Chapter 10
How Collaboration and Digitization Transform Large Project Business

Klaus Backhaus and Ulf König

Introduction

Collaboration and digitization are two trending buzzwords which companies both put their hopes in and struggle to handle at the same time. There are statements that the digitization process will destroy complete business models, including even those of current market leaders (Loebbecke & Picot, 2015). While the effect of collaboration and digitization is well covered in scientific B2C literature and both industry experts as well as consultancies offer seemingly endless amounts of practical advice, little is known with regard to the B2B sector (Miller, 2012). Adding to the matter's complexity, the B2B sector is rather heterogeneous consisting of four fundamentally different business models (Backhaus & Voeth, 2014). Out of these four, the so-called large project business (LPB) has enjoyed the least coverage in existing literature and also shares the fewest communalities with the B2C sector, therefore making a particularly insightful object of investigation.

Based on these considerations, our paper poses the following research question: How do increasing levels of collaboration and digitization transform the principles of LPB? To answer this question, section "Fundamentals of Large Project Business (LPB)" delineates the concept of LPB and describe its modus operandi as compared to other B2B business models. Section "Collaboration as a Key Characteristic of LPB" gives special focus to the role of collaboration, which has already been crucial in the past and which gains even more importance in today's globalized world. Section "Enlargement of Collaboration Partners in Times of Digitization" narrows down the effects of collaboration and digitization to three concrete examples: contract

K. Backhaus (✉) · U. König
WWU - University of Muenster, Münster, Germany
e-mail: backhaus@wiwi.uni-muenster.de

U. König
e-mail: ulf.koenig@uni-muenster.de

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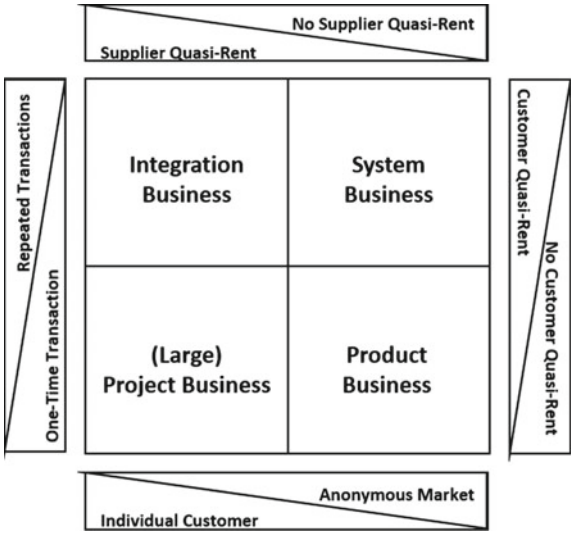

Fig. 10.1 Typology of B2B Business Models (Backhaus & Voeth, 2014)

negotiation, organizational charts, and advanced tools. Finally, section "Conclusion" closes with a short conclusion. Our contribution is to provide one of the first analyses of the impact of collaboration, digitization, and their interplay from a B2B and especially LPB perspective based on three clear-cut examples, which we deem highly illustrative of the forces at work. In contrast to the widespread belief that digitization impacts B2C businesses earlier and more strongly than their B2B counterparts (Backhaus & Voeth, 2014), we show that there is plenty of evidence against this cliché.

Fundamentals of Large Project Business (LPB)

In light of the broad range of B2B products, companies, and industries observed in practice, several authors such as Kleinaltenkamp (2001), Plinke (1997), and Richter (2001) have proposed typologies to structure the field. One of the most widely accepted typologies comes from Backhaus and Voeth (2014) and distinguishes between four different B2B business models along the following dimensions: (Fig. 10.1)

(1) Individual customer versus anonymous market: B2B customers can be either very few and therefore well identifiable or many and therefore more anonymous. The latter resembles B2C market structures as B2C consumers are almost always too many to e.g., develop intense seller-buyer relationships, truly customize products, and target them with personalized marketing messages.

(2) One-time transaction versus repeated transactions: B2B customers may either buy only once or repeatedly.
(3) Supplier quasi-rent versus no supplier quasi-rent: Suppliers may have or have not quasi-rents. The quasi-rent describes the supplier's investment specificity and therefore the switching costs, which can increase productivity while also restricting asset application possibilities. In particular, quasi-rents are defined as "[…] the excess of value over its salvage value, i.e., its value in its next best use to another renter" (Klein, Crawford, & Alchian, 1978).
(4) Customer quasi-rent versus no customer quasi-rent: analogous to (3).

The resulting four business models can be described as follows:

(1) The product business is characterized by an anonymous target market, one-time transactions, and the absence of both supplier as well as customer rents. In essence, this boils down to selling commodities. Typical examples are screws or computer hard drives. This business model shares the most similarities with classical B2C business models.
(2) The system business is characterized by an anonymous market, repeated transactions, no supplier quasi-rent but the presence of customer quasi-rents. Typical examples include office furniture and SAP software as products are complementary to each other and form a modular system. Once one has decided to make the initial purchase, there is a lock-in effect due to switching costs with regard to follow-up purchases.
(3) The integration business is characterized by few, identifiable customers, repeated transactions, and the presence of both supplier and customer quasi-rents. A typical example is an automotive supplier building a production line for a given OEM. Both the supplier as well as the OEM are highly dependent on the other party as reflected by the presence of mutual quasi-rents.
(4) Lastly, LPB as the subject of this paper is characterized by few, identifiable customers, one-time transactions, and the presence (absence) of supplier (customer) quasi-rents. Typical examples include rolling mills, power plants, and offshore wind parks, which are all technically complex systems of high monetary value (Backhaus & Voeth, 2014). Products are custom-made for each customer resulting in non-reciprocal quasi-rents on the supplier's side. To compete against the relatively small number of worldscale competitors in LPB, a company needs different technical and commercial competencies that vary from customer to customer.

Since LPB has rarely been addressed in existing literature so far and since it shares the least similarities with classical B2C business models, it represents a suitable object of analysis for this paper.

Collaboration as a Key Characteristic of LPB

Central Impact Factors

Managing LPB regularly means to bring together process and product know-how from different technical areas (like mechanics, mechatronics and electrical works) and companies on a project-specific basis. Moreover, the customer requires an individual solution that works reliably and meets the defined targets (e.g., "allowed downtimes" or "minimal output"; Backhaus & Voeth, 2014; Günter, 2013). Although project-specific competence mergers were historically the main reason for the broad and intensive collaboration in LPB, a large set of other reasons to collaborate has emerged in the meantime. Figure 10.2 contains a list of those reasons which Backhaus and Gnam (1999) consider as central impact factors in this context.

This non-exhaustive list of reasons to call LPB a collaborative business explains/accounts for the growing sizes of supplier coalitions (Backhaus & Gnam, 1999). In particular, the highlighted criteria #1, #3, #5 and #8 mainly determine size and structure of the alliances (see the following sections for an explanation why these criteria have led to coalitions with more and smaller members).

If one takes out these four dominant criteria, five criteria remain. These five criteria as a cluster are named "miscellaneous" not because they are less important, but their importance varies from situation to situation (Backhaus & Gnam, 1999). If patents are relevant, they are a strong argument in that situation. In other settings, patents

No.	Label	Short Description
1	Pooling of Know-how	Single supplier does not have enough Know-how to manage the project alone
2	Risk sharing	If the total project risk is too high to be handled by one supplier
3	Financial structuring	LPs regularly need an efficient financing structure that only can be realized, if one can get credit insurance in foreign countries which is linked to deliveries from that country these makes is necessary to join the coalition
4	Wanted by customer	The customer asks the supplier to include a special supplier into in the coalition
5	Local manufacturing	Legal prescription to produce parts of the order in customer country
6	Patents	Enlargement of partners because a technology is needed that is owned by a special supplier
7	Capacity enlargement	LP is too big for one supplier
8	"Cheapening"	Looking for partners who can "cheapen" the project-costs
9	Competitor reduction	By collaborating between competitors the number of competitors can be reduced
10	...	

Fig. 10.2 Reasons for collaboration in LPBs (Backhaus & Gnam, 1999)

may not be a driver at all. See Fig. 10.2 for a detailed description what the potential drivers are and how they contribute to the effect of growing collaboration units.

LPB and the Four Dominant Criteria

Criteria #1 (Pooling of Know-how) and #3 (Financial Structuring) are considered to be dominant because they are relevant with almost every order. As we have already pointed out, know-how pooling is the basic criterion that historically led to the effect of collaboration within LPB (Backhaus & Voeth, 2014; Backaus & Gnam, 1999). Furthermore, almost every LP has to be order financed which is why suppliers have to find credit agencies (e.g., private banks or other special institutions that are prepared to finance industrial projects like the IBRD, International Bank for Reconstruction and Development, shortly called World Bank).

To finance a project in dimensions of a billion dollars or even more, these institutions ask for international credit insurance (Backhaus, Brüne, & Wiegand, 2013). In all exporting countries, government supported public credit insurances have been installed providing exporters with the demanded credit risk coverages. These serve as a prerequisite for getting credits.

As all credit agencies—the German credit insurance company is called Euler-Hermes—have only limited budgets for individual countries, suppliers are often forced to get insurance and financial support from those countries that still have disposable budgets (Häberle, 2002). The supplier has to put together piece by piece like a puzzle in order to construct a complete financing and insurance package (financial engineering; Backhaus & Voeth, 2014). However, driven by political considerations, national insurers often ask supplier coalitions for national manufacturing in order to stimulate their local economies. This requires suppliers to make the local player a member of the supply consortium (Häberle, 2002), thereby enlarging the coalition (criterion #5).

Another supply-sided problem is the "Cheapening Criterion" (criterion #8). The rationale behind this criterion is as follows: to offer a competitive price, it may be a solution to find partners from countries with lower price levels. As a consequence of both the criteria "local manufacturing" and "cheapening", the project manager sometimes has to integrate partners from 20 countries or more in order to obtain the required financial package, which in turn makes collaboration ever more complex (Siepert, 1987).

Enlargement of Collaboration Partners in Times of Digitization

As we have shown, the number of coalition partners in LPB has always been larger than in other types of projects. In times of globalization and quickly developing economies in emerging countries, this number tends to grow even bigger. As a second megatrend, digitization has proved to be an omnipresent force with enormous potential of disruption. These two developments have some severe consequences for the mechanics of LPB. With large projects that have a two-digit number of consortial partners, managing the supplier alliance in times of digitization is a challenge. It gets even more complicated when—as often observed in practice—partners are not only more numerous, but come from different countries. The following sections will analyze in detail three illustrative effects of increased levels of collaboration and digitization on LPB, respectively: contract negotiation, organizational charts, and advanced tools.

Negotiating the Contract: Key to Legal Aspects

As customers and collaborating partners are located all around the world, the consortium is embedded into diverging legal frames (Backhaus & Gnam, 1999). In theory, the supplier should therefore have legal knowledge with respect to the specialties of almost every country in the world. As this is impossible to realize, players in LPB have developed contractual designs that enable the partners to build their own statute regulations and thus do not have to recur on the general rules of national legislation. It is this contract, which shall give the answer on any question that may arise. Exceptions become relevant only in those cases where national regulation is mandatory (e.g., in case of exclusion of liability or gross negligence) or if a claim comes up which is not accounted for in the contract. In these cases, the legal answer will be given by the respective national law. As it can be seen, a good contract is of mayor importance in LPB. But what makes a contract a good one? This is a question of perspective: we distinguish between a customer contract (CC) and a supplier contract (SC). The CC addresses the outer relationship between the customer and the seller as a whole, while the SC is mainly directed towards the inner relationship between coalition partners. The CC (also called "vertical contract") defines rights and obligations that may become relevant between supplier and customer, usually following a four-chapter-structure that can be taken as a check list during customer-supplier negotiations (for more details see Backhaus & Uekermann, 1990):

(1) Technical solution
(2) Commercial conditions
(3) Contract execution
(4) Breach of contract

The SC relates to two groups of rules, namely those

(1) which deal with regulating how to internally handle claims stemming from the CC (example: who is responsible for a delayed delivery and how to handle the claim?),
(2) regulating intra-coalition claims and obligations without a customer claim being involved (example: employee of supplier A damages the equipment of supplier B. If there will be no general delay from that event, A and B still have to be clear about their legal rights and obligations.).

Importantly, the SC as the inner relationship cannot contain paragraphs that do not match the conditions of the CC as the outer relationship (e.g., the CC promises a penalty in case of delay, but the SC frees all partners from paying). Thus, the SC is valid only if it matches the conditions of the CC, which raises the need for homologation of both contracts.

The Effect of Larger Coalitions—New Liability Concepts

As outlined before, today's supplier coalitions tend to grow big, which moves the SC into the center of attention. As the number of consortium partners increases, the order volume per partner naturally has to shrink. This makes it necessary to develop new liability concepts on the supplier side since traditional liability rules based on the no-fault-principle do not work anymore (Backhaus & Molter, 1984): Imagine a consortium with 10 partners handling a penalized EUR 100m project. The partners have agreed on the following contract clause addressing the consequences of a delay in delivery time: "The supply consortium will deliver hard- and software specified in Appendix A of this contract until March 15, 2020. In case of delay the suppliers will pay a penalty of 1% of the order volume per delayed week up to the maximum of 10% of the order volume if the delay lasts 10 weeks or longer". What does this mean for the penalty to pay in case of being 10 weeks late (worst case)? Assumed the 10 partners all have the same portion of the EUR 100m order volume (EUR 10m) and one partner is responsible for the delay, he has to pay the entire penalty which also amounts to EUR 10m—eating up his entire order volume.

As this is unreasonable, we need another concept for growing alliances. Such a concept could be the pre-liability concept (PLC): the basic idea is to split all liabilities in pre- and post-liabilities (see Fig. 10.3; Backhaus & Molter, 1984). The consortium member, who has caused the delay, is liable for an a priori determined part of the damage value—regularly the liability percentage defined in the customer contract, not on the entire order volume but rather on his own order volume. The rest will be paid according to the respective order shares of the coalition members. This concept socializes parts of payments for damages among the partners. Empirical analyses of new risk distributions have shown that besides the traditional liability concept based on the no-fault-principle, three alternatives can be observed in practice (see Fig. 10.3).

Liablity Rule \ Effective Burden of Contractual Penalty Referring to the Share of Order		Non-Responsible Consortial Member	Responsible Consortial Member	Key	
1.	**No Fault:** The responsible consortial member is solely liable	–	$p_i = p_g * \frac{100}{q_i}$	b	Penalty distributed as the remainder among all partners
				e	Penalty to be paid by responsible partner beforehand
2.	**Payment-Related:** The responsible consortial member is pre-liable for … percent of the amount to be paid to the customer Remainder according to the shares of order	$r_j = \frac{b * p_g}{100}$	$p_i = p_g \left[\frac{b}{100} + \frac{e}{q_i} \right]$	p_g	Maximum penalty as percentage of total order value
				p_i	Penalty of responsible partner i in percent of his/her order value
				q_i	Share of the responsible partner i of the total order value in percent
3.	**Penalty-Related:** The responsible consortial member is pre-liable for up to an amount of … percent of the amount of his/her share of order – Remainder according to the shares of order	$r_j = p_g - \frac{t * q_i}{100}$ $p_g \geq \frac{t * q_i}{100}$	$p_i = p_g + t \left[1 - \frac{q_i}{100} \right]$ $p_g \geq \frac{t * q_i}{100}$	r_j	Penalty of the non-responsible partner j as percent of his/her order
				s_j	Share of non-responsible partner j of the total order value in percent
				t	Percent of the value of share of order to be paid by the responsible partner as pre-liability
4.	**Multiplier:** Pre-liablility by a consortial quota-based multiplier	$r_j = \frac{100\, p_g}{100 + q\,(v-1)}$	$p_i = v * \frac{100\, p_g}{100 + q\,(v-1)}$	u	Percent of the value of share of order to be paid by the non-responsible partner
				v	Multiplier of the percentage of the consortium-based share

Fig. 10.3 Different liability rules (Backhaus & Molter, 1984)

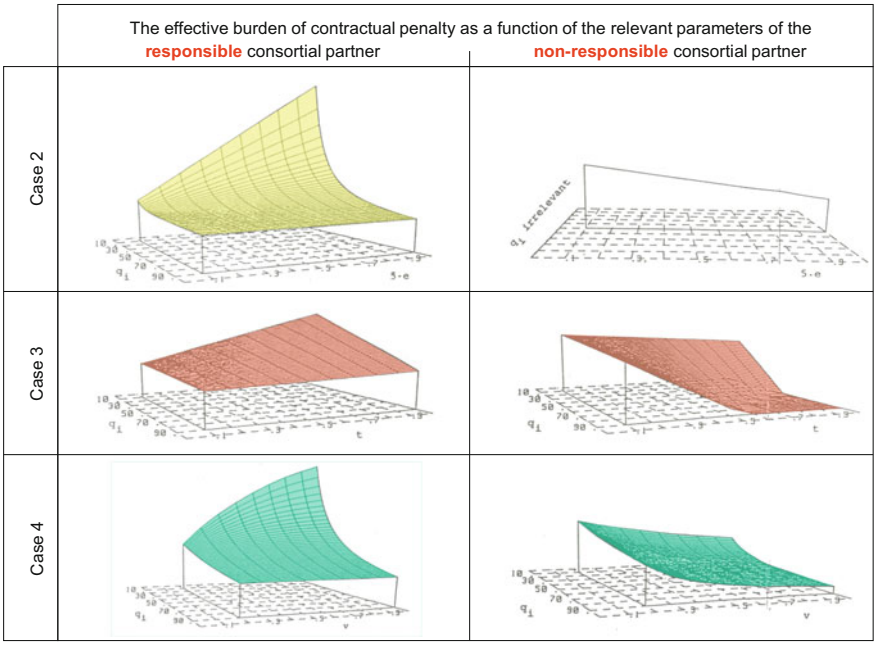

Fig. 10.4 Graphical illustration of different liability rules (Backhaus & Molter, 1984)

Column 2 specifies the liability effects depending on the SC. Column 3 (4) describes the liability effects of the different cases on the non-responsible (responsible) consortial members. Regarding the regulations of the pre-liability, they seem to be quite similar. However, looking at Fig. 10.4 as the graphical representation of the formulae in Fig. 10.3, it becomes clear that the effects of cases 2–4 on the penalty to be paid vary to a high extent. Simulating the effect of variations in the two parameters q_i (order share of the responsible consortial member) and the liability rule shows that their influence is in fact non-linear, except for case 3. Why is that? Case 3 is the only variant where the non-responsible partner can avoid any payment at all. Case 4 in comparison with case 2 shows that growing pre-liability rates in combination with shrinking consortial shares may lead to considerable higher payments.

The Effect of Digitization—Software-Aided Contract Negotiation

With an ever-bigger number of consortial partners, increased importance of the SC, and sophisticated liability rules, negotiation of such contracts has become a highly complex endeavor. While negotiation research has been the exclusive domain of game-theorists, economists, psychologists, and management/marketing scholars for decades, computer science and artificial intelligence (AI) have entered the arena with the advent of digitization. Historically, the application of AI in the context

of negotiation is rooted in computers' ability to win complex games such as chess (Hsu, 2002) or poker (Spice & Allen, 2017) against human opponents. For any such game, it can be assumed that there is a winning strategy—the Nash Equilibrium, as game theory calls it (Nash, 1950). In order to identify this winning strategy, computers can teach themselves which actions to take (and which not) by means of reinforcement learning and Bayesian belief update processes, i.e. practicing trillions of games against a clone of itself (Gershgorn, 2017; Zeng & Sycara, 1998). Especially playing poker resembles a LPB-like negotiation as both situations are characterized by high levels of uncertainty with regard to variables such as the counterparty's cards or negotiation goals—something called "imperfect knowledge" in game theory.

Inspired by such developments in the field of gaming, a broad body of literature on autonomous software agents in negotiations has emerged. The investigated issues range from the effect of different algorithms on negotiation outcomes and welfare to the role of different bidding strategies (e.g., Faratina, Sierra, & Jennings, 2002; Ros & Sierra, 2006). Since the aim of our article is to illustrate the impact of collaboration and digitization in LPB on a macro level, a detailed review of the various kinds of algorithmic implementation would exceed our scope. It must be noted, however, that machine-machine negotiations, as investigated in the majority of these publications, represent a rather unlikely scenario both today and in the near future (Yang, Falcao, Delicado, & Ortony, 2014). In contrast, machine-human negotiations become more likely as technology advances. In such an environment, having the computer negotiate with business partners, sub-contractors, and customers may imply both benefits as well as threats: on the one hand, a well-trained software agent may close better deals than even the most experienced senior executive, e.g. because—unlike humans—AI is not prone to psychological biases such as loss aversion (here and in the following, Lin & Kraus 2010). In case of a lack of experienced negotiators, AI may still compensate for weakly trained negotiation skills and poorly qualified employees. Before actual negotiations, AI could also serve for training purposes in order to obtain the required skills. On the other hand, the process of negotiation oftentimes is a deeply human one and especially in the case of business partners and sub-contractors, it may represent the beginning of a long-lasting relationship. This may get overshadowed by perceptions of anonymity and mistrust as a result of having the computer negotiate. However, AI can adopt various strategies such as tactically disclosing negotiation goals to appear more human-like (Yang et al. 2014) as well as making multiple simultaneous-equivalent offers or delay acceptance in order to better understand the counterparty's preferences and achieve a win-win situation (Yang, Singhal, and Xu 2014). Using these and similar strategies has shown to both improve the negotiation outcome (e.g., in terms of individual utility, joint utility, or distance to Pareto-efficient solution) and the human's attitude towards the software agent, thus opening the door for a fruitful collaboration in the future.

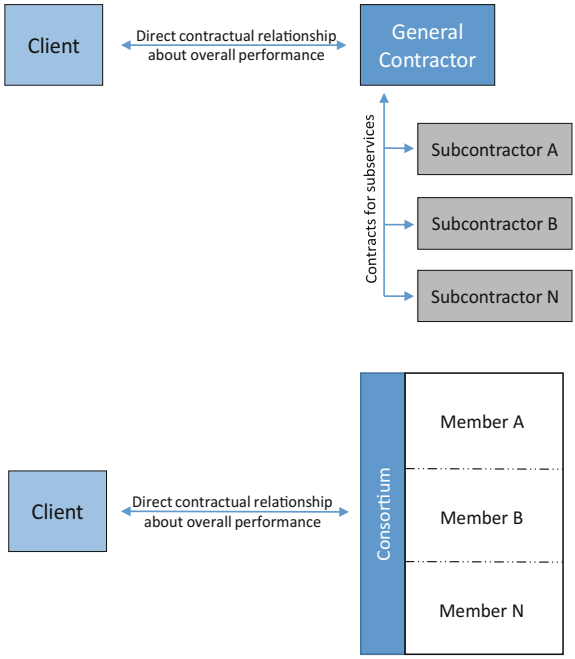

Fig. 10.5 Alternative legal forms of supplier coalitions (Backhaus & Voeth, 2014)

Changing the Organizational Chart

A basic decision in any alliance has to be made on the legal handling of different forms of cooperation. Basically we differentiate between two legal forms:

(1) General contractor model
(2) Project-specific consortium

For the differences between general contracting and a consortium see Fig. 10.5.

The general contractor is characterized by being the only representative of the supplier coalition to sign the customer contract (Backhaus & Voeth, 2014; Günter, 2013). Therefore, the general contractor is also the only one who has a direct contractual relationship with the customer. For the fulfilment of the contract, the general contractor places orders with sub-contractors. However, these sub-contractors are not liable for the delivery of the complete system, but only the general contractor.

In turn, a consortium can be understood as an unregistered company characterized by "joint and several liability". This means that each partner of the consortium is fully liable for any damage that the consortium as a whole or any of the involved partners may have caused (Backhaus & Voeth, 2014).

		General contracting	Consortia
Benefits	for clients	- only one negotiating partner - overall risk under one roof	- performance shares can be negotiated directly - liability basis increases
	for suppliers	- personal contribution is free determinable with a general contractor - free choice of subcontractors - reference advantage	- risk share decreases for all suppliers - direct client contact not just for the general contractor but for all members of a consortium (reference) - financing aids may be used, if as a requirement all direct client contacts are given
Disadvantages	for clients	- maybe lower liability basis at the supplier - if own know-how is great, in some circumstances it might be mandatory to give up performances which could be self performed	- more negotiating partners - must be able to judge the interface problems
	for suppliers	- if delivery conditions can not be passed on - bigger risk for the general contractor	- higher costs through coordination requirements - direct liability access to all members of a consortium

Fig. 10.6 Advantages and disadvantages of legal forms (Backhaus & Voeth, 2014)

The Effect of Larger Coalitions—Tendency Towards Consortia

Both legal forms have advantages and disadvantages. These are demonstrated in Fig. 10.6. While coalitions with smaller numbers of coalition partners may favor the consortium type of organization, growing numbers of consortial partners may make this type unattractive for various reasons (here and in the following Backhaus & Voeth, 2014):

(1) The supplier network becomes less transparent and the individual partner has less control. Therefore, many partners refrain from being made responsible for possible failures, which they had no power to prevent from happening. This development reinforces the need for new liability agreements.
(2) Coordination effort increases exponentially the more partners participate in a consortium leading to high friction loss and major inefficiencies. This is already a problem in the inner relationship between suppliers and can reach dramatic dimensions with regard to the outer relationship between customer and supplier.
(3) As a sub-domain of (2), negotiation effort increases with more partners joining an alliance.

The Effect of Digitization—Platform-Driven Partner Identification

Due to the trend of ever-larger alliances, which in turn make consortial forms of organization less attractive, the general contractor model gains increasing popularity. However, finding suitable sub-contractors in the traditional, offline way can represent a major challenge for many general contractors due to two primary reasons: first, as noted before, such networks may reach difficult-to-manage dimensions due to oftentimes very specialized customer requirements, which implies that a high number of sub-contractors has to be identified. Second, since each project is unique, one can rely only partly (if at all) on existing networks and former relationships. Here is where digitization comes in: apart from providing cheap, quick, and easy-to-use research possibilities such as Google's search application, which is increasingly used by B2B purchasers to gain information about business partners (Backhaus, Bröker, Brüne, & Gausling, 2013; Backhaus, Brüne, & Wiegand, 2013), digitization has paved the way for what is known as online reverse auctions (ORAs)—online platforms where sub-contractors bid for contracts (Sashi & O'Leary, 2002). Finding business partners via ORAs has shown to save time, effort, and ultimately costs because better candidates are identified at lower prices (Emiliani, 2000). However, attributing these achievements to digitization would be a premature oversimplification considering that traditional offline tenders have a similar effect. The digitization-induced advancement may rather be found in the surrounding service landscape, which not only helps to find suitable sub-contractors but guides collaboration at virtually every stage of the project in a way that would not be possible for offline tenders. For instance, the Oracle-owned platform GradeBeam offers contractors a matching algorithm, which refines the distribution of bid invitations to sub-contractors and thus helps reaching the most relevant ones (here and in the following, Oracle, 2016). Further down the process, GradeBeam provides pre-qualification services for shortlisted candidates, thereby reducing the risk of making a false choice due to lack of experience and/or heavy information asymmetries. Even later in the process, once the sub-contractor has been found, GradeBeam offers performance tracking and success evaluation far beyond the phase of tender preparation all the way through until the project's end. Finally, all data associated with this collaboration process and its different stages is collected, analyzed, and visualized in a central database at the general contractor's disposal. Looking at potential drawbacks of using such ORA platforms, it has to be noted that some contractors might have security and privacy concerns. Especially in the context of sensitive infrastructure or defense projects, business partners will be less willing to share information of the described extent with platform owners.

The above example shows not only how digitization radically alters the way sub-contractors can be found today—it also documents the manifold benefits and a potential downside for general contractors. However, ORA platforms function as two-sided markets, which are characterized by two distinct customer groups, to which the platform sells two different products (Rysman, 2009). While general contractors represent the first customer group, one also has to take into consideration the sub-contractors' interests as addressed in the following: on the positive side, suppliers also benefit from a highly convenient and time-efficient way to learn about new

business opportunities, tools for smoother communication, and ultimately reduced cost of sales (Smeltzer & Carr, 2002). In addition, the above mentioned matching algorithms could provide proactive recommendations on which projects to bid. This would not only maximize success probability but also allow especially small sub-contractors to focus their limited resources only on projects, which match their specific competencies. On the negative side, this kind of new transparency is not available to the focal sub-contractor exclusively and therefore most likely increases competition (Smeltzer & Carr, 2002). Higher competition may in turn lead to lower prices and smaller profits for suppliers. Further, there is a certain risk to put effort into an ORA when in fact general contractors are not interested in a real offer but only seek to understand the market dynamics in order to increase negotiation power for a deal with a different supplier. In conclusion, the benefit-risk tradeoff appears less favorable for sub-contractors than for general contractors as there are fewer adjacent services and increased competition.

Advanced Tools

Another consequence of a growing number of coalition members is the need of owning adequate management tools and an appropriate culture in many—especially—supplier coalitions. While there seems to be a complete lack of literature on the impact of company culture in the context of LPB, a hardly overseeable offer of tools for project management is available. Googling for the term "project management tool" ends up with more than 14 million hits with software solutions in the lead. The tools encompass time- and cost-optimizing concepts as well as tracking systems or interface systems that concentrate on integrating the project management tools into other systems like ERP or PPS.

The Effect of Larger Coalitions—Software Standardization

The main priority of any LPB project manager is to ensure smooth coordination between the different business partners participating in the project. Problems of communication, supply chain alignment etc. have the potential to cause severe project delays, which would be penalized as outlined previously. To avoid this, a whole array of tools is at his or her disposal and although most of them are to some extent software-based as explained above, specific forms of organizations including responsibility distribution or feedback culture should also be mentioned in this context.

To come up with a coordinated system, interfaces between these various software solutions need to be aligned. The probability that different software packages are used and consequently that their interfaces are not (fully) compatible rises with a larger number of consortial members. This phenomenon is not limited to LPB and in fact, most people may have experienced incompatibility issues in their personal life—however, in practice, the cost of this problem is often underestimated and

literature is silent about its severeness. To solve this issue, there exist three main approaches:

(1) The first solution is to keep the number of different systems as low as possible in order to avoid compatibility problems. This requires neither changes nor effort from the software developers' side, but LPB companies need to find a (possibly difficult-to-reach) consensus regarding which tools to apply.
(2) The second solution is to aim for interface standardization such that the software packages themselves can be kept, but the intersections become fully compatible to each other. This approach requires significant investments on the software developers' side while users can stick with their familiar routines.
(3) The third solution is to develop new tools that are fully compatible by nature, such as browser-based software. New tools would require considerable effort from both developers as well as users. Since these services have emerged along with the progress of digitization and heavily rely on technologies such as cloud computing etc., they will be discussed in more detail in the next chapter.

The Effect of Digitization—Virtual Organizations

A virtual organization can be considered as an alternative to conventional forms of corporate organization involving physically detached and disseminated entities connected through digital technologies (Gupta, 1997). Originally, the concept was used to describe service-like organizational constellations where value creation is more dependent on immaterial skills and knowledge rather than physical machinery (The Economist, 2009). However, in times of ever-larger consortia spread across the globe, virtual organizations have also turned into the backbone of collaboration between LPB partners. This development was enabled through the emergence of various new technologies aiming at the reduction of collaboration barriers: for instance, cloud computing has paved the way for ubiquitous, simultaneous, and instantaneous access to shared resources through storing documents, applications, and services on centralized webservers (Hassan, 2011). Relying on this technology, applications like Google Docs allow multiple authors to edit a document simultaneously and let the authors observe the others' changes in real time (Google, 2017). So-called wikis are another tool which is based on a cloud-like idea that has gained widespread popularity: Wikis are websites whose content is contributed by a potentially unlimited number of authors, who are not defined in advance and who typically do not have a leader (Encyclopedia Britannica, 2007). Authors do not need any website programming skills as the infrastructure is provided in form of a browser-based text editor without further add-ons (Leuf & Cunningham, 2001). In addition, wiki entries are connected to each other via hyperlinks, which promotes meaningful topic association. Invented by computer programmers Bo Leuf and Ward Cunningham in 2001, the Hawaiian word "wiki" means "quick" (Leuf & Cunningham, 2001). The most famous wiki is probably wikipedia.org ranking among the top ten most visited websites globally since 2007 (Alexa, 2017). In the case of LPB, companies operate private

wikis as knowledge management resources, notetaking tools, community websites, or intranets.

Both these examples, Google Docs and wikis, show how LPB consortia can organize themselves virtually by means of digital tools. What are the effects of such developments? On the one hand, there are effects rooted in the organizational change and on the other hand, there are effects stemming from the concrete application of the above mentioned tools. Regarding the former, virtual organizations clearly increase corporate flexibility, agility, and responsiveness as business partners do not have to resort to more bureaucratic forms of collaboration (Maccoby, 1991). What is more, virtual organizations as a whole as well as the separate members can better exploit their comparative advantages as they can focus on their core competencies and pool the remaining requirements (Igbaria & Tan, 1998). Isaca (2001) further found that virtual organizations are 30–50% more productive on average and significantly less prone to errors, which ultimately also leads to cost savings. These advantages stand in sharp contrast to the challenges that come along with virtual organizations. These mainly stem from the danger to neglect human nature in an increasingly anonymous process of collaboration: first, virtual interaction implies reduced face-to-face contact and therefore more room for misunderstandings. Lee (2014) observes lower levels of communication intensity in virtual organizations compared to physical ones, which is generally viewed as detrimental with regard to the project's success. In addition, Lee (2014) shows that participating partners are oftentimes confronted with a latent clash of organizational cultures, which does not get addressed as diligently as in other forms of cooperation such as post-merger integration in M&A. Lastly, Lee (2014) points out that virtual collaboration tends to hinder the cultivation of interpersonal relationships and trust among business partners.

On a lower level, the usage of digital collaboration tools such as cloud-based and cloud-like technology (wikis) also triggers various effects which go beyond the general ones presented above. On the one hand, collaboration has become more democratic and hierarchies have flattened since contributions to wikis etc. can be made on the spot without being filtered before. In fact, Leuf and Cunningham (2001) emphasize that wiki authorship must not be limited to experts in the traditional sense as content should be written by users for users. As a second consequence, reading what others have contributed in real time may result in higher levels of inspiration and creativity for the author's own contribution as it resembles idea generation approaches such as the 635-method (Rohrbach, 1969). This may ultimately lead to higher output quality at increased speed. On the other hand, having various authors edit and manipulate content and data simultaneously oftentimes results in redundancies and poor structure. In the worst possible case, the absence of revision and control can even lead to erroneous content being disseminated. This is why version control systems (VCSs) as another popular tool were called into existence: VCSs originally come from the field of software engineering, where a programming code is created in teams and needs to be reviewed by the other team members before implementation. The application tracks the changes to any given document and signs them with a timestamp, such that erroneous parts can be removed by retrieving a previous version. At the simplest level, this involves only saving a new copy of the document

whenever a change has been made. At the more sophisticated level, a project can be partitioned into trunks and branches that can be approved, discarded, merged, or separated further while also recording meta data such as authorship, comments, tags etc. In conclusion, since the threats of using cloud-based and cloud-like collaborative infrastructure can be mitigated by deploying version control, the advantages will most likely dominate.

Conclusion

Collaboration and digitization are omnipresent buzzwords in today's business world. While numerous publications, consultancies, curricula etc. address the undisputable effect of these two phenomena on B2C industries, the B2B sector and especially LPB tend to fall off the radar. LPB has always been characterized by the demand for close collaboration and while some of the resulting consequences were happily embraced in practice, others were largely neglected. However, the situation has changed with the rise of digitization and there are interaction effects between both phenomena that cannot be ignored any longer. Yet, we did not come across any publication dedicated to the effect of digitization and its interplay with collaboration in a B2B or LPB setting. This paper represents a first step towards filling this gap by contrasting how LPB used to operate (and to a large extent still continues to do so today) and how collaboration and digitization revolutionize this industry. Three examples are analyzed in particular: First, contracts now feature new forms of liability agreements and are negotiated by automated software agents. Second, there is a trend away from consortia in favor of general contractor models, which is supported by ORA platforms easing the search for and management of sub-contractors by providing a rich variety of surrounding services. Third, virtual organizations and digital collaboration tools alter the way how business partners collaborate on a day-to-day basis rendering physical contact (almost) needless. While these three examples may not be the only changes brought by digitization into LPB, they nicely illustrate the disruptive potential coming along with these forces. As our work is purely conceptual, we hope to stimulate further studies into this direction that may also provide empirical proof and quantification of the outlined effects.

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