Training and the competitiveness of the Québec multimedia-IT sector

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Abstract: This article studies the hypothesis that training is essential to contribute to the competitiveness of the Quebec multimedia-IT sector. We also hypothesised that intermediary organisations and associations contribute to this development of training and competitiveness. The research is based on 30 interviews (15 firms and 15 non-business) in seven different sub-sectors of the multimedia-IT ecosystem, with 11 different types of organisations, in order to determine to what extent training and development of competencies are adequate and do effectively contribute to the competitiveness of the sector. Based on these interviews, we conducted a SWOT analysis of training in the Quebec multimedia-IT sector. This article focuses on the quality of training, diversity of competencies and highlights the challenges in training for firms and non-business organisations, as reported by the interviewees. We conclude that while there are good quality training programs, there are some elements related to entrepreneurship and business issues that are lacking. An increased diversity of workers would be important and integrating more women and foreign workers could help for this.

Keywords: training; innovation; collaboration; multimedia; IT; intermediary organisations; incubators; accelerators; SWOT analysis; competitiveness; human resources management.

Reference to this paper should be made as follows: Rhéaume, L. and Tremblay, D-G. (2020) 'Training and the competitiveness of the Québec multimedia-IT sector', *Int. J. Human Resources Development and Management*, Vol. 20, No. 1, pp.25–42.

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1 Introduction

The continued development of the Québec multimedia-IT (MM-IT) sector is one of the main reasons why Quebec had a less severe recession than USA or the rest of Canada in 2008–2009, and the sector has continued to grow since then. However, some actors have indicated that there were limits to growth of the sector, and one of the limits could lie in lack of competencies. We thus decided to explore this hypothesis and analyse the content and level of training and development of competencies in the Québec MM-IT sector.

This article studies the hypothesis that training is essential to contribute to the competitiveness of the QuebecMM-IT sector, but that the level and content of training might not be sufficient at present to support this development. We also hypothesised that intermediary organisations and associations contribute to this development of training and competitiveness, and could possibly do more to support the MM-IT sector's competitiveness (Hypothesis 2). We investigate the impact the third hypothesis of employee diversity on innovation, as many studies have indicated a positive relationship. Finally, we study the fourth hypothesis of using foreign workers to compensate for the shortage of specialised workers.

The Quebec government has invested heavily in the IT and multimedia sectors through aggressive tax credits and development of technology districts. The Québec IT sector GDP is growing twice as fast as the rest of the Québec economy. If foreign firms were attracted first by the interesting tax credits, the availability and development of qualified workers explain why firms continue to be attracted to Québec, and particularly to the city of Montréal, although it seems that there may be limits to competitiveness and growth for the moment because of labour shortages in some sectors (TechnoCompétences, 2016a, 2016b, 2015).

The growth of the first decade was mainly due to the presence of foreign studios. In the last five years, however, the growth of the MM-IT ecosystem has come from the maturity of its entrepreneurs and the support organisations (i.e., incubators, accelerators

and professional business associations). Some emergent middle size leaders are experiencing fast international growth. A key issue for the competitiveness of the Quebec MM-IT sector resides in the labour shortage in some professional categories and in the ongoing development of human resources (TechnoCompétences, 2016a, 2016b, 2015). While our study is on the Montréal and Québec situation, we also studied the larger general context of MM and IT industries; the study is thus surely pertinent for other cities and regions that try to develop a MM-IT industry.

While there is a growing literature on the relation between diversity in the knowledge base and the performance of firms, few studies investigate the impact of employee diversity on innovation. Østergaard et al. (2011) investigated the relation between employee diversity and innovation in terms of gender, age, ethnicity, and education. The econometric analysis reveals a positive relation between diversity in education and gender on the likelihood of introducing an innovation. The logistic regression reveals a positive relationship between an open culture towards diversity and innovative performance.

Talke et al. (2010) report that diversity in top management teams has a strong impact on the strategic choice of firms to focus on innovation fields. Such focus then drives new product portfolio innovativeness and firm performance.

An empirical investigation of high-tech firms in Taiwan indicates that diversity in a firm's social network has an inverted U-shaped relationship with the firms' innovation performance. In addition, they report that by increasing absorptive capability (i.e., capacity to integrate new knowledge), it will systematically increase the scope of the positive effects of diversity as well as maximise the overall value of network-level technological diversity for firms' innovation performance. Their results suggest that even a moderate level of diversity can lead to high levels of innovation performance. Diversity of human resources appears to have a positive effect on organisational performance and innovation.

Our article addresses the hypotheses presented above and it identifies the strengths, weaknesses, opportunities and threats of training in the QuebecMM-IT sector. It also makes it possible to determine how training can improve the competitiveness of the MM-IT sector.

Our third hypothesis, mentioned above, postulates that diversity is important for innovation and we tried to determine if the diversity of the Montreal agglomeration provides enough strategic assets to the sector in terms of training and competitiveness and ultimately for innovation, especially in the context of new business models and ecosystems (Tremblay and Yagoubi, 2017a, 2017b). Montreal does count a good number and blend of artists and engineers, with the presence of quality universities and emergent industry collaboration, including in clusters (Hatch et al., 2017; Tremblay, 2017; Yagoubi and Tremblay, 2017a, 2017b). Some neighbourhoods of Montreal such as the Mile-End are seen as a mini Brooklyn in terms of creativity, diversity of cultures and strong tech entrepreneurship (Darchen and Tremblay, 2014, 2015). The strong mix of French and English cultures provides many innovation opportunities in the arts sector, but also in the technology sector. The crafting of a stronger Quebec MM-IT ecosystem is emerging due to this melting pot and also to the diversity of the support organisations: professionals, non-business and governments (Rhéaume and Tremblay, 2016). Many of the employees of big firms such as Cirque du Soleil, Ubisoft and CGI have started their own businesses

and there is a new dynamic emerging in leading middle-size firms, some of which are experiencing strong international growth.

La Caisse de dépôt, the big Quebec pension fund and venture capital firm, combined with unions' venture capital organisations such as Fonds de Solidarité (FSTQ) and Fondaction of CSN, are supporting some of the new initiatives of these emergent leaders, the incumbents and the newcomers. Just recently, FSTQ financed a new social accelerator in the Montreal Innovation District. The union venture capital organisations represent a major Quebec innovation in the world financial sector.

Now that the context and hypothesis of the research have been presented, we turn to the methodology. We then present the results, organised around the themes of the quality of training in Quebec, followed by the importance of the diversity in competencies and the major challenges of training in the Quebec MM-IT sector. We then identify what is missing to gain more competitiveness. We conclude with the key findings of this paper and some recommendations.

2 Method

In a knowledge economy where innovation is often seen as a requirement for survival, training is hypothesised to be essential for the competitiveness of the Quebec MM-IT sector. Our research tried to determine if the present level and content are sufficient to support competitiveness and our method is thus based on qualitative interviews with the main actors and firms.

We also hypothesised that educational institutions, intermediary organisations and associations contribute to this development of training and competitiveness, and this is why we sought to interview these actors. As mentioned above, we investigate the impact of employee diversity on innovation, as well as the possibility for foreign workers to compensate for labour shortages.

The research is based on 30 interviews (15 firms and 15 non-business) in seven different sub-sectors of the ecosystem, with 11 different types of organisations (Table 1). The interviews were based on open-ended questions and lasted around one or one hour and a half. The analysis was a thematic analysis based on the questions presented above.

Table 1 Respondents

Types of non-business organisations	*# 15*	*Types of firms*	*# 15*
Incubator	1	Start-up	4
Accelerator	2	Small	2
Local development	2	Medium	5
Professional association	2	Large	3
Support/consulting	2	Para-governmental	1
Training	1		
Research	1		
Cluster	1		
VC/incubator	1		
Consultant	1		
Government	1		

3 Issues

This section covers the main issues related to training and competitiveness of the Quebec MM-IT sector and presents elements to respond to our hypotheses. We start with an analysis of the quality of training in Quebec, followed by the importance of the diversity in the competencies. We study the main challenges of training, covering the new essential competencies and the new trends that can pose challenges. We conclude with the analysis of the issue of foreign workers that is sometimes presented as the solution, or one of the solutions, to the shortage of specialised workers.

3.1 Quality of training in Quebec

This section synthesises what the interviewees said about the quality of training in Quebec for the MM-IT sector in order to answer the first hypothesis of the importance of training, but also of its possible shortcomings as well as the second concerning the role of educational institutions.

Concerning the quality of engineers in Quebec, several CTOs or CEOs indicate that the quality and quantity of universities are essential for their organisations to prosper in Quebec, but point to some shortcomings. Several propose to increase the length of training at college (CEGEP[1]) level since they consider them to be significantly less productive than university undergraduates (bachelors).

In order to increase competitiveness, one CTO of an emerging leader firm in multimedia argues that the provincial government should stop the severe cuts of the last years and reinvest in universities. One of the negative consequences of those austerity measures is that universities must accept more students and thus reduce their standards of selection. He considers that the quality of undergraduates has decreased significantly in the past 15–20 years. Several universities give diplomas to more students without a decent performance, to compensate for budget cuts, with the registration costs for students. A CEO and a CTO suggest that some foreign workers have a better quality of education than local workers. In France for example, the students specialise more in learning some specific technologies from A to Z; these students are immediately productive and their knowledge can then be leveraged into other technologies or computer languages. Here in Quebec the quality of education is more focused on general competencies (i.e., CEGEP and major university degrees): “it is more a superficial knowledge that is acquired.”

Two managers suggest that technical competencies are generally adequate, but young engineers often lack entrepreneurship competencies: communications and customer management. Quality management is a big issue, where few engineers are aware of the whole life cycle of a product or a project. Few really know how to produce a good product, at a good price, at the right time. Learning math is important, but universities are focusing a lot on teamwork, while a CTO suggests: “I have never seen so many new undergraduates from CEGEP and universities with so little communications skills. They have a decent analytic spirit to evaluate a problem but to converge toward a good analysis is a major issue with young undergraduates.”

A CEO of an emergent leader in IT suggests that universities focus too much on the engineering skills targeted towards large corporations. “They want us to work for IBM or CGI while many engineers work in an evolving job market for SMEs and middle IT

firms. They want us to acquire people skills and management skills, but the reality in smaller organizations is that you can be just an IT engineer, and excel in that area by being autonomous, by adopting lean start-up methodologies, like the minimum viable product. Why not create more entrepreneurial engineers that will innovate through intrapreneurship or new firms and be ready for a more dynamic and more agile job market?" He suggests that students should become more aware of concrete business issues such as lean start-ups and agile management. More collaboration between universities, college and the private sector must be encouraged.

A CTO from a large IT firm suggests that the quality of education is good among universities but the actual use of technology is a major issue. Teaching too rarely incorporates IT technologies, such as MOOC and online courses. Engineering programs don't use much of web teaching tools, compared to MIT or Berkeley. "There is a 6 month learning curve before an undergraduate becomes semi-autonomous in the projects of our organization."

A CTO from an emergent leader in multimedia argues that they do a lot of internal training and career plans for their employees. "We are looking for multi-skilled people that can satisfy our needs quickly, but it represents a huge challenge to pay them according to their experience and skills. What emerging leaders can do to compete with large firms with big salary packages is to offer more attractive career paths, more responsibilities through empowerment and a better chance to make a bigger contribution to the value of the firm."

One emergent IT leader said that due to fiscal issues it is complex to offer competitive perks to his employees in comparison with Silicon Valley. "It is difficult to reproduce a Google in Québec, even though we have a strong culture with a focus on employee well-being. We created successful products for our customers in human resource management that we are using internally."

In general is the education adequate for the needs of the private sector? For a respondent from a support organisation specialised in training for the MM-IT sector, the answer is yes, but he says that the firms will never be fully satisfied. Solutions reside in the regular communication between the private sector and the training organisations. More numerous and longer internship programs with tight supervision represent another solution. The trainees would gain a better understanding of their skills, of the work organisation, and how they must adapt. Furthermore, this often leads to a job offer inside the organisation where the internship was done.

The quality of training in the video game sector is good in general according to our interviews, and this is a determinant in the success of the sector. A training centre like NAD has an international reputation, attracting foreign students, mainly Chinese and Latinos. "When you attract foreign students it shows you have quality training and it is now a model around the world," says a consultant.

To conclude, our interviewees consider that training is a determinant factor of competitiveness and business success, and that educational institutions have done well to this day, although there could be improvements in training on entrepreneurship and other business issues.

3.2 The importance of diversity in competencies

According to TechnoCompétences (2016a), only 16% of the Quebec video game sector is composed of women and it is 5–10% only in production. This is not specific to Québec,

as the same is observed in the USA, in Silicon Valley in particular (The Atlantic Daily, 2017). Our interviewees consider that new incentives must be developed to recruit women in IT education programs and increase the various forms of diversity in MM-IT (cultural diversity is also considered, but there are more diverse nationalities in firms than there are women). The recruitment of specialised foreign workers, men and women, is an interesting option to increase diversity as well as to favour continued growth.

As stated by TechnoCompétences: "In order to create video games more representative of the whole population, more heterogeneous teams (not just white French-speaking men) are important. Diversity (ex., gender, ethnicity, languages) offers more creative immersive and intuitive universes and better problem solving." A CEO from an emergent middle size firm suggests: "We tried to innovate in Spain, but our team of engineers was too homogenous. The last time we were very heterogeneous with different kinds of employees and consultants with different backgrounds and specialized fields. We were able to create our new flagship product in less than 2 months on that site. It is clearly because of team diversity that we could cover so many angles in that project." This confirms our third hypothesis, all the more so since other organisations hold the same view, as is indicated below.

One other emergent leader in multimedia indicates that heterogeneous teams are the 'secret sauce' for success. "It is the intersection and collaboration between industrial design and IT. We have people in software, urbanists, designers, architects, sometimes aeronautics engineers and 3D animators that are the core of our creative projects that we deliver to customers around the world." The multidisciplinary team project coordination is a key value creation for this organisation. They reuse and leverage those special competencies in totally new creative projects, for customers in different kinds of industries.

One emergent leader firm hires employees who have the right attitudes and aptitudes. "We don't really care about where they come from. We even hire some employees that come from unrelated fields, for example if they learned by themselves how to do programming," says the CEO. This is again a source of diversity, as self-educated workers will have different perspectives on gaming, MM and IT innovation than those trained as engineers in formal educational institutions.

A recent UK report (2016) suggests that there is definitely an economic return for organisations combining arts and science skills, and our interviewees also support this diversity perspective, even if they apparently have not managed to develop this diversity, at least as concerns gender diversity. All things equal, they argue that in 2010–2012 the UK organisations that employed workers in art and science had 8% superior revenue growth, compared to organisations only with scientific skills; had 2% more radical innovations on the market; had 20% of all UK workers even though those firms represent only 10% of all UK firms. Overall, it appears that organisations combining art and science skills are more productive and are better at creating new ideas and innovations.

One other emergent leader in multimedia and communications is hosting an 'artist-in-residency,' who will collaborate with their developers and create a new product; the artist will keep the intellectual property, but the introduction of this diversity of competencies has an impact on creativity and innovation in the firm.

One cofounder of a SME in IT that totally reinvented its business model three times in 22 years suggests that employees must be able to work on different types of projects and not be too specialised. "They must be able to work more in larger than deeper

contexts since our projects are all different. We are not looking for perfect competencies in a special field, but to be able to cover all the needs of the projects. The ongoing capacity to learn is a key competency."

For a multimedia firm the key competency is creativity management with creative people that possess a different perspective on life, have different comfort and uncomfortable zones, sensibilities that are different from traditional project management people.

To conclude on this diversity hypothesis, it is clear from the UK report (2016), as well as our interviews, that diversity is a source of creativity, innovation and competitiveness.

3.3 Challenges related to labour shortage and training

According to TechnoCompétences (2016b) the main issue in training is adopting more continuous training in order to better develop human capital on a regular basis. However, all do not agree on this issue, as several firms pinpointed that there is not really a shortage of workers but rather a shortage of experienced workers with qualified skills to fulfil the needs of firms (five to seven years of experience). They consider that there should be more efforts in the promotion of IT jobs for youth, and particularly for women, as mentioned above. The percentage of students who quit college is high, at 40%. More recruiting, but also more support measures, are needed to attract more undergraduates and graduate students with diplomas.

Among the weaknesses, our respondents mention the declining infrastructure (i.e., transportation), and the fact that only 19% of international students in Montreal get their residency. Some are just not interested, some find it too complex to complete the application, and others are simply refused. Those foreign students could be the workers or entrepreneurs missing in the Quebec MM-IT sector, as mentioned in the fourth hypothesis put forward.

TechnoCompétences states: "There are more and more new firms, foreign studios and new start-ups. Even though we have many talents, the demand for workers is very high. There is a shortage and this will be a key issue in the future. A new challenge will be to attract foreign talents very soon. " A CEO of an emergent video game firm suggests: "We are targeting the same workers not only as our competitors, but also in similar sub-sectors such as animation, and special effects."

A multimedia emergent leader organisation mentions a major shift in the market structures, technologies used and the types of employees hired. "A few years ago, a flash programmer was the best-paid employee in our firm. Now this expertise is worthless. Continuous training is not a luxury, it is the norm… In some web projects, the technology has a lifespan of only 6–8 months."

A founder from another multimedia emergent leader firm suggests that formal training must be improved. "Our jobs are at the intersection of many sectors. Young people are not really well prepared for the tasks. We must do a lot of internal training in order for them to understand our projects and our business model. The key issue for us is adaptability. We hire people for the good base they possess and because they want to grow with us. We add a talent, thus the system is growing, but we don't expect a loyalty of 30 years from young workers. They must have challenging tasks for 2-3 years and this is what we can offer. Our model must be agile, versatile, flexible, in order for our human resources to work properly in our different projects."

Another CEO from an emergent leader in video games says: "We differentiate ourselves from the big salaries of big firms by offering real empowerment and exposure to a diversity of job roles in the organization. In a big firm, you are often stuck in a very limited role for a long time. We have a subsidized cafeteria that is very popular and we offer a family business style: there are few hierarchical levels in our firm."

Mobility, job enrichment and intellectual stimulation are key strengths that emerging leader middle-size organisations try to put forward in order to attract the best talents, including foreign talent, to the MM-IT sector. We now turn to this issue of foreign workers (Hypothesis 4 on foreign workers, and the fact that diversity is important for innovation).

3.4 Foreign workers and shortage of specialised workers

A key issue for many interviewees is to obtain a positive net migration of IT workers in Quebec. According to our interviewees, the process to attract foreign workers (visa applications, bureaucracy), must be improved in order to increase the competitiveness of the sector. Foreign workers can fill at least part of the gap in competencies, in senior positions and in areas where there are big shortages like programming or 3D animation.

Among the challenges of hiring foreign workers is the huge difficulty of having a foreigner work for a Canadian firm in another country. Several firms do international projects and require mobile workers. Another big hurdle is the fact that Canada loses about half of its foreign workers. This situation might change with policy developments on immigration in the USA.

Quebec needs senior IT and multimedia managers. Some expatriates are returning to Quebec after five or ten years. They sometimes accept a lower salary but in return they get a better quality of life. Attractive working conditions and the immigration process are thus key issues, according to our interviewees, firms as well as support organisations.

An SME in IT reports that the competition for recruitment is in the East of North America. "Several of our employees can work in Toronto, Boston or New York but they choose to live in Montreal for several reasons such as quality of life and cheaper cost of living. The mobility of workers is very high compared to twenty years ago. Some areas have stronger shortages of workers: software computing engineers and 3D animation artists," says the CEO. With the new US policy on immigration and foreign workers, it is possible that the situation will be positive for attraction of workers to Canada.

A CEO from a middle-size firm suggests this issue has pushed the firm to collaborate with competitors to gain access to a bigger pool of human resources and to have all the resources required for the projects. For a CEO of a video game firm: "If we want to continue to grow I must steal human resources from my competitors and hire more foreign workers."

One analyst from TechnoCompétences states: "If the Quebec video game sector could hire 500 to 1,000 employees, it would do it now." There is an important shortage of workers in new technologies such as mobile applications. The sector also requires greater access to specialised workers with 5–10 years of experience. For the latter, foreign workers can be a good solution.

3.5 New competencies to be developed

According to a recent report by the World Economic Forum (2016), five years from now, over one third of skills (35%) that are considered important in today's workforce will have changed. This will, of course, mean new hires and training. By 2020, the fourth Industrial Revolution will have brought us advanced robotics and autonomous transport, artificial intelligence and machine learning, advanced materials, biotechnology and genomics. These developments will transform the way we live and work. Some jobs will disappear, and jobs that do not even exist today will become commonplace. The future workforce will need to align its skill set to keep pace.

The same report asked chief human resources and strategy officers from leading global employers what the current shifts mean, specifically for employment, skills and recruitment across industries and countries (Table 2). These trends are also observed by our interviewees, who put forward very similar skills.

Table 2 Top skills for the future

Top ten skills			
In 2020		*In 2015*	
1	Complex problem solving	1	Complex problem solving
2	Critical thinking	2	Coordinating with others
3	Creativity	3	People management
4	People management	4	Critical thinking
5	Coordinating with others	5	Negotiation
6	Emotional intelligence	6	Quality control
7	Judgement and decision making	7	Service orientation
8	Service orientation	8	Judgement and decision making
9	Negotiation	9	Active listening
10	Cognitive flexibility	10	Creativity

Source: World Economic Forum (2016)

3.5.1 What skills will change most?

Our literature review as well as interviews confirms that creativity will become one of the top three skills workers will need. With the avalanche of new products, new technologies and new ways of working, workers will need to become more creative. Similarly, active listening, considered a core skill today, will apparently disappear completely from the top ten. Emotional intelligence, which does not feature in the top ten today, will become one of the top skills needed by all. The nature of the change will depend very much on the specific sub-sector of the industry and its evolution. Global media and entertainment have already seen many changes in the past five years.

Some technologies such as mobile internet and cloud technology are already impacting work. Artificial intelligence, 3D printing and advanced materials are still in their early stages of use, but the pace of change is increasing. Business leaders, educators and governments all need to be proactive in up-skilling and retraining people so everyone can benefit from the Fourth Industrial Revolution.

In relation with these changes, Technocompétences (2016a), an intermediary organisation for the MM-IT sector, indicates that there are major challenges in HR in order for firms to be able to move forward and integrate these new technologies. Our interviewee put forward these challenges.

According to a report from TechnoCompétences (2016b), the top five major challenges in HR in the Quebec IT sector are the following:

1 hiring new workers (48.5%)

2 growth management of the firm (39.8%)

3 retention of workers (32.7%)

4 development of new competencies of ICT workers (31%)

5 evolution of organisational structure of the firm (24.6%).

According to the same report, the five most popular policies in the ICT sector are:

1 coaching of workers (63%)

2 recognition of the contribution of employees (57%)

3 career management of employees (54%)

4 communication between employees and management (52%)

5 telework (46%).

And finally, the five most popular work methods which have to be adopted in the ICT sector are the following:

1 agile work (54%)

2 team management (45%)

3 project management (32%)

4 lean management (18%)

5 others (12%).

To synthesise, we have seen above that there are divergent views on whether foreign workers can fill in for labour shortages (Hypothesis 4), but all agree that there will be continuous change, important adaptations in work and HR, all of which require that businesses face these challenges with external and internal training, as well as informal on-the-job training.

3.6 Quebec video games sub-sector

As Montréal and Québec have attracted a very strong video game industry, we will now present some elements specific to this sub-sector of the MM-IT industry. Indeed, from 2001 to 2015, the Quebec video games industry grew from 1,200 employees to 10,000, a 16% annual growth. The trend slowed down afterwards, as it did in the rest of the world. TechnoCompétences, the Quebec training support organisation, notes that independent studios are now about 180 over a total of 230 studios, with 11 studios counting over 200

employees. One of the main business challenges from new independent studios is to deal with both creativity management and business issues. The lack of those competencies is an obstacle to their growth, particularly for emerging studios. Hiring is here also a key issue: Quebec has attracted many big foreign studios and local firms must compete for the same limited pool of workers. Many new projects are abandoned for lack of specialised workers. A critical element related to competitiveness is the availability of senior workers to lead team projects. Our interviewees consider that external and internal training are key for that, as well as the hiring of senior foreign workers, which is very complex. Foreign workers are a huge strategic asset to the sector by enabling more diversity of cultures, diversity of competencies and, possibly, diversity of gender (Table 3). The cosmopolitan nature of Montreal represents an advantage that nurtures innovation and creativity, according to the experts of the sector.

Table 3 Highlights of the Quebec video games sector

Attributes	*Statistics*
Average age of workers	32 years old
Average salary of production professionals	$CAN 64,000
% of female workers	16%
Number of work specialties	60
Number of studios	230; (11 over 200 employees)
Number of employees	9,970

Source: TechnoCompétences (2016b)

3.6.1 New trends and challenges in videogames

According to TechnoCompétences (2016a), in the video game sector, new competencies will be related to simulation, experiential, events and immersive products and services. These are present in interaction design, 3D real-time production, programming, etc. New growth will also come from the convergence of sub-sectors such as automation, internet of objects and mediation.

A new trend is the growth of corporate universities (Rhéaume and Gardoni, 2016). One large video game firm has a corporate university, an internal unit that provides training with clear goals to improve the individual and organisational competencies. Another big telecom firm, recognised for its innovative human resources management, also has a corporate university with campus, e-learning training and coaching available to employees and managers. They also have an international R&D summit where knowledge is shared across countries, departments and colleagues.

A founder from IT SME suggests that workers must nurture their capacity to communicate, to articulate their thoughts, but most of all, their capacity to learn. With a good knowledge base a worker can easily learn new computing languages, even though the languages of the 90s became obsolete quickly. An analyst from TechnoCompétences suggests that the young workers must develop French and English but Spanish and Mandarin are also good assets. They must learn computing or video games in schools, but they must do continuous training to learn managerial skills later on, to lead teams or become a director.

One growth avenue in MM-IT is the promising use of big data in video games. A few years ago, it cost around $50M to create a console A video game. Today, with mobile technologies, 2–3 entrepreneurs can create a promising new mobile game. However, there is a challenge in marketing, to find one's place on iTunes. Big data management is a solution to reach communities of players of a certain type of video game (sports, action, simulation, etc.).

According to a consultant from a support organisation, a main skill that is lacking is emotional intelligence, and this is possibly more important in gaming than in the MM-IT sector in general. Several of those workers are good in computing, but lack social skills and are less effective in team coordination.

Workers that can easily work in different sectors or clusters are in huge demand in Quebec, particularly for the MM-IT sector. In the IT consulting service sector and video games, a lot of employees are stolen by competitors. The time and resources to train the employee is thus lost. There is also a shortage of young graduates, who tend to be good generalists but need to update their skills quickly and often. Several training organisations have implemented ongoing training for students and workers. Businesses are also implementing more internal training programs.

The Quebec MM-IT clusters and its intermediary organisations such as Alliance numérique and Technocompétences organise events for the education sector and the tech firms to share their needs in terms of new training and updating of programs. Technology is evolving quickly and training and educational organisations must have a regular dialogue with the private sector in order to update their programs.

4 Discussion

This section presents the synthesis of results and provides answers to the main research questions. The following table is a synthesis of the analysis of the 30 interviews, which highlights the strengths and weaknesses, as well as opportunities and threats for the MM-IT sector.

Table 4 Quebec MM-IT innovation profile

Strengths	MM-IT tax credits.
	Research base and higher education.
	Attracting international talent including students.
	Emerging international and university-industry collaboration.
	Emerging collaboration among competitors for talent development and business deals (New Guilde des producteurs de jeux vidéo indépendants du Québec).
	Access to capital (start-up and growth phase).
	Knowledge and technology outputs.
	Knowledge intensive employment, bilingual and young.
	Creative sector. Montreal well-known for design.
	Strong ecosystem with great intangibles.
	Foreign direct investment.

Table 4 Quebec MM-IT innovation profile (continued)

Strengths	A strategic growing sector affecting the rest of the economy, GDP of the sector is growing 2X the province.
	Quality of education: (primary), secondary and university.
	Ease of starting a business.
Can be strengths or can be weaknesses, depending on the subsector	Local competition and environment.
	Firms' innovations, especially in SMEs.
	Investment in R&D, especially in SMEs.
Weaknesses	Intellectual property protection, especially in SMEs.
	Productivity.
	Retaining foreign students.
	Burden of government regulation and trade barriers.
	Access to capital (between start-up and growth phase).
	Few women in the sector.
	Low number of patents.
	Transportation is not optimal (infrastructure and number of international flights).
Opportunities	Improve access to capital for SMEs. Emerging new fintech players are in this field.
	Launch productivity solutions.
	Retaining more foreign students as workers and entrepreneurs.
	Improve managerial skills of tech workers.
	Improve sales and commercialisation skills of entrepreneurs.
Threats	Not attracting new enough or senior workers in MM-IT.
	Low levels of spending in R&D and tax credits too concentrated in a very small number of very large firms.
	No improvement in the START-UP VISA or in the residency process.
	Losing (or not building enough) the networks with other innovation poles such as Silicon Valley, Silicon Alley, London, L.A. , Tokyo or Singapore.
	Excess of competition (among big cities) in the attraction of foreign investments. Providing too many subsidies.

Some Quebec medium firms are emerging as new leaders and must master key digital human capital skills. These medium firms often bet on the empowerment of their human resources to offer better opportunities for creativity and innovation and an improved contribution to organisational value creation. One CEO says: "It is a multitude of small things that enable us to innovate, but the key is that innovation is in the DNA of our human resources, with the help of empowerment."

TechnoCompétences (2016a) considers that the sector should promote a culture based on fundamental research in emerging domains such as artificial intelligence, virtual reality and the cognitive processes of video game players. Ongoing training is a solution to the lack of competencies in the MM-IT sector. However, for many SMEs, between 10 and 25% of their employees have no experience at all.

New video game support associations such as 'La Guilde des développeurs de jeux vidéo du Québec,' aim to develop better business competencies. Also, incubators and accelerators (i.e., Execution Labs, CEIM, Inno-Centre, Notman House) have had a positive influence on the level of entrepreneurship in the sector.

As a cofounder of IT SME mentions: "Among the main advantages of doing business in Montreal, there are the creativity and the diversity which are in harmony with the business requirements of technology organisations these days: technologies are evolving quickly, they are deeply linked to many types of jobs, of competencies… *There is really a unique sort of melting pot in Montreal that provides a considerable advantage*." However, as noted above, this diversity needs to be increased, through higher integration of women and foreign workers.

There is a new emerging trend in inter-sector collaboration across the Quebec MM-IT industries (Rhéaume and Tremblay, 2016) and this appears to be a possible source of diversity and innovation.

Some experts in the MM-IT sector suggest that the Quebec Provincial government has been innovative in the creation of tax credits and MM-IT districts. However, to continue to support the growth of the sector, many consider that the firms should become more independent and less reliant on tax credits, especially as 2–3 larger firms are getting almost 80% of tax credits in MM or R&D, while those measures would be more useful to SMEs and middle-size firms. What is also lacking is a real governmental digital strategy. The government has recently launched a preliminary strategy but interviewees consider that it needs a longer-term vision and concrete measures for support to value creation. The OCDE report (2016) on Montreal indicates that innovation tax credits and support should be more targeted towards small firms, as 69% of the jobs in Canada are in small firms of 1–99 employees (Normandin, 2016).

Another key area of improvement in training for the Quebec MM-IT sector is better measures to support marketing and international commercialisation. Being able to penetrate foreign markets is a key issue for Quebec firms, since the local market is small.

A consultant from an accelerator suggests: "What can help the sector is not a new program; it is to continue and increase the university-industry collaboration. Ten years ago they were 2 parallel worlds. There are more partnerships in the health sector. It is starting in multimedia."

There are a dozen technology associations in Quebec and the cluster tries to coordinate events to bring business and other actors together. The cluster wants to develop the intelligent transport segment (roads and maritime). It wants to offer a technology window of opportunities to local suppliers in order to promote internationally and locally their products and services. The cluster also wants to reduce bureaucracy so that doing business becomes easier.

The Quebec video game sector has just created a new association, a Producers' Guild, to promote cooperation among small producers, to obtain bigger contracts, to develop local intellectual property, to improve human resources management by reducing dead times, to gain access to a larger pool of employees and reduce turnover.

In some sub-sectors such as mobile applications, technical competencies must be updated every two years. The ongoing battle of architecture in mobile has been won by Apple's iOS and Samsung's Android. However, the mobile sector is evolving very fast and the winners of today can have difficulties in the future. One only has to think about RIM (Blackberry), the Smartphone pioneer, or Nokia the former mobile phone leader.

Employees who specialise in technical skills associated with specific platforms must always learn new skills to remain competent. Some new subsectors require the updating of technical skills every two to three years, even every 6–8 months: mobile, virtual reality, augmented reality, computing languages, etc.

Many MM-IT firms that were interviewed are increasing individual and organisational competencies in order to become real learning organisations. Tirelli and Goh (2015) suggest that trust is an antecedent to organisational learning capability and can play an important role in becoming a learning organisation. For many MM-IT firms in our sample, human resource management policies such as empowerment, better worker well-being, telecommuting and better balance between work and personal life enable a better trust between managers and employees. Trust and organisational learning are also key components for a better organisational commitment, a lower turnover, and attraction of new workers.

5 Conclusions and recommendations

Many firms consider that overall, training organisations not only essential, but are rather effective in the Quebec MM-IT sector, thus confirming hypothesis 1, concerning the impact of training organisations. Firms are mainly satisfied with the generalist training their employees get from the academic or the private sector. Specialised competencies are harder to acquire and can be obtained at work or through self-learning via online courses such as Coursera, UdaCity or MOOC, from large US universities. More and more these types of training are accepted in firms and demonstrate an ongoing desire to learn and to be more competent at work. These courses are usually regularly updated with the new technologies; they can often be updated more quickly than academic courses and programs. Emerging online academies are creating more quality courses and are also getting some recognition from the job market.

The IT sector is the heart of the strategy for many other sectors. One only has to think about transport, Fintech, aerospace, etc. Few industries donot need IT. The competitiveness of the Quebec MM-IT sector resides in the productivity of its workers. Better training, more ongoing training initiatives, better recruitment, better IT programs, more diversity, and the hiring of foreign workers represent solutions to this key issue, according to our respondents, which confirms Hypotheses 2, 3, and 4 presented above concerning the importance of educational institutions, support organisations, diversity and foreign talent.

Montreal offers a creative and multicultural environment and this appears to be an important dimension for innovation. The strong French and Anglo cultures represent a bridge between Europe and the USA. Montreal has a unique brand that is attracting many international talents in sub-sectors such as independent music or film animation, sectors which can connect to MM. Many foreign MM-IT studios have established in Montreal, first for the tax credits, but now for the quality and breadth of the talent pool, although they now consider there are shortages of talent. The next phase is the growth of the MM-IT ecosystem with more local successes such as: Behaviour, GSOFT and Frima as emergent middle-sized firms and the growth of the new start-ups.

As all research has some limits, we conclude by mentioning these limits. Amongst the limits of the research is the fact that we could not interview all actors of the ecosystem, although 30 interviews do give us a good sense of the sector. In future research we would

like to develop a quantitative dimension to the research and also do some work on the difficult path of MM-IT start-ups toward becoming middle-size firms. Nevertheless, the analysis of the situation in Montreal and Quebec is a source of knowledge for other cities or regions that would want to develop and IT-MM industry, or even other sectors. Training, knowledge development and diversity appear to constitute essential sources for creativity and innovation.

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Notes

1 A CEGEP is a Quebec academic institution between high school and college.