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Technologies pour les données massives : bénéfiques et coûts perçus par les entreprises adoptantes et non adoptantes

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Résumé :

Cette étude vise à identifier les différences de perception, parmi les entreprises, entre les adoptants et les non-adoptants des technologies pour les données massives (BDT) en termes de coûts et de bénéfices. Sur la base de la littérature et de recherches antérieures, un questionnaire a été conçu, y compris une étude pilote sur un sous-échantillon de la population ciblée d'entreprises. Au total, 200 questionnaires ont été remplis. L'échantillon final était composé de 86,5 % d'entreprises de taille moyenne et de 13,5 % de grandes entreprises, ce qui a permis d'assurer un niveau de confiance de 95 % et un intervalle de confiance de 6,9 %. Nous constatons des différences significatives entre les adoptants et les non adoptants des BDT en ce qui concerne la perception de leurs coûts et bénéfices. Par exemple, l'analyse a mis en évidence que les adoptants et les non-adoptants ont des perceptions différentes des bénéfices des BDT en termes de rentabilité : le taux de réussite des nouveaux produits ou services étant plus élevé que celui des concurrents et la croissance des ventes. Les non adoptants perçoivent que ces bénéfices sont inférieurs à la perception qu'ont les adoptants de ces bénéfices. Cette étude, en accord avec la théorie de la diffusion de l'innovation, identifie les différences de perception des coûts et des bénéfices entre les segments des entreprises qui adoptent les BDT et celles qui ne l'adoptent pas. En ce qui concerne les implications pratiques, nos résultats enrichissent les orientations dont disposent les dirigeants dans leurs décisions de mettre en œuvre les BDT dans leurs entreprises.

Mots clés :

technologies pour les données massives, coûts, bénéfices, adoption, digitalisation, perceptions



Big data technologies: perceived benefits and costs for adopter and non-adopter enterprises

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Abstract:

This study aims to identify perceptual differences, among companies, between big data technologies (BDT) adopters and non-adopters in terms of costs and benefits. Based on relevant literature and previous research, a questionnaire was designed, including a pilot study on a subsample of the targeted population of companies. Overall, 200 questionnaires were completed. The final sample was composed of 86.5% medium-sized companies and 13.5% large-sized companies, thus assuring a 95% confidence level and a 6.9% confidence interval. There were significant differences between adopters and non-adopters of BDT of their perceptual costs and benefits. For instance, the analysis highlighted that adopters and non-adopters have different perceptions in terms of the benefits of BDT in terms of profitability, the success rate of new products or services being higher than that of competitors and sales growth. Non-adopters perceive that these benefits are lower than the perception that the adopters have regarding these benefits. This study, in line with the diffusion of innovation theory, identifies the perceptual differences of costs and benefits between BDT adopter and non-adopter segments of enterprises. In terms of the implications for practice, our results enrich the available guidance that managers have at their disposal in their decisions to implement BDT in their companies.

Keywords :

big data; information technology; costs; benefits; digitalization; perceptions; adoption;

1.Introduction

In the last decade, technological change due to digitalization has had a strong impact on the competitive dynamics of sectors, human-machine interaction and value creation opportunities for companies (Kharlamov and Parry, 2020). Technological change brings benefits in many areas, such as decision-making processes and labor markets (Günther et al., 2017). Particularly, in business, digital transformation is very important since it enables companies to react and manage changing markets (Chen, 2019); it allows the automation of existing processes, i.e., the elimination of routine work (Schmitz et al., 2019) and the transformation of their value proposition and the features of the products and services provided (Frank et al., 2019).

Innovative businesses are using a wide range of novel digital tools, ranging from apps to artificial intelligence, with significant benefits for their business models (Loebbecke and Picot, 2015), their strategies and the ways in which they manage customers. This wave of technology disruption has already transformed many industries for both customers and firms from both the demand and supply sides (Constantiou and Kallinikos, 2015). From the customer side, for example, digital transformation plays a key part in delivering a better experience (Wiener et al., 2020). From the company side, artificial intelligence is revolutionizing companies' strategies and the way they set prices.

Among all the technologies that are revolutionizing the sectors, big data technologies (BDT) allow one to extract, process and analyze huge amounts of data in order to extract value from them. Managers, especially those of medium- and large-sized firms, know their features and what the market is able to offer. There are studies in the literature that have shown the possible benefits and their features of BDT (Ren, 2016). However, even though the literature has already investigated the costs and benefits involved in the adoption of BDT, the understanding is still scant, and the literature provides distinctive points of view of adopters and non-adopters regarding their perceptions of the benefits and costs of BDT. We focus on the benefits and costs because they contribute to determining the relative advantage of an innovation. The perceived relative advantage is the most significant innovation characteristic of the adoption process as part of the diffusion of innovation theory (Rogers, 2003). Moreover, regarding this adoption behavior, we split the target population into adopters and non-adopters (e.g., Karayanni, 2003; Eastlick and Lotz, 1999), which would provide the opportunity to reveal differences between the groups.

Given the increasing importance of BDT and their applications, the aim of this study is two-fold. First, the study examines the perceived benefits of BDT by BDT adopters and non-adopters to understand if the benefits are different for the two groups of companies. Second, the study also investigates the perceived costs of this technology from the points of view of both adopters and non-adopters, highlighting the presence of possible differences and in which terms. Accordingly, in this study, we answer the following research question: "What are the differences in the perception of benefits and costs of BDT between BDT adopters and non-adopters?" The results will help to better understand the IT investments of companies around their information management.

The remainder of this article is structured as follows. First, we discuss the research already published on BDT in companies, and we then present our two hypotheses. Second, we highlight the research methodology. In the following, we present our findings, and we discuss

them in light of the existing theory. Finally, we provide some implications for practice and the most pertinent avenues of future research, and we conclude the study.

2. Challenges of BDT in companies and hypotheses development

Even though the worldwide big data market is expected to account for USD 135.22 billion by 2025 with a growth rate of 19% from 2017 to 2025 (Navanath, 2020), many CIOs and managers hesitate to make BDT investments since they are scared of the costs they could encounter and of the uncertainty regarding the real benefits for their companies. Many challenges to big data use are advanced by the literature (Sivarajah et al., 2017), and they are of different natures and occur at different points in time throughout a BDT investment.

One of the first issues to solve is related to data life cycle management (Li et al., 2015) and the need to know how to collect, integrate and store the data from many sources (Chen et al., 2014). Data can be generated at a high speed and in huge volumes; hence, these data need to be classified to understand which data need to be stored and which data need to be discarded since they are not valuable. Once this selection is over, data compression (Zou et al., 2014) could be considered. Gathered data could be reduced, compressed and filtered in order to be useful for managers. Moreover, the accuracy, timeliness, precision, reliability, currency, completeness, and relevancy of all data need to be assured when managers have to handle big data. For example, if the data gathered about customers are not timely, they may be much less useful or even completely obsolete. If data are not complete regarding, for example, customers' behavior in a shop, the data could hinder managers' decision making. Furthermore, the decision making is largely influenced by the data representation (Brooker et al., 2016): when managers need to handle different types of data, they face heterogeneous types and structures of data at the same time. If companies have the right big data tools to represent data they possess, they can find the meaning of them more easily and interpret them properly.

From a longer perspective, the scalability of BDT investments has to be satisfied. The systems that support the storage and analysis of big data need to interconnect with existing databases as well as future databases. The analytical algorithms beyond them need to process databases that, over time, become more complex and increasingly large. However, this scalability toward future, new, and larger databases has to address the energy consumption issue (Diamantoulakis et al., 2015). With the increase in the variety of data, the veracity and volume, and the analytical demands, processing, storage, and transmission of big data, companies will unavoidably consume increasingly more electric energy. Therefore, companies should have mechanisms that manage and control power consumption in order to ensure the accessibility and expandability of big data.

2.1 Perceived benefits of BDT

Given these challenges, evaluating how BDT benefits the creation of the business value of a company is extremely important (e.g., McAfee et al. 2012; Kiron, Prentice, and Ferguson 2014; Akter et al. 2016). Considering the previous literature, the main benefits of big data are focused on increasing financial performance, market performance and customer satisfaction (Ren, 2016). Financial performance refers to the firm's ability to improve its profitability and return on investment. Market performance refers to a company's ability to enter new markets quicker than its competitors, introduce new products and services more frequently, have a

higher success rate with its new products and services, and have a higher market share. Customer satisfaction is a function of how goods and services meet or surpass the expectations of customers. Indeed, customers compare the perceived performance of a product with a performance standard, and they are satisfied when the perceived performance is greater than the standard and dissatisfied when performance falls short of the standard (Vorhies and Morgan, 2005).

However, since companies have difficulties in precisely computing the benefits of IT investments, the benefits are more perceived than calculated. These perceptions have nonetheless important consequences on the adoption of an innovation. The more that an innovation, such as BDT, is perceived as bringing benefits, the quicker the innovation will diffuse (Junglas et al. 2018). Hence, the companies that perceive that BDT delivers higher benefits adopt BDT while the companies that perceive that BDT delivers fewer benefits do not adopt BDT. Hence, our hypothesis is the following:

H1. BDT adopters perceive BDT as more beneficial than BDT non-adopters.

2.2 Perceived costs of BDT

BDT does not deliver only benefits, including large or small benefits; and costs are another important factor in the adoption decision. Indeed, BDT results in new costs to sustain and to incur to successfully implement the BDT adopted and exploiting its potential. Most organizations have extensive experience in the management of traditional IT solutions, but these new technologies may represent new costs that can be handled differently. Therefore, managers, before making big data investments, need to know the costs they will incur. Moreover, companies need to consider both direct and indirect costs. Some examples of direct costs include hardware costs or upgrades to increase processing power. Conversely, indirect costs could be management and staff resources, ownership costs and management time (Love et al., 2015).

More specifically, studies dealing with the costs of BDT have described many issues including consultancy support costs (e.g., Turok and Raco, 2000); installation engineers' costs (e.g., Singh and Hess, 2017); overhead; training costs (e.g., Brown and Souto-Otero, 2020); and expenditures for maintenance, networking security, personnel and equipment for hardware and software.

However, given the notorious difficulties for companies in determining the actual IT costs, managers largely rely on their perceptions of costs when they need to take action. In line with the diffusion of innovation theory, costs play a central role in the adoption decision (Wejnert, 2002). The higher the costs are, the longer the diffusion process will be. Hence, the companies that perceive that BDT has higher costs do not adopt BDT while the companies that perceive that BDT has lower costs adopt BDT. Hence, our hypothesis is the following:

H2. BDT adopters perceive BDT as less costly than BDT non-adopters.

Figure 1 summarizes the relationships investigated in this study and the hypotheses tested.

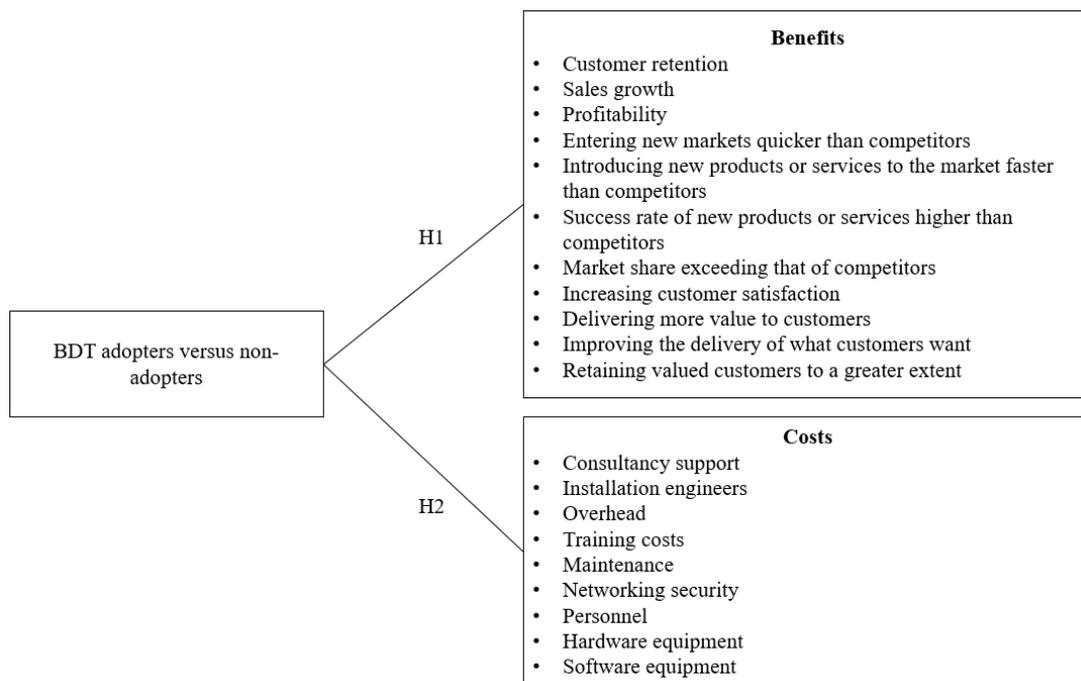


Figure 1 : Relationships investigated

3. Research methodology

3.1 Data collection

A questionnaire was used to examine perceived benefits and costs of BDT adoption and to test our hypotheses. The questionnaire was distributed to medium- and large-sized French companies in 2016. In order to determine whether a company was medium or large sized, the European definition using the number of employees was considered. A medium-sized firm is a company with from 50 to 249 employees, while a large company has more than 249 employees.

As this study was conducted at the firm level, we followed the choice of previous studies (Jifan Ren et al. 2016) and targeted chief information officers (CIOs). A random sampling method was implemented to select 1,962 medium and large French companies from a population of 19,875 companies registered in the Bureau Van Dijk database to survey. The data gathering process involved three steps. In the first step, the companies were contacted in order to inform them of the aim of the research study and to ask permission to contact the CIO. In the second step, the CIOs were contacted and asked whether they were willing to participate in the survey. When the CIO was not available at the time agreed upon in the first call, a second appointment was made. Therefore, the questionnaire was filled in, either in the second or third step according to the availability of the CIO. When the CIO was not willing to reply to the questionnaire, another person qualified to answer questions regarding investments and the adoption of BDT was identified and completed the questionnaire.

First, a pilot study was conducted on a subsample of companies in order to test the comprehensibility of the questions included in the questionnaire, to identify any possible criticalities and to establish the expected response rate. All the responses were positive, and

the questions appeared clear; therefore, the final questionnaire was unchanged. The response rate of the pilot test was 21.13% with 30 companies responding. After the pilot test, another 170 companies took part and completed the survey. Overall, 200 questionnaires were completed. The final sample was composed of 86.5% medium-sized companies and 13.5% large-sized companies, thus assuring a 95% confidence level and a 6.9% confidence interval, respectively (Table 1).

	No. = 200	Percentage (%)
Role of the respondent		
General Director	53	26.50%
Chief Executive Officer	8	4.00%
Chief Information Officer	127	63.50%
Other person qualified to answer questions regarding big data analytics investments	12	6.00%
Firm size according to the number of employees		
Medium (50-249 employees)	173	86.50%
Large (more than 249 employees)	27	13.50%
Industrial sectors		
Manufacturing	57	28.50%
Services	85	42.50%
Retail	41	20.50%
Construction	17	8.50%

Table 1. Sample characteristics

3.2 Measures

The questionnaire adapted existing measures. To measure the adoption of BDT, a list of eight different BDT was compiled based on existing lists (Gandomi and Haider, 2015; Davenport, 2014). A multiple choice question was given to respondents to answer which BDT were adopted or if none was adopted. The eight BDT included the following:

1. MapReduce and Hadoop software or other software for processing big data across multiple parallel servers;
2. Scripting languages or other programming languages that work well with big data (e.g., Python, Pig, and Hive);
3. Machine learning software or other software for rapidly finding the model that best fits a data set;
4. Visual analytics software or other software for the display of analytical results in visual or graphic formats;
5. Natural language processing (NLP) software or other software for analyzing text and conducting information extraction, text summarization, question answering, and sentiment analysis;
6. In-memory analytics software or other processing big data in computer memory for greater speed;
7. Social media analytics software (content-based analytics and structure-based analytics); and
8. Predictive analytics software.

Additionally, the taxonomy used to investigate the perceived benefits and costs related to BDT that was adapted was based on previous research (Ji-fan Ren et al., 2016; Love, Irani, Standing, Lin, & Burn, 2005; Wu & Wang, 2005; Vorhies and Morgan, 2005). Table 2 shows all the measurement items, which were based on a seven-point Likert scale, with responses ranging from “completely disagree” (-3) to “completely agree” (+3). Respondents were asked to evaluate the extent to which BDT led to benefits and costs.

Construct	ID	Item description	Reference
Benefits	B1	Customer retention	Ren, 2016
Benefits	B2	Sales growth	Ren, 2016
Benefits	B3	Profitability	Ren, 2016
Benefits	B4	Entering new markets quicker than competitors	Ren, 2016
Benefits	B5	Introducing new products or services to the market faster than competitors	Ren, 2016
Benefits	B6	Success rate of new products or services higher than competitors	Ren, 2016
Benefits	B7	Market share exceeding that of competitors	Ren, 2016
Benefits	B8	Increasing customer satisfaction	Vorhies and Morgan, 2005
Benefits	B9	Delivering more value to customers	Vorhies and Morgan, 2005
Benefits	B10	Improving the delivery of what customers want	Vorhies and Morgan, 2005
Benefits	B11	Retaining valued customers to a greater extent	Vorhies and Morgan, 2005
Costs	C1	Consultancy support	Love et al., 2005
Costs	C2	Installation engineers	Love et al., 2005
Costs	C3	Overhead	Love et al., 2005
Costs	C4	Training costs	Love et al., 2005
Costs	C5	Maintenance	Love et al., 2005
Costs	C6	Networking security	Love et al., 2005
Costs	C7	Personnel	Love et al., 2005
Costs	C8	Hardware equipment	Wu and Wang, 2005
Costs	C9	Software equipment	Wu and Wang, 2005

Table 2. Benefits and costs of BDT

3.3 Data analysis

A three-step procedure was followed to present the results. First, the percentages of adoption of the BDT were computed. Second, by focusing on the benefits side, the perceived benefits for adopters and non-adopters were computed to understand how benefits are perceived by adopters and non-adopters of BDT. An ANOVA test for every benefit was conducted between and within companies that adopt and do not adopt BDT. The ANOVA test between adopters and non-adopters allows us to understand which benefits are seen differently between the two subgroups of companies and which subgroup over- or underestimates their magnitude. The ANOVA test within companies that adopt and within companies that do not adopt gives us the ability to highlight the main benefits perceived by adopters and non-adopters. Third, by focusing on the costs side, the perceived costs for adopters and non-adopters were computed to understand how costs are perceived by adopters and non-adopters of BDT. An ANOVA test for every cost was conducted between companies that adopt and do not adopt BDT in order to understand which costs are seen differently between the two subgroups of companies and which subgroup over- or underestimates their magnitude. An ANOVA test for every cost was conducted within companies that adopt and within

companies that do not adopt BDT in order to highlight which costs are considered the most burdensome within the two subgroups of companies.

4. Findings

4.1 Adoption of BDT

Figure 2 shows the adoption level of every BDT investigated in the questionnaire. Visual analytics software or other software for the display of analytical results in visual or graphic formats is the most adopted BDT among the medium and large companies investigated (40.8% of companies adopt this technology). These solutions allow one to explore, visualize and understand data better than separately examining the different sources. The second most adopted solution, by 38.2% of the companies, is related to scripting languages or other programming languages that work well with big data (e.g., Python, Pig, and Hive). The third most adopted technology is in-memory analytics software or other software for processing big data in computer memory for greater speed with an adoption rate equal to 30.3%. The less adopted BDT is predictive analytics software with just 15.80% of the companies choosing to use these software solutions.

Overall, these adoption trends demonstrate that companies invest more money in tools able to visualize and process data gathered in order to understand how to extract value from them instead of investing in solutions able to predict future trends. Another interesting result is based on the low adoption rate of software able to conduct content-based analytics of social media data, demonstrating the low propensity of companies to perform semantic analysis to understand customers' needs and behaviors.

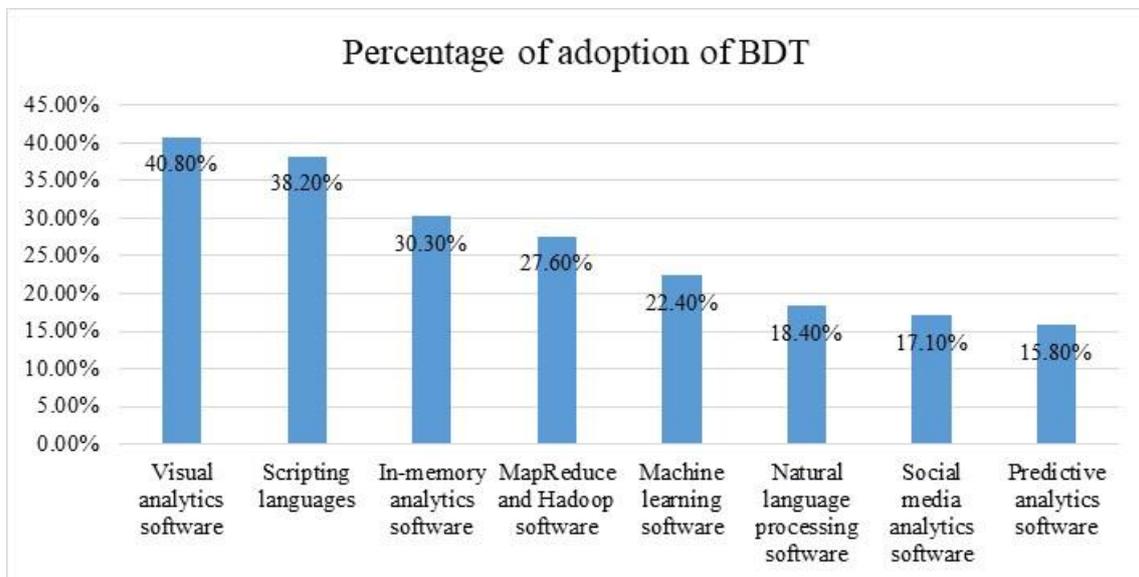


Figure 2. Adoption of BDT (base: all companies)

4.2 Perceived benefits of BDT

Table 3 shows the results regarding the perceived benefits for adopters versus non-adopters of BDT and within each subsample. Overall, the mean scores of non-adopters and adopters of BDT reveal that the companies that perceive that BDT delivers more benefits are among the

adopters of BDT, while the companies that perceive that BDT delivers fewer benefits are the non-adopters of BDT. Disaggregating benefits individually, the differences in the means between the two groups have an F statistic that is statistically significant at the 0.05 significance level for three benefits: profitability, the success rate of new products or services is higher than that of competitors, and sales growth. Moreover, the within-group differences indicate that, for adopters, profitability is perceived as the greatest benefit among the 11 types of benefits we listed. In addition to profitability, the success rate of new products or services being higher than that of competitors is equally important, as there is no statistically significant difference between the scores of these two kinds of benefits. Sales growth is ranked well behind the previous two benefits in the list of the main benefits. Regarding non-adopters, the order of the three benefits, which are perceived differently between the two groups, does not change: profitability is the most important benefit, sales growth is the third most important benefit, and the success rate of new products or services being higher than that of competitors is in the middle. Nonetheless, we noted that within non-adopters, the largest perceived benefit, among the whole list of 11 types of benefits, is improving the delivery of what customers want, which is hence higher than the perceived profitability of BDT.

Overall, we conclude that adopters and non-adopters of BDT have different perceptions regarding the impacts of BDT on their companies, highlighting that adopters perceived BDT as more beneficial than non-adopters in terms of profitability, sales growth and the success rate of new product and services. Therefore, Hypothesis 1 is partially supported.

	BDT benefits	Non-adopters		Adopter		F statistic	Prob > F
		Mean	Standard deviation	Mean	Standard deviation		
B10	Improving the delivery of what customers want	0.371	1.272	0.566	1.455	0.99	0.321
B3	Profitability	0.347	1.183	0.724	1.218	4.68	0.032
B8	Increase customer satisfaction	0.323	1.412	0.618	1.451	2.03	0.156
B11	Retaining valued customers to a greater extent	0.202	1.343	0.513	1.419	2.43	0.121
B4	Entering new markets faster than competitors	0.153	1.325	0.355	1.512	0.98	0.323
B6	Success rate of new products or services higher than that of competitors	0.145	1.377	0.566	1.360	4.440	0.036
B9	Delivering more value to customers	0.145	1.366	0.513	1.562	3.06	0.082
B1	Customer retention	0.081	1.234	0.211	1.389	0.47	0.492
B2	Sales growth	0.081	1.412	0.553	1.389	5.33	0.022
B5	Introducing new products or services to the market faster than competitors	0.056	1.553	0.303	1.442	1.25	0.265
B7	Market share exceeding that of competitors	-0.020	1.265	0.289	1.422	2.63	0.106
B1-B11	Statistical significance at p-value <0.05 of the within-group differences	All pairs are statistically significant except the pair B1-B2		All pairs are statistically significant except the pairs B3-B5 and B3-B6			

Table 3. Benefits of BDT: adopters versus non-adopters (with F statistic, significant at 0.05 level, in bold)

4.3 Perceived costs of BDT

Table 4 shows the results regarding the perceived costs for adopters versus non-adopters of BDT. Overall, the mean scores of non-adopters and adopters of BDT reveal that the companies that perceive that BDT increases costs are among the non-adopters of BDT while the companies that perceive that BDT decreases costs are adopters of BDT. Disaggregating costs individually, this difference in the means has an F statistic that is statistically significant at the 0.05 significance level for two of the costs: training costs and consultancy support.

Moreover, the within-group differences indicate that, for non-adopters, training costs are perceived as the largest cost among the nine types of costs we proposed; however, training costs do not seem to be a major issue for adopters, as it is the third lowest cost type among the nine types of costs. A similar gap in perception also appears for consultancy costs. While consultancy is among the costliest issues for non-adopters, consultancy is the second least expensive issue perceived by adopters. In contrast, we noted a sort of consensus on the costs of networking security and personnel. Networking security is perceived as the largest expense for adopters. Moreover, there is no significant difference in perception between adopters and non-adopters regarding networking security costs. Finally, networking security and joint training costs are the largest costs in the eyes of non-adopters. In contrast, both adopters and non-adopters perceive personnel costs to be the least expensive cost, and there is no significant difference in this perception between adopters and non-adopters.

In summary, adopters and non-adopters of BDT have different perceptions about the impacts of BDT on their companies, highlighting that adopters perceived BDT as being less costly than non-adopters in terms of training costs and consultancy support. Therefore, Hypothesis 2 is partially supported.

	BDT costs	Non-adopters		Adopters		F statistic	Prob > F
		Mean	Standard deviation	Mean	Standard deviation		
C4	Training costs	0.839	1.278	0.395	1.386	5.330	0.022
C6	Networking security	0.839	1.484	1.105	1.26	1.700	0.194
C9	Software equipment	0.782	1.533	0.618	1.591	0.520	0.470
C1	Consultancy support	0.774	1.486	0.171	1.587	7.370	0.007
C2	Installation engineers	0.774	1.508	0.632	1.274	0.470	0.492
C3	Overhead	0.669	1.545	0.789	1.463	0.300	0.587
C5	Maintenance	0.621	1.549	0.500	1.604	0.280	0.597
C8	Hardware equipment	0.573	1.536	0.566	1.464	0.002	0.975
C7	Personnel	0.121	1.389	-0.158	1.497	1.790	0.182
C1-C9	Statistical significance at p-value <0.05 of the within-group differences	All pairs are statistically significant except the pairs C1-C2, C3-C8, and C4-C6		All pairs are statistically significant except C2-C6, C2-C9, C3-C8, C5-C7, C6-C7, C6-C9, C7-C8, and C7-C9			

Table 4. BDT costs: adopters versus non-adopters (with the F statistics significant at the 0.05 level in bold)

5. Discussion

We analyzed the differences in the perceptions between adopters and non-adopters. This analysis highlighted that adopters and non-adopters have different perceptions in terms of the benefits of BDT in terms of profitability, the success rate of new products or services being higher than that of competitors and sales growth. Non-adopters perceive that these benefits are lower than the perception that the adopters have regarding these benefits. Hence, we enrich the literature on the importance of evaluating how BDT benefits the creation of the business value of a company (e.g., McAfee et al. 2012; Kiron, Prentice, and Ferguson 2014; Akter et al. 2016). These differences could partially explain the decisions to adopt or to not adopt BDT. On the one hand, the firms that perceived fewer benefits from BDT will postpone the adoption of the BDT. On the other hand, the firms that perceived that BDT delivers large benefits are those that have already adopted these technologies. Stated differently, the companies that perceive that BDT delivers higher benefits adopt BDT while the companies that perceive that BDT delivers fewer benefits do not adopt BDT. These interpretations do not depart from the diffusion of innovation theory (Rogers, 2003) and confirm, for some benefits, our first hypothesis: BDT adopters perceive BDT as more beneficial than BDT non-adopters.

Additionally, when we analyze the perceived costs of BDT, we find indicators supporting the diffusion of innovation theory. Indeed, costs are another important factor in the adoption decision. As far as these new technologies may represent new costs, our approach provided evidence regarding the most important costs in BDT (Love et al., 2015). Training and networking security are the most important costs perceived by non-adopters while training is not perceived as a very expensive issue for BDT adopters. Hence, we enriched the list of costs of BDT available in the literature (e.g., Turok and Raco, 2000; Singh and Hess, 2017; Brown and Souto-Otero, 2020), confirming some results, such as the importance of training costs (e.g., Brown and Souto-Otero, 2020) and consultancy support costs (e.g., Turok and Raco, 2000), while minimizing others, such as personnel costs.

Moreover, our results highlight that there are differences in the perceived costs of BDT between adopters and non-adopters, particularly for training costs and consultancy support. Non-adopters perceive that the training costs and consultancy support are higher than the costs perceived by adopters. These differences could once more partially justify the decision to not adopt BDT for non-adopters and the decision to adopt BDT for BDT adopters. Since the non-adopters estimate that the costs of BDT are high, they do not invest in BDT. In contrast, the companies that perceived that the costs of BDT are low adopt BDT. These results echo the statements highlighting that many CIOs and managers hesitate to make BDT investments since they are scared of the costs that could exist and by the uncertainty about the real benefits in their companies (Sivarajah et al., 2017).

Hence, the companies that perceive that BDT will burden the company with higher costs do not adopt the BDT, while the companies that perceive that BDT has lower costs do adopt the BDT, supporting, for some costs, our second hypothesis: BDT adopters perceive BDT as less costly than BDT non-adopters.

These teachings are important also for the BDT suppliers, as they can fine-grain their communication and commercial strategies toward their potential or actual customers, leveraging the customers' perceptions about the different costs and benefits of BDT.

6. Conclusion

The purpose of this paper was to develop a better understanding of the perceived benefits and costs, among enterprises, associated with the adoption of BDT between BDT adopters and non-adopters. A questionnaire was used to examine these aspects, and it was distributed to medium- and large-sized French companies. In so doing, the paper enriches the set of recommendations regarding how companies should proceed regarding their investments in BDT.

6.1 Key lessons learnt

Overall, the paper demonstrates that managers have different perceptions of the benefits and costs related to BDT. The relative importance of costs and benefits is different across adopters and non-adopters, and some costs and benefits are perceived as having different sizes between and within adopters and non-adopters. In general, adopters perceive that benefits are higher than non-adopters while non-adopters perceive higher costs than adopters. We consider that these differences in perceptions partially explain the decisions to adopt or not adopt BDT.

6.2 Implication for theory

The theoretical insights and the empirical findings discussed in this paper contribute to a more comprehensive view of benefits and costs of BDT and what managers should focus on when they adopt these technologies. Our results confirm that BDT can have a significant impact on competitive dynamics and value creation opportunities for companies (Kharlamov and Parry, 2020). Indeed, profitability and increased customer satisfaction are the preeminent benefits perceived by the adopters we sampled. Examining previous studies, our results agree on the importance of increasing financial performance and customer satisfaction while they underscore the previously measured contribution of BDT to market performance (Ren, 2016). These perceptions are partially different from those of non-adopters who consider that improving the delivery of what customers want could be the greatest benefit of BDT and that profitability would be ranked only second.

The identification of these greatest advantages should not hide the other advantages recognized by respondents as far as respondents agreed, more than disagreed, on all the positive contribution of BDT across the 11 listed benefits with an exception regarding the increase of their market shares. Hence, this list of benefits can be added to the basket of benefits already highlighted in the literature (Günther et al., 2017; Chen, 2019; Schmitz et al., 2019; Frank et al., 2019; Ren, 2016; Loebbecke and Picot, 2015; Wiener et al., 2020). Moreover, our results come from a survey investigating a large number of different technologies, giving a robust understanding of the main benefits of a diversity of BDT rather than providing an exclusive focus on a specific kind of BDT.

6.3 Implications for practice

In terms of the implications for practice, our results enrich the available guidance that managers have at their disposal in their decisions to implement BDT in their companies. We provide a list of the benefits and costs that managers should consider. We provide them with the perceptions that adopters and non-adopters possess regarding BDT. For practitioners, we highlight the cost categories that are perceived as the most expensive by adopters and non-adopters and the differences between these two groups. Furthermore, we state the benefits that are perceived as the most important by adopters and non-adopters and their differences between groups. In this way, managers can seek to position their companies using the results of our sample and to exploit their perceptions to justify their decisions to adopt or not adopt BDT.

6.4 Limitations of this research

We recognize three main limitations of this research. Both are related to the adopted methodology: a survey across a representative sample of French companies, collecting perceptual data from enterprise managers. First, our results are mainly based on perceptions about costs and benefits of BDT. Even if these perceptions are expressed by managers they could provide a partial and subjective view on BDT and their impact on the managers' companies. We should take this limit into account when interpreting the results. Second, we collected survey data from 200 enterprises that represent the medium and large French companies. The extension of this data collection limits the deepness of the investigation. Hence, we do not have insights highlighting how these perceptions on costs and benefits are generated and we do not know why enterprises adopted or did not adopt BDT. Finally, we interviewed only French companies and we do not know to what extent our results are precise outside the investigated country as far as our sample is representative only of the French enterprise population.

6.5 Future research recommendations

Regarding the avenues of future research, as our results are based on perceptions, future studies could investigate the same topic by examining different kinds of measures for costs and benefits in order to prove the robustness of our results with different instruments, such as financial data coming directly from companies or indirectly through financial databases. This move would also give space to translate the relative scores of our survey into more intersubjective or objective scores. Conversely, case studies would deepen our cross-sectional data by highlighting the mechanisms behind the adoption choices of managers. In this way, it would be possible to precisely consider all the costs and benefits that BDT investments have for companies. Future studies should also focus on other countries in order to verify the generalizability of the findings and provide the same managerial advice to managers that belong to different locations.

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