems (both new and existing) that originate from industry (Childe, 2011). Here, application of the KMC framework contributes to practice in several ways, for example:

- A very complex matter can be absorbed in a very short time.
- A visual picture of the current state configuration (capturing the results) that everyone can access (codification).
- Mapping different perspectives, against a future desired state, provides an overview where they are aligned or not, highlighting areas of concern.
- Provides a basis for benchmark activities, as the current state can be mapped against a future current state, where improvements as well as drawbacks can be outlined. For example, key insights across the cases centred on: what are the key activities to be performed, processes key to integration, 'linkages' between locations; alignment on priorities and goals; and empowerment.

There are a series of limitations to this study, which present interesting opportunities for future research. In specifically examining knowledge transfer mechanisms in knowledge-intensive manufacturing firms (and across their networks), first, is the nature of the case studies and access to a significant number of case examples. While the KMC framework was first developed using an extensive literature review, validation and insights were restricted to five case studies (with supporting secondary data) across a knowledge-critical sector. Access was limited to two SMEs and three OEMs at the time of framework application. This is understandable given sensitivities over IP and high rates of turnover/attrition, with respect to respondents and smaller firms. However, the selection criteria set out did allow a diversity of enterprises operating at different (and multiple) points across the value chain to be identified and targeted. In summary, additional validation with a more extensive set of cases would be beneficial. A second limitation is about the research design, particularly the unit of analysis. Three of the cases are networks of the same organisation, and this research treated them as individual cases, because they are fairly independent at both strategic and operational levels. With knowledge being obtained through organisational task and in specific settings, it may be

unique to individual organisations. Hence, these three case networks may be strongly influenced by the culture and orientations of the organisation's central function. However, as this research involved interviewing managers and engineers from different parts of the business this was beneficial in obtaining a comprehensive view of knowledge management for the organisation and its network operations.

Despite these limitations, engagement with industry served to identify the practice need for new avenues of research. Directions for future research are suggested here based on the above discussions.

One area of focus is to capture generic configuration patterns or archetypes of *Knowledge Mobility* through more studies in a broader range of industry sectors, and to enable refinement of the dimensions of analysis.

As part of an emerging technology research agenda, we will also examine how IT-enabled and e-commerce-based supply chains are changing the roles of information and knowledge, in addition to the future role of Knowledge Information Centres (KICs). SMEs are regarded as the 'backbone' in many sectors and, as a result, KICs are developing strategies to include a significant number of SMEs in various activities. KICs, themselves, could be regarded as start-ups with the complexity of a MNC, and a future focus of research will explore knowledge mobility mechanisms in regional open-innovation communities that support, catalyse and accelerate the embedding of innovation in SMEs, and across MNC-SME networks.

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